Doug Sutherland
Commissioner of Public Lands

July 2004

To Interested Parties:

Washington's Department of Natural Resources is pleased to submit the attached Final Environmental Impact Statement for sustainable forest management of state trust lands in western Washington.

When we began this effort more than three years ago, we were committed to creating a direction that was balanced and sustainable. Working with foresters, biologists, scientists, beneficiaries, and the public, this Final Environmental Impact Statement will aid in a decision that will help keep Washington at the forefront of innovative forestry and ecosystem management.

This Final EIS compares six alternatives, including a Preferred Alternative, under consideration by the Board of Natural Resources. Each alternative includes a suite of policies and procedures relevant to management of forested trust lands and the determination of a sustainable harvest level. Key environmental issues include the impact of the alternatives on development of old forests, riparian areas, wildlife habitat, and public utilities and services. Each alternative attempts to achieve sustainable forest management in a different way; the Preferred Alternative takes an innovative approach to achieve that objective.

During the next decade, the Preferred Alternative examined in this Final EIS, if adopted, will provide a number of environmental, social, and economic benefits by:

- Using active stewardship to increase the amount of old forest habitat in state forests and the diversity of habitat types for all wildlife
- Generating hundreds of millions of dollars for construction of public schools
- Significantly improving the health of western Washington forests
- Improving the health of forest streams and improving habitat for salmon and other fish
- Providing needed funding to counties, universities, and other beneficiaries

I want to thank the many people who participated in this process. This is the first time an EIS will be used to help determine the sustainable harvest level, and after dozens of meetings with the public and stakeholders and hundreds of comments, I think the Preferred Alternative strikes a balance that addresses the wide range of comments we received. I also want to thank our independent, technical review committee. Their innovative thinking helped craft a solution that is scientifically rigorous and forward-looking.

Finally, I want to thank Washington State Lands Steward Bruce Mackey and his team, who put in many long hours to ensure this analysis was complete and thorough. In the years to come they will only become more proud of their good work as the plan they helped craft begins to provide revenue for schools, create healthy ecosystems, and provide benefits for all the people of Washington.

It is a legacy I know we will all be proud of.

Sincerely,

Doug Sutherland
Commissioner of Public Lands

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Fact Sheet

Title: Final Environmental Impact Statement on Alternatives for Sustainable Forest Management of State Trust Lands in Western Washington.

Description: The proposal is the adoption of new policies and procedures resulting in a sustainable harvest level for forested trust lands managed by the Washington State Department of Natural Resources in western Washington.

Project Proponent: Washington State Department of Natural Resources
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Implementation Date: July 2004

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Date Draft Environmental Impact Statement Issued: November 10, 2003

Comment Period: Comments on the Draft Environmental Impact Statement were received by December 19, 2003. Comments were submitted electronically on the DNR website at www.dnr.wa.gov, sent as e-mail attachments to the SEPA Center, sepacenter@wadnr.gov, or mailed to:

SEPA Center
Washington State Department of Natural Resources
P. O. Box 47015
Olympia, WA 98504-7015

Public Meetings/Hearings Conducted:

Lacey	December 2, 2003
Port Angeles	December 3, 2003
Mount Vernon	December 4, 2003
Vancouver	December 9, 2003
Aberdeen	December 10, 2003
Spokane	December 10, 2003
Des Moines	December 11, 2003

Date of Next Action and Subsequent Environmental Reviews:
Final Environmental Impact Statement Release Date – July 2004

Location of Supporting Documents:
This Final Environmental Impact Statement is available on the Internet at http://www.dnr.wa.gov. Select the "Sustainable Harvest for State Trust Forestlands" link. Copies of the Final Environmental Impact Statement are available to read at public libraries throughout the state of Washington. Requests for mailed printed copies and CDs containing the document should be directed to:

Washington State Department of Natural Resources
SEPA Center
P.O. Box 47015
Olympia, WA 98504-7015
Phone (360) 902-1634

The 1992 Forest Resource Plan, 1997 Habitat Conservation Plan, DNR Procedures, and Washington Forest Practices Rules, upon which the Sustainable Harvest Calculation Alternatives are based, are available for review at each of the five westside DNR Region offices in Washington, and at the SEPA Center, Department of Natural Resources, 1111 Washington St. SE, Olympia, Washington.

Cost/Availability:
Copies of the Final Environmental Impact Statement are available for downloading at no charge from the Internet address listed above. A limited number of print copies and computer CDs will also be available at no charge. After these are distributed, additional copies will be available for the cost of printing or CD production, per RCW 42.17. Requests can be sent to the above address.

Distribution List

This final environmental impact statement is published on the DNR Internet website at http://www.dnr.wa.gov. In addition, copies have been distributed to:

Washington State Board of Natural Resources
Doug Sutherland, Commissioner of Public Lands
Bob Nichols, designated representative to the Governor
Terry Bergeson, the State Superintendent of Public Instruction
R. James Cook, the Dean of the College of Agriculture, Washington State University
Bruce Bare, the Dean of the College of Forest Resources, University of Washington
Glen Huntingford, Jefferson County Commissioner

State Agencies
Departments of Ecology and Fish and Wildlife

Indian Tribes of Washington
Western Washington Tribal/Board Chairs for: Chehalis Confederated Tribes, Chinook Indian Tribe, Columbia River Intertribal Fisheries Commission, Confederated Tribes of the Colville Reservation, Cowlitz Indian Tribe, Duwamish Tribe, Hoh Indian Tribe, Jamestown S'Klallam Indian Tribe, Kalispel Tribe of Indians, Lower Elwha Klallam Tribe, Lummi Nation, Makah Tribe, Muckleshoot Tribe, Nisqually Tribe, Nooksack Tribe, Northwest Indian Fisheries Commission, Point No Point Treaty Council, Port Gamble S'Klallam Tribe, Puyallup Tribe, Quileute Tribe, Quinault Nation, Samish Indian Nation, Shoalwater Bay Tribe, Skagit System Cooperative, Skokomish Tribe, Snohomish Tribe, Snoqualmie Tribe, Squaxin Island Tribe, Steilacoom Indian Tribe, Stillaguamish Tribe, Sauk-Suiattle Tribe, Suquamish Tribe, Swinomish Tribe, Tulalip Tribes, Umatilla Confederated Tribes, Upper Columbia United Tribes, Upper Skagit Tribe, Yakama Nation

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Counties
Western Washington County Commissioners/Executives for: Clallam, Clark, Cowlitz, Grays Harbor, Island, Jefferson, King, Kitsap, Lewis, Mason, Pacific, Pierce, San Juan, Skagit, Skamania, Snohomish, Thurston, Wahkiakum and Whatcom Counties

General Public
All other individuals and groups on the Board of Natural Resources and Sustainable Harvest Calculation mail lists will receive official SEPA notification of the document's availability. The full document is available on the DNR website: http://www.dnr.wa.gov.

N A T U R A L R E S O U R C E S

FINAL

ENVIRONMENTAL
IMPACT
STATEMENT

on

ALTERNATIVES FOR SUSTAINABLE FOREST MANAGEMENT OF STATE TRUST LANDS IN WESTERN WASHINGTON

And for Determining the Sustainable Harvest Level

July 2004

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Olympia, Washington

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BACKGROUND

The Washington State Department of Natural Resources (DNR) is the trust manager for 1.4 million acres of forested trust land in western Washington. The Legislature is the trustee and has directed DNR to serve as trust manager. This Final Environmental Impact Statement (Final EIS) is central to an environmental evaluation of sustainable forestry policies for these forested trust lands.

The overwhelming majority of the lands included in the sustainable harvest calculation are held in trusts created by federal and state laws. Although the management of these trusts provides many benefits to all the people of Washington, DNR has a clear legal duty of undivided loyalty to each separate beneficiary. Providing financial support is one of several legal trust land management responsibilities. Money goes to the beneficiaries (public schools, counties, public universities, local junior taxing districts, and others), who have received more than $4.55 billion since 1970. In addition to trust obligations, DNR is subject to a number of federal and state statutes that protect public resources and provide public benefits. To fulfill these mandates, there are governing policies and procedures for management of forested trust lands. The Board of Natural Resources (Board) sets the major policies for forested trust lands. DNR develops administrative procedures (see Appendix C, Overview of Policies and Procedures) to effectively and efficiently implement Board-approved policies.

The sustainable forest analysis in the Final EIS presents policy choices to the Board in a set of Alternatives. All the Alternatives would also produce a certain level of timber harvest. The sustainable harvest analysis creates an understanding of the conservation benefits of the policy choices in each Alternative and the anticipated levels of sustainable timber harvest. A computer model is used in this analysis. The model was not specifically designed to provide information for an environmental analysis; however, the model outputs provide useful information that can illustrate expected impacts from the Alternatives. This environmental analysis uses both qualitative and quantitative information to assess potential environmental impacts. The analysis also relies on information generated during the State Environmental Policy Act (WAC 197-11) public involvement processes.

ENVIRONMENTAL IMPACT STATEMENT PROCESS

The sustainable forestry calculation is a “non-project action” under the State Environmental Policy Act. Non-project actions include the adoption of plans, policies, programs, or regulations that contain standards for controlling the use of the environment or regulating future actions. Site-specific analyses under guidance of the State Environmental Policy Act will occur for “projects” such as thinning, road construction, or other forest management activities that constitute a governmental action subject to the State Environmental Policy Act.

In this Final EIS, six Alternatives are examined for the management of 1.4 million acres of forested trust land in western Washington. The Alternatives represent a range of policy choices, and the Preferred Alternative represents the Board’s policy preference for how the forested trust lands are to be managed. As required by the State Environmental Policy Act, the Alternatives are examined using reasonably available information to assess their potential significant adverse environmental impacts.

This Final EIS examines six Alternatives to sustainable forest management on forest trust lands in western Washington. All of forested trust lands considered in this Final EIS are included in DNR's Habitat Conservation Plan (HCP). A Final EIS on DNR's HCP was published in 1997 and the Board adopted the HCP in 1997. All the anticipated effects of the proposed Alternatives in this Final EIS on sustainable forest management fall within the range of that HCP Final EIS.

The State Environmental Policy Act creates an open process to gather public input about governmental actions (e.g., sustainable forestry) before final decisions are made. The State Environmental Policy Act process includes a number of steps in which public input is gathered and considered for subsequent environmental analysis. The information-gathering process started with DNR issuing a Determination of Significance and Scoping Notice followed by public scoping meetings held early in 2002.

Purpose and Need

This proposal is to evaluate options for long-term sustainable forest management and to recalculate a sustainable harvest level for western Washington forested state trust lands. This is necessary because state law requires DNR to periodically adjust the acreages designated for inclusion in the sustained yield management program and calculate a sustainable harvest level. In other words, DNR is required to re-state how much timber will be harvested over the next decade (Revised Code of Washington (RCW) 79.10.320).

Specifically, the purposes of the proposal are:

1. To incorporate new information into a new model to re-calculate the decadal sustainable timber harvest level (for western Washington) under current DNR policy and federal and state laws.
2. To permit the Board to evaluate any policy changes after a number of policy Alternatives have been modeled and analyzed through an Environmental Impact Statement.

The next step was to identify Alternatives in a Draft EIS. The six Alternatives include a No-Action Alternative. The Board did not select a Preferred Alternative for the Draft EIS; the objective of this approach is to allow the public involvement process to provide additional information prior to selecting a Preferred Alternative. Following the release of the Draft EIS, the public input process included public meetings, an extension of the formal comment period beyond the legally required minimum, and workshops with the Board. All Board meetings were public, and were often televised.

Following the close of the comment period and the Board workshops, the Preferred Alternative was selected and is now being analyzed in this Final EIS. The selection process was based on:

- Public comments on the Draft EIS;
- Public comments offered at regular monthly Board meetings;
- Public comments on the selection of a Preferred Alternative;
- Additional analyses provided by DNR staff at Board request; and
- The Draft EIS analysis.

The Board is to review the Final EIS and ultimately choose whether to accept the policy choices presented in the Preferred Alternative. These policy choices will form the direction for sustainable forestry for 1.4 million acres of forested trust land in western Washington. Policy changes will be implemented through the Board's adoption of a Preferred Alternative. Concurrently, with the Board's adoption of a Preferred Alternative, DNR's administrative procedures and tasks will be adjusted to reflect the choices made in the approved Final EIS Preferred Alternative.

Development of the Alternatives

At the January 2002 Board of Natural Resources meeting, prior to the release of the Determination of Significance and Public Scoping Notice according to the State Environmental Policy Act, the Board set the sideboards for the evaluation of policy Alternatives. The Board specified that Alternatives and components of Alternatives were to meet the DNR's legal and policy mandates (including federal and state laws), the Trust Mandate, and the objectives of the Habitat Conservation Plan. Alternatives that did not meet one or more of these objectives, or the purpose and need of the proposal, were not evaluated. These sideboards are consistent with the requirements of the State Environmental Policy Act.

The design of the six Alternatives was based on information collected from the public during the scoping period, discussions with the Board, and discussions with a Technical Review Committee (see Appendix B for list of members). Information was also used from the preliminary computer models and associated results presented to the public (July 2002) and the Board (August 2002).

The final set of six Alternatives reflect current management (Alternative 1), the 1997 Habitat Conservation Plan intent (Alternative 2), and four additional Alternatives that meet the Board's purpose. The intent of the six Alternatives was to examine a broad range of policy expectations that demonstrate passive, active, and innovative approaches to forest management. The six Alternatives, not including a Preferred Alternative, were analyzed in the Draft EIS that was released on November 10, 2003.

Development of the Preferred Alternative

The Board used public comments, staff reports, model information, and Board-generated criteria in addition to the Draft EIS to select a Preferred Alternative. The Preferred Alternative is now being reviewed along with the other five Alternatives in this Final EIS.

There are three primary ways the Board received public input: 1) from direct testimony to the Board, 2) from written material submitted directly to the Board, and 3) from the Draft EIS comments. The Board typically hears public testimony on subjects of interest to the public at every monthly Board meeting. As the Draft EIS was being developed and subsequent to its publication, the Board heard testimony at its regular monthly meetings from citizens, interest groups, and professionals regarding the development of a Preferred Alternative. The comments received during the Draft EIS comment period came from 700 groups and individuals, and included 4,500 individual comment statements. The comments are summarized and addressed in this Final EIS (see Appendix G).

Staff reports in addition to the Draft EIS included technical reports and Board presentations (available on the Web at http://www.dnr.wa.gov). Technical reports were presented regarding the social dimension of the Board decision process that included Public Opinion Research, a report on Socioeconomic Resiliency (Daniels 2004), and a statewide opinion poll.

Staff reports also incorporated computer model results that characterized the results of the various Alternatives in terms of projected volume flows, changes in forest inventory level, changes in habitat (characterized as forest structure), and net and gross cash flows. Forest structure includes the number and size of live trees, standing dead trees (snags) and down woody debris. Describing a forest in terms of its structural conditions allows for an improved description of a forest's ecological condition because forest stand structure is related to ecological functioning. The stages used in this analysis are adapted from three principal sources: Brown (1985), Carey et al. (1996), and Johnson and O'Neil (2001). Forest structure analysis focused on several items of public concern, among them were;

- Forest Health – Changes to relative forest stand density as an indicator of stand vigor and fire risk as it relates to harvest intensity.
- Old Forest – Acres of forest with old forest stand structure characteristics.

Concurrently and on an ongoing basis, DNR worked with the Technical Review Committee (see Appendix B), seeking its help to independently evaluate core assumptions used within the computer simulations.

After the release of the Draft EIS, the Board defined their decision criteria and created a table with important criteria in columns and key policy questions in rows. This table or matrix aided the Board's discussions. DNR staff helped the Board complete the matrix by using computer runs and reports to fill in the needed information. The information was qualitative in nature and was developed over time in collaboration between DNR staff and the Board (see Section 2.4.1.2 and Appendix F).

The Board refined their key outcomes and developed policy direction and principles to direct the development of a Preferred Alternative. The policy direction was titled "Sustainable Harvest Calculation Management Principles and Objectives" (Principles and

[1] Available on the Web at http://www.dnr.wa.gov/htdocs/fr/sales/sustainharvest/sustainharvest.html

Objectives), and was ultimately attached to Board Resolution 1110 that described the Preferred Alternative (see Appendix B). The Principles and Objectives included two significant core outcomes that would ultimately be incorporated into the Preferred Alternative:

1. Active forest management on an increased on-base acreage; and
2. Broader economic, conservation, and other public benefits consistent with fiduciary responsibilities.

On February 3, 2004, DNR staff used the Board's direction contained in its Principles and Objectives and the Board's discussion of the decision matrix to create the Preferred Alternative. This Alternative appeared to meet the Board's policy criteria. Implementation considerations were discussed and an economic analysis of the potential Preferred Alternative was presented on February 17, 2004. After further deliberation, the Board voted unanimously on the components of the Preferred Alternative and incorporated its elements in Resolution 1110. This resolution directs DNR to prepare a Final EIS using the Preferred Alternative, and incorporated by reference the Principles and Objectives.

Changes that Appear in the Final EIS

There are changes and additional analysis in the Final EIS that resulted primarily from a review of comments received during the Draft EIS process. Additional analysis was completed in a number of areas; they include additional analysis regarding northern spotted owl population changes, roads, public utilities and services and cumulative effects. The discussion of these topic areas is contained in Sections 4.4, 4.6, 4.11, and 4.15, respectively. Three changes incorporated in the Final EIS are described below. They are:

- Changes related to the Preferred Alternative,
- Changes to the computer model volume calculations for Alternatives 5 and the Preferred Alternative, and
- Adjustment of the forest structure models.

Draft EIS Alternative 6 Formed the Basis for the Preferred Alternative

The development of the Preferred Alternative by the Board of Natural Resources was based almost entirely on the policies and procedures of Alternative 6 as analyzed in the Draft EIS. The policy objectives of the Draft EIS Alternative 6 and the Preferred Alternative are very similar (see Appendix B, Section B.2), with the notable difference between the two Alternatives being the riparian management modeling assumptions.

As was noted in the Draft EIS, the riparian modeling assumptions of Alternative 6 did not clearly match the stated policy objectives, resulting in high levels of low-volume thinnings. The high levels of repeated-entry thinning activities raised numerous technical and policy questions by the Board, the Federal Services (National Oceanic and Atmospheric Administration Fisheries and U.S. Fish and Wildlife Service), and other key stakeholders, such as the Washington State Department of Fish and Wildlife.

In response to public comments and based on the Board's direction during the development of the Preferred Alternative, modeling assumptions were updated to reflect the Board's interest in implementing a biodiversity pathways approach across as much of the land base as possible, and implementing a more moderate level of riparian restoration activities. These considerations described the evolution of the Draft EIS Alternative 6 into the Preferred Alternative in this Final EIS.

Modeling Updates

Since the distribution of the Draft modeling results on June 25, 2003 and the Draft Environmental Impact Statement (Draft EIS) in November 2003, DNR has made a series of updates to the modeling process. These updates were made in part as a response to comments made by DNR region field staff and by public comments on the Draft EIS. Two areas of the modeling were updated: 1) the estimates of saleable timber volume (in Scribner board feet), and 2) the stand development stage modeling.

The update to the estimates of saleable volume, particularly for the value-based Alternatives (Alternative 5 and the Preferred Alternative; see Appendix B for Technical Notes) was in response to concerns from DNR field staff that the estimated yields were too high. Reviews of the modeling processes and estimates led to changes in how DNR estimated the growth and yield and inventory characteristics of existing older forest stands. These updates to the growth and yield aspects of the value-based models, detailed in Appendix B, resulted in the need to review the logic of the stand development stage modeling.

In addition, public comments on the Draft EIS and from the technical review committee suggested that the stand development stage modeling reported in the Draft EIS accelerated stands too quickly through the development stages. This trend was particularly noted for forest stands on a natural, no-management pathway. The stand development stage classification system was reviewed and changes were made to the system to reflect a more realistic prediction of stand development under a no-management scenario. The details of the changes are in Appendix B. These changes were incorporated into the modeling of the Alternatives presented in this Final EIS.

Modeling Uncertainty

Forest management models provide a useful way to generate information that compares Alternative management strategies for decision-making. For complex and interrelated problems, such as policy development related to the management of forests, models provide a tool by which decision-makers can explore and discover their choices. Models do not supply definitive answers; rather, they provide information useful for developing policy and implementation plans.

Models have a number of uncertainties, which often are a product of the necessity to simplify reality. Three general areas of modeling uncertainty are recognized with regard to the estimates of: 1) saleable timber volume (Scribner board feet), 2) the available harvestable area, and 3) the change in forest conditions from one stand development stage to another. Uncertainties are managed in the modeling process by making assumptions. Modeling assumptions are developed based on the level of risk associated with a modeling output. When the information is important to decision-makers, the level of risk is higher and more attention is paid to the associated assumptions related to the outputs. However, while more development about the assumptions may occur, the primary purpose of the model is still exploration and discovery of management options.

Implementation Considerations for the Preferred Alternative

The Alternatives identified the potential of the forested trust lands to produce financial, ecological, and social benefits. To achieve the potential of any of the Alternatives, there are a number of operational and administrative considerations. For example, Alternatives that demonstrate higher timber harvest levels than today, such as the Preferred Alternative, will require additional foresters and specialists to successfully implement the Alternative. Therefore, the ability to hire, train, and pay for these extra staffing needs and other operational considerations is part of the implementation of an Alternative.

Recognizing that a transition period would likely be needed to reach a higher harvest level, the Board of Natural Resources directed the DNR to "present an analysis….that identifies hiring, implementation timelines and cash flow necessary to transition to the Preferred Alternative management practices and associated harvest levels. The Department is directed to prepare a Preferred Alternative that shall meet an average annual harvest target of 636 million board feet as soon as possible" (Board of Natural Resources Resolution 1110). This unanimously voted resolution also directed DNR to start the Final Environmental Impact Statement (Final EIS).

The Final EIS analyzes environmental impacts of a first decadal harvest of 6,360 million board feet for the Preferred Alternative. The transition schedule presented to the Board shows a total of 5,900 million board feet, with a mean annual first decadal level of 590 million board feet per year.

Executive Summary

ENVIRONMENTAL IMPACT STATEMENT ALTERNATIVES

The following Alternatives represent sustainable forest management in various forms. Each Alternative provides a different mix of benefits and impacts while still meeting the Board's specified sideboards. A table of the policies, procedures, and tasks that are referenced here can be found in Appendix C, Table 2.6-1.

Alternative 1 – No Action (Current Operations)

Alternative 1 represents the Board's existing policies and DNR's forest management strategies as indicated by the DNR Forest Resource Plan, 1997 Habitat Conservation Plan, DNR procedures and tasks, current DNR operations, and all current federal and state statutes. This Alternative represents an estimate of continued management of forested trust lands with current management strategies. Under this Alternative, projecting the status quo into the future represents uncertainties, such as how DNR would manage riparian areas or marbled murrelet habitat in the future. Therefore, in the case of riparian areas and marbled murrelet habitat, current strategies of deferral are projected indefinitely.

Alternative 2 – Habitat Conservation Plan Intent

Alternative 2 represents existing Board-approved policies and forest management strategies as defined by the DNR Forest Resource Plan, 1997 Habitat Conservation Plan, and current federal and state statutes. It does not include those interim DNR procedures and tasks from Alternative 1 that have not been approved by the Board. Management under this Alternative would implement the Habitat Conservation Plan as originally negotiated with the Federal Services in 1997.

Alternative 3 – Combined Ownerships

Alternative 3 represents existing Board-approved policies (except Policy No. 6 on Trust Ownership Groups), forest management strategies defined in the DNR Forest Resource Plan, the 1997 Habitat Conservation Plan, and current federal and state statutes. "Combined Ownerships" refers to a change in Forest Resource Plan Policy No. 6 that defines how to group the forested trust lands when applying the even-flow requirement in Policy No. 4.

Alternative 4 – Passive Management Approach

Alternative 4 represents managing forested trust lands in western Washington with passive management approaches to provide increased conservation and habitat protection while producing revenue. This approach maintains the 1997 Habitat Conservation Plan objectives, the DNR Forest Resource Plan, and current federal and state statutes. "Passive management" refers to a land management approach that allows forest growth and structural development processes to occur with little silvicultural (cultivation of trees species) activity.

Alternative 5 – Intensive Management Approach

Alternative 5 represents managing forested trust lands in western Washington with emphasis on revenue production on lands that are not dedicated to habitat conservation. It maintains 1997 Habitat Conservation Plan objectives and strategies, Forest Resource Plan (with exception of proposed changes) guidelines, and meets current federal and state statutes. “Intensive or active management” refers to a land management approach that accelerates forest growth and structural development processes through greater use of silvicultural activities.

Preferred Alternative – Innovative Silvicultural Management

The Preferred Alternative represents managing forested trust lands in western Washington using a mix of “innovative silvicultural management” techniques in habitat areas and current silviculture techniques in lands that are not focused on habitat conservation. This approach attempts to integrate habitat and revenue generation objectives while maintaining the current Habitat Conservation Plan approach, adhering to the Forest Resource Plan policies, and meeting current federal and state statutes. The Preferred Alternative incorporates increased silvicultural activity designed to accelerate forest growth and structural development processes.

Features that Vary Among Alternatives

The six Alternatives feature changes to policies, procedures, and implementation strategies, which are summarized below, and are also presented in table form in Chapter 2 (Table 2.6-1).

Ownership Groups

Currently there are 24 ownership groups. This current organization is retained in Alternatives 1 (No Action), 2, and 4. Two variations of current policy are proposed in Alternatives 3, 5, and the Preferred Alternative. In Alternative 3, all western Washington forested state trust lands are placed into one ownership group. In Alternatives 5 and the Preferred Alternative, the federal grant lands and Forest Board purchase lands (currently five ownership groups) are placed into one ownership group. This reduces the overall number of groups from the current 24 to 20. The change to ownership groups proposed in Alternatives 3, 5, and the Preferred Alternative would require a change to Forest Resource Plan Policy No. 6.

Timber Harvest Levels

Sustainable harvest can be scheduled and reported by several means, including volume, acreage, and economic value. Current Board of Natural Resources policy uses timber volume to report and schedule harvest. Alternatives 1 through 4 incorporate current policy, regulating harvest by volume. Alternatives 5 and the Preferred Alternative schedule harvest by economic value, requiring a change to Forest Resource Plan Policy No. 5. Harvest levels continue to be reported by volume under Alternative 5 and the Preferred Alternative, but the selection of stands for harvest will reflect their financial characteristics in order to optimize their economic value. Projected harvest levels for the first decade (2004-2013) are presented in Table ES-1.

Sustainable Even-Flow Timber Harvest

Timber harvest "even-flow" ensures that about the same amount of timber is available now and for future generations in perpetuity. Basically, "sustained yield" means that harvest (yield) does not exceed productivity (growth).

Alternatives 1 and 4 propose no change to the current implementation of Forest Resource Plan Policy No. 4. As such, even-flow is managed as a narrow band of variation, allowing the harvest level to vary by as much as 25 percent above and below the long-term harvest level.

Alternative 2 proposes a "relative" non-declining even-flow approach (this is similar to how the 1996 DNR sustainable harvest calculation examined allowable cut levels by ownership group). In this Alternative, timber harvests are allowed to increase over time, but declining harvest levels are avoided. The resultant harvest flow variation should therefore be less than Alternative 1.

Table ES-1. Summary of Projected Harvest Levels in Millions of Board Feet Per Year for First Decade (2004-2013) by State Trust, by Alternative

	Sustainable Forest Management Alternatives					
	1	**2**	**3**	**4**	**5**	**PA**
Trusts	**First Decade Values in Millions of Board Feet per Year**					
Agricultural School	9	9	8	12	11	17
Capitol Grant	34	40	47	29	58	58
Charitable/Educational/Penal and Reformatory Institution	14	15	17	12	16	19
Community College Forest Reserve	113	174	180	119	202	197
Common School and Indemnity	1	0.9	0.3	1	0.5	1
Escheat	2	1.7	2	1	1	1
State Forest Board Purchase	6	12	11	7	13	9
State Forest Board Transfer	23	22	28	23	27	32
Normal School	33	37	60	36	45	42
Scientific School	159	212	299	167	260	248
University - Original	1	0.4	1	1	1	1
University - Transferred	1	12	9	3	13	12
Total	**396**	**537**	**663**	**411**	**648**	**636**

Alternative 3 expands the allowable variation in harvest level, controlling harvest fluctuation level as a wider band with no cessation or prolonged curtailment of harvest (formerly per RCW 79.68.030, re-codified at Laws of 2003, Ch. 334, sec. 555(3)). In this Alternative, there is little control on the harvest flow and therefore the variation in harvest levels between decades is likely to be greater than Alternative 1.

Alternatives 5 and the Preferred Alternative propose that timber harvest flows will not vary from a previous decade by more than approximately +/-25 percent. This approach uses the flow constraint approach from the University of Washington model (Bare et al. 1997).

Alternatives 2, 3, 5, and the Preferred Alternative would require a change to Forest Resource Plan Policy No. 4, the even-flow policy. If the Board selected a Preferred Alternative that schedules harvest level by value instead of volume, then Forest Resource Plan Policy No. 5, to schedule harvest by volume, would need to be amended accordingly.

Alternatives 2 to the Preferred Alternative would require revisions to Forest Resource Plan Policy No. 4 and DNR Procedure 14-001-010 (Determining Harvest Levels and Completing the Five-Year Action and Development Plan) and Forestry Handbook Task 14-001-020 (Developing the Draft Five-Year Action and Development Plan).

Silviculture

Silviculture is the art and science of cultivating forests to achieve objectives. The DNR uses a site-by-site approach for evaluating and implementing silvicultural treatments, based on site specific, rotational, or long term efficiency analysis return on investment, variable biological conditions, and social and physical limitations. Site-specific silvicultural prescriptions include activities such as site preparation, planting specific tree species at specified densities, fertilization, weeding of non-desirable species, and the harvesting of trees.

The principal silvicultural tool for altering the development pathway of a forest stand is a thinning. Thinnings are the cutting of live trees with the objective of leaving a specific numbers and types of trees that will lead towards a specific forest stand objective. DNR recognizes two broad categories of thinnings harvests based on forest stand objectives, although there are many variation between these two categories. One category is traditional or conventional commercial thinning, where trees are harvested for sale. These thinning usually results in about 70 percent of the initial stand remaining after harvest. The primary objective of this type of thinning is generally to produce a certain size timber product by the end of the rotation.

The other category of thinning activities relates to habitat restoration and revenue generation. Carey et al. (1996) coined the phased “biodiversity pathways” for the management of forest stands (and forested landscapes) to achieve objectives of conserving biodiversity and generating revenue through the application of silviculture that “accelerates” the development of structurally complex stands.

Thinning forest stands in a way that encourages diverse development of the residual forest stand, i.e., the development of vertical and horizontal diversity of tree sizes, is achieved through techniques such as variable density thinning, where the stand is thinned to different residual tree densities. Heavy thinning treatments can typically result in less than 50 percent of the initial stand remaining after harvest. Also, some dominant trees are removed from the upper canopy to create sufficient space and gaps for the development of smaller trees (Carey et al. 1999). Without such thinning treatments in dense competitive exclusion stands, the density of dominant trees will not allow for the development of understory trees within the stand. Normally, these variable density thinning treatments, both heavy and light, harvest across the diameter classes. For these reasons, variable density thinning is not necessarily inferior economically to traditional thinning.

The principles of the biodiversity pathways approach to silvicultural treatment (based on Carey et al., 1996, page 23) are to:

1. Retain large-tree legacies (snags, large live tress and their epiphytes) and conservation of soil organic matter, seed banks, coarse woody debris, and understory vegetation at harvest;
2. Minimize site preparation, but under-plant widely spaced, site-appropriate coniferous species to supplement natural regeneration of tree and shrub species;
3. Modify thinnings to retain patches and open up the forest canopy to encourage the development of a diverse and patchy understory that mimics that in old forests; and
4. Directly improve habitat quality by creating cavity trees and adding coarse woody debris in the form of felled trees.

Typically, a regeneration harvest will occur at the time when landscape and stand objectives are met, i.e., revenue generation and/or structurally complex forest restoration. A regeneration harvest is the end-of-the-rotation treatment before the stand is re-planted or re-established through natural regeneration.

Silviculture in the Alternatives

Alternatives 1, 2, and 3 reflect traditional even-age silviculture that DNR practices currently. Planting densities are typically 300 to 400 trees per acre, but are tailored to site-specific conditions, species, and stand objective needs. Vegetation management and pre-commercial thinning are applied to stands, although economic objectives determine the intensity and frequency of these treatments. Fertilization and pruning techniques are limited. Commercial thinning harvests are normally from below and result in a residual (post harvest) stand that retains 70 percent of the initial pre-harvested stand. The minimum regeneration harvest age or the earliest age that a stand is considered eligible for regeneration harvest is determined by balancing tree volume growth and economic potential, as well as site conditions, species, and stand objectives. For example, a Douglas-fir stand on site class III ground (average quality) has a maturity criterion modeled at 60 years. At regeneration harvest, a minimum of eight live trees per acre is left in the residual stand.

Silviculture in Alternative 4 is very similar to Alternatives 1, 2, and 3; however, the maturity criteria are lengthened. This has the effect of extending the rotation length of managed stands, whereby the stand may approach its culmination of growth (the end of the period of rapid growth). As an example, in Alternative 4, a Douglas-fir stand on site class III ground has a minimum regeneration harvest age of 80 years. At regeneration harvest, a minimum of eight live trees per acre is left in the residual stand.

In Alternative 5, the silviculture is more intensive. Planting densities are in the 300 to 400 tree per acre range with selected planting stock. Vegetation management and pre-commercial thinnings are applied and fertilization is used on selected sites. Stands are scheduled for regeneration harvest based on economic value and the maturity criteria are determined by the economic potential of stand growth. In this Alternative, the emphasis is on harvesting stands of trees when they have reached their maximum discounted economic value, expressed as net present value. As an example, in Alternative 5, a Douglas-fir stand on site class III ground has a minimum regeneration harvest age of 50 years. At regeneration harvest, a minimum of eight live trees per acre is left in the residual stand.

In the Preferred Alternative, the silviculture is a mix of current DNR silvicultural practices, more intensive silviculture and silvicultural approaches based on biodiversity pathways (Carey et al. 1996). For this Alternative, silviculture on forested trust Uplands with General Objectives reflects a mix of current DNR silvicultural practices (as in Alternative 1, 2, and 3) and more intensive approaches (as in Alternative 5). Commercial cohorts of trees (these are a group of trees of similar characteristics, such as age or size that exist in a stand) are typically managed with even-age silvicultural regimes. Planting densities typically range between 300 and 400 trees per acre, but maybe more or less as determined by the optimal pathway to achieve the objectives. Stands are also treated for vegetation management and pre-commercial thinning, as necessary. The maturity criteria are flexible and are determined by the landscape and stands objectives. Economic value of the growth potential of the stand is an important consideration; however, other aspects and conditions such as social and environmental factors will play a role in determining the stand's regeneration age. At regeneration harvest, a minimum of eight live trees per acre is left in the residual stand.

For the Preferred Alternative, silviculture in the Uplands with Specific Objectives, and Riparian and Wetland Areas is a mixture of current DNR silviculture (as in Alternatives 1, 2, and 3) and silviculture based on biodiversity pathways principles. Current DNR silviculture is assumed to be applied to hardwood-dominated stands, while biodiversity pathways silviculture is applied to conifer-dominated stands.

All of the Action Alternatives would require changes to Forest Resource Plan Policy No. 4, and to DNR Procedure 14-005-020 (Identifying and Prioritizing Stands for Regeneration Harvest).

Northern Spotted Owl Habitat Management

Northern spotted owl habitat requirements are addressed in DNR's Habitat Conservation Plan through the provision of Nesting, Roosting, and Foraging Management Areas and in Dispersal Management Areas. The primary contribution of forested trust lands to the owl conservation effort comes through the protection and/or development of suitable habitat in the designated Nesting, Roosting, and Foraging Management Areas, and Dispersal Management Areas that complement federal reserves. The recommendations of the Northern Spotted Owl Recovery Team (USDI 1992) and the Northern Spotted Owl Advisory Group (Hanson et al. 1993) were taken into consideration during the designation of the Nesting, Roosting, and Foraging Management Areas, and Dispersal Management Areas. These areas were established primarily within 4 miles of federal lands. The designation was intended to provide habitat that makes a significant contribution to demographic support, maintenance of species distribution, and facilitation of dispersal. Based on the analyses conducted for the Habitat Conservation Plan (HCP), potential negative effects to individual northern spotted owls outside those areas were not expected to result in significant adverse effects to recovery efforts for the spotted owl population in western Washington (DNR 1996). In the Biological Opinion for the Habitat Conservation Plan (USDI 1997), harvest in certain non-strategic northern spotted owl circles was permitted. This landscape-based management approach continues to be a valid strategy in the face of changing population statistics for many reasons (See Section 4.4). In general, the strategy is based on the concept that areas with larger continuous habitat patches that support clusters of 20 or more northern spotted owls, are considered to have greater likelihood of being self-sustaining (Thomas et al. 1990).

Interim strategies were established following the adoption of the Habitat Conservation Plan (HCP) to phase-in permitted activities in northern spotted owl circles. DNR committed to provide additional protection for 56 northern spotted owl circles identified by the U.S. Fish and Wildlife Service until 2007. DNR Procedure 14-004-120 also provided interim protection from harvesting of suitable habitat within all status 1-reproductive northern spotted owl circles and within four specific northern spotted owl circles in southwest Washington until 1996. (Further information on northern spotted owl circles can be found in Section 4.4 of this document.) In Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas, the HCP requires DNR to identify at least 50 percent of the DNR forested trust land area as the "threshold habitat target" within each Watershed Administrative Unit (WAU). However, the HCP allows harvests in watersheds designated for habitat that do not yet contain the 50 percent threshold if they do not impact the 50 percent of the WAU that is either presently nesting, roosting, foraging, or dispersal habitat, or that is closest to becoming nesting, roosting, foraging, or dispersal habitat.

The Alternatives differ with regard to how they treat the 50 percent habitat target. Some allow only habitat enhancement until the Nesting, Roosting, and Foraging Management Area or Dispersal Management Area has reached 50 percent habitat. Other Alternatives allow activity in the areas not designated for the 50 percent habitat. Additionally, the Alternatives vary with regard to when they allow the permitted activity to take place in the northern spotted owl circles. Table ES-2 summarizes the management in of northern spotted owl circles and Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas under in the Alternatives.

Table ES-2. Northern Spotted Owl Alternative Strategies for Habitat Conservation

Policy, Procedure, Task Reference	Forest Management Alternatives 1	2	3	4	5	Preferred Alternative
Nesting, roosting, foraging and dispersal PR 14-004-120	No regeneration harvest if under 50 % habitat	Regeneration harvest allowed if under 50% habitat, but not in 50% that is or is designated to become habitat.	Regeneration harvest allowed if under 50% habitat, but not in 50% that is or is designated to become habitat.	Regeneration harvest allowed if under 50% habitat, but not in 50% that is or is designated to become habitat.	Regeneration harvest allowed if under 50% habitat, but not in 50% that is or is designated to become habitat.	Regeneration harvest allowed if under 50% habitat, but not in 50% that is or is designated to become habitat. Uses habitat improvement technique.
Northern spotted owl circles PR 14-004-120	Restricts activity until indefinitely in USFW circles. Interim circle protections remain.	Restricts activity until 2007 in USFW circles.	Restricts activity until 2007 in USFW circles.	Restricts activity until 2007 in USFW circles.	Restricts activity until 2007 in USFW circles.	Restricts activity until 2007 in USFW circles.
		Interim Circle protections removed.	Interim Circle protections until 2007 except OESF	Interim Circle protections until 2007 except OESF	Interim Circle protections until 2007 except OESF	Interim Circle protections until 2007 except OESF
			SW Wash until 2006	SW Wash until 2006	SW Wash until 2006	SW Wash until 2006

Notes:
1/ Biodiversity management as described by Carey et al. 1996
OESF = Olympic Experimental State Forest
USFWS = U.S. Fish and Wildlife Service SW = Southwest

Old Forest Components

"Old forests," their definition, components, extent, and management are important issues in sustainable forestry management. Old forests are defined as a forest inventory unit with old growth structure.

Alternative 1 includes all provisions for old forest management in current operations, requiring no changes to policy or procedure.

Alternative 2 to the Preferred Alternative maintains two of the four basic components of current management—Old Growth Research Area deferrals as defined in Forest Resource Plan Policy No. 14, and the management for old forest conditions in the Olympic Experimental State Forest as defined in the Habitat Conservation Plan (page IV.88).

Alternative 2 to the Preferred Alternative does not maintain the “50/25” strategy (see Chapter 2, Section 2.6.3) and would require changes to Task 14-001-010 when the Board adopts one of these Alternatives. In addition, Alternatives 2 to the Preferred Alternative replace the required legacy and reserve tree level requirements in Procedure 14-006-090 with language implementing the protection of structurally unique trees and snags described in the Habitat Conservation Plan (pages IV.156-157). Under Alternatives 2 to the Preferred Alternative, this legacy and reserve tree procedure would change from the current procedure requiring retention of 7 percent of the trees in regeneration harvest units to the Habitat Conservation Plan (HCP) strategy of retaining a minimum of eight trees per acre.

Alternative 4 proposes to defer for the entire planning period all standing old forests with an age equal to or greater than 150 years in the 2001 forest inventory. This is an age-based criterion without structural considerations found in the HCP’s definition of old forests.

Rather than specifically preserving all forests of a certain age existing today, Alternatives 5 and the Preferred Alternative propose that 10 to 15 percent of each Westside HCP Planning Unit be targeted as old forests based on structural characteristics. In addition, the Preferred Alternative requires the DNR to use retention of existing old growth stands (as defined in the HCP) as a priority in achieving these targets.

Adoption of these features by the Board would require changing Forest Resource Plan Policy Nos. 3 and 14.

Riparian and Wetland Areas

The Riparian and Wetland Management Zone strategies in the Alternatives are based on the management objectives described in the Habitat Conservation Plan (HCP). The Board of Natural Resources and DNR are not deliberating a decision with regard to riparian management as part of this sustainable harvest calculation. Parallel with this analysis, the DNR and the Federal Services are undertaking development of a riparian strategy. However, this riparian strategy has not been completed. The analysis included within this sustainable harvest calculation, therefore, examines the effects of a reasonable set of estimates of future procedures that meet the HCP riparian management objectives. Frequency and intensity of management within these zones vary among the Alternatives.

None of the Alternatives proposes changes to the plan’s Riparian Management Zone designations or basic guidelines for management within those zones under the HCP. No changes are proposed for Wetland Management Zones in any of the Alternatives.

Currently, no harvest activities are conducted within designated Riparian Management Zones, except road and yarding corridor crossings. Activities are allowed within the Wetland Management Zones as identified in Procedure 14-004-110. These guidelines are assumed unchanged in Alternatives 1 and 4.

Alternatives 2, 3, 5, and the Preferred Alternative instead provide a range of restoration and silvicultural activities that may be considered under the final riparian procedure. Riparian ecosystem restoration encompasses a range of activities that must be site-specific and tailored to the physical and biological conditions at a particular site.

As defined in the HCP (page IV.62), disturbance of areas of potential slope instability, including those within riparian areas and wetlands, is restricted to light access development and maintenance (road and yarding corridors).

In Alternatives 2 and 3, restoration and silvicultural activities are assumed to occur at a moderate intensity, that is to say, less than 1 percent per year of the total Riparian and Wetland Area may have a silvicultural treatment. Most of these treatments are assumed to be traditional thinnings (see Chapter 2, Silviculture) within the outer Riparian Management Zones. The outer zones are the minimal-harvest zone and the low-harvest zone (HCP, page IV.70). These light thinnings normally retain at least 70 percent of a forest stand after thinning.

In Alternative 5, restoration and silvicultural activities are allowed at moderate intensity where less than 1 percent per year of the Riparian and Wetland Area may be treated with a restoration activity. Alternative 5 assumes similar thinning treatment to Alternatives 2 and 3.

The Preferred Alternative assumes that the restoration treatments in the outer Riparian Management Zones will be a combination of traditional thinnings, patch cuts of ½ to 2 acres in size, and biodiversity pathway approaches. Unlike the Draft EIS Alternative 6, where the restoration treatments could be characterized as extensive, the Preferred Alternative treats fewer acres per year: less than 1 percent per year of the total Riparian and Wetland Area. The change from the Draft EIS Alternative 6 to the Preferred Alternative was in response to the Board’s direction and public comments.

Summary of Environmental Consequences

This section summarizes the environmental analysis detailed in Chapter 4 of the Final Environmental Impact Statement (EIS), which examines the effects of proposed changes to the current policy and procedures, under each Alternative. Conclusions are based on reasonably available data and generally qualitative analyses, supported by quantitative data where available and appropriate. Computer model outputs provide useful information that illustrate expected impacts of the Alternatives. The Forest Resource Plan and the Habitat Conservation Plan (HCP) Environmental Impact Statements provide useful benchmarks for evaluating the effects of the 2003 sustainable harvest calculation level.

Potential relative risks are identified and discussed for the resource areas and are used to rank the Alternatives. The potential relative risks and rankings express the potential for environmental impacts to occur.

None of the Alternatives would result in any probable significant adverse impacts to any of the resource areas, relative to current conditions, beyond those anticipated in the HCP. A relatively high risk does not necessarily equate to a probable significant adverse impact when compared to another Alternative or to existing conditions.

Forest Structure

This section analyzes the environmental effects on forest structure, old forests, forest health, carbon sequestration, and threatened and endangered plant species. The analysis examines the current and proposed changes to policy and procedures under the different Alternatives. This analysis also assesses relative risks among Alternatives that are illustrated using modeling outputs.

Alternatives 1 and 4 would provide more old forest and would entail less risk of adversely affecting threatened, endangered, and sensitive plant species than the other Alternatives. However, Alternatives 1 and 4 would result in more dense forest stands that achieve lower individual tree growth rates and are more susceptible to damage from insects and disease. Alternative 2 and the Preferred Alternative are ranked intermediate in terms of their overall relative risk of causing negative environmental impacts. The Preferred Alternative has a higher risk associated with it over the short-term but in the long-term ranks highest in the development of structurally complex forest stands. Both the Preferred Alternative and Alternative 2 would require an intermediate level of investment for successfully implementing their management strategies and achieving the projected level of harvest.

Alternatives 3 and 5 would have fewer policy limitations for stand management and timber harvest and would apply more intensive management strategies than the other Alternatives. Management proposed under Alternatives 3 and 5 would result in more harvest area and forests that are less susceptible to insect and disease damage.

Alternative 5 and the Preferred Alternative would entail more relative risk of adversely affecting threatened, endangered, and sensitive species of plants due to more harvest and harvest-related disturbance.

Riparian

The distribution of stand development stages within Riparian Areas suggests that, compared to historic unmanaged stands, many moderate to large streams on western Washington forested state trust lands may have reduced levels of multiple riparian functions because of decreased levels of large, fully functioning stands. Riparian areas for smaller streams may have adequate shade and size for potential instream large woody debris, but may be deficient in decadent features and other riparian functions important to wildlife and other riparian-dependent species. Many riparian areas currently contain moderate to high levels of early stand development stages, and are not likely to change in the near future. Thinning can reduce the time necessary to produce very large trees and reduce the time needed to increase stand complexity.

Removing trees within the Riparian Management Zone may temporarily reduce the level of some riparian functions, but the extent of the reduction depends on where trees are removed, site-specific conditions, the amount of trees removed, and the particular riparian function being considered (Washington Forest Practices Board 2001). Such near-term impacts would have to be considered against the potential to accelerate functional recovery. The degree to which moderate intensity timber management would affect near-term riparian function is uncertain. However, active forest management can change species and stand composition and accelerate the development of more complex stand structures (Carey et al. 1996). Such events would help to restore long-term riparian functioning but may have some short-term adverse effects.

Each Alternative proposes different levels of harvest activities in Riparian Areas (Table 4.3-2). During the remaining period of the Habitat Conservation Plan, Alternatives with lower levels of activity, such as Alternatives 1, 2, 3, and 4, are expected to have a higher proportion of Riparian Area with large and very large trees that are in competitive exclusion stages. In contrast, Alternatives with higher levels of active management, such as the Preferred Alternative, are expected to have more Riparian Area that will be fully functioning, or be on a trajectory towards full function. (Descriptions of these stand development stages are provided in Appendix B, Section B.2.3.) Regardless, riparian conditions are expected to improve under all Alternatives relative to current conditions. This is due to changes in stand structure, particularly increases in the amount of stand development stages that include large and very large trees, which are in moderate supply throughout much of the forested trust lands (see Figure 4.3-2). The rate of improvement in structurally complex forests overall is similar among most Alternatives, though the Preferred Alternative performs better through 2067. When looking at the two most complex stages of niche diversification and fully functional forests, the Preferred Alternative accounts for over 13 percent of Riparian Areas by 2067 compared to about 7 percent for Alternative 1.

Wildlife

None of the Alternatives, including the Preferred Alternative, propose changes to the northern spotted owl conservation strategy, as outlined in the Habitat Conservation Plan (HCP) on pages IV.1 to IV.19 and IV.86 to IV.106. The HCP Environmental Impact Statement (EIS) is incorporated by reference and relied on in this Final EIS. In addition, this Final EIS analyzes the Alternatives in light of the new information on northern spotted owl demography discussed in Section 4.4.3 of this document. The analysis also includes a comparison of the Alternatives using three criteria:

- changes in the amount of structurally complex forest ;
- the amount of timber harvest in areas designated as Nesting, Roosting, Foraging, and Dispersal Management Areas; and
- changes in the management of northern spotted owl circles.

Other policy and procedure changes under the Alternatives would influence the amount and distribution of wildlife habitat on forested trust lands. The Alternatives would vary in the timing and amount of forest structures they would create, but would not be expected to have any significant adverse environmental effects on wildlife.

The sustainable harvest calculation analysis uses the stand development stages to represent structural diversity and habitat values. (Descriptions of these stand development stages are provided in Appendix B, Section B.2.3.) Changes in the relative amount of forested habitat types are a product of varying rates and intensities of timber harvest under the different Alternatives. Appendix Table D-10 presents the modeled proportion of forested trust lands comprising ecosystem initiation, competitive exclusion, and structurally complex forests under each Alternative in the years 2013 (short-term) and 2067 (long-term). Competitive exclusion forests are the most common forest habitat type on forested trust lands, making up 68 percent of the total forested area (Table 4.4-1). Approximately 26 percent of this habitat type occurs in upland areas with general management objectives. Structurally complex forest makes up about 25 percent of the total area on forested trust lands (Table 4.4-1). In the short term and long term, the amount of structurally complex forest is modeled as increasing in all HCP Planning Units under all Alternatives

The structurally complex forests stages serve as a relative indicator of change in the amount of habitats of management concern. Several examples follow:

- Northern Spotted Owl - Throughout much of their range, northern spotted owls are strongly associated with forested areas that are classified as structurally complex in this Final EIS.
- Marbled Murrelet - The Marbled Murrelet Recovery Plan (USFWS 1997) identifies terrestrial (upland) habitat essential for marbled murrelet recovery. The Recovery Plan identifies additional areas on non-federal land where existing habitat should be protected because habitat in federal reserves is insufficient to reverse population declines and maintain a well-distributed population. In the state of Washington, such additional essential habitat occurs on state lands within 40 miles of marine waters. These areas are critical for improving the distribution of the population and suitable habitat, especially in southwestern Washington (USFWS 1997). Effects on forestlands within 40 miles of marine waters, therefore, are of particular concern in determining the effects of the Alternatives on marbled murrelet populations. Of the approximately 340,000 acres of structurally complex forest on western Washington forested state trust lands (Table 4.4-1), approximately 85 percent occur within 40 miles of marine waters (see Table D-16).
- Deer and Elk - The results from the Washington Forest Landscape Management Project (1996) indicated that the estimated carrying capacities for deer and elk are comparable when either timber production is maximized or when 30 percent of the watershed is maintained in a fully functional forest stage.

Forest in the competitive exclusion stages is currently the most abundant habitat type on forested trust lands. Under all Alternatives, the majority of timber harvest is expected to occur in this habitat type. Two processes would likely affect the amount of competitive exclusion forest: conversion to ecosystem initiation forest through high-volume timber harvest, and development into structurally complex forest through natural forest succession, as well as forest management activities such as thinning.

Model output data indicate that the amount of competitive exclusion forest on western Washington forested state trust lands would decline under all six Alternatives in both the short term and the long term (Figure 4.4-3). In the short term, results show very little difference in the amount of competitive exclusion forest among the Alternatives (Appendix D, Table D-10). Model outputs indicate that at the end of the planning period, by 2067, all Alternatives would reduce the amount of forestlands in competitive exclusion, ranging from 1 to 8 percent. Under Alternatives 1, 4, and 5, approximately 65 percent of forested trust lands would consist of competitive exclusion forest, while Alternatives 2, and 3 would result in about 64 percent. Under the Preferred Alternative, 60 percent of the forested trust lands would consist of competitive exclusion forest (Appendix D, Table D-10).

For the most part, decreases in the amount of competitive exclusion forest correspond to increases in the amount of structurally complex forest. This result suggests that many areas that currently sustain competitive exclusion forest would acquire the characteristics of structurally complex forest over time. The greatest long-term declines in competitive exclusion forest would likely occur under the Preferred Alternative, followed in descending order by Alternatives 1, 4, 5, 2, and 3. Declines in the amount of competitive exclusion forest would not be expected to result in any significant adverse effects to wildlife species overall. No wildlife species are found exclusively in competitive exclusion forests, and decreases in the amount of competitive exclusion forest would nearly be matched by increases in structurally complex forest.

Air Quality

None of the proposed Alternatives would create new policies or procedures related to air quality. Impacts related to air quality would result from the projected forest management activities associated with each of the Alternatives.

The Alternatives differ slightly in their effects to air quality, but none of the Alternatives has the potential for significant environmental impacts relative to current conditions, beyond those anticipated in the Habitat Conservation Plan Environmental Impact Statement. Air pollution from dust would be mitigated by dust abatement measures under all Alternatives, and the total amount of prescribed burning would likely continue to be below the level anticipated in the Habitat Conservation Plan.

Geomorphology, Soils, and Sediment

Significant increases in landslide frequency or severity and loss of soil productivity relative to current conditions, beyond those anticipated in the Habitat Conservation Plan (HCP) Environmental Impact Statement (EIS), are not anticipated under any of the Alternatives. Increased soil erosion may occur in certain intensely managed areas as road use increases. Further discussion of relative impacts among the HCP Planning Units and for individual watersheds is included in Cumulative Effects (Section 4.15). The Alternatives are ranked according to percent of uplands impacted per decade by intensity of harvest type (Table 4.6-8). By this ranking, Alternative 5 carries the highest potential overall relative impact, followed by Alternatives 2, 3, the Preferred Alternative, and 4 and 1.

The public comments requested that the Final EIS review the differences between Alternatives with regard to forest roads. Section 4.6 presents information relevant to road impacts. In general, it is not expected that the number of road miles or road density will vary as a result of the implementation of any of the proposed Alternatives. While the Final EIS Alternatives propose different harvest timings and locations, the basic road network statewide will evolve to the end condition, over time, virtually independent of which Alternative is chosen. Road spacing is mostly dependent on topography. Topography drives the type of logging system used to achieve the desired silvicultural objectives, which in turn dictates optimal yarding distance to road spacing combinations. This is illustrated by Table 4.6-3 (Chapter 4, Section 4.6), Road Density by Deferral Class under the Preferred Alternative in 2004. The table shows that there are small differences between road density in areas that would be deferred from harvest under the Preferred Alternative and the areas that would allow activity.

Road impacts for all the Alternatives should be well within the range anticipated by the HCP due to the relationship to the total acres harvested. As indicated in Table 4.6-4, harvest levels in each of activity types for each of the Alternatives are within those expected under the HCP and analyzed in the HCP Draft and Final EIS. The HCP Draft EIS (DNR 1996) analyzes effects related to sediment (p. 4-163) and stream flow (p. 4-170). Mitigation in the form of Riparian Management Zones, management for hydrologically mature forest in the significant rain-on-snow zones, wetland protection, and road management planning (identified above) are detailed in those sections.

The Washington Forest Practices Rules Final EIS (DNR 2001) also presents an analysis of the effects of sediment, peak flows, and roads in riparian areas and wetlands on water quality and on fish. A discussion of sediment is contained in Section 3.2 (p. 3-7), which discusses road surface erosion and road-related landslides. The evaluation of the Alternatives in this analysis offers the 2001 rules package that provides measures necessary to address impacts due to road-related sedimentation (p. 3-16). These mitigation measures include implementation of road maintenance and abandonment plans and the adaptive management program. In addition, Appendix F in the Final EIS for the Forest Practices Rules discusses the effects of road construction and maintenance and describes recommended and accepted practices for building and maintaining roads. It states that, "Roads built following Forest Practices Rules that provide specific direction and recommended Best Management Practices (BMPs) from the literature have the lowest risk of causing sediment delivery" (p. F-2). As stated above, all of the Alternatives will meet the requirements as specified in the Forest Practices Rules.

Hydrology

Procedure 14-004-060, which prohibits harvest of hydrologically mature forest in the rain-on-snow and snow zones where the mature forest type makes up less than 66 percent of these zones, would not change under any of the Alternatives. Consequently, significant changes in peak flows due to harvest activities would continue to be avoided under all of the Alternatives. The Habitat Conservation Plan Environmental Impact Statement (DNR 1997) provides more detailed analyses of the effectiveness of the measures laid out in Procedure 14-004-060 and other procedures in minimizing potential adverse effects to peak flows from harvest activities (see Sections 4.2.3, 4.4.2, and 4.8).

Water Quality

None of the Alternatives would increase the risk of water quality degradation in the long term. Existing procedures adequately protect water resources. Short-term, localized sedimentation may increase in some areas immediately following harvest, but the vegetation in the inner and no-harvest portion of the Riparian Management Zones would prevent most sediment from entering streams. Over the long term, improved riparian function would likely lead to improved water quality on forested trust lands.

In the short term, additional planning and implementation resources would be required to prevent sediment delivery to streams as a function of greater harvest in the Riparian Management Zones under Alternatives 2 and 3, and, to a greater extent, under Alternative 5 and the Preferred Alternative. However, in the long term, riparian function across the land base is expected to improve more rapidly under the Preferred Alternative than any other Alternative proposed, as discussed in Section 4.3 (Riparian).

Wetlands

DNR Forest Resource Plan Policy No. 21 states, "the Department will allow no overall net loss of naturally occurring wetland acreage and function." The procedure (PR 14-004-110 Wetland Management) governs harvest activities in and around wetlands and is not proposed to change under the Alternatives.

The approximate delineation method, an approved approach to determine wetland boundaries, primarily uses maps and aerial photographs. However, not all wetlands, particularly forested wetlands, are visible on aerial photographs. Also, the Habitat Conservation Plan and its Environmental Impact Statement acknowledge that wetlands less than 0.25 acre may be affected by forest management activities. Thus, the difference in environmental impacts to wetlands under the proposed Alternatives would be a function of the acreage to be harvested and the amount of related activities under each Alternative. Over all, Alternative 1 would result in the lowest level of disturbance (an average of 11 percent per decade), followed by the Preferred Alternative, Alternatives 4, 2, 3, and 5 (at 14, 15, 16, 17 percent, respectively). Alternative 5 would disturb the most acres, an average of 24 percent per decade, and would have the greatest affect on wetlands.

Fish

In general, the effects would be expected to follow those described in Section 4.3, Riparian Areas. Over the long term, all Alternatives would be expected to result in improved riparian and aquatic conditions for fish because of increased riparian function associated with continued growth or restoration of riparian stands. Larger and taller riparian tree stands with multiple canopy layers are expected to increase shade levels, functional in stream large woody debris, leaf and needle litter, and improvements to coarse and fine sediment input and hydrologic regimes. In part, this would result by recovery from current degraded conditions in many areas caused by practices prior to the Habitat Conservation Plan (HCP), rather than enhancement of natural conditions.

Relative to Alternative 1 and other Alternatives, the Preferred Alternative is expected to have more beneficial effects by increasing the rate at which riparian stands transition to structurally diverse, fully functioning stands. However, the Preferred Alternative also includes more intensive management of riparian areas for habitat enhancement. Under the Preferred Alternative, management activities would include a moderate level of infrequent, but heavy thinning activities designed to promote structural diversity in competitive exclusion stands that currently dominate in Riparian Areas. The current and proposed policies and procedures are designed to avoid, minimize, and mitigate for forest management practices on forested trust lands that have the potential to adversely effect the aquatic habitat features described below. On a relative basis, the slightly higher activity levels proposed under Alternative 5 and the Preferred Alternative suggest a slightly higher risk of adverse effects from forest management activities if mitigation measures are followed. Regardless of Alternative, the potential for adverse effects appear to be within levels anticipated under the HCP.

Public Utilities and Services

This analysis considers the potential effects of the Alternatives on harvest volumes. Volume directly affects revenue to the beneficiaries, and some beneficiaries partially fund public utilities and services with timber revenue. This section also considers the potential effects of the proposed Alternatives on transportation infrastructure. The analysis uses the modeling outputs to inform the public and decision-makers of the relative differences in potential environmental impacts. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

The Alternatives provide a wide array of direct economic benefits to the beneficiaries. In other words, the relationship between the Alternatives is not consistent across all beneficiaries. Projected annual average harvest levels are, for example, highest for Agricultural School Grant lands under Preferred Alternative, but highest for University Grant lands under Alternative 5. This variation is also evident for sate forestlands when projected harvest levels are viewed by county. Projected state forestland harvest levels are, for example, highest under Alternative 5 in Wahkiakum County, but highest under Alternative 3 in Skamania County. These modeling outputs do not provide precise harvest schedules, but they can represent a likely distribution of harvest levels over time at the county level. While they provide an indication of the possible distribution of harvest by county, it is difficult to predict what effect this variation would have on the built environment.

Potential effects on transportation infrastructure would vary by Alternative, with larger projected harvest volumes resulting in increased logging truck traffic. Alternatives with larger projected harvest volumes would, however, also result in more revenue available for maintenance and improvements to public utilities and services. Potential transportation impacts would occur within the context of total forest management activity within the state of Washington and surrounding regions. Current DNR harvests represent about 13 percent of total western Washington harvest. Logging companies harvesting timber from forested trust lands must meet Washington State Department of Transportation weight requirements and pay taxes that support road improvements. DNR regularly meets with local government officials and engineers to discuss the effects of logging-related traffic (DNR 1992b). These measures would help mitigate potential impacts associated with increased road traffic. As a result, none of the Alternatives is expected to result in any probable significant adverse environmental impacts on transportation infrastructure.

Cultural Resources

While there are relative differences among the Alternatives, none is expected to result in any probable significant adverse environmental impacts to cultural resources relative to current conditions. Forest Resource Plan Policy No. 24 requires protection of such resources and DNR is committed to consulting with Native American tribes and other interested parties about areas of cultural importance to them. These two forms of mitigation are expected to minimize risk to cultural resources.

Recreation

Environmental impacts on recreation resources are assessed in relation to harvest level. More intensive harvest would have a larger impact on the landscape, potentially affecting the quality of recreation experiences in adjacent and nearby areas. Potential effects on recreation may be mitigated on a case-by-case basis during operational planning prior to the initiation of harvest activities. Potential effects may be mitigated by employing harvest systems that minimize potential visual effects and by relocating or rerouting affected recreation facilities, particularly trails, as appropriate. All of the Alternatives would meet the requirements of DNR policies and procedures that address recreation and public access (Policy Nos. 25 and 29). As a result, none of the Alternatives is expected to result in any probable significant adverse environmental impacts to recreation.

The effects of the proposed Alternatives on fish and wildlife could, in turn, affect recreational fishing and hunting on forested trust lands. Fishing and hunting opportunities on forested trust lands could be positively affected to the extent that improvements in habitat and habitat suitability contribute to greater numbers of fish and game populations in some or all of the HCP Planning Units. The potential effects on fish and wildlife are discussed in more detail in Sections 4.10 and 4.4, respectively.

Scenic Resources

Lands managed for timber production under all Alternatives would be managed under DNR's visual management procedure (14-004-080), which seeks to minimize potential impacts to scenic resources by managing harvest activities with respect to sensitive viewshed areas. Potential visual effects associated with the proposed Alternatives may be mitigated on a case-by-case basis during operational planning prior to the initiation of harvest activities. Operational planning by DNR includes policies and procedures related to green-up (growing young trees for a specific time before adjacent trees may be cut), reforestation, and harvest unit size that contribute to the management of forested landscapes. As a result, none of the Alternatives is expected to result in any probable significant adverse environmental impacts on scenic resources.

Cumulative Effects

Cumulative effects are defined under both a broad and narrow definition for this analysis. DNR recognizes that cumulative effects conditions are occurring and have the potential to occur in the future in watersheds where DNR manages forested trust lands. The analysis examines current forest conditions, wildlife habitats, fish, water resources, and potential impacts of future harvests. DNR’s policies and procedures are in place and implemented to manage and reduce the risk of cumulative effects occurring. The Alternatives with higher levels of activities in the first decade, Alternative 5 and the Preferred Alternative have a somewhat higher risk of contributing to cumulative effects, especially related to water resources. However, all Alternatives implement various mitigation measures for cumulative effect to forest vegetation, wildlife, and water resources. These measures include, but are not limited to, implementation of the Habitat Conservation Plan (HCP) Riparian Management Zones, procedure for management of potential slope instability, visual area management, procedure for adjacency of regeneration harvest units, and leave trees strategy. The expectation is that the overall level of cumulative effects would be reduced under all Alternatives in the future due to the Board of Natural Resources’ forest management policies; DNR's HCP and operational procedures in combination with Forest Practices Rules; the Northwest Forest Plan; and other regional programs, such as salmon recovery efforts (Salmon Recovery Funding Resource Board), and habitat conservation plans developed by private forestry companies (e.g., Plum Creek, Port Blakely, Simpson Timber, West Fork Timber) and utility companies (e.g., City of Seattle, Tacoma Water). These programs should reduce the potential for future cumulative effects by requiring that landowners do their share of mitigation and avoidance. All of the proposed Alternatives would be expected to provide effective mechanisms in policy and procedures to provide mitigation against cumulative effects where DNR manages a portion of the landscape.

Chapter 1

Chapter 1

1. BACKGROUND AND OBJECTIVES

1.1 INTRODUCTION

The first chapter of this Final Environmental Impact Statement describes the background and purpose for a new sustainable harvest calculation for forested trust lands managed by the Washington State Department of Natural Resources in western Washington. Included are the legal and regulatory framework surrounding the sustainable forest management of forested trust lands and the significant issues that have been identified relating to establishment of a sustainable harvest level for the next decade. The chapter concludes with a discussion of the final decision to be made.

1.2 BACKGROUND

1.2.1 Washington State Department of Natural Resources as a Land Manager

The Washington State Department of Natural Resources (DNR) was established in 1957 with the consolidation of at least ten agencies, boards, and commissions to serve, in part, as a land steward for a variety of state-owned lands. These state-owned lands include various trust lands, aquatic lands, and natural areas. In its role as a land steward, DNR manages approximately 2.1 million acres of forestlands; 2 million acres of aquatic lands (primarily tidelands and bedlands); and 1 million acres of range, agricultural, and urban land (DNR 1992a). Other agency responsibilities include managing Natural Area Preserves and

Natural Resource Conservation Areas, fighting wildfires, and regulating forest practices on all non-federal lands in the state.

DNR has a diverse staff of foresters, engineers, geologists, biologists, cartographers, hydrologists, soils scientists, and economists—just to mention a few—who protect and manage lands and natural resources for long-term productivity; habitat; and other conservation, education, and recreation benefits.

The Board of Natural Resources is charged with the oversight and the approval of major policies for forested trust lands and resources. The Board is composed of six members: the Commissioner of Public Lands; the Governor (or a designated representative); the State Superintendent of Public Instruction; the Dean of the College of Agriculture, Washington State University; the Dean of the College of Forest Resources, University of Washington; and an elected representative from a county that contains forested trust land. By statute, the Board of Natural Resources is part of the Department of Natural Resources (Revised Code of Washington [RCW] 43.30.030).

Management of forested trust lands is conducted within the framework of state and federal laws, DNR's Forest Resource Plan, DNR's 1997 Habitat Conservation Plan, the 2001 Washington State Forest Practices Rules (which establish legal requirements for forest management on all non-federal lands in the state), the state constitution and Enabling Act, and with oversight and policy direction provided by the Board of Natural Resources.

The Forest Resource Plan was developed to guide the management of 2.1 million acres of state forested trust land, and describes DNR's guiding policies and management priorities. The plan contains 40 policies and associated discussions guiding the management of forested trust lands. In 2002, the Board of Natural Resources extended the Forest Resource Plan until June 2005 to allow for the examination of sustainable forestry options and calculation of the sustainable harvest level for western Washington.

DNR manages all western Washington forested state trust lands according to a Habitat Conservation Plan agreement with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration – Fisheries Service (or National Marine Fisheries Service) (collectively referred to as "the Federal Services"). The Habitat Conservation Plan is a multi-species land management plan that takes a multi-species and landscape approach to managing for conservation of threatened and endangered species. It therefore allows DNR to manage under a landscape approach. The plan protects all currently listed and potentially future listed species, and manages for species populations, not individual plants or animals.

The Habitat Conservation Plan covers approximately 1.6 million acres of state lands managed by DNR within the range of the northern spotted owl. The plan provides DNR assurance that forest management activities will be able to continue while providing for threatened and endangered species conservation at landscape levels. DNR's conservation is designed to supplement federal land management protections at landscape levels (DNR 1997). The plan also provides DNR with a federal permit for incidental "taking" of species listed under the federal Endangered Species Act (16 U.S.C. 1531 et seq.). The "take" provision is in exchange for implementing forest management practices designed to conserve threatened and endangered species and their habitats for the long term.

DNR has a set of departmental procedures, tasks, and guidelines that direct and guide the operational management of forested trust lands. These procedures, tasks, and guidelines implement directives provided in the Forest Resource Plan, Habitat Conservation Plan, Forest Practices Rules, and additional operational management strategies for DNR-managed forested trust lands.

1.2.2 Trust Duties

DNR has unique obligations in managing the lands covered by the Forest Resource Plan and Habitat Conservation Plan because they are forested trust lands. Congress, through the Enabling Act, granted the majority of these lands when Washington became a state in 1889. The federally granted lands are to provide financial support to specific designated beneficiaries, in perpetuity. The beneficiaries include state institutions such as public schools; state universities; and charitable, educational, penal, and reformatory institutions.

During the 1920s and 1930s, the state purchased cutover forestlands and received title to cutover or abandoned forestlands from counties due to tax foreclosures. The legislature has directed that the "state forest lands" (RCW 79.02.010) be held in trust and administered and protected by DNR, as are other federally granted forested trust lands. The "state forest lands" are commonly known as "Forest Board lands," and are located in 17 western Washington counties. These lands are managed to help fund state schools and county services in the counties where they are located.

Out of the roughly 3 million acres currently managed for these trusts, about 2.1 million acres are forested. Of these, about 1.4 million acres are west of the Cascade Crest (see Map 1).

1.2.2.1 Trust

A trust is a relationship in which one person, the trustee, holds title to property that must be kept or used for the benefit of another (Bogert 1987). The relationship between the trustee and the beneficiary for these lands is a fiduciary relationship. A trust includes a grantor (the entity establishing the trust), a trustee (the entity holding the title), one or more beneficiaries (entities receiving the benefits from the assets), and trust assets (the property kept or used for the benefit of the beneficiaries). In the case of Washington's trust responsibility, the trust assets are the trust lands, funds in certain dedicated accounts, and the permanent funds associated with them.

With the state as trustee, the legislature has designated DNR as manager of the federally granted trust and state forest lands. Statutorily, DNR consists of the Board of Natural Resources, the Commissioner of Public Lands as administrator, and the Department Supervisor (RCWs 43.30.205, 105, and 155, respectively). The Board of Natural Resources is required, by statute, to establish "policies to insure that the acquisition, management and disposition of lands and resources within the Department's jurisdiction are based on sound principles designed to achieve the maximum effective development and use of such lands and resources consistent with laws applicable thereto" (RCW 43.30.215).

As a trust manager, DNR follows the common law duties of a trustee, which include administering the trust in accordance with the provisions that created it; maintaining undivided loyalty to each of the trusts and its beneficiaries; managing trust assets prudently; making the trust property productive while recognizing the perpetual nature of the trusts; dealing impartially with beneficiaries; and reducing the risk of loss to the trusts. DNR must also comply with all laws of general applicability.

In 1984, the Washington State Supreme Court specifically addressed the state trust relationship in County of Skamania v. State of Washington, 102 Wn.2d 127, 685 P.2d 576. The Skamania decision explicitly addresses two of a trustee's duties. The Supreme Court found that a trustee must act with undivided loyalty to the trust beneficiaries, to the exclusion of all other interests, and manage trust assets prudently. The Court also cited a series of cases in which private trust principles were applied to land grant trusts. While all but one of these cases are from other states with differently worded Enabling Acts, they generally indicate that a state's duty is to strive to obtain the most substantial financial support possible from the trust property while exercising ordinary prudence and taking necessary precautions for the preservation of the trust estate. This principle has often been generally referred to as the trust mandate. The 1992 Forest Resource Plan (DNR 1992a) contains a succinct discussion of the trust mandate and the common law duties of a trustee as interpreted by DNR and approved by the Board.

In short, any management action taken on the state's forested trust lands, including this examination of sustainable forestry options and setting of a harvest level, should be consistent with the principles of trust management. It is important to retain the long-term capacity of the forest, recognizing that near-term actions can create long-term ecological, social, and economic benefits.

The following excerpt from the Forest Resource Plan's (DNR 1992a) discussion of DNR's interpretation of a trust manager's duty as a prudent person helps to explain how this calculation ties to trust management obligations:

> The Prudent Person Doctrine
>
> Trust managers are legally required to manage a trust as a prudent person, exercising such care and skill as a person of ordinary prudence would exercise in dealing with his or her own property. In the Department's view, this means, among other things, avoiding undue risk, avoiding tortious acts, etc.
>
> The Department believes it is in the best interests of the trust beneficiaries over the long run to:
>
> - Manage state forestland to prevent the listing of additional species as threatened or endangered.
> - Prevent public demand for ever-increasing, restrictive regulations of forest practices.
> - Avoid the resulting contract disputes and uncertainty.

That is why the Department has, in certain policies, retained the freedom to exceed existing Forest Practices Act regulations if necessary to protect a public resource on forestland (Appendix B of DNR 1992a).

1.2.2.2 Revenue to Beneficiaries

Since 1970, DNR-managed forested trust lands have benefited all the people of Washington by producing more than $4.55 billion in trust revenue, thereby reducing the need for taxes to pay for the state's public projects and services. Forested trust lands are managed to produce income to build public schools, capitol buildings, universities, prisons, state mental hospitals, and community colleges. They also help fund local services in many counties, as well as the state general fund.

1.2.3 Legislative Directive

State law (RCW 79.10.320) directs DNR to apply "sustained yield" management of forested trust lands. The law requires DNR to periodically adjust acreages designated for inclusion in the sustained yield management program, and calculate a sustainable harvest level.

The "sustainable harvest level" means the volume of timber to be scheduled for sale from forested trust lands during a planning decade. This is part of DNR's strategic plan for sustainable forest management. It provides for sustainable harvesting on a continuing basis without major prolonged curtailment or cessation of harvest.

DNR also has the obligation to provide for other public uses of trust lands when the uses are compatible with the obligations of trust management discussed above. Public uses that may be compatible with trust management activities could include recreational areas; recreational trails for both vehicular and non-vehicular uses; special educational or scientific studies; research and experimental programs managed by various public agencies; special events; hunting, fishing, and other sports activities; maintenance of scenic areas; maintenance of historical sites; municipal or other public watershed protection; greenbelt areas; public rights-of-way; and other uses or activities by public agencies (RCW 79.10.120).

1.3 REGULATORY FRAMEWORK

1.3.1 State Forest Practices Act

In 1974, the state of Washington Legislature enacted an expanded Forest Practices Act, Chapter 76.09 of the Revised Code of Washington (RCW). The Act established rules to protect the state's public natural resources while maintaining a viable timber industry (RCW 76.09.010). The Act regulates activities related to growing and harvesting timber on all non-federal forestlands in the state, including DNR-managed forested trust lands.

The Forest Practices Board was established by the State Legislature under the 1974 Forest Practices Act. The Forest Practices Rules, Washington Administrative Code 222, give direction on how to implement the Forest Practices Act.

In 1999, the state of Washington Legislature encouraged the Forest Practices Board to adopt new rules consistent with the April 1999 Forests and Fish Report (RCW 76.09.055). In response, the Washington Forest Practices Board amended the Forest Practices Rules in July 2001. The objectives are to protect public resources; the focus is on water quality, salmon habitat, and other aquatic and riparian resources.

It is important to note that the Forest Practices Division that enforces the Forest Practices Act and Forest Practices Rules is completely independent of the state land management divisions of DNR, which manages forested trust lands. Management activities on forested trust lands are subject to the same Forest Practices Rules as those on local public and private forestland.

1.3.2 Federal Endangered Species Act

The purposes of the Endangered Species Act are to protect the ecosystems upon which threatened and endangered species depend, to provide a program for the conservation of populations of threatened and endangered species, and to take such steps as may be appropriate to achieve the purposes of the Act (16 U.S.C. 1531 et seq.).

Section 10 of the Endangered Species Act (16 U.S.C. 1539) authorizes a landowner to negotiate a habitat conservation plan with the Secretary of the Interior to minimize and mitigate any incidental impact to threatened and endangered species while conducting lawful activities such as forest practices. A habitat conservation plan allows the landowner to manage for endangered species at a landscape level, rather than protecting only the individual sites at which the species is found. A habitat conservation plan is intended to offset any harm that may be caused to individual animals by focusing on building, over time, viable population levels of the species. As long as the landowner manages within the limits of the habitat conservation plan, the landowner will not be prosecuted for “take” of an individual animal should its habitat be disturbed during lawful activities. The permit issued to DNR by the federal government is referred to as an “incidental take permit,” and sets the limits for activities allowed under the Habitat Conservation Plan (DNR 1997).

In 1997, DNR and the federal services signed a multi-species Habitat Conservation Plan to address state forested trust lands management compliance with the federal Endangered Species Act. The plan covers approximately 1.6 million acres of forested trust lands managed by DNR within the range of the northern spotted owl.

1.3.3 Other Laws

DNR complies with all other applicable state and federal laws. They include such laws as the Shoreline Management Act, which is intended to protect valuable shoreline resources, and the Clean Water Act, which establishes the basic structure for regulating discharges of pollutants into the waters of the United States. The Clean Air Act, State Environmental Policy Act, and certain local laws also affect the management of DNR’s forested land base.

1.4 NEED AND PURPOSE

1.4.1 Need

This proposal is to evaluate options for long-term sustainable forest management and recalculate a sustainable harvest level. State law requires DNR to periodically adjust the acreages designated for inclusion in the sustained yield management program and calculate a sustainable harvest level.

DNR manages approximately 1.4 million acres of forestland in western Washington. DNR has a duty to produce a perpetual source of income for the trust beneficiaries. Consistent with its fiduciary duties, DNR uses best forest management principles in its stewardship of these lands.

DNR recalculates timber harvest volumes with the goal of producing sustainable, relatively even-flow harvest volumes over time. This ensures that harvests can be sustained into the future to meet the needs of today's beneficiaries, as well as all future generations of trust beneficiaries.

Improvements in DNR forest inventory data, a 2001 Forest Practices Rules update, and several years of land management under the 1997 Habitat Conservation Plan collectively warrant a review of the suite of applicable policies, procedures, and management strategies currently in place on western Washington forested state trust lands to establish the sustainable harvest level.

1.4.2 Purpose

The purposes of the recalculation proposal are:

1. **To incorporate new information into a new model to recalculate the decadal sustainable timber harvest level (for western Washington) under current DNR policy, federal and state laws; and**
2. **To permit the Board of Natural Resources to evaluate any policy changes after a number of policy alternatives have been modeled and analyzed through an Environmental Impact Statement.**

As a result of examining different sustainable forestry management options, the Board of Natural Resources and DNR recognize the potential need to change some Forest Resource Plan policies and some DNR policies, procedures, and tasks.

This sustainable forest management project utilizes a spatial computer model to recalculate a 10-year sustainable harvest level for DNR-managed western Washington forested state trust lands. The result is a robust analysis of forest landscapes for the following:

- conservation benefits;
- growing and harvesting scenarios;
- fish and wildlife habitat;
- economic benefits; and

- other information to assist Board of Natural Resources policy decisions.

At the January 2002 Board meeting, prior to the release of the State Environmental Policy Act determination of Significance and Public Scoping Notice, the Board set the criteria for evaluating policy alternatives. The Board specified that Alternatives and components of Alternatives were to meet the DNR's legal and policy mandates, including federal and state laws, the Trust Mandate, and the objectives of the Habitat Conservation Plan. Alternatives that did not meet one or more of these objectives or the purpose and need were not evaluated within this process.

1.5 SCOPING AND SIGNIFICANT ISSUES

1.5.1 Scoping

Scoping is the first formal step in preparing an Environmental Impact Statement under the State Environmental Policy Act. Scoping is intended to initiate public involvement in the process, and is conducted to fulfill a three-fold purpose:

1. Narrow the focus of the Environmental Impact Statement to significant environmental issues;
2. Eliminate issues that would have insignificant impacts, or that are not directly related to the proposal; and
3. Help identify reasonable Alternatives to be analyzed in the Environmental Impact Statement.

The scoping process alerts the public, the project proponent, as well as the lead agency to areas of concern and controversy early in the process. Here, DNR is both the project proponent and the lead agency.

The State Environmental Policy Act process was formally initiated with the scoping notice released on February 22, 2002 that was followed with a series of six public meetings held between March 6 and 21, 2002 in Seattle, Sedro Woolley, Ellensburg, Port Angeles, Longview, and Lacey.

More than 300 people attended six public meetings. During the public meetings, DNR extended the offer of additional meetings to stakeholder groups who were interested in the technical and policy details behind the development of the sustainable harvest calculation. The offer resulted in ten additional informal meetings with 26 organizations.

In addition to these meetings, DNR received 410 written scoping comment letters. In all, about 2,000 individual comments were received regarding the sustainable harvest calculation.

1.5.2 Significant Issues

The State Environmental Policy Act requires an Environmental Impact Statement to analyze significant **environmental** impacts (Washington Administrative Code 197-11-440 and 448). Issues that are not significant do not need to be analyzed. The intent is that the responsible agency will weigh the Environmental Impact Statement as one of several pieces of information needed in the decision-making process. The focus of this document is to compare a reasonable range of sustainable forest management alternatives and to assess their probable significant adverse environmental impacts. The analysis is based on reasonably available information (Washington Administrative Code 197-11-080).

The 2,000 public and stakeholder comments captured diverse issues, ideas, and opinions proposed by the public and stakeholders during the scoping process. Comments were summarized and responses provided in a document completed in August 2002 titled, "2003 Calculation of the Sustainable Harvest for DNR-Managed Forests in Western Washington: Environmental Impact Statement Scoping Summary and Responses to Public Comments received during the Scoping Process" (see Appendix A).

The comments were summarized by subject, and were examined to determine if the issues were germane to sustainable forestry and the sustainable harvest calculation for DNR-managed western Washington forested state trust lands.

The comments received led DNR to develop four questions that highlight the broad policy issues for the Board of Natural Resources.

1. How should DNR manage for biological conservation?
2. How intensively should DNR manage forested trust lands?
3. How should harvest levels be organized (for instance, as a whole, by trust, by ownership group, as currently defined in the DNR Forest Resource Plan, etc.)?
4. How much older forest is desirable on western Washington forested state trust lands?

These four questions helped DNR staff and Board of Natural Resources members identify issues for consideration in developing the sustainable forestry analyses.

1.5.3 State Environmental Policy Act Non-Project Proposal

The sustainable forestry calculation is a "non-project action" under the State Environmental Policy Act. Non-project actions include the adoption of plans, policies, programs, or regulations that contain standards controlling the use of the environment or standards that will regulate future actions. Such actions are not site-specific in nature and therefore do not warrant site-specific environmental analyses (Washington Administrative Code 197-11-774). Future management decisions on the forested trust lands will depend in part on the decisions made during this process.

1.5.4 Alternatives Considered

In addition to providing an impartial discussion of potentially significant negative environmental impacts, an Environmental Impact Statement identifies reasonable Alternatives and mitigation measures to avoid or minimize adverse environmental impacts. An Environmental Impact Statement evaluates the proposal (known as the "Preferred Alternative"), the No Action Alternative, and other "reasonable Alternatives." A reasonable Alternative is an action that could feasibly attain or approximate the proposal's objectives, but at a lower environmental cost or decreased level of environmental impacts (Washington Administrative Code 197-11-440(5)(b)). Reasonable Alternatives may be limited to those that an agency with jurisdiction has authority to control either directly or indirectly through mitigation.

Alternatives are one of the basic building blocks of an Environmental Impact Statement. They present options in a meaningful way for decision-makers. Policy changes being considered by the Board of Natural Resources are reflected in six reasonable Alternatives described in detail in Chapter 2 of this document. The Board of Natural Resources is responsible for making decisions on policy direction, while DNR makes decisions on how to implement policies through a series of procedures. The Alternatives in this document represent different choices in both policy and procedure. They incorporate information gathered and issues raised through the project scoping process, forest modeling, and Board of Natural Resources discussion.

The Draft Environmental Impact Statement was prepared without a Preferred Alternative to provide a wider range of choices for the Board of Natural Resources prior to making a final decision. The Preferred Alternative was identified by the Board of Natural Resources after the publication of the Draft Environmental Impact Statement and the collection of public comment, and is evaluated in this Final Environmental Impact Statement.

1.6 FINAL DECISIONS TO BE MADE

This Final Environmental Impact Statement provides part of the information that the Board of Natural Resources will use, along with other information, in setting a new sustainable harvest level (according to RCW 79.10.320). The land management strategies of the Preferred Alternative represent prospective changes to DNR policies (set by the Board of Natural Resources), procedures, and operational management (set administratively by DNR). The Preferred Alternative is part of this Final Environmental Impact Statement that, if approved by the Board of Natural Resources, will expressly change some current policies. Any policies that are changed will be implemented through the Board's adoption of the Final Environmental Impact Statement Alternative.

Concurrently, with the Board's approval of the document, DNR's policies, procedures, and tasks will be adjusted to reflect those included in the approved Final Environmental Impact Statement Alternative. The Board of Natural Resources will adopt their preferred option by using the following information:

- Public comments on the Draft Environmental Impact Statement;
- Final Environmental Impact Statement;
- Additional analyses provided by DNR staff at the Board of Natural Resources' request; and
- Public comments offered at regular monthly Board of Natural Resources meetings.

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Chapter 2

Chapter 2

2. ALTERNATIVES INCLUDING THE PROPOSAL

2.1 INTRODUCTION

This chapter describes and compares the Preferred Alternative and five other forest management Alternatives and outlines the processes used by the Board of Natural Resources (Board) to develop the Preferred Alternative. The final decision by the Board will define sustainable forest management and the associated sustainable harvest level that will be achieved for forested trust lands in western Washington.

Section 2.2 reviews the policy, procedure, and implementation strategies contained in the Alternatives. Section 2.3 briefly describes the computer modeling process used to analyze the Alternatives and updates to the modeling since publication of the Draft EIS. Section 2.4 addresses the development of the six forest management Alternatives. Section 2.5 discusses Alternatives that were considered but eliminated from detailed study in the Environmental Impact Statement because they did not meet the purpose and need of the project. Section 2.6 describes and reviews the Preferred Alternative in contrast with the other five Alternatives.

2.2 POLICIES, PROCEDURES, AND IMPLEMENTATION STRATEGIES

DNR serves as manager of approximately 1.4 million acres of forested state trust lands in western Washington. Except for the State Natural Area Preserves and the Natural Resource Conservation Areas, these forestlands are managed in trust. Over the short and long term, DNR's fiduciary responsibility is to maintain the body of the forested trust lands with undivided loyalty to the designated beneficiaries, and generate revenue from those forested trust lands for those beneficiaries. In order to meet obligations to all generations of beneficiaries, DNR must carry out land management that strikes the appropriate balance between current and future income production and the long-term preservation of trust assets. In addition to trust obligations, DNR is subject to a number of federal and state statutes that protect public resources and provide public benefits. To fulfill these mandates, there are governing policies, procedures, and strategies for management of forested trust lands.

- The Board of Natural Resources sets the major policies for DNR-managed state lands.
- DNR develops administrative procedures to effectively and efficiently implement Board-approved policies.
- DNR retains the flexibility in its field operations to respond to changing or unique circumstances with specific implementation strategies.

As stated in Section 1.3, the sustainable harvest calculation gives the Board and DNR an opportunity to examine the policies and procedures. The State Environmental Policy Act requires DNR to examine potential environmental impacts of reasonable Alternatives consistent with the purpose and need statement. Six Alternatives were prepared by grouping various combinations of policy changes that represented different approaches to achieving the desired results. The State Environmental Policy Act stipulates that DNR analyze only probable adverse environmental impacts that are significant, and that such analyses be based on reasonably available information. The level of detail of the analysis is to be commensurate with the importance of the impact, with less important material summarized, consolidated, or referenced (Washington Administrative Code 197-11-402).

Once Alternatives were defined, DNR used several analytical tools to evaluate each Alternative to understand the short- and long-term consequences of such actions. These include either formal or informal analyses of costs and revenue, stakeholder interests and concerns, operational feasibility, and the environmental analysis contained in this document.

2.2.1 Transition and Implementation

The Alternatives identified the potential of the forested trust lands to produce financial, ecological, and social benefits. To achieve the potential of any of the Alternatives, there are a number of operational and administrative considerations. For example, Alternatives that demonstrate higher harvest levels than today, such as the Preferred Alternative, will require additional foresters and specialists to successfully implement the Alternative. Therefore the ability to hire, train, and pay for these extra staffing needs and other operational considerations is part of the implementation of an Alternative.

Recent annual harvest levels have been lower than the average sustainable harvest level estimated in 1997 after the DNR's Habitat Conservation Plan was adopted. Harvest levels have been lower for several reasons, including: 1) protected riparian and marbled murrelet areas that were more extensive than originally estimated; 2) a cautious early approach to implementation based on threatened litigation; and 3) temporary restrictions imposed on harvesting, beyond those envisioned in the Habitat Conservation Plan, as an ecological precaution for the first decade of the implementation. As a result, transitioning to a new higher harvest level, such as with the Preferred Alternative, entails building up capacity in the short term.

Recognizing that a transition period is likely to reach a higher harvest level, the Board of Natural Resources directed the DNR to "present an analysis….that identifies hiring, implementation timelines and cash flow necessary to transition to the Preferred Alternative management practices and associated harvest levels. The Department is directed to prepare a Preferred Alternative that shall meet an average annual harvest target of 636 million board feet as soon as possible" (Board of Natural Resources Resolution 1110). This unanimously approved resolution also directed DNR to start the Final Environmental Impact Statement (EIS).

In May 2004, DNR presented to the Board a detailed harvest transition plan. In that presentation, DNR explained the budget, cash-flow, hiring and other operational considerations that would limit DNR's ability to immediately start harvesting at the new anticipated higher sustainable level.

As part of the transition plan, DNR would shorten the duration of timber sales contracts to accelerate revenues to help fund the transition. Cost savings, such as region reorganization and other structural changes, have been implemented that will allow DNR to achieve the 636 million board feet harvest level within 5 years. If possible, DNR will meet this level sooner, attempting to meet the clear intent of Section 5 of the Board's resolution.

The Final EIS analyzes environmental impacts of a first decadal harvest of 6,360 million board feet for the Preferred Alternative. The transition schedule presented to the Board shows a total of 5,900 million board feet, with a mean annual first decadal level of 590 million board feet per year.

2.2.1.1 Linking Plans to Timber Sales

The Forest Resource Plan and 1997 Habitat Conservation Plan (HCP) provide a policy framework for the DNR to implement its policy direction through a series of planning processes, such as landscape planning and timber harvest scheduling (see Figure 2.2-1). The Habitat Conservation Plan developed management strategies at the landscape level and utilizes five western Washington HCP Planning Units and the Olympic Experimental State Forest as management areas on which to set performance standards and reporting functions.

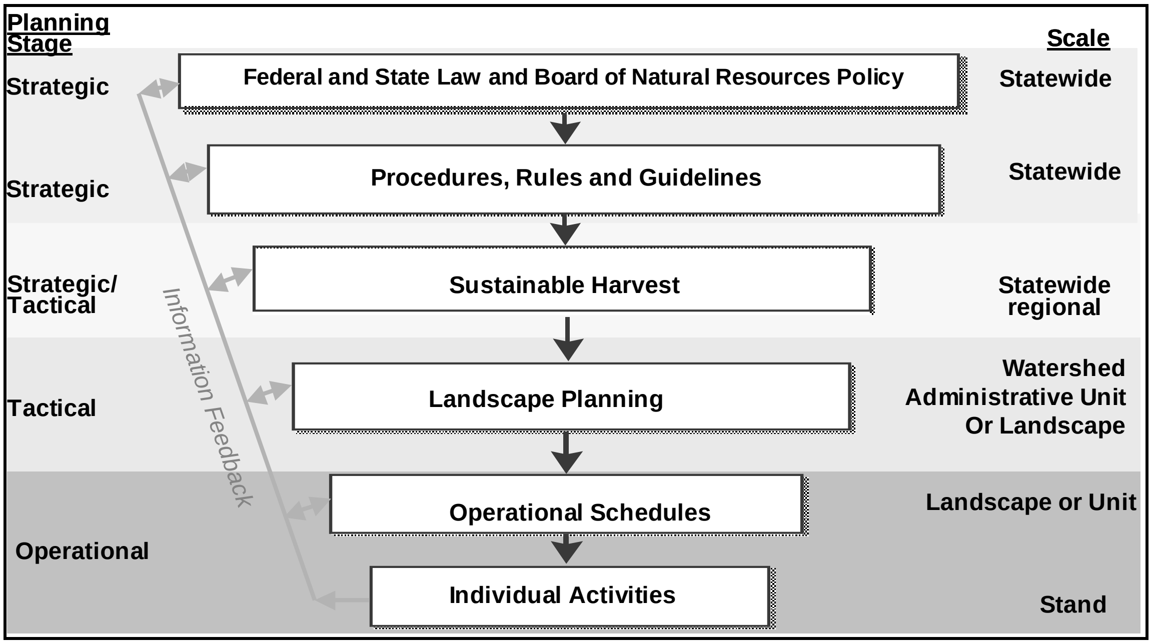

Figure 2.2-1. Hierarchical Planning Model

When the Board ultimately adopts a Preferred Alternative and associated sustainable harvest level, DNR would incorporate implementation planning for the adopted Alternative concurrently with its programs of landscape planning and timber harvest scheduling. Information from these planning exercises, in conjunction with specific Habitat Conservation Plan reporting should provide much of the information for a structured reporting program on the implementation of the Preferred Alternative.

2.3 SUSTAINABLE FOREST MODELING AND THE EIS

There are several key outcomes of the sustainable harvest modeling analyses. They range from an understanding of the anticipated conservation benefits to the projected levels of sustainable harvests of trees. A key expectation of the modeling is to determine the volume of trees that can be harvested on a continuing basis without major prolonged curtailment or cessation of harvest (Revised Code of Washington 79.10.310). The western Washington forested state trust lands under DNR's jurisdiction are primarily valuable for growing forests on a sustained yield basis. In determining the sustainable level of harvest, DNR incorporates statutes and options for policies, procedures, and operations that could affect management on the forested trust lands for decades to come.

The foundations of a sustainable harvest calculation are: 1) an inventory of the forest including age and species; 2) a thorough understanding of various options available for managing the forest to achieve goals (to be defined through policies and procedures that form a management approach or Alternative); and 3) a way to calculate potential outcomes of various strategies, which is facilitated using a computer model. The model helps one to organize and analyze information. The sustainable harvest model was designed to inform the Board of Natural Resources during their decision-making regarding key forest management policies, and to provide information for the DNR to recommend an associated sustainable harvest level with the Board's key policy decisions. The model's major purpose is to provide information to assist in understanding and being able to compare the changes in forest inventory, habitat conditions, and timber harvest that result from the various Alternatives over the next 64 years (the remainder of the 70-year term of the Habitat Conservation Plan).

The term "model" (as used in this document) denotes a process by which a suite or set of policy preferences are expressed in computer language and are simulated through a process of modeling software. The outputs of this modeling process are estimates of forest inventory, harvest, stand development stage, revenue, and costs. Included in DNR's modeling process is modeling software called OPTIONS. OPTIONS is a spatially explicit, land-based planning model that has been designed specifically to address forestland management issues. OPTIONS can model "what happens, where it could happen in the landscape, and show how it would change over time." This model simulates forest growth over time, tracking where management activities could happen, and gives DNR the ability to view detailed changes in the forest inventory and conditions over time and space. This ability to track spatially where activities could happen facilities ground-truthing and to a certain extent tests the feasibility of a model run. Although the modeling process provides much useful information for policy analysis, it does not provide an operational harvest schedule. Simply put, the modeling process is to the DNR's forest planning as a flight simulator is to Boeing.

The sustainable harvest modeling process was not specifically designed to provide information for an environmental analysis. However, many of the modeling outputs, such as forecasting the changes in forest inventory and habitat conditions under different Alternatives, provide useful information that can assist in confirming expected impacts of proposed changes in policies and procedures. Modeling outputs are presented in this environmental analysis alongside other information—both qualitative (such as expected outcomes derived from readings of current literature, expert opinion, and public comment) and quantitative (such as data on current conditions or relevant research studies). The Board's decision-making process also relies on information generated during the State Environmental Policy Act analysis and public involvement processes.

Revised Code of Washington (RCW) 79.10.320 requires that "the Department shall periodically adjust the acreages designated for inclusion in the sustained yield management program and calculate a sustainable harvest level." The model relies on the best and most complete acreage and forest inventory information available. Forest inventories are updated with current tree growth models and data from Geographic Information Systems, provided by a variety of sources including on-the-ground foresters and records of harvest planning, sales, and other management activities. This information has improved since the last calculation in 1996.

John Sessions, a renowned forest engineering scientist from Oregon State University, informed the Board of Natural Resources (November 2001) that there are four steps to credibility and operational success in building a forest model to derive a sustainable harvest level:

1. Represent organizational goals and constraints accurately in the model;
2. Use an adequate vegetation inventory;
3. Choose an appropriate land classification; and
4. Link strategic planning to implementation.

DNR followed these steps in modeling the sustainable harvest Alternatives presented in this Environmental Impact Statement. DNR seeks to carry out each step as it proceeds through the sustainable forestry calculation process, as well as while implementing the new harvest level once it has been established.

2.3.1 Modeling Updates

Since the distribution of the Draft modeling results on June 25, 2003 and the Draft Environmental Impact Statement (EIS) in November 2003, DNR has made a series of updates to the modeling process. These updates were made in part as a response to comments made by DNR region field staff and by public comments on the Draft EIS. Two areas of the modeling were updated: 1) the estimates of saleable timber volume (in Scribner board feet) and 2) the stand development stage modeling.

The update to the estimates of saleable volume, particularly for the value-based Alternatives (Alternative 5 and the Preferred Alternative; see 2.6.3.2 Timber Harvest Levels) was in response to concerns from the technical review committee and DNR field staff that the estimated yields in the Draft EIS were too high. Review of the modeling processes and estimates led to changes in how DNR estimated the growth and yield and inventory characteristics of existing older forest stands. These updates to the growth and yield aspects of the value-based models, detailed in Appendix B, resulted in the need to review the logic of the stand development stage modeling.

In addition, public comments on the Draft EIS and from the technical review committee suggested that the stand development stage modeling reported in the Draft EIS accelerated stands too quickly through the development stages. This trend was particularly noted for forest stands on a natural, no-management pathway. The stand development stage classification system was reviewed and changes were made to the system to reflect a more realistic prediction of stand development under a no-management scenario. The details of the changes are in Appendix B. These changes were incorporated into the modeling of the Alternatives presented in this Final EIS.

2.3.2 Uncertainty in the Modeling Results

The implementation of the Board’s selected Alternative and harvest level will be a test of modeling assumptions. Implementation will provide feedback for refining DNR’s planning process. The Board, in Resolution 1110, anticipated this aspect and requested a regular and structured reporting program.

During the design and model analysis, DNR included a number of reviews of modeling outputs with field staff and the technical review committee. However, with modeling, uncertainties exist, and not all can be quantified or identified clearly. The three general areas of modeling uncertainty are the estimates of:

- saleable timber volume (Scribner board feet),
- available harvestable area, and
- changes in forest conditions from one stand development stage to another.

To illustrate the first of these two points, assume that an average of 60 years between regeneration harvest would be implemented on a forest base of 1 million acres. To calculate the sustainable harvest level, divide the 1 million acres by 60, resulting in approximately 16,700 acres of harvest per year. These 16,700 acres are assumed to yield on average 35 thousand board feet Scribner an acre, resulting in a harvest level of 585 million board feet per year.

Note: 1 million acres / 60-year rotation = 16,700 acres harvested per year
16,700 acres x average yield of 35 thousand board feet per acre = 585 million board feet per year.

As illustrated in Table 2.3-1, an approximate 10 percent reduction either in yield or area on-base for timber harvesting would result in a corresponding approximate 10 percent reduction in harvest level.

2.3.2.1 Uncertainty in Harvestable Volume

The estimate of saleable timber volume is a complex but key assumption in DNR's modeling process, because the purpose of the sustainable harvest calculation is to recommend a sustainable harvest level that will be offered for sale (RCW 79.10.340). Uncertainty exists because the volume used to advertise a timber sale is not the same as the volume from the forest inventory, even though both can and typically are described in

Table 2.3-1. A Simple Harvest Model

Assumptions	Base	10 Percent less yield	10 Percent fewer acres
On-base acres	1,000,000	1,000,000	900,000
Average rotation length	60	60	60
Average expected yield (thousand board feet per acre) of saleable timber	35	32	35
Annual areas harvested	16,700	16,700	15,000
Annual sustainable harvest level (million board feet per year)	585	534	525
Reduction in sustainable harvest level (million board feet per year)		51	60

Scribner board feet units. A timber sale volume is a sample estimate of the removable lumber in a stand just prior to sale. A forest inventory is a sample estimate of the total biomass in the forest stand from periodic inventory events. The two sample estimates, timber sales and forest inventory, use different field measurement standards and techniques to collect the data and derive a volume estimate. The DNR's forest inventory provides a far more extensive and detailed database of stand conditions across the entire forestland base and is therefore used for modeling. Timber sale samples exist only for a small proportion of the land base, stands that have been harvested or will shortly be harvested. Therefore, because DNR's modeling process is based on forest inventory volumes, these inventory volumes need to be converted to estimate timber sale volume.

In addition, uncertainty about a modeled saleable volume is heightened when "unexpected" outcomes are produced. Unexpected outcomes are, in part, the result of expectations of the future being based on past experience. Future timber sales volumes and harvest practices are expected to be similar to the past. As the Preferred Alternative implements innovative harvest systems (for example, variable density thinning, riparian restoration harvest), of which there are few current examples, future actual sale timber volumes per acre may be different from the past. From the simple model illustrated above, a relatively small change between 35 thousand board feet per acre and 32 thousand board feet per acre illustrates differences between modeled yields and sold advertised timber sales. The relatively small change in yield has the potential to change the overall sustainable harvest level substantially, as noted in the example. For the Preferred Alternative, the greatest area of uncertainty in saleable yields is probably associated with riparian restoration harvests and harvest associated with biodiversity pathways. This uncertainty is a result of lack of historical experience and data.

2.3.2.2 Uncertainty in Available Area for Timber Harvesting

The most obvious uncertainty that exists with available harvest areas lies in the differences between Geographic Information System data and what actually exists on the ground, such as the degree of potential slope instability. Other less obvious uncertainties exist when changes are made to the land base as a result of a future policy or management decision, such as the development of a long-term conservation strategy for marbled murrelets, a strategy for the Southwest Washington owl circles, and the development of other local management strategies to address recreational or visual concerns. It is difficult to quantify all of these uncertainties; however, using the simple harvest model above, one can see that to significantly affect the sustainable harvest level, the change in the available area has to be quite substantial, on the order of several thousands of acres.

2.3.2.3 Uncertainty in Modeling Stand Development

There is uncertainty in modeling stand development because the modeling approaches are new. Forest management objectives of habitat conservation require knowledge of forest stand development processes, i.e. how a forest stand develops from one stage to another under natural and managed pathways. However, even for natural forest stands, the stand development processes for the development of structurally complex stands have only recently been understood and described for some forests in the Pacific Northwest (for example Franklin et al. 2002). As for managed stands, there are little empirical data about how managed stands will develop over long rotations as a result of various silvicultural treatments.

The stand development modeling presented in the Draft EIS was the first attempt by DNR to model stand structural development stages to support policy analysis. The approach used stand structural and treatment variables such as tree size and density in combination with thinning treatments. Presenting the results and getting feedback from the public, interested parties, and the technical review committee was a valuable learning experience. With these inputs, DNR reviewed and revised the approach to incorporate the development of multiple canopies as a principal determinate of stand development. The results presented in this Final EIS as compared to those in the Draft EIS are different. While DNR believes the Final EIS modeling approach is an improved modeling process, there will undoubtedly be future improvements. A systematic ground-truthing of the modeling approach and outputs has yet to be undertaken. This ground-truthing will provide important information to improve the modeling process.

2.3.2.4 Risk of Modeling Uncertainties

Forest management models provide a useful way to generate information that compares Alternative management strategies for decision-making. For complex and interrelated problems, such as policy development related to the management of forests, models provide a tool by which decision-makers can explore and discover their choices. Models do not supply definitive answers; rather, they provide information useful for developing policy and implementation plans.

Models have a number of uncertainties, often because of the necessity of simplifying reality. Uncertainties are managed in the modeling process by making assumptions. Modeling assumptions are developed in keeping with the level of risk associated with a modeling output. For example, if saleable volume was only of casual interest to the decision-makers, then the associated risk of modeling sale volume could be considered low. When the risk is low, it may be only important to discern the relative differences between Alternatives rather than more precise tangible differences. When the information is important to decision-makers, the level of risk is higher and more attention is paid to the associated assumptions related to the outputs. However, while more development about the assumptions may occur, the primary purpose of the model is still exploration and discovery of management options.

2.4 DEVELOPMENT OF FOREST MANAGEMENT ALTERNATIVES

Alternatives are one of the basic building blocks of an Environmental Impact Statement (EIS). They present meaningful options to decision-makers. Policy changes being considered by the Board of Natural Resources (Board) determine the characteristics of the Preferred Alternative being reviewed in this document. The Board sets policy direction, while DNR implements those policies through a series of internal procedures and implementation strategies.

The six forest management Alternatives in the Final Environmental Impact Statement represent the range of choices considered by the Board of Natural Resources. The Preferred Alternative represents the Board's policy preference for how the forested trust lands are to be managed.

Design of the six Alternatives was based on information collected from the public during the scoping period, discussions with the Board, and discussions with a Technical Review Committee (see Appendix B for list of members). Information was also used from the preliminary models and associated results presented to the public (July 2002) and the Board (August 2002).

One objective of the Alternatives is to provide analysis and information about the results from potential policy and procedural changes. The Alternatives were designed to meet the purpose and need statement, facilitate the analyses, reflect public comment from the scoping process, and focus on Board interests.

The final set of six Alternatives reflect current management (Alternative 1), the 1997 Habitat Conservation Plan intent (Alternative 2), and four additional Alternatives that meet the Board's purpose. The intent of the six Alternatives is to examine a broad range of policy expectations that demonstrate passive, active, and innovative approaches to forest management.

The Alternatives and the information from the Environmental Impact Statement, along with separate financial and social analyses and public comment, provide key information for decision-making.

Policy changes will be implemented through the Board's adoption of a Preferred Alternative. Concurrently, with the Board's adoption of an Alternative, DNR's procedures and tasks will be adjusted to reflect the choices made in the approved Final EIS Preferred Alternative.

The Board will make a final decision regarding the Preferred Alternative and sustainable harvest level based on the following:

- Public comments on the Draft Environmental Impact Statement;
- Public comments offered at regular monthly Board meetings;
- Public comments on the selection of a Preferred Alternative;
- Additional analyses provided by DNR staff at Board request; and
- Final Environmental Impact Statement.

2.4.1 The Process for Defining the Preferred Alternative

The Preferred Alternative represents a series of choices in both policy and procedures. It incorporates information gathered and issues raised through the Draft EIS comment period, public meetings, comments at Board meetings, forest modeling, and Board discussion.

2.4.1.1 Board Deliberations to Select a Preferred Alternative

Public Comments

There are three primary ways the Board received public input: 1) from direct testimony to the Board, 2) from written material submitted directly to the Board, and 3) from the Draft EIS comments. The Board typically hears public testimony on subjects of interest to the public at every monthly Board meeting. As the Draft EIS was being developed and subsequent to its publication, the Board heard testimony at its regular monthly meetings from citizens, interest groups, and professionals regarding the development of a Preferred Alternative.

After the Draft EIS was released on November 10, 2003, seven public meetings were held in Lacey, Port Angeles, Mt. Vernon, Vancouver, Aberdeen, Spokane, and Des Moines. More than 350 people attended these meetings, and 146 commented. The public comments were taped and subsequently transcribed. Comments from these meetings, and comments received by mail and e-mail, were summarized and given to the Board at their January 2004 meeting. The Board also received the entire text of all the comments. The comments received during the Draft EIS comment period came from more than 740 groups and individuals, and included more than 4,500 individual comment statements. These comments were summarized into more than 100 categories. In general, comments encompassed the themes of trust income, environmental protection, and social benefits (see Response to Comments Summary in Appendix G).

Staff Reports

The Board requested a number of staff reports to aid their discussions of the various policy choices that are imbedded in the Preferred Alternative. The analyses were designed to address the Board's main questions:

- How do we conserve, enhance, and restore ecosystem habitats on landscape levels to meet Endangered Species Act requirements?
- How do we conserve, enhance, and create healthy working forests to meet the economic obligations to present and future trust beneficiaries?

The Board also wanted to understand the social dimensions of their decision. Several studies were presented to the Board before the Draft EIS was released.

- DNR undertook comprehensive public opinion research to understand the public's feelings and values about stewardship on state forested trust lands. DNR conducted focus groups during the spring of 2002 in three western Washington communities. The goal was to understand Washington residents' values related to forestry. The *2002 Sustainable Harvest Public Opinion Research: Washington's Vision for Forest Management* was presented to the Board on July 19, 2002.

- DNR also commissioned a statewide public opinion poll using the same questions as the public opinion research in order to provide statistically significant data to supplement the qualitative data provided in focus groups. The results of both the focus groups and the statewide survey were combined with input received at the town meetings held during the scoping process into a presentation delivered to the Board on July 19, 2002.
- In an effort to measure the impact on communities of timber harvests on forested trust lands across the state, the Board also received a report on “Socioeconomic Resiliency,” which provides an indication of how reduction or increase in timber harvest will affect counties across the state. That report was presented to the Board on October 7, 2003 (Daniels 2004).

In December 2003, the Board further reviewed the social dimension of their decisions by asking for additional discussion of the size and nature of the rural-urban interface. At the January 8, 2004 Board meeting, reference material was presented that analyzed the extent of the rural-urban interface and possible issues in those areas. The Board then discussed implications of various policy positions for both rural and urban areas.

The economic and ecological outcomes of the policy choices before the Board were discussed in the Draft EIS. The Board discussed those results and asked for additional analysis based on comments from the public and their own discussions. The Board requested several additional model runs to understand the policy impacts of various approaches. The model runs examined the impacts of various combinations and variations for flow control, maturity criteria, ownership groups, intensive silviculture, and biodiversity pathways. These model runs were presented to the Board at meetings through January, February, and March of 2004. The Board also requested additional information about riparian areas, older forests, and social impacts of various policy options, especially in the rural-urban interface areas. They requested additional financial analysis and a closer examination of implementation costs under various policy options.

Concurrently and on an ongoing basis, DNR worked with the Technical Review Committee (see Appendix B), seeking its help to independently evaluate core assumptions used within the computer simulations.

2.4.1.2 Board-Generated Criteria

After the release of the Draft EIS, the Board defined their decision criteria and created a decision matrix as an aid to the discussion. To create this matrix, the Board had to identify key results they wanted, and then decide which policy decisions had a critical influence on the key outcomes. DNR staff helped the Board complete the matrix by using computer runs and reports to fill in the needed information. The information was qualitative, not quantitative, and was developed over time in collaboration between DNR staff and the Board (see Appendix F).

The key policy areas discussed by the Board included:

- Prioritizing Harvest by Volume or Value – Timber harvests are to be measured by volume; however, discussions focused on how forest stands should be selected for harvest to generate revenue. Discussions considered either prioritizing by standing volume or by economic criteria.
- Silviculture – Silviculture is a term that can be defined as the art and science of growing trees and managing a forest for a particular purpose. This discussion involved deciding to use one approach or a combination of forest management approaches, each of which produce different outcomes. The choices ranged from more active techniques, like thinning and fertilization, to less active, using longer rotations and less management. Within that range is a newer concept called biodiversity pathways, which is an innovative, active approach with the intent of restoring and creating both habitat and income.
- Timber Harvest Flow Constraints – Discussions involved how much to allow the sustainable harvest level to vary from decade to decade.
- Ownership Groups (sustainable harvest units)– The Board considered how various forested trust lands ownerships should be combined or separated for the purposes of calculating distinct sustainable harvest levels.
- On-Base Land – The Board discussed how much land is available for timber harvesting and forest management activities.
- Older Forests – This discussion reflected the Board's concern about how to treat older forests.
- Riparian Areas – The Board discussed the modeling assumptions being made about the management in riparian areas that would be consistent with the federal approved procedures based on the Habitat Conservation Plan.

After conducting sensitivity and other types of analyses, some results of choosing among the various policy issues appeared more significant than others. Key factors ultimately included: 1) revenue, 2) variability of revenue, 3) structurally complex forest development, 4) implementation costs and timing, and 5) long-term standing inventory. These items were discussed in a number of Board meetings.

2.4.1.3 Choosing a Preferred Alternative

The Board refined their key outcomes and developed policy direction and principles to direct the development of a Preferred Alternative. The policy direction was titled *Sustainable Harvest Calculation Management Principles and Objectives* (Principles and Objectives), and was ultimately attached to Board Resolution 1110 that described the Preferred Alternative. The Principles and Objectives included two significant core outcomes that would ultimately be incorporated into the Preferred Alternative:

1. Active management on an enlarged on-base landscape and
2. Broader economic, conservation, and other public benefits consistent with fiduciary responsibilities.

On February 3, 2004, DNR staff used the Board's direction contained in its Principles and Objectives, and the Board's discussion of the decision matrix, to create the Preferred Alternative. This Alternative appeared to meet the Board's policy criteria. The Board agreed on most of the policy choices in the Preferred Alternative, but requested more discussion about sustainable harvest units (ownership groups) and older forests.

Implementation considerations were discussed and economic analysis of the potential Preferred Alternative was presented on February 17, 2004. After further deliberation, the draft Preferred Alternative was agreed upon, and the Board directed DNR to prepare further analysis of the Preferred Alternative. This analysis was presented at the March 2, 2004 Board meeting. DNR discussed how the Preferred Alternative met the Board's two core outcomes.

The Board voted unanimously on the components of the Preferred Alternative and incorporated its elements in Resolution 1110. This resolution directs DNR to prepare a Final EIS that includes the Preferred Alternative and incorporates by reference the Principles and Objectives.

2.4.1.4 Draft EIS Alternative 6 Formed the Basis for the Preferred Alternative

The development of the Preferred Alternative by the Board of Natural Resources was largely based on the policies and procedures of Alternative 6 as analyzed in the Draft EIS. The policy objectives of the Draft EIS Alternative 6 and the Preferred Alternative are similar (see Appendix B, Section B.2.4), with the notable difference between the two Alternatives being the riparian management modeling assumptions.

As was noted in the Draft EIS, the riparian modeling assumptions of Alternative 6 did not clearly match the stated policy objectives, resulting in high levels of low-volume thinnings. The high levels of repeated-entry thinning activities raised numerous technical and policy questions by the Board, the Federal Services, and other key stakeholders, such as the Washington State Department of Fish and Wildlife.

In response to public comments and based on the Board's direction during the development of the Preferred Alternative, modeling assumptions were updated to reflect the Board's interest in implementing a biodiversity pathways approach across as much of the land base as possible, and implementing a more moderate level of riparian restoration activities. These considerations resulted in the evolution of the Draft EIS Alternative 6 into the Preferred Alternative in this Final EIS.

2.5 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

Under the State Environmental Policy Act, a "reasonable Alternative" is a feasible Alternative that meets the proposal's purpose and need statement at a low environmental cost (Washington Administrative Code 197-11-786). The following Alternatives were considered but not included in the detailed analysis because they did not meet the purpose and need and were therefore not determined to be "reasonable."

2.5.1 The "Un-Zoned Forest" Alternative

In the process of developing the six Draft EIS Alternatives (see Section 2.6), a seventh was developed, known as the "Biodiversity Pathways with Un-Zoned Management." An un-zoned management concept is one in which there are no special areas or zones set aside exclusively for either conservation benefits or commodity production. An un-zoned forest concept combines active forest management at the landscape and forest stand level for attaining conservation benefits and revenue goals. The goal of this Alternative was to examine an un-zoned management approach for all western Washington forested state trust lands following the principles of DNR's Habitat Conservation Plan approach for the Olympic Experimental State Forest.

Upon further analysis the un-zoned forest Alternative was rejected as a reasonable Alternative because it did not meet the requirements of the current Habitat Conservation Plan. Such an approach would likely require a major amendment to the plan (see Implementation Agreement, Habitat Conservation Plan, DNR 1997). Meeting the requirements of the Habitat Conservation Plan was one of the criteria for selecting a reasonable Alternative, along with meeting the trust mandate and federal and state laws.

2.5.2 Other Alternatives, Comments, and Suggestions

A very limited number of other Alternatives and a large number of suggestions were received from the public. DNR examined the details and included many elements of them in the six Alternatives presented in the Draft EIS. Components not included in the six Draft EIS Alternatives did not meet the purpose and needs statement (Appendix A).

2.6 FEIS ALTERNATIVES CONSIDERED IN DETAIL

Each of the Alternatives is a set of proposed policies and procedures, each of which represents a different way of achieving DNR's legal mandates and goals. As with any extensive activities on a landscape, implementation of any of the Final EIS Alternatives across western Washington could have environmental impacts. Potential impacts are evaluated in this document. In order to understand the range of possible impacts, the Alternatives are best understood in terms of their differences.

In this section, Final EIS Alternatives, including the Preferred Alternative, are described in terms of the:

- Common features shared by each Alternative; and
- Main policy, procedure, and implementation strategy choices that meaningfully distinguish each Alternative from the others.

2.6.1 Features Common to all Reasonable Final EIS Alternatives

Alternative 1 and each of the reasonable Final EIS Alternatives have the following common features:

- Comply with all state and federal laws;
- Meet DNR's trust mandates (the state's fiduciary duties as a trustee); and
- Fulfill DNR's 1997 Habitat Conservation Plan.

Each of the Alternatives is consistent with the Forest Resource Plan and DNR procedures, tasks, and guidelines, except where otherwise noted in the following Alternative descriptions.

In cases where Forest Resource Plan amendments are proposed, selection of that Alternative by the Board would result in Board-adopted amendments to the Forest Resource Plan.

Six Alternatives are analyzed in detail in this Final Environmental Impact Statement. If approved by the Board, Alternatives 2 through 5 and the Preferred Alternative would expressly change current policies to align with those included in the Environmental Impact Statement. Concurrent with the Board's adoption of a set of new policies and a new sustainable harvest level, DNR's procedures and implementation strategies would be adjusted to reflect the final policy choices.

2.6.1.1 The Olympic Experimental State Forest

The Olympic Experimental State Forest has specific management objectives and strategies in the Habitat Conservation Plan (HCP) that distinguish it from the other HCP Planning Units. The goal of the Olympic Experimental State Forest is to learn how to integrate timber production and conservation across the landscape, known as an "un-zoned" approach. The Olympic Experimental State Forest is treated in each of the Alternatives as an un-zoned forest, as specified by the Habitat Conservation Plan (page IV.81).

A few procedures that affect the Olympic Experimental State Forest vary among the Alternatives. Differences include the level of harvest deferrals, such as site-specific management direction for marbled murrelets, northern spotted owls, and other resources (see Appendix B, Deferrals Among Alternatives). In addition, some aspects of the Alternatives, when coupled with the unique management in the Olympic Experimental State Forest, would result in different impacts than anticipated in the other five westside HCP Planning Units. These differences are described, by resource, in the environmental effects sections of Chapter 4.

2.6.1.2 Policies and Procedures Common to All Alternatives

A small proportion of the policies, procedures, and implementation strategies vary among the reasonable Alternatives and those are detailed in the following subsections. All other policies, procedures, and strategies remain constant for each Alternative. Refer to Appendix C for a discussion of select resource areas evaluated in this environmental analysis that did not vary among the Alternatives.

2.6.2 Alternatives

The following subsections describe each Final EIS Alternative.

2.6.2.1 Alternative 1 – No Action (Current Operations)

Alternative 1 represents the Board of Natural Resources' existing policies and DNR's forest management strategies as indicated by the DNR Forest Resource Plan, 1997 Habitat Conservation Plan, departmental procedures and tasks, current DNR operations, and all current federal and state statutes. This Alternative represents an estimate of continued management of western Washington forested state trust lands with current management strategies. In this Alternative, projecting the status quo into the future represents uncertainties, such as how DNR would manage riparian areas or marbled murrelet habitat. Therefore, in the case of riparian areas and marbled murrelet habitat, current strategies of deferral are projected indefinitely.

2.6.2.2 Alternative 2 – Habitat Conservation Plan Intent

Alternative 2 represents existing Board of Natural Resources-approved policies and forest management strategies as defined by the DNR Forest Resource Plan, 1997 Habitat Conservation Plan, and current federal and state statutes. It does not include those current departmental procedures and tasks that were not approved by the Board. Management under this Alternative implements the Habitat Conservation Plan as originally negotiated with the Federal Services in 1997.

2.6.2.3 Alternative 3 – Combined Ownerships

Alternative 3 represents existing Board-approved policies (except Policy No. 6 on Trust Ownership Groups), forest management strategies defined in the DNR Forest Resource Plan, the 1997 Habitat Conservation Plan, and current federal and state statutes. "Combined Ownerships" refers to a change in Forest Resource Plan Policy No. 6 defining how to group the trusts' lands when applying the even-flow requirement in Policy No. 4.

2.6.2.4 Alternative 4 – Passive Management Approach

Alternative 4 represents managing western Washington forested state trust lands with passive management approaches to provide increased conservation and habitat protection while producing revenue. This approach maintains the 1997 Habitat Conservation Plan objectives, the DNR Forest Resource Plan, and current federal and state statutes. "Passive management" refers to a land management approach that allows forest growth and structural development processes to occur with little silvicultural (cultivation of forest species and stand care) activity.

2.6.2.5 Alternative 5 – Intensive Management Approach

Alternative 5 represents managing forested trust lands in western Washington with emphasis on revenue production on lands that are not dedicated to habitat conservation. It maintains 1997 Habitat Conservation Plan objectives and strategies, adheres to the DNR Forest Resource Plan (with exception of proposed changes), and meets current federal and state statutes. “Intensive or active management” refers to a land management approach that accelerates forest growth and structural development processes through greater use of silvicultural activities.

2.6.2.6 Preferred Alternative – Innovative Silvicultural Management

The Preferred Alternative represents managing forested trust lands in western Washington using innovative silvicultural management techniques, including biodiversity thinnings, to generate both increased conservation benefits and revenue for the trusts. Less intensive management of the riparian zones is a key distinction between this and Alternative 6 analyzed in the Draft EIS. This approach attempts to integrate habitat and revenue generation objectives while maintaining the current Habitat Conservation Plan approach and DNR Forest Resource Plan objectives, and meeting current federal and state statutes. Central to active management is placing more land in an on-base status with increased silvicultural activity. Many of these activities are designed to accelerate forest growth and structural development processes. The Preferred Alternative is expected to produce more complex stands than the other Alternatives.

2.6.3 Features that Vary Among Reasonable Alternatives

The six Alternatives feature changes to policies, procedures, and implementation strategies, which are summarized below.

2.6.3.1 Sustainable Harvest Units – Ownership Groups

Currently, the sustainable harvest calculation is based on sustainable harvest units or “ownership groups.” The term “ownership groups” is used in the Forest Resource Plan to describe the grouping of different forested trust lands together for the purpose of calculating a discrete sustainable harvest level. Ownership groups include the state forested trust (also known as Forest Board Transfer) lands [individual counties (17 total in western Washington)], federal grant lands, and state forest non-trust (also known as Forest Board Purchase) lands (by DNR administrative regions, of which there are five in western Washington), Capitol State Forest, and Olympic Experimental State Forest (see Map 3 in Appendix). Current policy on ownership groups is defined in the DNR Forest Resource Plan under Policy No. 6 (Western Washington Ownership Groups). In all, there are 24 ownership groups. This current organization is retained in Alternatives 1 (No Action), 2, and 4.

Two variations of current policy are proposed in Alternatives 3, 5, and the Preferred Alternative. In Alternative 3, all western Washington forested state trust lands are placed into one ownership group. In Alternative 5 and the Preferred Alternative, the federal grant lands and state forest non-trust lands (currently five ownership groups) are placed into one ownership group. This reduces the overall number of groups from the current 24 to 20. The change to ownership groups proposed in Alternatives 3, 5, and Preferred Alternative would require a change to Forest Resource Plan Policy No. 6.

2.6.3.2 Timber Harvest Levels

The method of calculating the sustainable harvest levels is central to the management of forested trust lands. The sustainable harvest level is defined in volumetric terms in the statues (Revised Code of Washington 79-10-300(s)) and, regardless of how it is calculated, the Board will adopted a sustainable harvest level in volumetric units. However, the sustainable harvest level can be calculated by several means, including volume, acreage, and economic value. Current Board of Natural Resources policy uses timber volume.

When the sustainable harvest is calculated by volume, as current policy dictates (Forest Resource Plan Policy No. 5), the objective is to determine the maximum harvest volume that can be sustained over a planning period, subject to a large number of legal and policy constraints. Timber volume is expressed in terms of millions of board feet of timber.

If economic value is used to replace volume, the objective is to maximize the revenue value of the harvest, subject to other policy goals and constraints. This is significantly different from a volume model approach because the selection of stands for harvest in an economic model is likely to be more responsive to market demands and operational costs. The net effect may not be a difference in harvest level, but a difference in revenue generated.

Alternatives 1 through 4 incorporate current policy, calculating the harvest level by volume. Alternative 5 and the Preferred Alternative calculate the harvest level using an economic value approach and require a change to Forest Resource Plan Policy No. 5.

2.6.3.3 Sustainable Even-Flow Timber Harvest

"Even-Flow" Timber harvest ensures that about the same amount of timber is available now and for future generations in perpetuity. Basically, "sustained yield" means that harvest (yield) does not exceed productivity (growth). Theoretically it is a method for reaching forest equilibrium over time. However, changes in forest practices regulations, management objectives, land classifications (zoning), listing of threatened and endangered species, variable market conditions, and other factors can alter the equilibrium. This necessitates periodic adjustments in the calculation.

The current policy for sustainable even-flow timber harvest is defined in Forest Resource Plan Policy No. 4. The policy states, "The Department will manage state [trust] forest lands to produce a sustainable, even flow harvest of timber, subject to economic, environmental and regulatory considerations." In application, the term "even flow" means that roughly the same amount of timber is offered for sale by DNR on an ongoing basis. It refers to the amount of variability from the sustainable harvest level that will be entered into the computer model. Different interpretations of sustainable even flow would result in different harvest levels.

The definition for sustained yield contained in the Revised Code of Washington (RCW 79.10.310) requires "management of the forest to provide harvesting on a continuing basis without major prolonged curtailment or cessation of harvest." This concept of sustained or sustainable even flow can be characterized in several ways. Alternative 1 (No Action) and the five other Alternatives explore different approaches to what is an "appropriate" level of variability by approaching even flow in different ways.

Alternatives 1 and 4 propose no change to the current implementation of Forest Resource Plan Policy No. 4. As such, even flow is managed as a narrow band of variation, allowing the decadal harvest level to vary by as much as 25 percent above and below the long-term harvest level.

Alternative 2 proposes a non-declining even-flow approach, similar to the 1996 DNR sustainable harvest calculation.

Alternative 3 expands the allowable variation in harvest level, controlling the harvest fluctuation level within a wider band with no prolonged curtailment or cessation of harvest (RCW 79.10.310).

Alternative 5 and the Preferred Alternative propose to implement the sustainable timber harvest even-flow policy by not varying the subsequent decadal harvest from a previous decade by more than plus or minus 25 percent. This approach is similar to the flow constraint approach used by Bare et al. in their 1997 analysis and modeling the DNR Habitat Conservation Plan.

Alternatives 2 ,3 ,4, 5, and the Preferred Alternative would require revisions to DNR Procedure 14-001-010 (Determining Harvest Levels and Completing the Five-Year Action and Development Plan) and Forestry Handbook Task 14-001-020 (Developing the Draft Five-Year Action and Development Plan).

2.6.3.4 Silviculture

Silviculture is the art and science of cultivating forests to achieve objectives. DNR uses a site-by-site approach for evaluating and implementing silvicultural treatments, based on site-specific, rotational or long-term efficiency analysis return on investment, variable biological conditions, and social and physical limitations. Site-specific silvicultural prescriptions include activities such as: site preparation, planting specific tree species at specified densities, fertilization, weeding of non-desirable species, and the harvesting of trees.

Cutting of trees is prescribed to achieve objectives, i.e., revenue generation and/or restoration of structurally complex forests. Not all cut trees are harvested, i.e., removed from the stand. For example, young, dense, naturally regenerated western hemlock forest stands are often thinned to reduce the number of trees so that the residual trees can develop into larger trees. This type of thinning is called pre-commercial thinning.

Commercial thinning removes a portion of a stand, leaving a substantial number of trees to remain after a timber harvest. Commercial thinnings are typically carried out with the multiple objectives of generating revenue and accelerating the forest stand's development.

DNR typically implements commercial thinnings in stands when they are in the competitive exclusion stage of stand development (see Appendix B for a description of stand development stages). Trees in the competitive exclusion stage compete for direct sunlight, nutrients, water, and space. These stands are nearing, or have exceeded, full site occupancy and have little diversity in tree sizes. Traditional commercial forestry thinning "captures" the natural tree mortality before it occurs by harvesting the smaller trees that would normally die without harvest. Normally, commercial thinning in these competitive exclusion stands is from below, i.e., the thinning treatment removes the smallest trees first. Thinning usually results in about 70 percent of the initial stand remaining after harvest, measured as basal area. The traditional thinning treatment typically does not affect the stand's most dominant trees and the treatment perpetuates the competitive exclusion stage, with perhaps a brief interlude of understory development after the thinning harvest (see Photograph 1). The diversity of tree sizes of the dominant trees remains much the same as prior to the thinning treatment, but the stand's optimal growth rate is sustained.

For a forest stand to develop into a more structurally complex forest stage (Photograph 2), it must have vertical and horizontal diversity of tree sizes (in terms of tree heights and diameters) and tree spacing; large standing dead trees (snags); and large down logs (down woody debris). To develop such structural characteristics, a stand needs to develop along additional pathways than the single one described in the preceding paragraph. Stands in a competitive exclusion stage need to transition into an understory development stage to establish tree species under the main tree canopy so that these smaller trees can grow and develop into the mid-story. This development will, in time, provide the vertical and horizontal diversity of tree sizes. The remaining overstory trees will continue to develop and grow larger until they can be recruited either naturally (through disease or natural death for snags and through blowdown for large woody debris) or artificially through management to provide large standing dead trees or down woody debris.

To manage a stand along such a development pathway requires forest managers to have a comprehensive understanding of the structures and developmental processes in forest stands (Franklin 2002; Carey 2003). Carey et al. (1996) coined the phased "biodiversity pathways" for the management of forest stands (and forested landscapes) to achieve objectives of conserving biodiversity and generating revenue through the application silviculture that "accelerates" the development of structurally complex stands

Photograph 1. A thinned 60-year-old Douglas-fir stand on average site (III) in competitive exclusion.

Photograph 2. A Sitka spruce, Western hemlock, Douglas-fir stand on average site in a structurally complex stage with active management. It is estimated that similar structures could be obtained in 60 to 80 years.

The principal silvicultural tool of biodiversity pathways is thinning forest stands in a way that encourages diverse development of the residual forest stand, i.e., a thinning treatment that will likely result in the development of vertical and horizontal diversity of tree sizes. This is achieved through techniques such as variable density thinning, where the stand is thinned to different residual tree densities. Heavy thinning treatments can typically result in less than 50 percent of the initial stand remaining after harvest. Also, some dominant trees are removed from the upper canopy to create sufficient space and gaps for the development of smaller trees (Carey et al. 1999). Without such thinning treatments in dense competitive exclusion stands, the density of dominant trees will not allow for the development of understory trees within the stand. Normally, these variable density thinning treatments, both heavy and light, harvest across the diameter classes. For these reasons, variable density thinning is not necessarily inferior economically to traditional thinning.

The objective of variable density thinning and other treatments that encourage structural development is to increase the diversity of the trees that represent the largest cohort of trees within a stand. Figure 2.6-1 provides a hypothetical comparison between a stand in competitive exclusion stage and a structurally complex stage. Note that the distribution of tree sizes is narrow for the competitive exclusion stand (also see Photograph 1), while the structural complex stand demonstrates more diversity in tree sizes and species (also see Photograph 2).

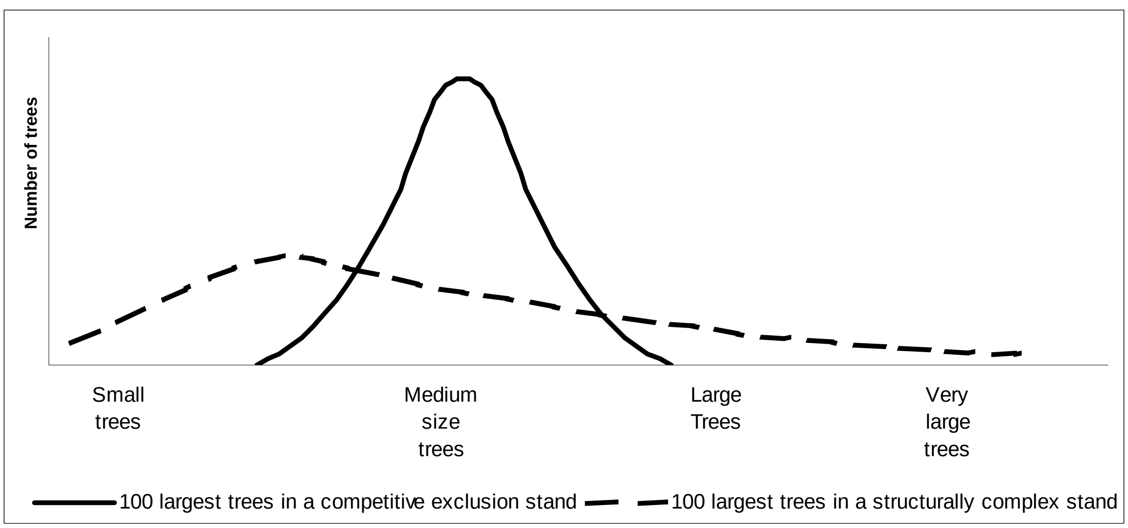

Figure 2.6-1. Hypothetical Example of the Distribution of Tree Sizes for the 100 Largest Trees in a Competitive Exclusion and Structurally Complex Stand

Typically, a regeneration harvest will occur at the time when landscape and stand objectives are met, i.e., revenue generation and/or structurally complex forest restoration. A regeneration harvest is the end-of-the-rotation treatment before the stand is re-planted or re-established through natural regeneration.

The principles of the biodiversity pathways approach to silvicultural treatment (based on Carey et al. 1996, page 23) are to:

1. Retain large-tree legacies (snags, large live trees, and their epiphytes) and conservation of soil organic matter, seed banks, and coarse woody debris and understory vegetation at harvest;
2. Minimize site preparation, but under-plant widely spaced, site-appropriate coniferous species to supplement natural regeneration of tree and shrub species;
3. Implement modified thinnings that retain patches and opens up the forest canopy to encourage the development of a diverse and patchy understory that mimics that in old forests; and
4. Directly improve habitat quality by creating cavity trees and adding coarse woody debris in the form of felled trees.

The principles call for a new silvicultural system that manages stand cohorts. The principles are applied over a rotational length silvicultural prescription. Depending upon a stand’s current condition, site, and species composition, different combinations of treatments based on the principles above would be applied at different stages during the rotation to maintain the stand on a pathway towards developing a structurally complex forest stand. The pathway is geared to optimally meeting these stand objectives.

The harvest treatments in the biodiversity pathways approach would typically be variable density thinnings that use a mix of heavy and light thinning, and regeneration harvests. The variable density thinnings would likely include a mix of heavily thinned areas (e.g., where less than 50 percent of the initial stand remains after harvest), lightly thinned areas (e.g., where more than 50 percent of the initial stand remains), small openings (of approximately 0.25 to 10 acres in size depending upon the stand conditions and objectives), and un-thinned areas.

Selecting the type of treatment and intensiveness of the thinning would be determined by site-specific conditions and stand objectives. Analysis of current forest conditions, the riparian and wetlands areas, and designated habitat management areas suggests that only about 35 percent of this area (231,000 acres) is suitable for long (140-year) rotation silviculture with heavy thinnings. Suitability is defined here as conifer-dominated stands that are not in a densely overstocked state. Thinning large-diameter closed (*competitive exclusion*) stands too heavily could lead to blow-down that may damage much of the existing forest structure (e.g., snags). In addition to the harvest treatments, the silvicultural prescriptions would likely include treatments to create and maintain snags, coarse woody debris, and small openings.

Regeneration of stands within the biodiversity approach is determined by alternating maturity criteria. Forest stands with current conditions that can be managed with variable density thinnings on long rotation may have maturity criteria of 110 to140 years depending upon the site, species ,and stand objectives. Forest stands that are currently overly stocked (i.e., have too many trees) and are beyond response to thinning without acceptance of undue risk are not conducive to longer rotations with variable density thinning. These stands have earlier maturity criteria, between 40 to 70 years depending upon site, species, and stand objectives. After their regeneration, these stands will be managed on a long rotation.

Silviculture in the Alternatives

Alternatives 1, 2, and 3 reflect traditional even-age silviculture that DNR practices currently. Planting densities are typically 300 to 400 trees per acre, but are tailored to site-specific conditions, species, and stand objective needs. Vegetation management and pre-commercial thinning are applied to stands, although economic objectives determine the intensity and frequency of these treatments. Fertilization and pruning techniques are limited. Commercial thinning harvests are normally from below and result in a residual (post harvest) stand that retains 70 percent of the initial pre-harvested stand. The minimum regeneration harvest age (the earliest age that a stand is considered eligible for regeneration harvest) is determined by balancing tree volume growth and economic potential, as well as site conditions, species, and stand objectives. For example, a Douglas-fir stand on site class III ground (average quality) has a maturity criterion modeled at 60 years. At regeneration harvest, a minimum of eight live trees per acre is left in the residual stand (7 percent of the original stand under Alternative 1).

Silviculture in Alternative 4 is very similar to Alternative 1, 2, and 3; however, the maturity criteria are lengthened. This has the effect of extending the rotation length of managed stands, whereby the stand may approach its culmination of growth (the end of the period of rapid growth). As an example, in Alternative 4, a Douglas-fir stand on site class III ground has a minimum regeneration harvest age of 80 years. At regeneration harvest, a minimum of eight live trees per acre is left in the residual stand.

In Alternative 5, the silviculture is more intensive. Planting densities are in the 300 to 400 tree per acre range with selected planting stock. Vegetation management and pre-commercial thinnings are applied and fertilization is used on selected sites. Stands are scheduled for regeneration harvest based on economic value and the maturity criteria are determined by the economic potential of stand growth. In this Alternative, the emphasis is on harvesting stands of trees when they have reached their maximum discounted economic value, expressed as net present value. As an example, in Alternative 5, a Douglas-fir stand on site class III ground has a minimum regeneration harvest age of 50 years. At regeneration harvest, a minimum of eight live trees per acre is left in the residual stand.

In the Preferred Alternative, the silviculture is a mix of current DNR silvicultural practices, more intensive silviculture and silvicultural approaches based on biodiversity pathways (Carey et al. 1996). For this Alternative, silviculture on Upland Areas with General Management Objectives (see Chapter 4, Section 4.2) reflects a mix of current DNR silvicultural practices (as in Alternative 1 through 3) and more intensive approaches (as in Alternative 5). Commercial cohorts of trees (these are a group of trees of similar characteristics, such as age or size that exist in a stand) are typically managed with even-age silvicultural regimes. Planting densities typically range between 300 and 400 trees per acre, but may be more or less as determined by the optimal pathway to achieve the objectives. Stands are also treated for vegetation management and pre-commercial thinning as necessary. The maturity criteria are flexibly determined by the landscape and stands objectives. Economic value of the growth potential of the stand is an important consideration; however, other aspects and conditions such as social and environmental factors will play a role in determining the stand's regeneration age. At regeneration harvest, a minimum of 8 trees per acre is left in the residual stand.

For the Preferred Alternative, silviculture in Upland Areas with Specific Management Objectives and Riparian and Wetland Areas is a mixture of current DNR silviculture (as in Alternative 1 through 3) and silviculture based on biodiversity pathways principles. DNR silviculture is assumed to be applied to hardwood-dominated stands, while biodiversity pathways silviculture is applied to conifer-dominated stands.

Each Alternative would require changes to Forest Resource Plan Policy No. 4, and to DNR Procedure 14-005-020 (Identifying and Prioritizing Stands for Regeneration Harvest).

2.6.3.5 Northern Spotted Owl Habitat Management

None of the Alternatives proposes changes to the nesting, roosting, foraging, and dispersal habitat strategies outlined in the Habitat Conservation Plan (page IV.3). Northern spotted owl management is represented by a suite of policy, procedural, and implementation strategies. These are currently specified in the Habitat Conservation Plan and Procedure 14-004-120.

Northern spotted owl habitat circle management is currently applied to three types of owl circles listed in Procedure 14-004-120. As specified in the Implementation Agreement Memorandum # 1 of the Habitat Conservation Plan, no timber harvest is allowed within certain northern spotted owl circles prior to 2007, and harvest is allowed only within non-habitat areas of several other circles. These areas are identified as "Memorandum # 1" northern spotted owl circles.

Management in two other groups of northern spotted owl circles—"Status 1 – Reproductive" and "Southwest Washington"—is restricted by Procedure 14-004-120. Timber harvest activities are allowed only in the non-habitat portions of Southwest Washington northern spotted owl circles, and only habitat enhancement activities are allowed in the non-habitat portion of all Status 1 – Reproductive northern spotted owl circles throughout the planning area. The Washington Department of Fish and Wildlife defined both Status 1 – Reproductive and Southwest Washington northern spotted owl circles.

All Alternatives maintain the management of Memorandum # 1 northern spotted owl circles until 2007.

Management of Status 1 – Reproductive and Southwest Washington northern spotted owl circles outside the Olympic Experimental State Forest varies among the Alternatives. Alternatives 3, 4, 5, and the Preferred Alternative propose to defer Status 1 – Reproductive northern spotted owl circles from harvest prior to 2007, while Alternative 2 proposes no deferral of these circles. Final EIS Alternatives 3, 4, 5, and the Preferred Alternative protect the Southwest Washington northern spotted owl circles prior to 2006, while Alternative 2 proposes no deferral of these circles. In all Alternatives except Alternative 1, timber harvests in Status 1 – Reproductive northern spotted owl circles in the Olympic Experimental State Forest are not deferred. Adoption of any of the Alternatives other than Alternative1would require a change in Procedure 14-004-120, but no amendment to the Habitat Conservation Plan would be required.

Under current procedures, when the area designated for nesting, roosting, foraging, or dispersal management within a watershed (based on 2000 Watershed Administrative Unit delineations and referred to in this document as "watershed") is below 50 percent of the desired habitat threshold, regeneration harvests are not allowed. Regeneration harvests are allowed when the threshold is reached or exceeded (Habitat Conservation Plan, page IV.4). If less than 50 percent of designated nesting, roosting, foraging, or dispersal management areas in a watershed meets the habitat requirements, then only habitat enhancement activities may be conducted, even in the non-habitat portion of that watershed. Habitat enhancement includes thinnings that accelerate the development of structurally complex forest stands. This current management is modeled only in Alternative 1 (No Action), and would require no change to procedure.

In Alternatives 2, 3, 4, 5, and the Preferred Alternative, a target of 50 percent desirable habitat is established for designated nesting, roosting, foraging, or dispersal management areas within a watershed. In addition, regeneration harvests and thinnings are allowed in non-habitat areas in the rest of the watershed even if the watershed currently has less than 50 percent habitat.

The Preferred Alternative takes this strategy one step further to include silvicultural treatments based on concepts of biodiversity pathways described in Section 2.6.3.4 on Silviculture.

Alternatives 2, 3, 4, 5, and the Preferred Alternative would require a change to Procedure 14-004-120 (Management Activities Within Spotted Owl Nest Patches, Circles, Designated Nesting, Roosting, Foraging, and Dispersal Management Areas) and are consistent with the Habitat Conservation Plan.

2.6.3.6 Old Forest Components

The definition, components, extent, and management of "old forest" are important issues in sustainable forestry management. Old forests are defined as forest inventory units with old growth structure. DNR currently manages old forests with four basic guidelines, in addition to the northern spotted owl requirements discussed previously.

1. The Old Growth Research Area deferrals (Forest Resource Plan Policy No. 14) will be deferred from harvest. The purpose of these deferrals is to maintain DNR's ability to conduct research and collect data that may assist management elsewhere and benefit the trusts in the long run.
2. Olympic Experimental State Forest conservation strategies in the Habitat Conservation Plan specify that 20 percent of forested trust lands in any given Olympic Experimental State Forest landscape will be maintained in older forest conditions (Habitat Conservation Plan, page IV.88).
3. Where DNR manages at least 5 percent of the total watershed, DNR will maintain at least 50 percent of forested trust land in trees 25 years old or older (Task 14-001-010, Maintain Mature Forest Components). This "50/25" strategy stipulates that until 50 percent of a watershed meets the forest maturity criterion, no regeneration harvest is allowed in that watershed.
4. Legacy and reserve trees will be retained in regeneration harvest units as detailed in Procedure 14-006-090 [Legacy and Reserve Tree Levels for Regeneration Harvest Units (Variable Retention Harvesting)].

Alternative 1 includes all provisions for old forest management in current operations, as defined above, requiring no changes to policy or procedure.

The remaining Alternatives maintain two of the four basic components of current management—Old Growth Research Area deferrals as defined in Forest Resource Plan Policy No. 14, and the management for old forest conditions in the Olympic Experimental State Forest as defined in the Habitat Conservation Plan (page IV.88).

Alternatives 2, 3, 4, 5, and the Preferred Alternative do not maintain the "50/25" strategy and would require changes to Task 14-001-010 if one of these Alternatives is adopted by the Board. In addition, all Alternatives except Alternative 1 replace the required legacy and reserve tree level requirements in Procedure 14-006-090 with language implementing the protection of structurally unique trees and snags described in the Habitat Conservation Plan (pages IV.156-157). Under Alternatives 2, 3, 4, 5, and the Preferred Alternative, this legacy and reserve tree procedure would change from the current procedure requiring retention of 7 percent of the trees in regeneration harvest units to the Habitat Conservation Plan strategy of retaining a minimum of 8 trees per acre.

Alternatives 4, 5, and the Preferred Alternative have different approaches to maintaining and/or creating old forest conditions.

Alternative 4 proposes to defer for the entire planning period all current forest stands with an age equal to or greater than 150 years in the 2001 forest inventory.

Rather than specifically preserving all forests of a certain age existing today, Alternative 5 and the Preferred Alternative propose that 10 to 15 percent of each HCP Planning Unit be targeted as old forests, based on structural characteristics.

Adoption of these features by the Board would require changing Forest Resource Plan Policies to reflect this change in policy direction.

2.6.3.7 Riparian and Wetland Areas

The Riparian and Wetland Management Zone strategies in the Alternatives are based on the management objectives described in the Habitat Conservation Plan. The Board of Natural Resource and the DNR are not deliberating a decision with regard to riparian management as part of this sustainable harvest calculation. Parallel with this analysis, the DNR and the Federal Services are undertaking development of a riparian strategy. However, this riparian strategy has not been completed.

The analysis included within this sustainable harvest calculation, therefore, examines the effects of a reasonable set of estimates of future procedures that meet the Habitat Conservation Plan riparian management objectives. To aid in understanding DNR's Habitat Conservation Plan management of Riparian and Wetland Areas, some of the history of planning and implementation is provided below.

The Habitat Conservation Plan specified an interim set of management procedures to be used until permanent procedures could be developed by DNR, then reviewed and approved by the Federal Services (Habitat Conservation Plan, page IV.61). Once implementation began according to the plan, DNR agreed not to conduct activities in Riparian Management Zones—other than limited road development and maintenance—until a permanent procedure had been agreed upon. Current management of these sensitive areas follows the plan's guidelines and is identified in Procedure 14-004-150 (Identifying and Protecting Riparian and Wetland Management Zones in Westside Habitat Conservation Plan Planning Units, excluding the Olympic Experimental State Forest Planning Unit). As stated in the plan, Riparian Management Zones are to be developed on stream types 1, 2, 3, and 4, and Wetland Management Zones are to be developed for wetlands greater in size than 0.25 acre.

Currently, no harvest activities are conducted within designated Riparian Management Zones, except road and yarding corridor crossings. Activities are allowed within the Wetland Management Zones as identified in Procedure 14-004-110. These guidelines are assumed unchanged in Alternatives 1 and 4.

Alternatives 2, 3, 5, and the Preferred Alternative instead provide a range of restoration and silvicultural activities that may be considered under the final riparian procedure. Riparian ecosystem restoration encompasses a range of activities that must be site-specific and tailored to the physical and biological conditions at a particular site.

As defined in the Habitat Conservation Plan (page IV.62), disturbance of areas of potential slope instability, including those within Riparian and Wetland Areas, is restricted to light access development and maintenance (road and yarding corridors).

In Alternatives 2 and 3, restoration and silvicultural activities are assumed to occur at a moderate intensity, that is to say less than 1 percent per year of the total Riparian and Wetland Area may have a silvicultural treatment. Most of these treatments are assumed to be traditional thinnings (see Section 2.6.3.4) within the outer Riparian Management Zones. The outer zones are the minimal-harvest zone and the low-harvest zone (HCP page IV.70). These light thinnings normally retain at least 50 percent of a forest stand after thinning.

In Alternative 5, restoration and silvicultural activities are allowed at moderate intensity where less than 1 percent per year of the Riparian and Wetland Area may be treated with a restoration activity. Alternative 5 assumes similar thinning treatment to Alternatives 2 and 3.

The Preferred Alternative assumes that the restoration treatments in the outer Riparian Management Zones will be a combination of traditional thinnings, patch cuts of 0.5 to 2 acres, and biodiversity pathway approaches. Unlike the Draft EIS Alternative 6, where the restoration treatments could be characterized as extensive, the Preferred Alternative treats fewer acres per year: less than 1 percent per year of the total Riparian and Wetland Area. The change from the Draft EIS Alternative 6 to the Preferred Alternative was in response to the Board's direction and public comments.

The Habitat Conservation Plan management strategies for the Olympic Experimental State Forest are designed to effectively maintain key physical and biological functions until streams recover sufficiently from past disturbances. Combined with the current forest conditions and experimental objectives, the Olympic Experimental State Forest riparian strategies are different from the five Westside HCP Planning Units (page IV.132).

2.6.4 Projected Harvest Levels by Alternative

Each Alternative has two major components. The first is the set of policy and procedural changes (Table 2.6-1) necessary to accomplish the goals of that Alternative, and the second is the decadal sustainable harvest levels by ownership groups and trusts (Tables 2.6-2 and 2.6-3).

The modeling outputs for an Alternative provide substantial information to help understand the management impacts and harvest levels associated with each Alternative. The modeling outputs are based on reasonably available information, and are used in the Environmental Impact Statement to inform decision-makers and the public of possible significant impacts on various resources. These outputs, however, do not form the basis of the analyses in this document. Instead, the environmental analysis is based on a review of proposed changes to policy and procedures under which DNR operates. This is because DNR's actions under all Alternatives would be governed by policies and procedures, and would not simply follow the management pathways shown by modeling outputs. The analysis, therefore, takes into consideration the complete suite of policies, strategic plans, and procedures that direct and guide DNR's forest management activities on western Washington forested state trust lands. DNR considers the model outputs as the best information available to illustrate the range of likely outcomes for each of the Alternatives at the HCP Planning Unit scale. In Section 4.15, Cumulative Effects, modeling outputs and additional data are used to help describe the relative potential impacts at the watershed scale.

Table 2.6-1. Summary of Policy, Procedure, and Task Changes under the FEIS Alternatives

Management Issue	Policy, Procedure, Task Reference	Forest Management Alternatives 1	2	3	4	5	Preferred Alternative
Ownership groups	Policy No. 6	Current policy (24 groups)	Current policy (24 groups)	Change policy (1 group)	Current policy (24 groups)	Change policy (20 groups)	Change policy (20 groups)
Even-flow of harvest	Policy No. 4	Current policy	Update policy discussion	Update policy discussion	Current policy	Update policy discussion	Change policy
	PR 14-001-010 TK 14-001-020		Change procedure, task	Change procedure, task	Change procedure, task	Change procedure, task	Change procedure, task
Harvest regulation	Policy No. 5	Current policy	Current policy	Current policy	Current policy	Change policy	Change policy
Maturity criteria	Policies No. 4, 11, 30	Current policy and procedure	Update policy discussion (No. 4)	Update policy discussion (No. 4)	Update policy discussion (Nos. 4, 11)	Update policy discussion (Nos. 4, 11)	Change policy (Nos. 4, 11, 30)
	PR 14-005-020		Change procedure	Change procedure	Change procedure	Change procedure	Change procedure
Northern spotted owl conservation	Nesting, roosting, foraging, and dispersal PR 14-004-120	Current procedure	Change procedure	Change procedure	Change procedure	Change procedure	Change procedure
	Owl circles PR 14-004-120	Current procedure	Change procedure	Change procedure	Change procedure	Change procedure	Change procedure
Old forest components	Targeting Older Forest Conditions	Current policy	Current policy	Current policy	Update policy discussion	Change policy	Change policy
	Task 14-001-010 (Maintaining Mature Forest Components)	Current task	Change Task	Change Task	Change Task	Change Task	Change Task
	PR 14-006-090 (Legacy and Leave Tree Levels)	Current procedure	Change procedure	Change procedure	Change procedure	Change procedure	Change procedure

Table 2.6-2. Summary of State Trust Lands Sustainable Harvest Level in Million Board Feet per Year by Sustainable Harvest Unit (Ownership Group) for First Decade (2004-2013) Under Each Alternative

		Sustainable Forest Management Alternatives					
		1	2	3	4	5	PA
Trust Group	Ownership Group	First Decade Values in Millions of Board Feet per Year					
Federal Granted Trusts	DNR Central Region	42	66		62		
	DNR Northwest Region	44	56		48		
	DNR Olympic Region	7	17		14		
	DNR South Puget South Region	41	34		24		
	DNR Southwest Region	56	65		56		
	Federal Grants as one Westside group					260	307
	Capitol State Forest	39	42		39	41	37
	Olympic Experimental State Forest	18	63		10	136	77
State Forest Transfer Trust	Clallam County	7	15		17	23	20
	Clark County	12	13		10	13	10
	Cowlitz County	5	6		5	6	5
	Jefferson County	5	6		3	7	6
	King County	9	8		6	11	10
	Kitsap County	3	3		2	3	2
	Lewis County	15	21		18	22	18
	Mason County	8	9		7	9	5
	Pacific County	4	8		7	9	10
	Pierce County	4	4		1	5	7
	Skagit County	30	35		32	36	49
	Skamania County	5	14		3	15	21
	Snohomish County	23	28		27	27	27
	Thurston County	3	6		3	4	5
	Wahkiakum County	4	5		6	7	6
	Whatcom County	11	14		13	13	14
	All trusts as one Westside group			663			
	Westside harvest level	396	537	663	411	648	636

Note: Total harvest values in this table do not match all values in Table 2.6-3 due to rounding.

Table 2.6-3. Summary of Projected Harvest Levels in Millions of Board Feet Per Year for First Decade (2004-2013) by State Trust, by Alternative

Trusts	Sustainable Forest Management Alternatives					
	1	2	3	4	5	PA
	First Decade Values in Millions of Board Feet per Year					
Agricultural School	9	9	8	12	11	17
Capitol Grant	34	0	47	29	58	58
Charitable/Educational/Penal & Reformatory Institution	14	15	17	12	16	19
Common School and Indemnity	113	174	180	119	202	197
Community College Forest Reserve	1	0.9	0.3	1	0.5	1
Escheat	2	1.7	2	1	1	1
Normal School	6	12	11	7	13	9
Scientific School	23	22	28	23	27	32
State Forest Purchase	33	37	60	36	45	42
State Forest Transfer	159	212	299	167	260	248
University - Original	1	0.4	1	1	1	1
University - Transferred	1	12	9	3	13	12
Total	**396**	**537**	**663**	**411**	**648**	**636**

Note: Total harvest values in this table do not match all values in Table 2.6-2 due to rounding. A“zero” value in the table is where the estimated harvest level is less than 1 million board feet annually. A zero value **does not** denote that there is no harvest for the trust in that decade.

Tables 2.6-4 through 2.6-6 present a summary of the Alternatives’ major policy and procedural changes, modeled harvest volumes by sustainable harvest unit (ownership group) and trust, off- and on-base acres, land class acreages, and average rotation lengths.

2.6.4.1 Summary of Rotation Lengths

The application of silviculture policy decisions on the forest interacts with other policy objectives such as sustainable timber harvest flow, sustainable harvest units, and habitat objectives. The interaction of these policy goals together in an Alternative can be expressed as an average rotation length. These are presented for the Alternatives in Table 2.6-6.

Table 2.6-4. Summary of Off- and On-Base Lands

				On-Base					
Year	Alternative	Off-Base		Riparian and Wetland Area		Uplands with Specific Objectives		Uplands with General Objectives	
		Acres	%	Acres	%	Acres	%	Acres	%
2004	Alt.1	763,000	55%		0%	322,500	23%	305,200	22%
	Alt.2	489,300	35%	214,800	15%	343,100	25%	343,500	25%
	Alt.3	514,400	37%	238,600	17%	328,100	24%	309,600	22%
	Alt.4	755,500	54%		0%	326,400	23%	308,800	22%
	Alt.5	513,400	37%	238,700	17%	329,600	24%	309,000	22%
	PA	515,500	37%	237,800	17%	327,800	24%	309,600	22%
2013	Alt.1	736,600	53%		0%	348,400	25%	305,700	22%
	Alt.2	281,100	20%	278,100	20%	477,200	34%	354,200	25%
	Alt.3	213,000	15%	346,200	25%	477,200	34%	354,200	25%
	Alt.4	573,400	41%		0%	463,500	33%	353,800	25%
	Alt.5	213,000	15%	346,200	25%	477,200	34%	354,200	25%
	PA	232,100	17%	329,000	24%	475,400	34%	354,200	25%

Notes:
Off-base acres include both long-term (multiple decade) timber harvest deferrals (such as northern spotted owl nest patches, Natural Area Preserves) and short-term deferrals (such as some transition lands, northern spotted owl circles in some Alternatives).
PA = Preferred Alternative

Table 2.6-5. Approximate Land Class Areas by HCP Planning Unit

HCP Planning Unit	Riparian and Wetland Areas		Uplands with Specific Objectives		Uplands with General Objectives		Total
	Acres	%	Acres	%	Acres	%	Acres
Columbia	86,400	32%	99,500	37%	81,600	31%	**267,500**
N. Puget	92,700	24%	205,000	54%	83,800	22%	**381,500**
OESF	111,300	43%	145,200	57%			**256,500**
S. Coast	81,000	35%	36,700	16%	115,300	49%	**233,000**
S. Puget	34,600	24%	82,100	58%	25,200	18%	**141,900**
Straits	20,700	19%	32,900	30%	56,800	51%	**110,400**
Total	**426,700**	**31%**	**601,300**	**43%**	**362,700**	**26%**	**1,390,700**

OESF = Olympic Experimental State Forest

Table 2.6-6. Average Rotation length (in years) by Alternative

	Alternatives					
Decades	**Alt.1**	**Alt.2**	**Alt.3**	**Alt.4**	**Alt.5**	**PA**
1	86	70	57	116	63	58
2	103	75	61	99	58	83
3	112	80	93	113	64	95
4	105	69	67	123	71	90
5	98	64	50	111	70	84
6	107	68	64	106	68	81
7	104	69	57	108	69	96
Average	**102**	**71**	**64**	**111**	**66**	**84**

Note: The rotation length is calculated by dividing the regeneration harvest area divided by the total on-base area in the upland land classes (approximately 831,450 acres). Riparian treatments are considered un-even age management and therefore do not have rotation.
PA = Preferred Alternative

The average rotation length, while may be useful for conveying a general message about an Alternative, hides the detail and variation of site-specific management that an Alternative will implement. Also, an average rotation length is easily misconstrued as a policy objective in itself. None of the Alternatives explicitly state this type of policy objective. The six Alternatives are designed to search for a balance of generating income for the trusts while restoring the forest conditions for habitat conservation.

2.6.4.2 Summary of Proposed Alternatives

As detailed in Section 2.6.2, there are several policy, procedure, and implementation strategy changes for each of the Alternatives (except Alternative 1). Table 2.6-1 summarizes changes that would be necessary if the Board eventually selects an Alternative or a feature of an Alternative. If selected, such changes would become effective following the release of the Final Environmental Impact Statement and closure of the statutory waiting period.

2.6.5 Summary of Environmental Consequences

This section summarizes the environmental analysis detailed in Chapter 4 of the Environmental Impact Statement, which examines the effects of proposed changes to the current policy and procedures under each Alternative. Conclusions are based on reasonably available data and generally qualitative analysis, supported by quantitative data where available and appropriate. Computer model outputs provide useful information that illustrates expected impacts of the Alternatives. The Forest Resource Plan and the Habitat Conservation Plan Environmental Impact Statements provide useful benchmarks for evaluating the effects of the 2003 sustainable harvest calculation level.

Potential relative risks are identified and discussed for the resource areas and are used to rank the Alternatives. The potential relative risks and rankings express the potential for environmental impacts to occur.

None of the Alternatives would result in any probable significant adverse impacts to any of the resource areas, relative to current conditions, beyond those anticipated in the Habitat Conservation Plan. A relatively high risk does not necessarily equate to a probable significant adverse impact when compared to another Alternative or to existing conditions.

2.6.5.1 Forest Structure

This section analyzes the environmental effects on forest structure, old forests, forest health, carbon sequestration, and threatened and endangered plant species. The analysis examines the current and proposed changes to policy and procedures under the different Alternatives. This analysis also assesses relative risks among Alternatives that are illustrated using modeling outputs.

Alternatives 1 and 4 would provide more old forest and would entail less risk of adversely affecting threatened, endangered, and sensitive plant species than the other Alternatives. However, Alternatives 1 and 4 would result in more dense forest stands that achieve lower individual tree growth rates and are more susceptible to damage from insects and disease. Alternative 2 and the Preferred Alternative are ranked intermediate in terms of their overall relative risk of causing negative environmental impacts. The Preferred Alternative has a higher risk associated with it over the short term, but in the long term ranks highest in the development of structurally complex forest stands. Both the Preferred Alternative and Alternative 2 would require an intermediate level of investment for successfully implementing their management strategies and achieving the projected level of harvest.

Alternatives 3 and 5 would have fewer policy limitations for stand management and timber harvest and would apply more intensive management strategies than the other Alternatives. Management proposed under Alternatives 3 and 5 would result in more harvest area and forests that are less susceptible to insect and disease damage.

Alternative 5 and the Preferred Alternative would entail more relative risk of adversely affecting threatened, endangered, and sensitive species of plants due to more harvest and harvest-related disturbance.

2.6.5.2 Riparian

The distribution of stand development stages within riparian areas suggests that compared to historic unmanaged stands, many moderate to large streams on western Washington forested state trust lands may have reduced levels of multiple riparian functions because of decreased levels of large, fully functioning stands. Riparian areas for smaller streams may have adequate shade and size for potential instream large woody debris, but may be deficient in decadent features and other riparian functions important to wildlife and other riparian-dependent species. Many riparian areas currently contain moderate to high levels of early stand development stages, and are not likely to change in the near future. Thinning can reduce the time necessary to produce very large trees and reduce the time needed to increase stand complexity.

Removing trees within the Riparian Management Zone may temporarily reduce the level of some riparian functions, but the extent of the reduction depends on where trees are removed, site-specific conditions, the amount of trees removed, and the particular riparian function being considered (Washington Forest Practices Board 2001). Such near-term impacts would have to be considered against the potential to accelerate functional recovery. The degree to which moderate intensity timber management would affect near-term riparian function is uncertain. However, active forest management can change species and stand composition and accelerate the development of more complex stand structures (Carey et al. 1996). Such events would help to restore long-term riparian functioning but may have some short-term adverse effects.

Each Alternative proposes different levels of harvest activities in riparian areas (Table 4.3-2). During the remaining period of the Habitat Conservation Plan, Alternatives with lower levels of activity, such as Alternatives 1, 2, 3, and 4, are expected to have a higher proportion of riparian area with large and very large trees that are in competitive exclusion stages. In contrast, Alternatives with higher levels of active management, such as the Preferred Alternative, are expected to have more riparian area that will be fully functioning (descriptions of these stand development stages are provided in Appendix B, Section B.2.3), or be on a trajectory towards full function. Regardless, riparian conditions are expected to improve under all Alternatives relative to current conditions. This is due to changes in stand structure, particularly increases in the amount of stand development stages that include large and very large trees, which are in moderate supply throughout much of the forested trust lands (see Figure 4.3-2). The rate of improvement in structurally complex forests overall is similar among most Alternatives, though the Preferred Alternative performs better through 2067. When looking at the two most complex stages of niche diversification and fully functional forests, the Preferred Alternative accounts for more than 13 percent of riparian areas by 2067 compared to about 7 percent for Alternative 1.

2.6.5.3 Wildlife

None of the Alternatives, including the Preferred Alternative, proposes changes to the northern spotted owl conservation strategy, as outlined in the Habitat Conservation Plan (HCP) on pages IV.1 to IV.19 and IV.86 to IV.106. The HCP Environmental Impact Statement is incorporated by reference and relied on in this Final EIS. In addition, this Final EIS analyzes the Alternatives in light of the new information on northern spotted owl demography discussed in Section 4.4.3 of this document. The analysis also includes a comparison of the Alternatives using three criteria:

- changes in the amount of structurally complex forest ;
- the amount of timber harvest in designated Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas; and
- changes in the management of owl circles.

Other policy and procedure changes under the Alternatives would influence the amount and distribution of wildlife habitat on forested trust lands. The Alternatives would vary in the timing and amount of forest structures they would create, but would not be expected to have any significant adverse environmental effects on wildlife.

The sustainable harvest calculation analysis uses the stand development stages to represent structural diversity and habitat values (descriptions of these stand development stages are provided in Appendix B, Section B.2.3). Changes in the relative amount of forested habitat types are a product of varying rates and intensities of timber harvest under the different Alternatives. Appendix D, Table D-12 presents the modeled proportion of forested trust lands comprising ecosystem initiation, competitive exclusion, and structurally complex forests under each Alternative in the years 2013 (short term) and 2067 (long term). Competitive exclusion forests are the most common forest habitat type on forested trust lands, making up 68 percent of the total forested area (Table 4.4-1). Approximately 26 percent of this habitat type occurs in Upland Areas with General Management Objectives. Structurally complex forest makes up about 25 percent of the total area on forested trust lands (Table 4.4-1). In the short term and long term, the amount of structurally complex forest is modeled as increasing in all HCP Planning Units under all Alternatives.

The structurally complex forests stages serve as a relative indicator of change in the amount of habitats of management concern. Several examples follow:

- <u>Northern Spotted Owl</u> - Throughout much of their range, northern spotted owls are strongly associated with forested areas that are classified as structurally complex in this Environmental Impact Statement.
- <u>Marbled Murrelet</u> - The Marbled Murrelet Recovery Plan (USFWS 1997) identifies terrestrial (upland) habitat essential for marbled murrelet recovery. The Recovery Plan identifies additional areas on non-federal land where existing habitat should be protected because habitat in federal reserves is insufficient to reverse population declines and maintain a well-distributed population. In the state of Washington, such additional essential habitat occurs on state lands within 40 miles of marine waters. These areas are critical for improving the distribution of the population and suitable habitat, especially in southwestern Washington (USFWS 1997). Effects on forestlands within 40 miles of marine waters, therefore, are of particular concern in determining the effects of the Alternatives on marbled murrelet populations. Of the approximately 340,000 acres of structurally complex forest on forested trust lands (Table 4.4-1), approximately 85 percent occur within 40 miles of marine waters (see Table D-16).
- <u>Deer and Elk</u> - The results from the Washington Forest Landscape Management Project (1996) indicated that the estimated carrying capacities for deer and elk are comparable when either timber production is maximized or when 30 percent of the watershed is maintained in a fully functional forest stage.

Forest in the competitive exclusion stages is currently the most abundant habitat type on forested trust lands. Under all Alternatives, the majority of timber harvest is expected to occur in this habitat type. Two processes would likely affect the amount of competitive exclusion forest: conversion to ecosystem initiation forest through high-volume timber harvest, and development into structurally complex forest through natural forest succession, as well as forest management activities such as thinning.

Model output data indicate that the amount of competitive exclusion forest on forested trust lands would decline under all six Alternatives in both the short term and the long term (Table 4.4-3). In the short term, results show very little difference in the amount of competitive exclusion forest among the Alternatives (Appendix D, Table D-12). Model outputs indicated that at the end of the planning period, by 2067, all Alternatives would reduce the amount of forestlands in competitive exclusion, ranging from 1 to 8 percent. Under Alternatives 1, 4, and 5, approximately 65 percent of forested trust lands would consist of competitive exclusion forest, while Alternatives 2 and 3 would result in about 64 percent. Under the Preferred Alternative, 60 percent of the forested trust lands would consist of competitive exclusion forest (Appendix D, Table D-12).

For the most part, decreases in the amount of competitive exclusion forest correspond to increases in the amount of structurally complex forest. This result suggests that many areas that currently sustain competitive exclusion forest would acquire the characteristics of structurally complex forest over time. The greatest long-term declines in competitive exclusion forest would likely occur under the Preferred Alternative, followed in descending order by Alternatives 1, 4, and 5, and 2 and 3. Declines in the amount of competitive exclusion forest would not be expected to result in any significant adverse effects to wildlife species overall. No wildlife species are found exclusively in competitive exclusion forests, and decreases in the amount of competitive exclusion forest would nearly be matched by increases in structurally complex forest.

2.6.5.4 Air Quality

None of the proposed Alternatives would create new policies or procedures related to air quality. Impacts related to air quality would result from the projected forest management activities associated with each of the Alternatives.

The Alternatives differ slightly in their effects to air quality, but none of the Alternatives has the potential for significant environmental impacts relative to current conditions, beyond those anticipated in the Habitat Conservation Plan Environmental Impact Statement. Air pollution from dust would be mitigated by dust abatement measures under all Alternatives, and the total amount of prescribed burning would likely continue to be below the level anticipated in the Habitat Conservation Plan.

2.6.5.5 Geomorphology, Soils, and Sediment

Significant increases in landslide frequency or severity and loss of soil productivity relative to current conditions, beyond those anticipated in the Habitat Conservation Plan (HCP) Environmental Impact Statement, are not anticipated under any of the Alternatives. Increased soil erosion may occur in certain intensely managed areas as road use increases. Further discussion of relative impacts among the HCP Planning Units and for individual watersheds is included in Section 4.15, Cumulative Effects. The Alternatives are ranked according to percent of uplands impacted per decade by intensity of harvest type (Table 4.6-8). By this ranking, Alternative 5 carries the highest potential overall relative impact, followed by Alternatives 2, 3, the Preferred Alternative, 4 and 1.

The public comments requested that the Final EIS review the differences between Alternatives with regard to forest roads. Section 4.6 presents information relevant to road impacts. In general, it is not expected that the number of road miles or road density will vary as a result of the implementation of any of the proposed Alternatives. While the Final EIS Alternatives propose different harvest timings and locations, the basic road network statewide will evolve to the end condition, over time, virtually independent of which Alternative is chosen. Road spacing is mostly dependent on topography. Topography drives the type of logging system used to achieve the desired silvicultural objectives, which in turn dictates optimal yarding distance to road spacing combinations. This is illustrated by Table 4.6-3 (Section 4.6), “Road Density Analysis by Deferral Class under the Preferred Alternative in 2004.” The table shows that there are small differences between road density in areas that would be deferred from harvest under the Preferred Alternative and the areas that would allow activity.

Road impacts for all the Alternatives should be well within the range anticipated by the Habitat Conservation Plan (HCP) due to the relationship to the total acres harvested. As indicated in Table 4.6-4, harvest levels in each of the activity types for each of the Alternatives are within those expected under the Habitat Conservation Plan and analyzed in the HCP Draft and Final Environmental Impact Statement (EIS). The HCP Draft EIS (DNR 1996) analyzes effects related to sediment (p. 4-163) and stream flow (p. 4-170). Mitigation in the form of Riparian Management Zones, management for hydrologically mature forest in the significant rain-on-snow zones, wetland protection, and road management planning (identified above) are detailed in those sections.

The Washington Forest Practices Rules Final EIS (DNR 2001) also presents an analysis of the effects of sediment, peak flows, and roads in Riparian and Wetland Areas on water quality and on fish. A discussion of sediment is contained in Section 3.2 (p. 3-7), which discusses road surface erosion and road-related landslides. The evaluation of the Alternatives in this analysis offers the 2001 rules package that provides measures necessary to address impacts due to road-related sedimentation (p. 3-16). These mitigation measures include implementation of road maintenance and abandonment plans and the adaptive management program. In addition, Appendix F in the Final EIS for the Forest Practices Rules discusses the effects of road construction and maintenance and describes recommended and accepted practices for building and maintaining roads. It states that, "Roads built following Forest Practices Rules that provide specific direction and recommended Best Management Practices (BMPs) from the literature have the lowest risk of causing sediment delivery" (p. F-2). As stated above, all of the Alternatives will meet the requirements as specified in the Forest Practices Rules.

2.6.5.6 Hydrology

Procedure 14-004-060, which prohibits harvest of hydrologically mature forest in the rain-on-snow and snow zones where the mature forest type makes up less than 66 percent of these zones, would not change under any of the Alternatives. Consequently, significant changes in peak flows due to harvest activities would continue to be avoided under all of the Alternatives. The Habitat Conservation Plan Environmental Impact Statement (DNR 1996) provides more detailed analyses of the effectiveness of the measures laid out in Procedure 14-004-060 and other procedures in minimizing potential adverse effects to peak flows from harvest activities (see Sections 4.2.4, 4.4.3, and 4.8).

2.6.5.7 Water Quality

None of the Alternatives would increase the risk of water quality degradation in the long term. Existing procedures adequately protect water resources. Short-term, localized sedimentation may increase in some areas immediately following harvest, but the vegetation in the inner and no-harvest portion of the Riparian Management Zones would prevent most sediment from entering streams. Over the long term, improved riparian function would likely lead to improved water quality on DNR forested trust lands.

In the short term, additional planning and implementation resources would be required to prevent sediment delivery to streams as a function of greater harvest in the Riparian Management Zones under Alternatives 2 and 3, and, to a greater extent, under Alternative 5 and the Preferred Alternative. However, in the long term, riparian function across the land base is expected to improve more rapidly under the Preferred Alternative than any other Alternative proposed, as discussed in Section 4.3 (Riparian).

2.6.5.8 Wetlands

DNR Forest Resource Plan Policy No. 21 states, "the Department will allow no overall net loss of naturally occurring wetland acreage and function." The procedure (PR 14-004-110 Wetland Management) governs harvest activities in and around wetlands and is not proposed to change under the Alternatives.

The approximate delineation method, an approved approach to determine wetland boundaries, primarily uses maps and aerial photographs. However, not all wetlands, particularly forested wetlands, are visible on aerial photographs. Also, the Habitat Conservation Plan and its Environmental Impact Statement acknowledge that wetlands less than 0.25 acre may be affected by forest management activities. Thus, the difference in environmental impacts to wetlands under the proposed Alternatives would be a function of the acreage to be harvested and the amount of related activities under each Alternative. Over all, Alternative 1 would result in the lowest level of disturbance (an average of 11 percent per decade), followed by the Preferred Alternative, Alternatives 4, 2, 3, and 5 (at

14, 15, 16, and 17 percent, respectively). Alternative 5 would disturb the most acres, an average of 24 percent per decade, and would have the greatest affect on wetlands.

2.6.5.9 Fish

In general, the effects would be expected to follow those described in Section 4.3, Riparian Areas. Over the long term, all Alternatives would be expected to result in improved riparian and aquatic conditions for fish because of increased riparian function associated with continued growth or restoration of riparian stands. Larger and taller riparian tree stands with multiple canopy layers are expected to increase shade levels, functional in stream large woody debris, and leaf and needle litter, and improve coarse and fine sediment input and hydrologic regimes. In part, this would result by recovery from current degraded conditions in many areas caused by practices prior to the Habitat Conservation Plan rather than enhancement of natural conditions.

Relative to Alternative 1 and other Alternatives, the Preferred Alternative is expected to have more beneficial effects by increasing the rate at which riparian stands transition to structurally diverse, fully functioning stands. However, the Preferred Alternative also includes more intensive management of riparian areas for habitat enhancement. Under the Preferred Alternative, management activities would include a moderate level of infrequent, but heavy thinning activities designed to promote structural diversity in competitive exclusion stands that currently dominate in riparian areas. The current and proposed policies and procedures are designed to avoid, minimize, and mitigate for forest management practices on forested trust lands that have the potential to adversely effect aquatic habitat features. On a relative basis, the slightly higher activity levels proposed under Alternative 5 and the Preferred Alternative suggest a slightly higher risk of adverse effects from forest management activities if mitigation measures are followed. Regardless of Alternative, the potential for adverse effects appear to be within levels anticipated under the Habitat Conservation Plan.

2.6.5.10 Public Utilities and Services

This analysis considers the potential effects of the Alternatives on harvest volumes. Volume directly affects revenue to the beneficiaries, and some beneficiaries partially fund public utilities and services with timber revenue. This section also considers the potential effects of the proposed Alternatives on transportation infrastructure. The analysis uses the modeling outputs to inform the public and decision-makers of the relative differences in potential environmental impacts. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

The Alternatives provide a wide array of direct economic benefits to the beneficiaries. In other words, the relationship between the Alternatives is not consistent across all beneficiaries. Projected annual average harvest levels are, for example, highest for Agricultural School Grant lands under the Preferred Alternative, but highest for University Grant lands under Alternative 5. This variation is also evident for State Forest lands when projected harvest levels are viewed by county. Projected State Forest land harvest levels are, for example, highest under Alternative 5 in Wahkiakum County, but highest under

Alternative 3 in Skamania County. These modeling outputs do not provide precise harvest schedules, but they can represent a likely distribution of harvest levels over time at the county level. While they provide an indication of the possible distribution of harvest by county, it is difficult to predict what effect this variation would have on the built environment.

Potential effects on transportation infrastructure would vary by Alternative, with larger projected harvest volumes resulting in increased logging truck traffic. Alternatives with larger projected harvest volumes would, however, also result in more revenue available for maintenance and improvements to public utilities and services. Potential transportation impacts would occur within the context of total forest management activity within the state of Washington and surrounding regions. Current DNR harvests represent about 13 percent of total western Washington harvest. Logging companies harvesting timber from forested trust lands must meet Washington State Department of Transportation weight requirements and pay taxes that support road improvements. DNR regularly meets with local government officials and engineers to discuss the effects of logging-related traffic (DNR 1992b). These measures would help mitigate potential impacts associated with increased road traffic. As a result, none of the Alternatives is expected to result in any probable significant adverse environmental impacts on transportation infrastructure.

2.6.5.11 Cultural Resources

While there are relative differences among the Alternatives, none is expected to result in any probable significant adverse environmental impacts to cultural resources relative to current conditions. Forest Resource Plan Policy No. 24 requires protection of such resources and DNR is committed to consulting with Native American tribes and other interested parties about areas of cultural importance to them. These two forms of mitigation are expected to minimize risk to cultural resources.

2.6.5.12 Recreation

Environmental impacts on recreation resources are assessed in relation to harvest level. More intensive harvest would have a larger impact on the landscape, potentially affecting the quality of recreation experiences in adjacent and nearby areas. Potential effects on recreation may be mitigated on a case-by-case basis during operational planning prior to the initiation of harvest activities. Potential effects may be mitigated by employing harvest systems that minimize potential visual effects and by relocating or rerouting affected recreation facilities, particularly trails, as appropriate. All of the Alternatives would meet the requirements of DNR policies and procedures that address recreation and public access (Policy Nos. 25 and 29). As a result, none of the Alternatives is expected to result in any probable significant adverse environmental impacts to recreation.

The effects of the proposed Alternatives on fish and wildlife could, in turn, affect recreational fishing and hunting on forested trust lands. Fishing and hunting opportunities on forested trust lands could be positively affected to the extent that improvements in habitat and habitat suitability contribute to greater numbers of fish and game populations in some or all of the HCP Planning Units. The potential effects on fish and wildlife are discussed in more detail in Sections 4.10 and 4.4, respectively.

2.6.5.13 Scenic Resources

Lands managed for timber production under all Alternatives would be managed under DNR’s visual management procedure (14-004-080), which seeks to minimize potential impacts to scenic resources by managing harvest activities with respect to sensitive viewshed areas. Potential visual effects associated with the proposed Alternatives may be mitigated on a case-by-case basis during operational planning prior to the initiation of harvest activities. Operational planning by the DNR includes policies and procedures related to green-up (growing young trees for a specific time before adjacent trees may be cut), reforestation, and harvest unit size that contribute to the management of forested landscapes. As a result, none of the Alternatives is expected to result in any probable significant adverse environmental impacts on scenic resources.

2.6.5.14 Cumulative Effects

Cumulative effects are defined under both a broad and narrow definition for this analysis. DNR recognizes that cumulative effects conditions are occurring and have the potential to occur in the future in watersheds where DNR manages forested trust lands. The analysis examines current forest conditions, wildlife habitats, fish, water resources, and potential impacts of future harvests. DNR’s policies and procedures are in place and implemented to manage and reduce the risk of cumulative effects occurring. The Alternatives with higher levels of activities in the first decade, Alternative 5 and the Preferred Alternative, have a somewhat higher risk of contributing to cumulative effects, especially related to water resources. However, all Alternatives implement various mitigation measures for cumulative effect to forest vegetation, wildlife, and water resources. These measures include, but are not limited to, implementation of the Habitat Conservation Plan (HCP) Riparian Management Zones, procedure for management of potential slope instability, visual area management, procedure for adjacency of regeneration harvest units, and a leave trees strategy. The expectation is that the overall level of cumulative effects would be reduced under all Alternatives in the future due to the Board of Natural Resources forest management policies; DNR's HCP and operational procedures in combination with Forest Practices Rules; the Northwest Forest Plan; and other regional programs, such as salmon recovery efforts (Salmon Recovery Funding Resource Board), and HCPs developed by private forestry companies (e.g., Plum Creek, Port Blakely, Simpson Timber, West Fork Timber) and utility companies (e.g., City of Seattle, Tacoma Water). These programs should reduce the potential for future cumulative effects by requiring that landowners do their share of mitigation and avoidance. All of the proposed Alternatives would be expected to provide effective mechanisms in policy and procedures to provide mitigation against cumulative effects where DNR manages a portion of the landscape.

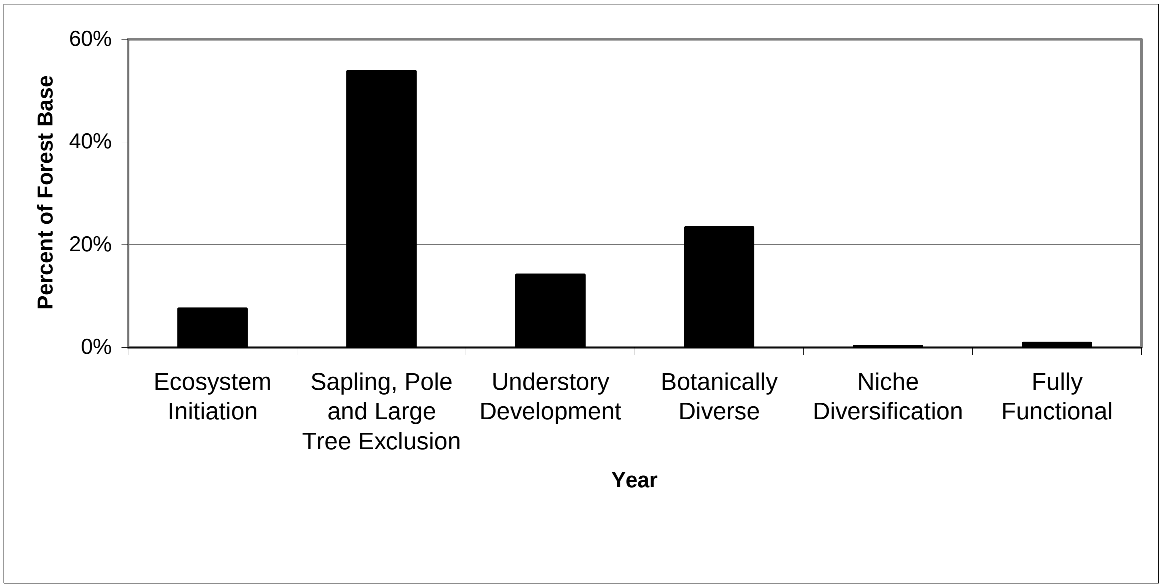

Figure 2.6-2. Modeled Proportion of Forested Trust Lands Forest in Each Stand Development Stage in 2004

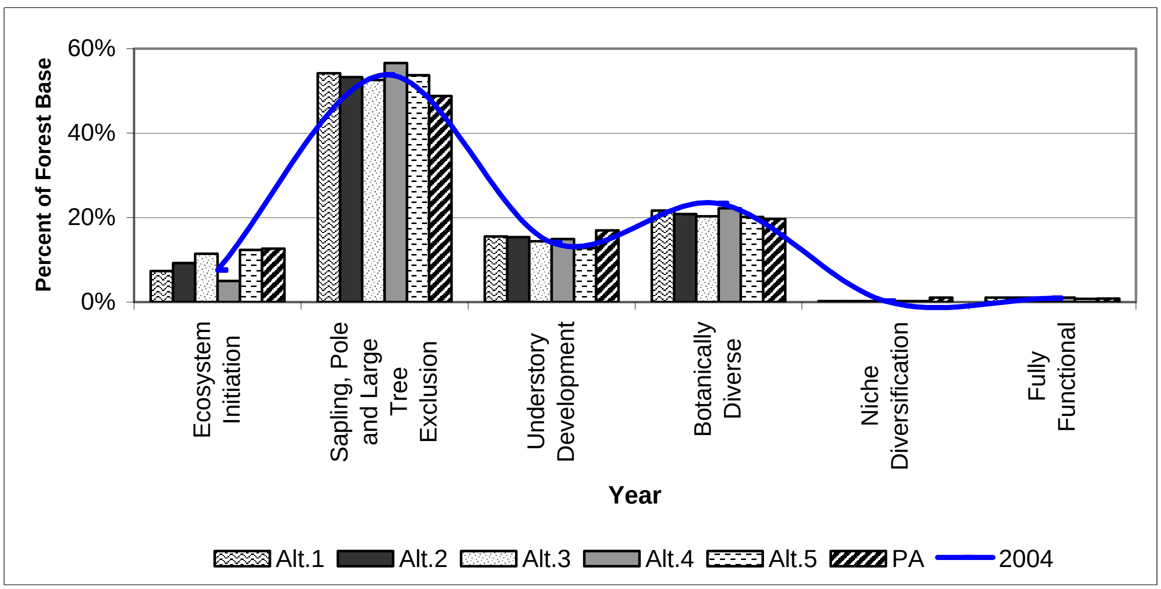

Figure 2.6-3. Modeled Proportion of Forested Trust Lands Forest Stand Development in Each Stage in 2013 by Alternative

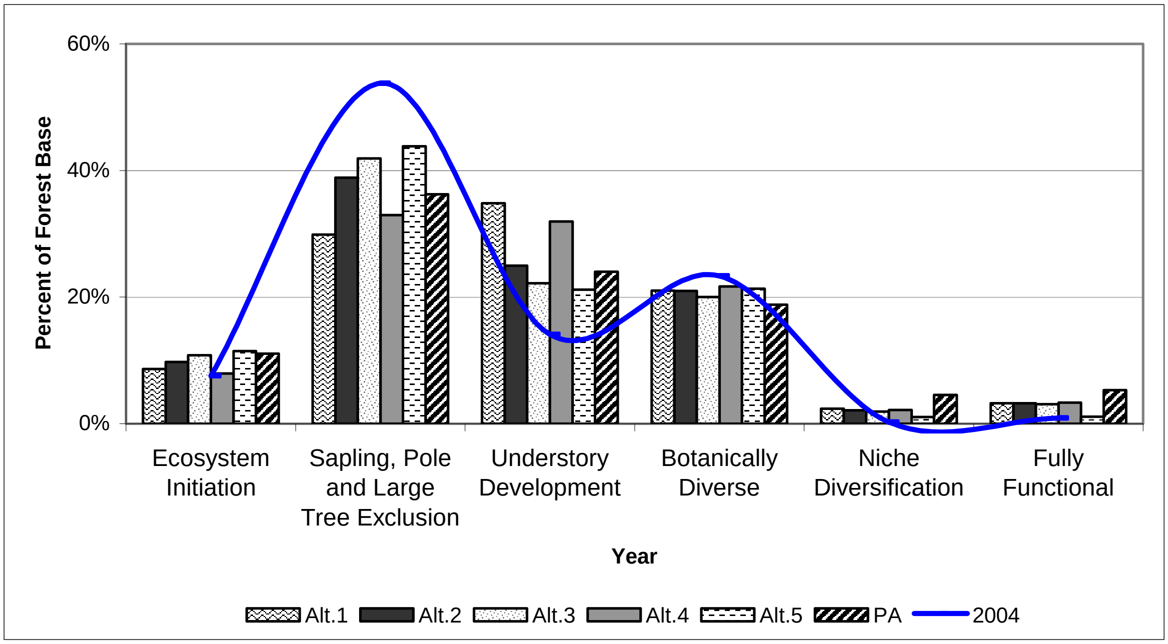

Figure 2.6-4. Modeled Proportion of Forested Trust Lands Forest Stand Development in Each Stage in 2067 by Alternative

Chapter 3

Chapter 3

3. ENVIRONMENTAL SETTING

3.1 SUMMARY OF DNR-MANAGED LANDS

The Washington Department of Natural Resources (DNR) manages more than 5 million acres of state-owned lands, including aquatic lands and uplands. Tidelands and beds of marine waters and navigable lakes and streams make up the 2.4 million acres of aquatic lands managed by DNR. The 2.9 million acres of uplands primarily consist of lands granted to the state by the federal government at the time of statehood, tax-delinquent logged and abandoned timberlands that had reverted to the counties and were transferred to the state, timberlands purchased to be managed as state forests, and community college reserve lands. These uplands are managed, in trust, for the various beneficiaries. Income is derived from these uplands through leases and the sale of minerals and renewable resources. In addition, DNR manages uplands for Natural Area Preserves, Natural Resource Conservation Areas, administrative sites, and recreation areas. The forested trust lands in western Washington are managed by DNR under a Habitat Conservation Plan, which also covers three planning areas on the east side of the Cascades. The Habitat Conservation Plan is a long-term land management plan authorized under the Endangered Species Act to conserve threatened and endangered species, while carrying out management activities on the trust lands (DNR 1997).

3.1.1 Land Covered by the Proposal

The proposed action described in this Environmental Impact Statement covers DNR-managed forested lands west of the Cascade Crest. Included are the state trust lands: federal grant lands, state forest lands (formerly known as Forest Board lands, RCW 79.02.010(10)), and community college reserves, totaling approximately 1.5 million acres. Table 3.1-1 presents the approximate acreage for each category of trust land covered by the proposed action.

Table 3.1-1. Acreage of DNR-Managed Trust and other Forested Lands in Western Washington (by Trust Category)

Trust #	Trust Name	Total Acres	Acres	
			Forested	Nonforested
1	State Forest - Transfer[1/]	523,704	490,304	33,400
2	State Forest - Purchase[1/]	79,321	73,300	6,021
3	Common School and Indemnity	556,414	504,715	51,698
4	Agricultural School	27,579	26,210	1,369
5	University - Transferred	40,832	38,554	2,279
6	Charitable/Educational/Penal and Reformatory Institute	29,289	26,810	2,479
7	Capitol Grant	91,715	85,460	6,255
8	Normal School	34,757	32,549	2,208
9	Escheat	3,963	3,592	371
10	Scientific School	56,268	52,995	3,273
11	University - Original	2,891	2,576	315
12	Community College Forest Reserve	3,341	3,079	262
	Other non-revenue producing lands			
	Administrative Sites and Other Lands[2/]	5,730	4,671	1,059
	Natural Area Preserve[2/]	14,182	7,286	6,896
	Natural Resources Conservation Area[2/]	59,762	38,601	21,160
Total		**1,529,746**	**1,390,704**	**139,045**

1/ RCW 79.02.010(10)
2/ Not managed for timber production.
Data Source: DNR POCAALL Geographic Information System layer.

The lands managed by DNR vary from scattered separate parcels of less than 40 acres to large contiguous blocks in excess of 110,000 acres. These lands are distributed throughout western Washington.

3.1.2 Land Use

As described above, the western Washington state trust lands encompass federal grant lands, state forest lands, and community college reserves managed by DNR. All but approximately 139,000 acres within these trust lands are forested. Non-forested land within this area includes natural features such as wetlands, ponds, exposed rock and soil, and perennial snowfields. Other land is maintained in a nonforested condition for specific uses such as utility and road rights-of-way and communication tower sites.

Of the approximately 1,390,700 acres of forested land considered in this analysis, approximately 865,000 acres are currently managed by DNR to grow and harvest timber, although these lands include areas where little or no harvest occur under current policies and procedures, such as riparian areas. Approximately 486,000 acres are currently in a long-term deferred status (beyond the decade-long planning period). They include recreation sites, old forest research areas, gene pool reserves, and other areas. Approximately 40,000 acres are currently in a short-term deferred status (released within the planning period), and include northern spotted owl habitat circles.

In order to plan efficiently and to manage for regional variation, the western Washington forested state trust lands were divided into six Habitat Conservation Plan (HCP) Planning Units as part of the HCP development process. Five of these HCP Planning Units were delineated by clustering Water Resource Inventory Areas (as defined by the Washington State Department of Ecology, and that drain to common water bodies). Because of the unique history and role of the Olympic Experimental State Forest HCP Planning Unit, it was considered separately. The five Westside HCP Planning Units are also used in this document to identify regional variation of environmental effects.

3.1.3 Ownerships in Western Washington

DNR-managed lands in western Washington covered by the Habitat Conservation Plan are interspersed among a variety of other ownerships. Map 1 shows the distribution of this land. Table 3.1-2 summarizes the approximate acreage held by various landowners in western Washington.

This pattern of ownership has varied since statehood. DNR's active land exchange program has consolidated many scattered parcels of state trust forestlands into larger, more manageable blocks. Exchanges are expected to continue into the future to position assets to benefit the trusts.

Table 3.1-2. Acreage by Ownership within Western Washington in 2003

Landowner/Manager/Use	Acres[1/]	Percent of Total[2/]
DNR	1,500,000	9.6
Other Washington State Land	100,000	0.6
Federal Land	5,600,000	35.7
City and County Land	200,000	1.2
Private Industrial Forest Land	3,800,000	24.2
Private Non-Industrial Forest Land	3,800,000	24.2
Tribal Lands	300,000	1.9
Other	400,000	2.5
Total	**15,700,000**	**100**

[1/] Acre figures rounded to nearest 100,000 acres.
[2/] Percents are not exact due to rounding.
Data Source: DNR MASK Geographic Information System layer.

3.2 CLIMATE

Washington's climate is controlled by three factors: 1) location on the windward coast of the Pacific Ocean; 2) the Cascade mountain range, which runs north to south just west of center through the state; and 3) the semi-permanent high- and low-pressure regions located over the north Pacific Ocean. These factors combine to produce dramatically different conditions within relatively short distances. The Cascade Range, for instance, blocks the initial thrust of Pacific storms into eastern Washington, while protecting western Washington from the polar-continental influence. Thus, western Washington has a marine-influenced climate.

Successive moisture-laden storms move into the Pacific Northwest during late fall, winter, and early spring. They are intercepted first by coastal ranges (the Olympic Mountains and Willapa Hills) and then by the Cascade Mountains. From late spring to early fall, the Pacific high-pressure area moves progressively farther north, weakening storms and limiting rainfall.

Annual precipitation ranges from 75 inches along the coast to 175 inches along the western slopes of the Olympic Mountains and nearly 100 inches in the Willapa Hills. The rain shadow effect of the Olympic Mountains results in only 16 to 25 inches of rain on the northeastern part of the Olympic Peninsula and in parts of the San Juan Islands. From the Puget Sound lowlands south to the Columbia River, the mean annual precipitation is 40 to 60 inches. Precipitation increases along the west slopes of the Cascades, reaching 120 inches annually in some places.

Prevailing winds are generally southwesterly over the state from late fall to early spring and northwesterly and lighter during the rest of the year. The most intense storms take place in late fall and early winter. Wind velocities range from 50 to 70 miles per hour or higher along the coast almost every winter. Wind speeds approaching or exceeding 100 miles per hour have been observed occasionally on coastal ridges. Wind speeds inland are lower during these storms but have been observed at 50 to 60 miles per hour, and gusting higher.

In general, western Washington has 10 to 12 lightning storms each year, mostly along the western slopes of the Cascades. Rain usually accompanies lightning storms. Outbreaks of "dry lightning" are rare in western Washington.

The sun shines about 24 percent of the time on December days in western Washington. In July, the figure is typically about 61 percent. Frost-free days begin in late April and continue to early November.

3.3 FOREST DISTURBANCE ON FORESTED TRUST LANDS

Major disturbance events, both natural- and human-caused, have defined the current condition of western Washington forested state trust lands. Windstorms, which create chaotic patterns of broken and windthrown trees, have shaped Washington forests throughout the centuries. Examples of notable historic windstorms are the 1921 storm on the western Olympic Peninsula and the Columbus Day storm of 1962, which blew down thousands of acres of mature timber in western Washington. Major ice storms, such as the 1955 freeze, have also changed the structure of forests all over western Washington. Today, numerous forest stands containing trees with crooked boles and forked tops serve as reminders of the millions of treetops killed by this freeze. Fire, both natural- and human-caused, has historically been one of the great shapers of forest composition in both eastern and western Washington. As an example, parts of the 94,055-acre Yacolt Burn State Forest in southwestern Washington burned several times between 1902 and 1952. Today, this area is forested with young Douglas-fir trees and a few old remnant trees in riparian areas and ravines.

While a century of fire control has played a key role in creating the current forestland conditions in western Washington, timber harvest is probably the greatest human influence. Most forested trust lands have been logged at least once in the last 100 years. Much land in western Washington was clearcut and logged from 1910 to 1930**,** abandoned, and then acquired later by the state. Remnants of logging railroads and abandoned truck roads are scattered on state lands and bear witness to the intensity of logging in western Washington in the early 20th century. Fire scars on residual trees and charred old-forest stumps show the effects of frequent fires that followed the first logging in those early years. Large parts of these forests naturally reseeded themselves from trees that survived the fires and from the hardwoods and other species in unburned riparian areas. After the fires, alder flourished in some landscapes that were once dominated by old conifers. The presence of large conifer stumps in many alder stands shows this vegetation change.

Since the 1960s, DNR has used a sustainable harvest approach in managing state trust forestlands. Designated areas are harvested and regenerated each year. Most early regeneration efforts concentrated on establishing Douglas-fir in recently clearcut areas. Today, a mix of species is typically prescribed to conform to the native environmental characteristics of a site.

3.4 GENERAL FOREST STAND CONDITIONS

Conifers dominate the majority of the forests on forested trust lands in western Washington. Less than 12 percent of the stands are dominated by hardwood trees (some of these stands are mixed with conifers). There are 2,000 acres of “natural” old forest that have never been harvested. More than 141,000 acres support multi-storied forests of large-diameter (30 inches and larger) Douglas-fir, western red cedar, and western hemlock with the varying degrees of structural complexity typically associated with older forests. As noted previously, most forested trust lands have been logged at least once in the last 100 years.

DNR categorizes forestlands as even-aged or uneven-aged. In general, even-aged stands predominate in western Washington and are categorized in terms of the dominant age class of trees within a stand. However, while the dominant age or size class is determined and tracked, any acre of a forest stand may contain a mix of different age and/or size of trees, just as a mix of tree species will be present within the vast majority of stands.

Because trees of the same age can vary greatly in size due to variations in site conditions and stand density, size class is often a more useful way to display forest conditions (Table 3.4-1).

Chapter 4 of this Final Environmental Impact Statement presents detailed information about the existing conditions (also referred to as “affected environment”) of the key resource areas for which the effects of this proposed action are being assessed.

Table 3.4-1. Dominant Size Class Distribution for Western Washington Forested State Trust Lands in 2002

Size Class (diameter in inches)	Acres	Percent
0-9	345,000	25
10-19	246,000	18
20-29	659,000	47
30+	141,000	10
Total Acres	**1,391,000**	**100**

Data Source: DNR FRIS database.

3.5 ECOREGIONS

The U.S. Environmental Protection Agency has established a system of ecoregion designations based on soils, topography, climate, potential vegetation, and land use (Omernik and Gallant 1986; Omernik 1987). The ecoregion descriptions described below provide a general synopsis of the more important characteristics that affect aquatic and terrestrial ecosystems. The western Washington forested state trust lands fall within the Coastal Range, Puget Lowland, and Cascade Ecoregions.

3.5.1 Coastal Range

In Washington, the Coastal Range Ecoregion extends from the Olympic Peninsula (excluding the Olympic Mountains) through the coastal area to the Willapa Hills. This region is influenced by high levels of rainfall due to the interaction of the marine weather systems and the mountains. The mountains are generally rugged with steep canyons. Tributary streams are typically short and have a steep gradient, which result in rapid runoff. Peak flows generally occur during the rainstorms of December and January as well as during snow melt in the spring. Stream flows are at their lowest in the summer when there is less rain. Forests in this ecoregion generally support dense stands of conifers (Sitka spruce, western hemlock, Douglas-fir, and western red cedar) and, in some cases, red alder, and many shrubs and herbaceous plants.

3.5.2 Puget Lowland

The Puget Lowland Ecoregion in Washington lies between the Coastal Range and the Cascade Mountains. The area is relatively flat and soils are composed of alluvial and lacustrine deposits, which are of glacial origin north of Centralia. Because of the rain shadow effect of the mountains bordering this ecoregion to the west, average rainfall is moderate compared to the ecoregions to the east and west. River flows are sustained by streams with headwaters in the adjacent mountains. Peak flows can occur between fall and spring, depending on snow pack and storm events. Forested areas support dense stands of conifers (western hemlock, Douglas-fir, and western red cedar) and hardwoods. Much of the land in this region has been converted to urban, industrial, and agricultural uses.

3.5.3 Cascades

The Cascade Ecoregion in Washington includes the Cascade and the Olympic Mountains. Several peaks above 10,000 feet in elevation occur along the crest of the Cascades, which averages over 4,500 feet above sea level. The Olympic Mountains include several peaks over 6,000 feet. Dams and reservoirs are common at lower elevations in this ecoregion. Precipitation is highest between October and March, and much of it falls as snow. Peak flows generally occur during periods of heavy rainfall and rapid snowmelt. Forests in this ecoregion generally support dense stands of conifers (western hemlock, Douglas-fir, silver fir, noble fir, and western red cedar), and understory vegetation can be dense. Alpine meadows consist of grasses and sedges.

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Chapter 4

Chapter 4

4. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Chapter 4

4.1 CHAPTER INTRODUCTION

This chapter provides information describing the affected environment of western Washington forested state trust lands managed by the Washington Department of Natural Resources (DNR), including the policies, procedures, and strategies that govern their management. The affected environment sections describe the current condition of the forested trust lands against which the proposed Alternatives are evaluated. The following resource areas are discussed:

- Forest Structure and Vegetation (Section 4.2)
- Riparian Areas (Section 4.3)
- Wildlife (Section 4.4)
- Air Quality (Section 4.5)
- Geomorphology, Soils, and Sediment (Section 4.6)
- Hydrology (Section 4.7)
- Water Quality (Section 4.8)
- Wetlands (Section 4.9)
- Fish (Section 4.10)
- Public Utilities and Services (Section 4.11)
- Cultural Resources (Section 4.12)
- Recreation (Section 4.13)
- Scenic Resources (Section 4.14)
- Cumulative Effects (Section 4.15)

The environmental effects related to each of the above resource areas are discussed following a presentation of the affected environment. The environmental effects sections provide the scientific and analytical basis for the comparison of Alternatives presented in Chapter 2. Because of the long length of Section 4.2, Forest Structure and Vegetation, this section is presented in a somewhat different format than the others. General background material is presented first, then the affected environment and the associated environmental effects are presented separately for each of six major subsections.

The following Environmental Impact Statements are incorporated by reference in full: 1) the draft and final Forest Resource Plan Environmental Impact Statement (DNR 1992), (2) the draft and final Habitat Conservation Plan Environmental Impact Statement (DNR 1996); and 3) the draft and final Forest Practices Rules Environmental Impact Statement (Washington Forest Practices Board 2001). These EISs contain relevant information concerning the impacts of harvesting on forested trust lands managed by DNR, done in compliance with DNR's Habitat Conservation Plan, existing Forest Resource Plan policies, and the Forest Practices Rules that apply to both state and private lands. These EISs may be located in public libraries throughout the state of Washington, including the Washington State Library, depository libraries, university and college libraries, and county and city libraries. Many resource area sections in this EIS refer to information presented in the affected environment sections of those EISs. However, some information has been updated, and other subject areas (e.g., soil productivity, recreation) not covered in those EISs have been added.

The Forest Resource Plan and the Habitat Conservation Plan Environmental Impact Statements provide useful benchmarks for evaluating the effects of the 2003 sustainable harvest calculation level.

This is a programmatic Environmental Impact Statement (i.e., non-project under the State Environmental Policy Act). Consequently, the analysis for each resource area focuses specifically on evaluating the impacts of the policies and procedures that are being proposed for modification under the Alternatives. Conclusions are based on reasonably available data and generally qualitative analyses, supported by quantitative data where available and appropriate.

For some resource areas, changes in policy, procedure, or operational management proposed under the Alternatives are different for the Olympic Experimental State Forest compared to the other five Westside HCP Planning Units. Consequently, the likelihood of adverse effects may also be different. In these instances, the Olympic Experimental State Forest is discussed separately from the other five Westside HCP Planning Units.

The temporal scale for resource analyses is both the short term (10 years) and long term (30 to 64 years). These time periods reflect the planning period for the sustainable harvest calculation and the remaining lifespan, to 2067, of the 70-year Habitat Conservation Plan. Data are presented by decade for many resources.

The analyses presented in this chapter indicate that there are different levels of relative risk associated with the various Alternatives. Where this is the case, the Alternatives are ranked. Ranking does not imply that the Alternative with the highest risk rating would result in a significant adverse impact. In many cases, the higher ranking simply implies that greater care would be taken in implementing a strategy and higher levels of investment would likely be needed to ensure that careful planning, implementation, and monitoring are included at the project level.

4.2 FOREST STRUCTURE AND VEGETATION

4.2.1 Forest Structure

This section analyzes the environmental effects on forest structure, old forests, forest health, carbon sequestration, and threatened and endangered plant species. The analysis examines the current and proposed changes to policy and procedures under the different Alternatives. This analysis also assesses relative risks among Alternatives that are illustrated using modeling outputs.

Alternatives 1 and 4 would provide more old forest and would entail less risk of adversely affecting threatened, endangered, and sensitive plant species than the other Alternatives. However, Alternatives 1 and 4 would result in more dense forest stands that achieve lower individual tree growth rates and are more susceptible to damage from insects and disease. Alternative 2 and the Preferred Alternative are ranked intermediate in terms of their overall relative risk of causing negative environmental impacts. The Preferred Alternative has a higher risk associated with it over the short term, but in the long term ranks highest in the development of structurally complex forest stands. Both the Preferred Alternative and Alternative 2 would require an intermediate level of investment for successfully implementing their management strategies and achieving the projected level of harvest.

Alternatives 3 and 5 would have fewer policy limitations for stand management and timber harvest and would apply more intensive management strategies than the other Alternatives. Management proposed under Alternatives 3 and 5 would result in more harvest area and forests that are less susceptible to insect and disease damage.

Alternative 5 and the Preferred Alternative would entail more relative risk of adversely affecting threatened, endangered, and sensitive species of plants due to more harvest and harvest-related disturbance.

4.2.2 Introduction

This section describes the existing forest structure and vegetation resources on western Washington forested state trust lands, and assesses potential effects to these resources resulting from changes to DNR's management policies under the analyzed Alternatives. During the public scoping process, concerns were raised about the effects of the proposed Alternatives on forest conditions, growth and yield, forest health (including fire, insect, and disease damage, windthrow, and the spread of noxious weeds), and old forests. The following areas were assessed for effects of the proposed policy changes to the management of forest resources on forested trust lands:

- Forest Condition – Changes in the proportion of forest acreage within different forest stand development stages; changes in the quantity and types of forest management activities
- Growth and Yield – Potential factors changing individual tree and stand growth as indicated by changes in forest conditions (stand development stages and forest stand density)

- Forest Health – Changes to relative forest stand density as an indicator of stand vigor and fire risk as it relates to harvest intensity
- Old Forest – Acres of forest with old forest stand structure characteristics
- Carbon Sequestration – Changes in carbon storage capacity
- Threatened, Endangered, and Sensitive Plants – Frequency of potentially physically disturbing events, and management strategies and changes in stand complexity and understory development

Analysis of effects to the forest vegetation resources focuses on the approximately 1.4 million acres of western Washington forested state trust lands. Each of the six proposed Alternatives represents a strategy for implementing DNR's 70-year Habitat Conservation Plan (DNR 1997). The analysis covers the period between 2004 and 2067, and is to be re-assessed at periodic time intervals within this period.

4.2.3 Current Conditions

4.2.3.1 Physical Setting

The western Washington forested state trust lands span vegetation zones from near sea level to mountaintops. Vegetation zones represent areas of similar environmental settings (soils, climate, elevation, aspect, and disturbance regimes). Vegetation zones tend to occur sequentially up mountain slopes, depending upon changed conditions at these elevations—generally, changes in moisture and temperature levels (Franklin and Dyrness 1988). Vegetation zones are named for climax tree species that would dominate the area in the absence of wildfire, timber harvest, or windstorms, or until such a disturbance occurs. However, plant communities associated with a specific seral stage may occupy the site at any given time, depending on the forest's development.

The **western hemlock zone** covers approximately 71 percent of the forested trust lands. It extends from sea level to about 2,000 feet in elevation. Tree species include western hemlock, Douglas-fir, western red cedar, Pacific silver fir, grand fir, red alder, and bigleaf maple. Portions of the Puget Sound lowlands (see Chapter 3) located in the Olympic Mountains' rain shadow have gravelly glacial soils and relatively low rainfall. These areas often support lodgepole pine along with Douglas-fir.

The **Sitka spruce zone** is found in a narrow band along the Pacific Coast and in "fingers" up coastal river valleys where the climate is mild and moist year-round. Ten percent of the western Washington forested state trust lands is in the Sitka spruce zone. Mixed conifer forests, consisting of Sitka spruce, western hemlock, western red cedar, Douglas-fir, grand fir, Pacific silver fir, lodgepole pine, and red alder occur in this zone, though in different proportions than in the western hemlock zone.

The **Pacific silver fir zone** occupies approximately 16 percent of the forested trust lands. This zone generally occurs between 2,000 and 4,000 feet in elevation where the cool, wet climate results in a relatively short growing season. Pacific silver fir, noble fir (south of Stevens Pass), Douglas-fir, yellow cedar, western red cedar, and Sitka spruce are tree species that characterize this zone.

Less than 2 percent of the forested trust lands are in the high-elevation forest zones, which extend from about 4,000 feet in elevation up to the “tree line.”

4.2.3.2 Forest Conditions

Disturbance has long been a factor in Pacific Northwest forests. The extensive Douglas-fir forests seen by European settlers in the nineteenth century were born of fire (Agee 1993; Franklin and Dyrness 1988). Wind was a major disturbance factor, especially in coastal Sitka spruce and higher elevation Pacific silver fir and alpine forests, where the moist conditions generally limited fire spread (Agee 1993). In higher elevations, snow-downed trees opened up the forest for regeneration. Insects and disease were also disturbance agents. Disturbance after European settlement has been primarily through timber harvest, land-clearing, and fire. Most of the western Washington forested state trust lands have been logged at least once in the past 100 years (DNR 1997).

Conditions that followed clearcutting (i.e., the removal of all trees) differ greatly from the conditions following most natural disturbances in terms of the structural legacies remaining after natural types of disturbance. Currently, DNR retains legacy trees (sometimes called reserve trees) in all harvests. Conversely, past clearcutting did not leave a legacy of overstory trees.

Clearcutting, as popularly conceived, removed all trees—merchantable as well as snags, cull trees, seedlings, saplings, tops, and branches—in order to start a new rotation with even-aged trees that would fully occupy the site. Following the timber harvest, large woody debris was lost with intensive slash disposal practices such as broadcast burning or piling and burning. With the exception of stands regenerated within the past 15 to 20 years and those destroyed by fire, most of the forest stands found on western Washington forested state trust lands were regenerated from past clearcutting.

4.2.3.3 Current Forest Management and Harvest Levels

Since 1996, and the adoption of the Habitat Conservation Plan, all regeneration harvests on western Washington forested state trust lands have followed the policy and procedural direction describe in Chapter 2 for Alternative 1 (No Action).

Table 4.2-1 shows the average annual acres of forest stand management activities that occurred on western Washington forested state trust lands from 1997 through 2002.

Table 4.2-2 displays the acres of pre-commercial thinning (thinning done before the trees are merchantable) that have occurred since DNR began implementation of the Habitat Conservation Plan.

Table 4.2-1. Average Annual Acres of Forest Management Activities by Habitat Conservation Plan Planning Unit, 1997 through 2002

		Site Preparation					Vegetation Management	
	Fertilization	Aerial Herbicide Application	Ground Herbicide Application	Mechanical	Pile and Burn	Broadcast Burn	Aerial Herbicide Application	Ground Herbicide Application
HCP Planning Unit	**Acres per Year**	**Acres per Year**	**Acres per Year**	**Acres per Year**	**Acres per Year**	**Acres per Year**	**Acres per Year**	**Acres per Year**
Straits	0	0	15	1	9	0	0	343
North Puget	1,114	338	0	0	6	10	704	1,533
South Puget	113	0	0	0	10	0	31	253
Columbia	0	573	123	40	80	5	1,473	260
South Coast	0	23	13	11	144	0	603	574
Olympic Experimental State Forest	0	0	0	0	20	0	0	60
Total	**1,227**	**934**	**151**	**52**	**269**	**15**	**2,811**	**3,023**

Data Source: DNR Planning and Tracking database.
Note: Area fertilized includes both application of biosolids and aerial fertilizer application in North Puget and South Puget HCP Planning Units. Area fertilized updated from e-mail communication from Carol Thayer, 7/24/03.

Table 4.2-2. Acres Pre-Commercially Thinned on Forested Trust Lands by Habitat Conservation Plan Planning Unit, 1996 through 2002

HCP Planning Unit	Average Acres/Year Pre-Commercially Thinned	Total Acres Pre-Commercially Thinned
Straits	624	3,743
North Puget	3,782	22,691
South Puget	830	4,982
Columbia	751	4,504
South Coast	1,604	9,621
Olympic Experimental State Forest	5,034	30,203
Total	**12,625**	**75,744**

Data Source: DNR Planning and Tracking database.

DNR is required to provide for long-term stable harvest of timber measured in volume according to Policy Nos. 4 and 5 (DNR 1992b). State law mandates the periodic recalculation of this sustained yield harvest (Revised Code of Washington 79.10.320). In 1996, the Board of Natural Resources adopted an annual sustainable harvest level of 655 million board feet for the forested trust lands statewide. This equates to approximately 575 million board feet as the sustainable harvest level for western Washington forested state trust lands.

During the past 5 years (1998 to 2002), an average of approximately 479 million board feet of timber per year (see Section 4.11, Table 4-11) has been harvested from approximately 20,000 acres of forested trust lands. The majority of the harvest volume removed was in the Central (Grays Harbor, Lewis, Pacific, and Thurston Counties) and Northwest Regions (Skagit, Snohomish, and Whatcom Counties). Each of these two regions produced about 31 and 27 percent, respectively, of the total 5-year timber volume yield. The Southwest Region (Clark, Cowlitz, Klickitat, Pacific, Skamania, and Wahkiakum Counties) contributed about 18 percent of the volume. The South Puget Sound (King, Kitsap, Lewis, Mason, and Pierce Counties) and Olympic (Clallam, Grays Harbor, and Jefferson Counties) Regions produced 13 and 12 percent of the total yield, respectively.

Table 4.2-3 displays the total current estimate for standing inventory by land class. The standing volume is expressed in both cubic feet and Scribner board feet to reflect the estimate of both total tree biomass in the forest (cubic feet) and an estimate of the merchantable standing volume (Scribner board feet) (see Chapter 2, Uncertainty in the Modeling Results, for further discussion). Approximately 26 percent of forested trust lands timber volume is located in the "Uplands with General Objectives" land class, 43 percent and 31 percent of the volume are in the "Uplands with Specific Objectives" and "Riparian" land classes, respectively. (See description of land classes in Chapter 6 Glossary)

The estimates of standing merchantable volume (Scribner board feet) differ from those published in the Draft Environmental Impact Statement (Draft EIS). In the Draft EIS, the standing volume was published as 52 billion board feet. This inventory figure was not adjusted for merchantability. (See Appendix B for details on growth and yield.)

4.2.4 Forest Structure, Growth, and Yield

4.2.4.1 Affected Environment

Forest Structure

The condition of a forest can be expressed in a number of ways. A popular way to measure the condition of even-aged forests in the Pacific Northwest is age class. For an even-aged

Table 4.2-3. Total Current Standing Timber Volume for Western Washington Forested State Trust Lands by Land Class

	Standing Volume	
Land Classification	**Billion Cubic Feet**	**Billion Board Feet (Scribner)**
Uplands with General Objectives	2	8
Uplands with Specific Objectives	3	13
Riparian	2	10
Total	**7**	**31**

Data Source: Model output data (stand development stages).

managed forest, an age class distribution can help describe the previous disturbance history. The extent of younger forests suggests that disturbances, regeneration harvests, and/or natural disturbances, have occurred recently. An older age class forest suggests that there have been less disturbance events in recent history. However, as a comparison of Photographs 1 and 2 in Chapter 2 illustrates, the use of stand age can be difficult to estimate and can be a deceiving measure for describing the condition of a forest stand. While age class is useful for describing the conditions of an even-aged forest managed for timber production, it is not considered as useful for describing the ecological conditions of a forest when managed for habitat conditions, which are typically represented in un-even-aged forests.

Ecological condition is best described with stand development stages that use structural conditions to define a developmental stage. Structural conditions include the number and size of live trees, standing dead trees (snags), and down woody debris. Describing a forest in terms of its structural conditions allows for an improved description of a forest's ecological condition because forest stand structure is related to ecological functioning. The stages used in this analysis are adapted from three principal sources: Brown (1985), Carey et al. (1996), and Johnson and O'Neil (2001).

The forest stand development stages used in this analysis differ from the "age class-based structural description" used to describe forest structure for the Habitat Conservation Plan. At the time that the Habitat Conservation Plan was developed, age class was the best available data. However, age class is not a sufficient indicator of stand structure, nor is it a satisfactory indicator of ecological functioning. This fact was recognized in the Habitat Conservation Plan, and methods were put in place to change management focus from age to structure (DNR 1997, page IV-180).

Many factors affect the rate at which a stand develops, including site conditions, tree genetics, the tree species used to initiate regeneration after harvest, the density of the new trees, natural disturbance, and management activities (Oliver and Larson 1996; Franklin et al. 2002).

The stand development stages used in this analysis are based on:

- number of tree canopy levels,
- tree size,
- percent of canopy closure (relative density),
- abundance of dead or decadent trees, and
- abundance of dead down wood.

Descriptions of these stand development stages are provided in Appendix B, Section B.2.3. The following is a brief description of how these stages develop. Ecosystem initiation stages are open, newly regenerated stands that are actively growing. Stands enter the competitive exclusion stages when competition for direct sunlight, nutrients, water, and space increases (Oliver and Larson 1996) and stands near, or exceed, full site occupancy. When growing space is fully occupied, stand growth measured in volume per unit area is probably at its peak. Stand growth only declines by mortality. As growing space becomes fully occupied, tree mortality ensues and the net stand growth begins declining. The understory development stage develops as stand gaps increase due to mortality of larger trees or groups of trees or silvicultural treatments. It is tree mortality that primarily influences forest development, not tree growth. In understory development, a stand has lost some of its large trees from the upper canopy due to mortality or a harvest, competition between trees is reduced, and understory trees and shrubs are developing. This stage is transitional; the stand may return to a competitive exclusion stage as the taller trees' crowns re-close, or conversely, the crowns may not close and the stand may develop into a botanically diverse or niche diversification stage. This later development occurs as a result of continued understory development and tree mortality. Botanically diverse, niche diversification, and fully functional development stages provide progressively more stand biodiversity and structural diversity with each development stage. In a botanically diverse stage, forest stands have two or more tree canopies but are lacking in dead tree components such as large snags and/or down woody debris. These components are all present in niche diversification and fully functional development stages. The distinction between niche diversification and fully functional is principally time to accumulate greater levels of structural and biological diversity.

Distribution of Stages

Table 4.2-4 displays the percent distribution of stand development stages on western Washington forested state trust lands, while Table 4.2-5 provides a breakdown by HCP Planning Unit. The ecosystem initiation stage comprises about 8 percent of forested trust

Table 4.2-4. Distribution of Stand Development Stages on Forested Trust Lands

Summarized Stand Development Stage	Stand Development Stage	Acres	Percent of Forested Trust Lands
Ecosystem Initiation	Ecosystem Initiation	105,240	8
Competitive Exclusion	Sapling Exclusion	234,979	17
	Pole Exclusion	286,880	21
	Large Tree Exclusion	226,347	16
	Understory Development	196,417	14
Structurally Complex	Botanical Diversity	324,725	23
	Niche Diversification	3,681	0
	Fully Functional	12,435	1
Total		**1,390,704**	**100**

Data source: Model output data - stand development stages.

Table 4.2-5. Stand Development Stages in Forested Trust Lands, by Habitat Conservation Plan Planning Unit

	HCP Planning Unit							
	Straits	North Puget	South Puget	Columbia	South Coast	OESF[1/]		
Forest Stand Development Stage	Percent of Total Acres	Percent of Total Acres	Percent of Total Acres	Percent of Total Acres	Percent of Total Acres	Percent of Total Acres	Total Percent of Forested Trust Lands	Total Acres
Ecosystem Initiation	7	8	7	7	8	8	8	**105,240**
Sapling Exclusion	11	17	25	15	17	15	17	**234,979**
Pole Exclusion	23	17	29	15	22	19	21	**286,880**
Large Tree Exclusion	26	13	6	27	13	11	16	**226,347**
Understory Development	11	17	6	18	15	21	14	**196,416**
Botanical Diversity	21	26	25	18	25	25	23	**324,724**
Niche Diversification	<1	0	1	<1	<1	<1	0	**3,683**
Fully Functional	1	2	1	<1	<1	<1	1	**12,435**
Total Percent	**100**	**100**	**100**	**100**	**100**	**100**	**100**	
Total Acres HCP Planning Unit	**110,222**	**381,516**	**141,845**	**267,530**	**232,931**	**256,659**		**1,390,704**

Data Source: Model output data – stand development stages.
[1/] OESF = Olympic Experimental State Forest
Note: Due to rounding, the numbers may not equal 100 percent when added.

lands. The competitive exclusion stage is the majority, about 69 percent (945,000 acres). In the table, the competitive exclusion stage includes the sapling exclusion, pole exclusion, large tree exclusion, and the understory development stages. Approximately 14 percent (196,000 acres) of the forest is estimated to be in an understory development stage. Approximately 25 percent (340,000 acres) of the forests are in botanically diverse, niche diversification, and fully functional development stages.

Forest Growth and Yield

"Forest growth and yield" refers to the change in surviving tree volume over time, i.e., individual tree and stand growth over time (yield). Characteristics that influence growth and yield are the species, spacing of trees in stands (density), and the site productivity of stands. The effects of the analyzed Alternatives are measured by how management activities change standing volumes and the distribution of stand development stage. Comparing the changes in standing inventory volumes and the changing distribution of stand development stages among Alternatives provides a means for summarizing the effects of changes in forest condition on future growth and yield of the forest base.

4.2.4.2 Environmental Effects

The Alternatives contain a number of changes to current policies and procedures. Table 4.2-6 summarizes the proposed changes to specific policies and procedures. Chapter 2 details proposed changes by Alternative, while Appendix C provides the current policies and procedures and the proposed new policies and procedures under the Preferred Alternative.

The effect of the proposed changes to the policy and procedures on the forest environment can be summarized as:

- changes in forest conditions as measured by the forests standing volume and stand development stages, and
- changes in the amount of disturbance or area under harvest activities.

The environmental effects of each of the proposed policy and procedural changes are examined for differences between Alternatives and differences in short- or long-term effects.

Sustainable, Even-Flow Timber Harvest

All Alternatives, except Alternative 1, propose to ease the sustainable even-flow policy. This policy directs DNR on how to meet its objective of revenue generation over the long term. The policy choices are a restricted flow policy (Alternatives 1 and 4), a non-declining policy (Alternative 2), a modulating timber flow policy (Alternative 5 and the Preferred Alternative), and a policy that essentially provides no constraint on the harvest flow (Alternative 3).

Changes in standing inventory are presented in Table 4.2-7 for all the Alternatives. All Alternatives, including Alternative 3, demonstrate an increase in standing volume over time (ensuring timber yields for future generations) and a more-diverse forest in terms of structural conditions (Table 4.2-8). In Appendix D, Table D-8, stand structural development over time is presented for individual HCP Planning Units.

Table 4.2-6. Policy, Procedure, and Operational Changes that Affect Forest Structure, Growth, and Yield

Policy and Procedure Changes Proposed	Alternative					
	1	2	3	4	5	PA
Policy No. 4 – Sustainable, Even-Flow Timber Harvest		X	X	X	X	X
Policy No. 6 – Western Washington Ownership Groups			X		X	X
Policy No. 5 – Harvest Levels Based on Volume					X	X
Procedure 14-004-120 – Management Activities within Spotted Owl Nest Patches, Circles, Designated Nesting, Roosting, and Foraging and Dispersal Management Areas		X	X	X	X	X
Policy No. 30 – Silviculture Activities; Policy No. 31 – Harvest and Reforestation Methods						X

X = indicates a proposed change in the policy or procedure
PA = Preferred Alternative

Table 4.2-7. Change in Standing Volume from Base Year 2004 by Alternative through 2067 (billion board feet)

Year Modeled	Alternative					
	1	2	3	4	5	PA
2004	31	31	31	31	31	31
2013	35	34	33	35	32	32
2031	46	41	38	45	34	37
2067	60	50	46	58	41	45

PA = Preferred Alternative
Source: Model output data (stand development stages).

Table 4.2-8. Comparison of Forest Stand Development Stage Distribution (percent of forested acres) in 2067

Forest Stand Development Stage	Existing Condition (2004)	Alternative					
		1	2	3	4	5	PA
Ecosystem Initiation	8%	9%	10%	11%	8%	11%	11%
Sapling Exclusion	17%	2%	3%	4%	1%	2%	5%
Pole Exclusion	21%	18%	26%	29%	18%	33%	21%
Large Tree Exclusion	16%	10%	10%	9%	14%	9%	10%
Understory Development	14%	35%	25%	22%	32%	21%	24%
Botanically Diversity	23%	21%	21%	20%	22%	21%	19%
Niche Diversification	<1	2%	2%	2%	2%	1%	5%
Fully Functional	1%	3%	3%	3%	3%	1%	5%

PA = Preferred Alternative
Source: Model output data (stand development stages).

The effects on forest condition appear positive for all the Alternatives over the long term. The distribution of harvest area across forested trust lands in western Washington, and therefore short-term impacts, may differ among the Alternatives. This aspect is examined in more detail in the Harvest Area section of Section 4.2.

Model outputs suggest most Alternatives would maintain a relatively constant timber harvest volume and timber area over the planning period 2004 through 2067 (Figures 4.2-1 and 4.2-2, respectively). Alternative 5 has a higher harvest area in the first half of the planning period and then the harvest area reduces to a similar level as the other Alternatives. This higher harvest level is predominantly thinnings (Figure 4.2-3). Alternative 3, which produces the most variation in the first half of the planning period, begins to produce a steadier flow towards the end of the planning period.

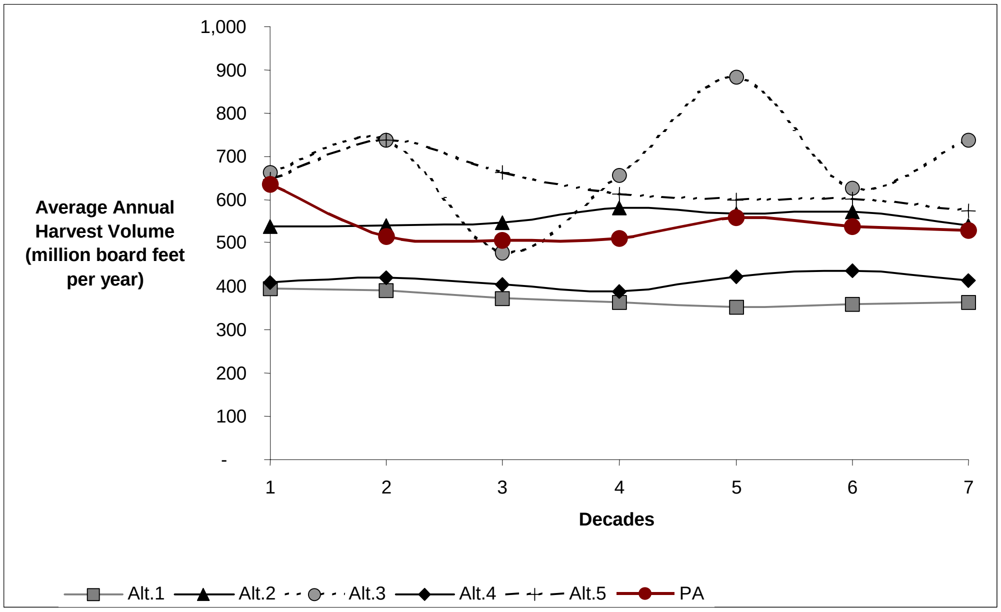

Figure 4.2-1. Average Annual Western Washington Forested State Trust Land Timber Harvest Volume per Decade over the Planning Period (2004-2067)

PA = Preferred Alternative

Data Source: Model output data – timber flow levels.

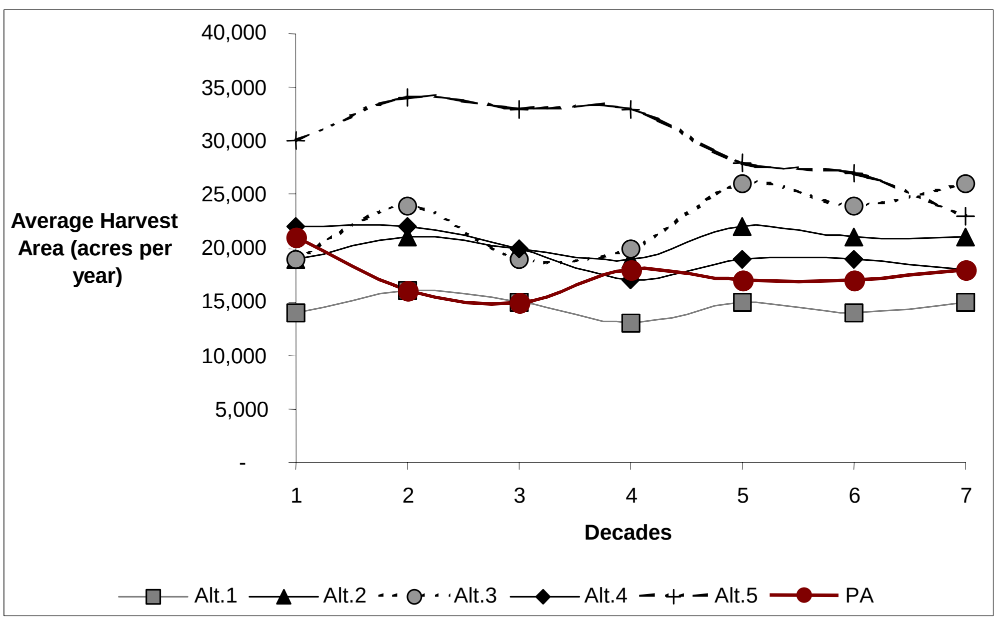

Figure 4.2-2. Average Annual Western Washington Forested State Trust Land Timber Harvest Area per Decade Over the Planning Period (2004-2067)

PA = Preferred Alternative

Data Source: Model output data – timber flow levels.

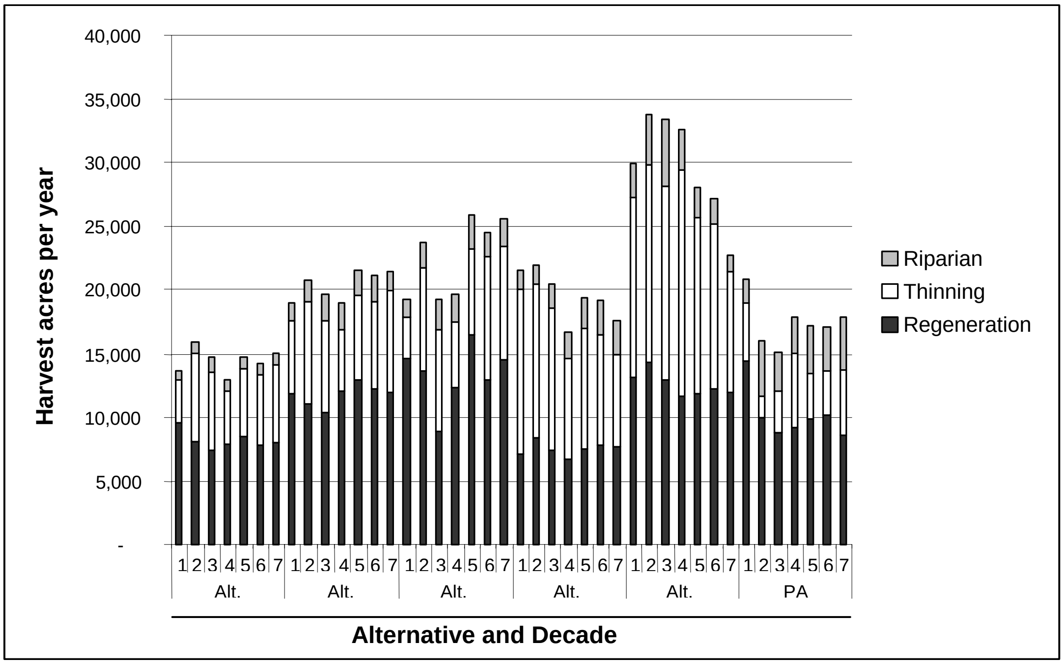

Figure 4.2-3. Harvest Type and Area by Alternative
PA = Preferred Alternative
Data Source: Model output data – timber flow levels.

Western Washington Ownership Groups (renamed as Sustainable Harvest Units, see Appendix F)

Policy choices that determine the size (area) of the management unit on which a sustainable even-flow of timber is managed can affect not only the total amount of harvest at any one time, but also the harvest distribution across the forested trust lands in western Washington. The policy choices considered in the Alternatives are: maintaining the sustainable harvest units (Ownerships Groups, Forest Resource Plan Policy No. 6) at 24 units; reducing the number to 20 by grouping all the federally granted trusts into one westside sustainable harvest unit, or eliminating all the sustainable harvest units and grouping all trusts into one westside sustainable harvest unit.

The reduction in sustainable harvest units is expected to increase the available harvest area, as synergies of available merchantable volume may occur between existing units and could be realized. The increase in harvest area may also be accompanied by an increase in the concentration of harvests in a particular geographical region over time. Therefore, a policy of one westside sustainable harvest unit might be expected to express these trends the most. However, other policy and management strategies may tend to limit the expected effects of an increase in sustainable harvest unit size. The combination of Habitat Conservation Plan management goals, such as riparian management and the protection of public resources (e.g., management of slope instability), results in a DNR-managed forest landscape where approximately:

- 31 percent of the land is within a Riparian and Wetlands Management Area,
- 43 percent is within a Upland Area where management will result in extended rotations and/or the maintenance of a portion of a forest canopy, and
- the remaining 26 percent is forestland that is managed with a primary focus on revenue generation (Table 4.2-9).

Therefore, the combined effects of the DNR's revenue generation and habitat conservation policy goals are likely to sufficiently limit the effects of the reduction in the number of sustainable harvest units.

Harvest Levels Based on Volume

Harvest levels can be calculated using either volume or value to represent forest growth. Either choice is consistent with the law (Revised Code of Washington 79.10.340). If this policy decision on how to calculate the harvest level were considered in isolation (i.e., no change in other policies), the choice may be expected to produce differences in forest conditions in terms of standing volumes. A policy that uses a volume calculation method (Alternatives 1 through 4) would likely be reflected by silvicultural and harvest regimes that increase volume. The standing inventory may be expected to increase over time as rotation lengths extend to maximize volume. A value-based method (Alternative 5 and the Preferred Alternative) may be expected to reduce standing volume over time, as rotation lengths reflect an economic rotation. However, this policy choice is not considered in isolation of other policies, particularly silviculture.

Table 4.2-9. Land Classes for Westside Habitat Conservation Plan Planning Units

HCP Planning Unit	Riparian and Wetlands		Uplands with Specific Objectives		Uplands with General Objectives		Total
	Acres	%	Acres	%	Acres	%	Acres
Columbia	86,400	32%	99,500	37%	81,600	31%	**267,500**
North Puget	92,700	24%	205,000	54%	83,800	22%	**381,500**
OESF	111,300	43%	145,200	57%			**256,500**
South Coast	81,000	35%	36,700	16%	115,300	49%	**233,000**
South Puget	34,600	24%	82,100	58%	25,200	18%	**141,900**
Straits	20,700	19%	32,900	30%	56,800	51%	**110,400**
Total[1/]	**426,700**	**31%**	**601,300**	**43%**	**362,700**	**26%**	**1,390,700**

Note: the Olympic Experimental State Forest (OESF) is an "unzoned" approach; therefore, there are no acres of Uplands with General Objectives.

1/ Acreage totals include lands in both short-term and long-term deferral status. This contrasts with other places in the document where acreages may not include short- and long-term deferral lands.

For Alternative 5 and the Preferred Alternative the silvicultural regimes are designed to increase the net present value of the forest stand subject to other objectives, as applicable. On Uplands with General Objectives, the expected effects may be a reduction in standinginventory, a younger age class distribution, and a higher percentage of ecosystem initiation forest. The modeling outputs (Table 4.2-10) support this trend for Alternative 5. Alternative 3 also demonstrates a similar trend, but this is related more to the level of harvest, which is influenced by the flow constraint and type of harvest than to the method of calculation.

Silviculture Activities

The choice of silviculture systems and treatments has the potential to influence forest conditions at multiple scales, both temporal and spatial. In general, all the Alternatives assume a continuation of the forest practices of even-aged plantation forestry on portions of forested trust lands in western Washington. The exceptions to this general statement are the silvicultural regimes to be developed for Riparian Management Zones and resource sensitive areas, such as visual areas and areas of slope instability. In these areas, it is more likely that DNR would develop silviculture prescriptions based on un-even aged silvicultural systems.

The Preferred Alternative provides policy direction to DNR to implement biodiversity pathway approaches to silviculture on forested trust lands. The other Alternatives essentially maintain the status quo on the type of silviculture to be implemented (Alternative 1, 2, and 3), use more-intensive silviculture (Alternative 5), or use even-aged silviculture with longer rotations (Alternative 4). The Preferred Alternative focuses the implementation of biodiversity pathway approaches on Riparian and Wetland Management Areas and the upland areas designated for habitat management (Olympic Experimental State Forest; nesting, roosting, foraging, and dispersal areas). The modeling results for stand development stages illustrate the increase in structurally complex forest for the Preferred Alternative compared to the other Alternatives (see Figure 2.6-4).

Table 4.2-10. Percentage Change in Standing Forest Inventory in the Uplands with General Objectives between 2004 and 2067

Alternatives	Percent Standing Volume change	Percent Area Change in Ecosystem Initiation
Alt.1	24%	76%
Alt.2	26%	54%
Alt.3	-10%	100%
Alt.4	12%	76%
Alt.5	-9%	14%
Preferred Alternative	21%	47%

Notes:
Current standing inventory is estimated at 8 billion board feet.
Current area of Ecosystem Initiation is estimated at 39,563 acres.

A key silvicultural principle of biodiversity pathways is to replicate some of the natural processes by removing more trees from the stand than in a traditional thinning, thereby allowing for light and water to encourage growth of understory tree species and other flora.

Depending upon stand conditions, the combination of thinning for variable residual tree densities, underplanting, vegetation management, and the recruitment of snags and coarse woody debris is thought to "accelerate" the development of complex structural conditions in second-growth forests. Exact treatments are dependent upon the stand objectives and site conditions. For example, forest stands that have a lot of tall trees in them with small crowns (dense tall stands) are probably not suitable for thinnings that remove a lot of trees at once (heavy thinnings). However, a combination of removing less trees (lighter thinning) and patch cuts (1/2 to 10 acres in size) may result in a forest stand that has improved future structures as the patches provide opportunity for understory trees to develop.

While biodiversity pathways approaches to silviculture are designed to promote a stand's structural development, implementation of these treatments is likely to be limited by current stand conditions. Analysis of current forest conditions of the riparian-wetland and designated habitat management areas (770,000 acres) suggests that only about 35 percent (270,000 acres) is suitable for long-rotation (140-year) silviculture with variable-density thinnings. Suitability is defined here as conifer-dominated stands that are not in a densely overstocked state. Variable-density thinnings, with heavy thinning treatments in dense and especially dense-tall mature stands can be problematic. Removing a large number of trees from an overly stocked stand to promote understory development may severely increase the risks of catastrophic blowdown and collapse of the stand. In these cases, other stand-level prescriptions would be developed. For example, lighter thinnings that maintain more of the overstory could be used in combination with patch-cutting. For specific stands, regeneration harvest may be the appropriate option. In practice, for riparian and designated habitat management areas, DNR forest managers design site-specific prescriptions to meet Habitat Conservation Plan objectives that account for current conditions.

The forested trust lands in western Washington are dominated by second-growth even-aged stands (see Figure 2.6-2). The majority of this forestland is dominated by single-canopy stands with little diversity in tree size or species. These stands are in a competitive exclusion stage. If these stands were left to develop along nature's path (i.e., with no human management), it is unlikely that many would develop into multiple-story structurally complex stands over the life of the Habitat Conservation Plan. Franklin et al. (2002) suggested that competitive exclusion in Douglas-fir/western hemlock forests could be maintained for 100 years or more. One-hundred-year simulations of DNR's forest inventory using the USDA Forest Service Forest Vegetation Simulator demonstrated little change in the forest structure in terms of the area with multiple tree strata (see Appendix B, Section B.2.2). This is because it takes a long time for nature to lower the number of dominant canopy trees per acre through natural mortality alone to a level where the remaining trees can grow to a large size and other trees can then develop under the upper canopy.

Even-aged silvicultural systems, in general, are designed to maintain stands in a competitive exclusion state to maximize volume production per unit area. Therefore, these systems do not necessarily encourage the development of structurally complex forests. Even-aged silviculture maintains the live tree density too high for the development of a functional understory. In addition, some “mortality” that would have been expected as snags or coarse woody debris is removed during thinning. These thinnings are typically designed to maintain the health and vigor of the residual growing trees as they get larger over time.

Shorter rotations as in Alternative 5 may be expected to develop a younger forest over time. Longer rotations, as in Alternatives 4 and the Preferred Alternative, may be expected to develop an older forest over time. Longer rotations and older forest stands do not guarantee that the forest will become more structurally complex. However, longer rotations do provide more time between disturbances, which may be important for certain flora and fauna.

Harvest Area

The combination of policy and procedural changes presented in the six Alternatives would likely result in differing disturbance regimes (i.e., amounts of area harvested) among the HCP Planning Units. Equally, if a smaller scale is used (e.g., watershed), then differences among Alternatives might be expected to be more noticeable. While the forest modeling used to inform the Board of Natural Resources’ policy analysis and this Final EIS are not designed to produce a site-specific harvest schedule for each forest stand in western Washington forested trust lands over the next decade, the modeling outputs can be used to provide a level of information on the likely harvest level at the watershed scale. The modeling results report only one possible outcome. DNR forest managers will design actual harvest schedules. It is reasonable to expect that there will be differences between the processes. Using the modeled outcomes for this Final EIS analysis provides a picture of the relative differences between Alternatives in terms of the variation of possible harvest regimes at the HCP Planning Unit and watershed scale. It does not provide a meaningful schedule of harvest events.

DNR manages forested trust lands in 324 watersheds in western Washington. Watersheds are represented here by the April 2002 Washington Department of Ecology Watershed Administrative Unit Geographic Information System coverage and provide a convenient spatial scale at which to conduct this analysis. Trust ownership in these 324 watersheds varies from 1 acre (0.003 percent of the watershed area) to 56,800 acres (98 percent of the watershed area). To simplify this analysis, only the watersheds in the upper quartile of percent ownership are considered. The threshold, the upper quartile, requires that 22 percent or more of the land in the watershed be DNR-managed forested trust lands. Eighty-three watersheds meet that ownership threshold, and they represent approximately 68 percent (944,000 acres) of all the forested trust land ownership in western Washington.

The impact of a decade’s cumulative regeneration harvest activity in these 83-watersheds is presented in Table 4.2-11. As expected, the Alternatives result in differing levels of areas harvested. The decadal cumulative level of activity is described in three categories: less than 10 percent, between 10 and 20 percent, and more than 20 percent of the forested trust land in the watershed is regenerated over a decade. The groupings are somewhat arbitrary; however; the group of “more than 20 percent” represents approximately 5 percent of the regeneration harvest area in decade 1.

Table 4.2-11. Number of Watersheds[1/] with Rates of Regeneration Harvests for each Alternative over Seven Decades

Decade	Level of Regeneration Harvest Activity (percent[2/])	Alternatives					
		1	2	3	4	5	PA
	1-9	46	36	38	36	7	25
1	10-20	27	33	27	23	33	32
	>20	8	12	16	23	42	23
	1-9	41	24	25	32	4	33
2	10-20	32	40	31	27	24	44
	>20	9	18	26	22	53	4
	1-9	47	17	20	31	2	31
3	10-20	30	57	56	32	29	49
	>20	5	8	6	19	51	2
	1-9	52	28	21	29	3	25
4	10-20	25	43	51	47	22	51
	>20	5	10	10	6	57	5
	1-9	41	16	11	29	3	29
5	10-20	35	55	40	37	51	45
	>20	6	11	31	16	28	7
	1-9	41	19	17	26	8	30
6	10-20	33	48	40	40	42	43
	>20	7	14	24	15	31	8
	1-9	75	73	64	75	64	76
7	10-20	3	9	18	6	16	5
	>20	0	0	0	0	0	0

Notes:

1/ Values presented in the table represent watersheds where forested trust lands ownership equals 22 percent or greater of the watershed area and regeneration harvests occur in the decade. Some watersheds do not have harvests in them in a given decade; therefore, the totals will not add up to 83 watersheds, as discussed in Chapter 4, Section 4.15.

2/ The level of harvest activity is expressed as a percentage of the forested trust lands ownership acreage in a watershed that is regenerated over a decade period.

PA = Preferred Alternative

Data Source: Model output data – timber flow levels.

Alternative 5 is projected to have the highest level; regeneration harvest levels of more than 20 percent of the watershed would affect 42 watersheds in decade 1 (Table 4.4-11). Alternative 1 and 2 are projected to have the lowest number of watersheds (8 and 12, respectfully), while the Preferred Alternative (23) and Alternative 3 (16) and 4 (23) have an intermediate number of watersheds with more than 20 percent of the watershed affected by regeneration harvest. This trend between the Alternatives is generally repeated over the seven decades, with the exception of the Preferred Alternative, which after the first decade is projected to have fewer watersheds in the “more than 20 percent” regeneration group. This trend for the Preferred Alternative may be due to the high level of regeneration harvest in stands that are not suitable for long rotation biodiversity management in the first decade. Similar patterns and trends among the Alternatives are projected at the HCP Planning Unit scale (see Appendix D.1).

While the above analysis identifies the potential for relatively high harvest rates in some watersheds, the combination of DNR’s policies of habitat conservation (Riparian Management Zones and designated habitat management areas) and protection of public resources applies to all watersheds. For example, riparian and wetland areas and areas of slope instability are managed with the same objectives as are watersheds that receive lesser harvest. The distribution of land classes by watershed is presented in Appendix E, Section E.1. The relative risks of the short-term impacts are identified and assessed at further planning levels and at the project level. Analysis of the type above and in the Cumulative Effects section (Section 4.15) will assist in focusing mitigation and planning efforts on the watersheds that could potentially receive relative high harvest levels.

4.2.5 Old Forest

4.2.5.1 Affected Environment

There is no single definition of an old forest, sometimes referred to as old growth. Depending on the definition of these terms, the extent and value of the forest varies. For some individuals, the definition of old forest is deeply rooted in science; for others, old forest simply means big trees. To many people, old forests have spiritual or aesthetic values or are important for recreation. The intangible benefits of old forest will be the focus of this subsection, and will be measured by the presence of stands with old forest characteristics. Refer to Section 4.4 (Wildlife) for a discussion of old forest as wildlife habitat.

In this section, various definitions to describe old forests are used, which include:

- Forest stands older than 150 years of age; and
- Forest stands that have various old forest characteristics, labeled here as “structurally complex” forests, which include botanically diverse, niche diversification, and fully functional stand development stages (Table 4.2-4).

In the Olympic Experimental State Forest, 20 percent of forested trust lands are managed for old forest conditions (DNR 1997, page IV.88). While the term is not used in this analysis, the Habitat Conservation Plan glossary provides the following definition for old-growth forest.

> A successional stage after maturity that may or may not include climax old-growth species; the final seral stage. Typically contains trees older than 200 years. Stands containing Douglas fir [*sic*] older than 160 years, which are past full maturity and starting to deteriorate, may be classified as old forest. DNR's GIS forest classification for old forest is: a dominant DBH (diameter at breast height) of 30 inches or greater; usually more than eight dominant trees/acre; three or more canopy layers with less than complete canopy closure; several snags/acre with 20 inch dbh or greater; and several down logs per acre with a 24 inch dbh or greater."

According to Forest Resource Plan Policy No. 14, about 2,000 acres of old forest (stands larger than 80 acres and greater than 160 years old) are currently deferred from timber harvest in Old Growth Research Areas

DNR estimates there are about 341,000 acres of structurally complex forests on western Washington forested state trust lands. The distribution of these structurally complex acres among the HCP Planning Units is provided in Table 4.4-1. Field observations and local research indicate some level of agreement with these estimates; however, the criteria used to identity old forests and structural complexity will vary depending upon the purpose. DNR's stand development stage classification uses criteria principally from studies in the western hemlock/Douglas-fir forests and may not accurately categorize other forest types, for example the spruce forests in the Olympic Experimental State Forest.

4.2.5.2 Environmental Effects Associated with Old Forest

Proposed changes to policy and procedures among the Alternatives that would affect old forest are summarized in Table 4.2-12.

All Alternatives, with the exception of Alternative 5, show an increase in the area of old forest conditions over the 64-year planning period. Figure 4.2-4 graphically displays the distribution of structurally complex forest at the end of the planning period. Figure 4.2-5 displays acres of forests 150 years old or greater occurring at the end of the first and last decades of the analysis period.

Table 4.2-12. Policy and Procedure Changes that Affect Old Forest on Forested Trust Lands

Policy Change Proposed	Alternative					
	1	2	3	4	5	PA
Procedure 14-006-090 – Legacy and Leave Tree Levels		X	X	X	X	X
Manage 10-15% of each Planning Unit in Mature Forest Component					X	X
Maintain All Stands Greater than 150 Years Old				X		

PA = Preferred Alternative

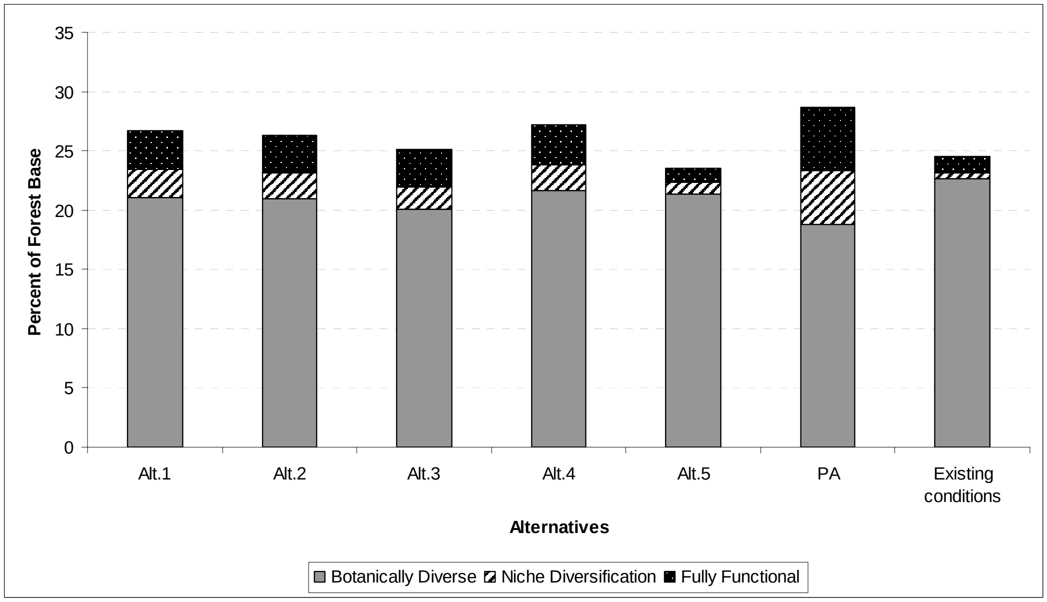

Figure 4.2-4. Percent Distribution Structurally Complex Forest at Year 2067

PA = Preferred Alternative

Data Source: Model output data – stand development stages

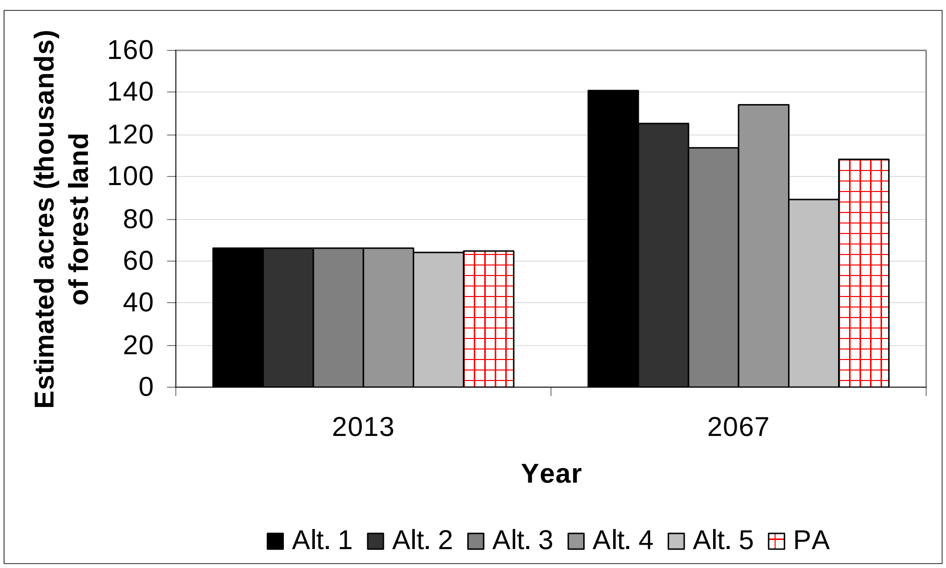

Figure 4.2-5. Acres of Forests 150 years and Greater by Alternative at Years 2013 and 2067

Note: Current conditions estimated at 60,000 acres of old forest are represented as forests 150 years and greater.

PA = Preferred Alternative

Data Source: Model output data – stand development stages.

Alternatives 1, 2, 3, 4, and the Preferred Alternative all show that the increase in the amount of structurally complex forest over the planning period is not large: between 2 percent for Alternative 3 and 17 percent for the Preferred Alternative. The Preferred Alternative also increases the area of forest in a fully functional condition. This most likely is the result of silvicultural treatment associated with biodiversity approaches. Alternative 5 displays a slight decrease in structurally complex forests. This is mostly the result of the combination of large harvest areas in the first half of the planning period and shorter rotations. The modeling results for Alternative 5 suggest that over the planning period structurally complex conditions could actually be lost due to harvesting. However, in practice with a policy of targeting 10 to 15 percent of each HCP Planning Unit's forested trust lands to be in structurally complex forest, it is unlikely that any area would be lost. DNR field foresters would most likely target existing older and more structurally complex stands for a no harvest regime.

In terms of forest area at or greater than 150 years of age, Alternative 5 and the other Alternatives all demonstrate increases in areas (Figure 4.2-5). The increase in forest area with a stand age of 150 years or more is greatest in Alternatives 1 and 4 compared to the other Alternatives. Both these areas have less on-base acres and less area under harvest in any decade compared to the other Alternatives (Figure 4.2-5). Alternative 4 also provides protection to all existing stands over 150 years of age. Alternative 1, however, demonstrates the effect of maintaining a large part of the land base off-base as an effective mechanism for developing an older forest. Alternatives 2, 3, and the Preferred Alternative demonstrate less acreage in 2067 in forest area over 150 years of age than Alternative 1. For Alternatives 3, 5, and the Preferred Alternative, the differences are approximately 27,000, 52,000, and 34,000 acres.

4.2.6 Forest Health

4.2.6.1 Affected Environment

Forest Resource Plan Policy No. 9, Forest Health, and Guideline 14-004-030, Assessing and Maintaining Forest Health, both incorporate forest health practices into forest management, stressing prevention through early detection and management such as the maintenance of appropriate species and tree density in state forests.

Growing space is the sum of conditions needed for tree growth. Relative density indicates the amount of growing space occupied by each tree within a forest stand (relative density is a ratio based on a sampling of tree measurements). Often used as a tool to determine when thinning is needed to maintain steady stand growth, relative density can also be used as an indicator of stand health. As competition among trees for growing space increases, relative density increases and vigor for some trees decline.

Increased susceptibility to insects and disease in densely stocked forest stands is, in part, a function of the way a tree allocates its food resources or nutrients. Although allocation of food may vary among tree species and different tree ages, most trees have a set priority for allocating resources. Maintenance of the tree's existing living tissue (tree growth) and reproduction are of higher priority than the production of resistance mechanisms to ward off insects and disease (Oliver and Larson 1996). High density does not ensure poor stand health, because it is not specifically the cause of stress and mortality. Insects, disease, and environmental factors that cause mortality may affect a stand at any time. However, forest stands with decreased vigor are more susceptible to these stresses (Drew and Flewelling 1979). The point at which density-caused mortality occurs serves as an indicator of forests at increased risk for forest health concerns.

The relative density at which competition-related mortality occurs varies by tree species.

- Western hemlock and Douglas-fir trees dominate the majority of the forest stands on forested trust lands.
- Douglas-fir dominated stands begin to experience density-related mortality at a relative density of 50, although some stands do not show mortality until they reach a relative density of 70 (Curtis 1982; Bailey et al. 1998).
- Western hemlock stands begin to experience density-related mortality at a relative density of 55 (USDA Forest Service 2002a).
- Red alder stands begin to experience density-related mortality at a relative density of 44 (Puettmann et al. 1993).

Table 4.2-13 shows the relative density level when the susceptibility for competitive mortality increases for the three major tree species in western Washington forested state trust lands. Approximately 459,000 acres of Douglas-fir stands, 331,000 acres of western hemlock stands, and 82,000 acres of red alder stands are nearing or at increased risk to mortality, based on elevated relative density. Thinning to maintain growth also increases stand vigor.

The 2002 aerial survey showed that the major causes of damage in western Washington forests include hemlock looper and black bear (DNR 2003). Hemlock looper is a tree defoliator that is associated with multi-storied old forest. Its primary hosts are western hemlock, Douglas-fir, and western red cedar. Outbreaks of hemlock looper have been quite extensive in recent years, presumably due to drought.

Table 4.2-13. Forests at or Above the Relative Density Levels at Which Tree Mortality Occurs by Tree Species

Major Dominate Tree Species	Relative Density When Density-Related Mortality May Begin	Acres on Forested Trust Land	Percent of Total Forested Area
Douglas-fir	50 and above	459,000	33
Western hemlock	55 and above	331,000	24
Red alder	44 and above	82,000	6
Total		**872,000**	**63**

Data Source: Model output data (stand development stages).

Black bear damage increased from about 38,000 acres in 2001 to 172,000 acres in 2002. Damage to sapling and pole-sized stands can be high. Bears strip the bark to eat the cambium layer, reducing stand growth and introducing stem decay. Laminated root rot poses a major threat to its most economically important host, second-growth Douglas-fir. The disease causes root decay, which can cause significant growth reduction, and makes trees susceptible to blowdown (Thies and Sturrock 1995). Recently cut stumps are infected by spores. The disease can remain viable for decades in old stumps and roots. Thinning can worsen the problem, causing the disease to spread to uninfected trees. Black-stain root disease is spread by insects, primarily root-feeding bark beetles such as *Hylastes nigrinus*. Trees damaged by logging operations, including thinning, have an increased risk of infection. Soil compaction may also play a role (Otrosina and Ferrell 1995). Treatment of root disease generally is by removing the diseased trees. The area is typically then reforested with a less susceptible tree species (DNR 1997).

Bark beetles are usually associated with events that kill or weaken trees, such as windthrow or drought. When populations increase, bark beetle will attack healthy trees.

Fire Risk

The operation of logging equipment can ignite a forest fire, especially when surface fuels (slash) associated with logging are present. Additionally, intensive management requires greater access, which may lead to increases in human-caused fires. Fire intensity and expected fire spread rates increase in areas adjacent to harvest. This analysis uses the level of harvest intensity by Alternative to evaluate fire risk.

4.2.6.2 Environmental Effects Associated with Forest Health

There are no proposed changes in policy, procedures, or tasks among the Alternatives that specifically address forest health. However, proposed policy changes that affect harvest intensity and, consequently, forest structures across the landscape can affect forest health. (Refer to Appendix D for a discussion on harvest intensity.)

Under Alternatives 1, 2, and 4 there would be a slight increases in the acres of forest stands with a high relative density (Table 4.2-14). Only Alternatives 3, 5, and the Preferred Alternative illustrate any reduction in area of stands with high relative density. Intensive management that includes regeneration harvest and aggressive thinning strategies under Alternative 5 would result in the greatest reduction of acres with high relative densities (Table 4.2-15).

The high levels of moderate to heavy thinning associated with Alternative 5 and the Preferred Alternative could increase the risk of tree mortality and growth loss from root disease (Thies and Sturrock 1995) and windthrow if harvest is not properly designed and implemented. Bark beetle tree mortality is generally associated with weakened or dead trees. Windthrow would increase the risk of beetle population increases and consequent tree mortality from bark beetles. Therefore, additional resources and staff would need to be committed to ensure that harvests are carefully planned and administrated.

Table 4.2-14. Percent of Total Forested Acres with Elevated Relative Density Levels over the Planning Period by Alternative[1/]

Alternative	Dominant Tree Species	Analysis Period					
		2004	2008	2013	2031	2048	2067
1	Douglas-fir	33%	34%	37%	38%	33%	34%
	W. Hemlock	24%	29%	30%	31%	24%	29%
	Red Alder	6%	6%	5%	5%	6%	6%
	Total Acres	**63%**	**68%**	**72%**	**73%**	**63%**	**68%**
2	Douglas-fir	33%	32%	37%	36%	33%	32%
	W. Hemlock	24%	28%	28%	28%	24%	28%
	Red Alder	6%	6%	5%	5%	6%	6%
	Total Acres	**63%**	**66%**	**70%**	**69%**	**63%**	**66%**
3	Douglas-fir	33%	30%	32%	33%	33%	30%
	W. Hemlock	24%	29%	26%	28%	24%	29%
	Red Alder	6%	6%	5%	5%	6%	6%
	Total Acres	**63%**	**65%**	**64%**	**66%**	**63%**	**65%**
4	Douglas-fir	33%	34%	37%	36%	33%	34%
	W. Hemlock	24%	28%	29%	29%	24%	28%
	Red Alder	6%	5%	5%	5%	6%	5%
	Total Acres	**63%**	**67%**	**70%**	**70%**	**63%**	**67%**
5	Douglas-fir	31%	28%	27%	30%	31%	28%
	W. Hemlock	24%	28%	23%	27%	24%	28%
	Red Alder	6%	5%	5%	4%	6%	5%
	Total Acres	**61%**	**60%**	**55%**	**61%**	**61%**	**60%**
Preferred Alternative	Douglas-fir	33%	31%	34%	28%	33%	31%
	W. Hemlock	24%	25%	26%	26%	24%	25%
	Red Alder	6%	5%	3%	6%	6%	5%
	Total Acres	**63%**	**61%**	**63%**	**60%**	**63%**	**61%**

[1/] See Table 4.2-13 for relative density levels when tree mortality occurs by tree species.
Data Source: Model output data - stand development stages.

Table 4.2-15. Harvest in Riparian Zones and Percent of Forest with Botanical Diversity, by Alternative

Alternative	Average Percent of Riparian Land Class Impacted per Decade by Harvest Type				Percent of Forested Acres (Upland and Riparian) with Botanical Diversity[4/] in 2067
	Low Volume Removal Harvest [1/]	Medium Volume Removal Harvest[2/]	High Volume Removal Harvest[3/]	Total	
1	1	0	1	2	30
2	1	0	3	4	30
3	1	0	3	5	29
4	2	1	2	5	30
5	4	0	3	7	29
PA	1	2	6	8	33

Data Source: Model output data – timber flow levels and stand development stages.
1/ Less than 11 thousand board feet per acre volume harvests
2/ Between 11 and 20 thousand board feet per acre volume harvests
3/ Greater than 20 thousand board feet per acre volume harvests
4/ Includes botanically diverse, niche diversification, and fully functional forest stages
PA = Preferred Alternative

The risk for hemlock looper outbreak may increase slightly under all Alternatives because all Alternatives promote multi-layered canopy forest structure; however, looper is generally associated with old forests and drought (DNR 2003).

Alternatives that feature thinning entries (such as Alternative 5 and the Preferred Alternative) could increase the risk of diseases spread through wounds made by logging equipment (Otrosina and Ferrell 1995).

Alternatives that have the greatest amount of forest in the sapling and pole exclusion stages would have the greatest risk for bear damage. At the end of the planning period (2067), Alternatives 1 and 4 would have the least area at risk of bear damage, with 20 and 19 percent of the forested trust lands in sapling and pole exclusion stands, respectively (Table 4.2-8). Alternatives 2, 3, 5, and the Preferred Alternative would have a greater percent of the area in these stand development stages—between 26 and 35 percent of forested trust lands would be in sapling and pole exclusion stand development stage at the end of the planning period.

Fire Risk

Harvest intensity under Alternatives 1, 2, and 4 would be relatively low. The risk for wildfire associated with operator fires and logging residue would be similar to the existing risk under these Alternatives. Harvest intensity under Alternative 3 would fluctuate over time. Regeneration harvest would be higher than the other Alternatives in the first decade but would decrease over time. Fire risk under Alternative 3 would be highest in those years when harvest intensity is high (Appendix D). Alternative 5 and the Preferred Alternative would have the highest harvest intensity levels over the duration of the planning period, with Alternative 5 slightly higher than the Preferred Alternative. The higher number of harvested acres would increase the risk of a fire compared to the other Alternatives. Under all Alternatives, fire risk would be mitigated by treatment of logging slash after the timber has been harvested if it is determined to be an extreme hazard (DNR 1992b). Slash treatments are designed to burn, remove, or rearrange the slash to reduce fire risk. In periods of high fire risk, logging operations are normally suspended, thereby mitigating fire risk during logging operations.

4.2.7 Carbon Sequestration

Carbon, primarily in the form of carbon dioxide, is one of the major greenhouse gases that are being released into the atmosphere (McPherson and Simpson 1999). The global carbon cycle involves the earth’s atmosphere, fossil fuels, the oceans, and the vegetation and soils of the earth’s terrestrial ecosystems. Gases that make up the earth’s atmosphere, such as carbon dioxide, methane, nitrous oxide, and water molecules, trap the sun’s heat, creating a natural “greenhouse effect” that makes life on earth possible (McPherson and Simpson 1999). These gases are released into, and removed from, the atmosphere by a variety of natural sources and sinks.

Forestlands have the capacity to absorb large quantities of carbon dioxide emissions and sequester carbon for potentially long periods of time (Binkley et al. 1997). Forests have the potential to store a great deal more carbon than they currently do (Harmon 2001), which, in turn, may temporarily slow the increase of atmospheric carbon dioxide concentrations. Although studies have shown that intensive forest management can lead to increased rates of carbon dioxide sequestration (Schroeder 1991; Binkley et al. 1997), other research suggests that not all forestry-related projects are equally likely to sequester carbon and that some may actually release carbon to the atmosphere (Harmon 2001).

The term “carbon sequestration” refers to the removal of carbon dioxide from the atmosphere, and the long-term storage of carbon as trees or as products such as lumber (U.S. Department of Energy, Office of Fossil Energy 2001). Forest carbon sequestration refers to the annual rate of storage of carbon dioxide in both aboveground and belowground biomass over the course of a growing season (McPherson and Simpson 1999).

Carbon sequestration depends on tree growth and mortality. Newly planted forests accumulate carbon rapidly for several decades and then sequestration declines as trees mature and growth slows, resulting in less new wood being produced each year. Old forests can release more carbon from decay than they sequester in new growth. It can take several decades or longer for large trees to decay, and old forests generally store considerable amounts of carbon on the forest floor. However, while old forests can maintain a large amount of stored carbon, they reach a point at which they no longer add additional carbon to their stockpile of stored carbon. Harvesting large trees, storing the wood as lumber in buildings, and replanting the area with young, fast-growing trees can add to the stockpile of stored carbon.

4.2.7.1 Affected Environment

Approximately 68 percent of western Washington forested state trust lands are in competitive exclusion and understory development stages. During the sapling and pole exclusion stages, trees begin to compete for space, light, and nutrients; ultimately the taller, faster-growing trees become dominant, causing mortality in the suppressed, smaller trees and creating the first cohort of small snags. Following mortality, decay will cause a release of carbon back to the atmosphere. Additional releases of carbon will come from those trees that are suppressed and ultimately die during the large tree exclusion stage. These larger stems, trees over 20 inches diameter at breast height, have sequestered considerably more carbon than those stems in the sapling and pole exclusion stages. An acre of trees in the sapling and pole stage may accumulate between 5 and 10 tons per acre, while a stand with fewer but larger trees may accumulate carbon at two to three times that rate (McPherson and Simpson 1999). Based on research by Schroeder (1991), thinning of very dense younger stands could increase carbon storage by concentrating growth into crop trees that eventually are used to produce lumber and other products.

Research conducted by Haswell (2000) indicates that lengthening rotation increases the aboveground carbon storage. Extending the rotation age from 40 to 65 years resulted in a 41 percent increase in aboveground carbon storage. Also, larger diameter trees achieved through longer rotation lengths are more likely to produce wood products, such as lumber used in building construction, that will store carbon over long periods of time. The management regime affects the nature of the forest products carbon pool (short rotations tend to produce a higher fraction of short-term products such as paper and cardboard).

4.2.7.2 Environmental Effects Associated with Carbon Sequestration

Estimating the effects of the proposed Alternatives on carbon sequestration is complex. There are many factors that affect sequestration and storage; some components of an Alternative may contribute to a net removal of carbon while some components may offset those gains. Much of the western Washington forested state trust lands support stands in the large stem exclusion and understory re-development stages. Alternatives that propose passive management, Alternatives 1 and 4, would allow much of this area to develop naturally. These stands contain many small trees that will die over the next 2 to 3 decades, allowing the remaining trees to grow and sequester additional carbon. However, the small trees that die will decay over this period, releasing carbon into the atmosphere and offsetting carbon sequestration by living trees, resulting in little or no net gain. Also, these stands have a higher risk of fire because of the heavier fuel loads created by dead and dying trees. If these stands do burn, large amounts carbon would be released. Alternatives that thin these stands (Alternative 5 and the Preferred Alternative), converting a portion of the trees that would likely die into lumber, would increase the net amount of stored carbon because the buildings created with the lumber are likely to last much longer than it would take for these trees to die and decay if left uncut.

Alternatives with longer rotation lengths and intermediate thinnings could increase aboveground carbon storage compared to Alternatives with shorter rotation lengths and no thinnings. Alternatives 1 and 4 are projected to produce more large trees (trees greater than 20 inches diameter at breast height) and, therefore, are likely to store more carbon on site than the other Alternatives. The Preferred Alternative has the next highest distribution of forested acres with large trees, which would likely result in the next highest amount of carbon sequestered and stored on site, followed by Alternatives 2, 3, and 5. However, long-term storage is also affected by the decay of trees and down wood.

While Alternatives 1 and 4 would grow more large trees, they would also harvest less wood than other Alternatives and use less thinning to reduce within-stand competition and tree mortality. More young trees would die and decay, releasing carbon into the atmosphere. Alternatives that concentrate tree growth into crop trees that are harvested and converted to wood products used in buildings would store carbon for longer periods.

In terms of carbon sequestered in lumber and other wood products over the period of analysis, Alternatives 2, 3, 5, and the Preferred Alternative are projected to produce the highest harvest volumes per decade. Much of this volume is projected to be from large trees by the end of the planning period (2067). Harvested trees are likely to be processed into long-term wood products, such as lumber used in building and home construction, and would maintain sequestered carbon well beyond the planning period. Alternatives 4 and 1 are projected to produce the lowest harvested volumes. Alternatives 1 to 4 are likely to store less carbon in the long term than the other Alternatives.

4.2.8 Threatened, Endangered, and Sensitive Plants

4.2.8.1 Affected Environment

The Washington Natural Heritage Program maintains a list of threatened, endangered, and sensitive plant species known to occur in each county. The list is derived from a comprehensive Geographic Information System database of known occurrences of threatened, endangered, and sensitive plants in the state. Appendix D contains a list of threatened, endangered, and sensitive species that either occur or may occur in the general area of forested trust lands. The list is compiled from threatened, endangered, and sensitive species lists for each county that includes western Washington forested state trust lands. The table also includes the habitat requirements for each species and known occurrences of threatened, endangered, and sensitive plants on the forested trust lands.

As shown in Appendix D, many threatened, endangered, and sensitive plant habitats, such as alpine, beach, exposed rock, or exposed grassy bluff, are not likely to be affected by harvest or harvest-related activities. Other habitats such as meadows, prairies, or forest openings may not support trees for harvest but may be adjacent to harvest areas and could potentially be affected by harvest activities. The species that occur in forested habitat, including microhabitats in forests such as forest openings, have a higher likelihood of being affected by harvest or harvest-related activities.

No comprehensive inventory of threatened, endangered, and sensitive plants exists for the forested trust lands. The known occurrence lists do not represent a full inventory. A list of potential species for individual projects can be developed from the Washington Natural Heritage Program database on threatened, endangered, and sensitive species by county.

DNR management activities on all forested trust lands follow Forest Resource Plan Policy No. 23, Endangered, Threatened, and Sensitive Species. The policies and regulations that govern the management of threatened, endangered, and sensitive plants on forested trust lands can be found in Appendix C. DNR’s rare plant database is generally reviewed for known occurrences of listed threatened, endangered, and sensitive plants during planning of timber management activities (personal communication with F. Caplow, Washington Natural Heritage Program). There are no DNR procedures requiring review of known occurrences or avoidance of threatened, endangered, and sensitive plants during operations. However, the Habitat Conservation Plan’s protection of rare habitats, cliffs, talus slopes, combined with wetland and riparian management measures, provide some incidental protection. The limitations of activities in these areas reduce the likelihood of physically disturbing threatened, endangered, and sensitive plant populations that may exist in these areas.

4.2.8.2 Environmental Effects Related to Threatened, Endangered, and Sensitive Plants

Direct effects to threatened, endangered, and sensitive plants include physical damage or destruction of the plant due to harvest or related activities. Indirect effects include changes in the micro-environment, such as changes in canopy (i.e., available sunlight), changes in hydrology, and increases in competition from weeds or other native species. The range of effects is wide and varied because there are many threatened, endangered, and sensitive plant species with different habitat requirements and life histories. Therefore, each species would potentially have a different sensitivity to particular disturbances. For example, while one species may benefit from additional light due to a reduced canopy cover, another could be negatively affected by direct sunlight.

Comparison of Alternatives

The Alternatives considered in this analysis do not propose any policies or procedures changes related to the management of threatened, endangered, and sensitive plants. The management of these plants is identical under all Alternatives. The difference in effects among the Alternatives would, therefore, be a function of acres of harvest in habitats that may contain threatened, endangered, and sensitive plants. Because the locations of these plant populations are not known, it is assumed that more harvest and harvest-related disturbance has a greater probability of physically disturbing such populations or their habitat. For this analysis, areas that may experience harvest activities and where threatened, endangered, and sensitive plants can occur are considered. These include both riparian and upland areas.

RIPARIAN AREAS

Differences among Alternatives in policies and procedures for managing Riparian Management Zones would affect the amount of harvest within the Riparian Management Zone boundaries. The level of harvest or harvest-related activities in the Riparian Land Class is expected to be related to the potential to disturb or harm a threatened, endangered, and sensitive plant population. More harvest per acre has more potential to physically disturb a plant population. The Preferred Alternative has the highest level of harvest activities, an average of 8 percent of the Riparian Area may be affected based on model results (Table 4.2-15). Therefore, the Preferred Alternative is expected to have the highest probability of affecting threatened, endangered, and sensitive plant populations in riparian or wetland habitats. This is followed by Alternative 5 at approximately 7 percent per decade, Alternatives 3 and 4 at 5 percent per decade, and Alternative 2 at 4 percent per decade. Alternative 1 at 2 percent per decade would have the lowest total harvest in Riparian Areas.

UPLAND AREAS

Diversity of habitats appears to be relatively limited in a fully stocked, young forest (Spies and Franklin 1991), and species diversity is likely to be low. With time, a forest can form a well-developed, multi-layered understory and can become botanically diverse (Carey et al. 1996; Franklin and Spies 1991). A natural consequence of a stand aging is an increase in structural complexity and microsite diversity. Diversity in microsites offers a diversity of habitats and opportunity for species with different habitat requirements to exist. As a stand ages beyond a young forest with a closed canopy, species diversity is expected to increase (Scientia Silvica 1997).

While it is not known whether habitats for specific threatened, endangered, and sensitive plants are developed as harvested areas regenerate, it is expected that as stands develop structural complexity, a more botanically diverse understory would develop, possibly including microhabitats that could potentially support these species. Forest stand development stages that have had sufficient time to develop structural complexity, an understory, and botanically diverse include botanically diverse, niche diversification, and fully functional forest. The effects of harvest on the botanical diversity of these forest stand development stages are discussed in Section 4.2.4.2 of this document and summarized in Table 4.2-8.

The model results show a difference between Alternatives in the acreage that is expected to be in botanically diverse stand development stages by the end of the analysis period (2067). The Preferred Alternative would have the largest portion of forested trust lands (33 percent) in stand development stages with botanically diverse by the year 2067. Therefore, the Preferred Alternative is expected to have developed the largest area with diversity of habitats in forested areas. The Preferred Alternative is followed by Alternatives 1, 2, and 4, with 30 percent, and Alternatives 3 and 5, with 29 percent of acres that would be expected to be in stand development stages with high levels of botanically diverse by the year 2067.

In summary, for riparian habitats, Alternative 1 is expected to have the least potential to affect threatened, endangered, and sensitive plants and the Preferred Alternative would have the greatest potential. However, for forested areas as a whole, the Preferred Alternative would be expected to provide the most acres of diverse habitat to support threatened, endangered, and sensitive plants. In all Alternatives, site-specific analysis would determine the likely effects of individual harvest proposals.

4.3 RIPARIAN AREAS

4.3.1 Summary of Effects

This section analyzes the environmental effects on riparian resources. The analysis examines the current policy and procedures and the future changes proposed to them under the Alternatives. This analysis also allows DNR to assess relative risks that are qualified using modeling outputs.

The distribution of stand development stages within Riparian Areas suggests that, compared to historic unmanaged stands, many moderate to large streams on western Washington forested state trust lands may have reduced levels of multiple riparian functions because of decreased levels of large, fully functioning stands. Riparian areas for smaller streams may have adequate shade and size for potential in-stream large woody debris, but may be deficient in decadent features and other riparian functions important to wildlife and other riparian-dependent species. Many Riparian Areas currently contain moderate to high levels of early stand development stages, and are not likely to change in the near future. Thinning can reduce the time necessary to produce very large trees and reduce the time needed to increase stand complexity.

Removing trees within the Riparian Management Zone may temporarily reduce the level of some riparian functions, but the extent of the reduction depends on where trees are removed, site specific conditions, the amount of trees removed, and the particular riparian function being considered (Washington Forest Practices Board 2001). Such near-term impacts would have to be considered against the potential to accelerate functional recovery. The degree to which moderate intensity timber management would affect near-term riparian function is uncertain. However, active forest management can change species and stand composition and accelerate the development of more complex stand structures (Carey et al. 1996). Such events would help to restore long-term riparian functioning but may have some short-term adverse effects.

Each Alternative proposes different levels of harvest activities in Riparian Areas (Table 4.3-2). During the remaining period of the Habitat Conservation Plan, Alternatives with lower levels of activity, such as Alternatives 1, 2, 3, and 4, are expected to have a higher proportion of Riparian Area with large and very large trees that are in competitive exclusion stages. In contrast, Alternatives with higher levels of active management, such as the Preferred Alternative, are expected to have more Riparian Area that will be fully functioning. (Descriptions of these stand development stages are provided in Appendix B, Section B.2.3.), or be on a trajectory towards full function. Regardless, riparian conditions are expected to improve under all Alternatives relative to current conditions. This is due to changes in stand structure, particularly increases in the amount of stand development stages that include large and very large trees, which are in moderate supply throughout much of the western Washington forested state trust lands (see Figure 4.3-2). The rate of improvement in structurally complex forests overall is similar among most Alternatives, though the Preferred Alternative performs better through 2067. When looking at the two most complex stages of niche diversification and fully functional forests, the Preferred

Alternative accounts for more than 13 percent of Riparian Areas by 2067 compared to about 7 percent for Alternative 1.

4.3.2 Introduction

This section describes the riparian ecosystem and its various functions, the current condition of riparian areas on forested trust lands, the types of allowable activities in Riparian Management Zones, and the likely effects of the Alternatives on the condition of riparian areas. Although riparian areas include in-stream habitat and stream channels, adjacent floodplains, and wetlands (which often include seeps and springs), this section focuses on stream riparian areas. A discussion of riparian buffer protection for wetlands can be found in Section 4.9 (Wetlands).

A wide variety of hydrologic, geomorphic, and biotic processes determine the character of riparian areas. Riparian areas have distinctive resource values and characteristics that make them important zones of interaction between terrestrial and aquatic ecosystems.

On forested trust lands, riparian functions are protected through the use of Riparian Management Zones, where the amount and type of management activities that can be implemented are restricted to meet the Habitat Conservation Plan's conservation objectives. During the scoping for this Environmental Impact Statement, the amount of activity in Riparian Management Zones was identified as an important issue, particularly concerning activities for restoration of targeted riparian functions.

4.3.3 Affected Environment

This section provides a short discussion of riparian functions. It also discusses the current condition of riparian areas on forested trust lands.

4.3.3.1 Riparian Functions

The most important recognized functions of stream riparian areas include large woody debris recruitment, leaf and needle litter recruitment, stream shade, microclimate, streambank stability, and sediment control. To understand the impacts of various management actions, it is important to understand these functions. Many authors have reviewed these functions (e.g., Murphy and Meehan 1991; Forest Ecosystem Management Assessment Team 1993; Spence et al. 1996; DNR 1996 [pages IV-145 to IV-175]; Washington Forest Practices Board 2001 [pages 3-36 to 3-40]), and their work provides the basis for this analysis.

Large Woody Debris Recruitment

Large woody debris includes entire trees, rootwads, stems, and larger branches. The Washington Forest Practices Board (1995) defines large woody debris as pieces greater than 4 inches in diameter and more than 6.5 feet in length. Riparian areas are an important source of large woody debris that can be recruited to the stream channel. Large woody debris recruitment originates from a variety of processes, including tree mortality (toppling), windthrow, undercutting of streambanks, debris avalanches, deep-seated mass soil movements, and redistribution from upstream (Swanson and Lienkamper 1978). The loss of large woody debris results from breakage, decomposition, and redistribution downstream.

Numerous studies have shown that large woody debris is an important component of fish habitat (Swanson et al. 1976; Bisson et al. 1987; Naiman et al. 1992) and that it is critical for sediment retention (Keller and Swanson 1979; Sedell et al. 1988), gradient modification, structural diversity (Ralph et al. 1994), nutrient production and retention (Cummins 1974), and protective cover from predators.

There is a strong relationship between channel width and the size (diameter, length, and volume) of large woody debris that forms a pool, an important component to fish habitat (Bilby and Ward 1989). Large woody debris that is large enough to form a pool is referred to as “functional large woody debris,” and can have a minimum size of about 12 inches in diameter in small streams (Bilby and Ward 1989). Even larger woody debris that is also effective in trapping smaller more mobile pieces of large woody debris (i.e., forming logjams), and more likely to have long-term stability is sometimes referred to as “key piece large woody debris.” Key piece large woody debris is considered by some to be a better measure of the important wood recruitment sizes with a minimum size of 16.5 inches in diameter for small streams (Washington Forest Practices Board 1995).

The relationship between large woody debris size and function needs to be evaluated when considering activities in buffer strips. Riparian Management Zones need to ensure not only an appropriate amount or volume of wood, but wood of sufficient size to serve as both functional and key pieces (Murphy 1995). Consequently, the size distribution and type of trees present in the riparian zone are important factors for maintaining adequate large woody debris recruitment. Measurable contributions of wood from second-growth riparian areas are documented to take anywhere from 60 to 250 or more years, depending on region and size of stream (Grette 1985; Bilby and Wasserman 1989; Murphy and Koski 1989). Conifers tend to have a larger potential maximum size and decompose more slowly than hardwoods, but they also tend to grow more slowly, particularly in unmanaged conditions, than most western Washington hardwoods.

Leaf and Needle Litter Production

In aquatic systems, some vegetative organic materials (such as algae) originate within the stream while others (such as leaf and needle litter) originate from sources outside the stream. Stream benthic communities (e.g., aquatic insects) are highly dependent on materials from both sources. The abundance and diversity of aquatic species can vary significantly depending upon the total and relative amounts of algae, leaf, and litter inputs to a stream (IMST 1999).

Most of the vegetative organic debris input into small- and medium-sized streams comes from outside the stream, through the annual contribution of large amounts of needles, leaves, cones, wood, and dissolved organic matter (Gregory et al. 1991; Richardson 1992). In contrast, wide high-order (larger) streams with higher levels of direct sunlight, or low-order (smaller) streams with an open riparian canopy also rely on in-stream processes such as algae production for organic material input. The source and level of organic debris input can change in a riparian stand. For example, as a riparian stand ages, the amount of litter-fall increases (IMST 1999).

The importance of leaf and needle litter input varies among streams, but it can provide up to 60 percent of the total energy input into stream communities (Richardson 1992). Litter deposited into small, steep-gradient streams in forested areas high in a watershed is generally transported downstream, because higher gradient streams are less likely to retain deposited organic material until it has decomposed. Therefore, small (low-order) streams are important sources of nutrients and contribute substantially to the productivity of larger streams in the lower reaches of a watershed (IMST 1999).

Stream Shade

Stream temperature is an important factor affecting the types of aquatic life that can live in a stream, and all aquatic organisms have a temperature range outside of which they cannot exist. Stream temperature also influences water chemistry, which can affect the amount of oxygen present to support aquatic life. Stream shade is an important factor affecting stream temperature. Several factors control the heat balance of water in streams, including air temperature, solar radiation, evaporation, convection, conduction, and advection (Brown 1983; Adams and Sullivan 1990). Stream temperatures have a natural tendency to warm from the headwaters of a stream to the ocean (Sullivan et al. 1990; Zwieniecki and Newton 1999). However, seasonal and daily cycles produce a high degree of variability in-stream temperature.

Summertime temperatures are of particular interest in western Washington. During the summer, when stream temperatures are the highest, the major factors affecting stream temperature are warmer air temperatures, increased direct solar radiation, and decreased stream flows (Beschta et al. 1987). Forest management activities can have the greatest effect on direct solar radiation by reducing or promoting shade. Shade cannot physically cool a stream down, but it can prevent further solar heating and thus maintain the water temperature from groundwater inputs or tributaries. Shade provided by riparian vegetation has been shown to be successful in minimizing or eliminating increases in-stream temperature associated with timber harvest (Brazier and Brown 1973; Lynch et al. 1985). Other factors that affect shading include stream size and stream orientation, local topography, tree species, stand age, and stand density.

Microclimate

Microclimates tend to vary greatly across the landscape. Each microclimate is a collection of variables that are highly dependent on local conditions. Important components of microclimate include solar radiation, soil temperature, soil moisture, air temperature, wind velocity, and air moisture or humidity (reviewed in Spence et al. 1996; Forest Ecosystem Management Assessment Team 1993).

Removing streamside vegetation may result in changes in microclimatic conditions within the riparian zone. These changes can influence a variety of ecological processes that may affect the long-term integrity of riparian ecosystems (Spence et al. 1996). For example, many of the variables considered in microclimate studies (air temperature, humidity, wind velocity) are also variables that affect water temperature (Sullivan et al. 1990).

Microclimate is also important to stream/riparian species other than fish, such as amphibians.

In general, due to their low-lying position on the landscape, riparian areas tend to be cooler than the surrounding hillslopes, especially during the night. Because riparian areas are adjacent to water bodies, they often have a higher relative humidity under the canopy than similar upslope areas. This increase in humidity combined with shading effects can cause intact forested riparian areas to have a moderating effect on microclimate (Beschta and Boyle 1995).

Sediment Control and Streambank Stability

The delivery of fine and coarse sediment to streams can lead to stream channel instability, pool filling by coarse sediment, creation of spawning gravels, or introduction of fine sediment to spawning gravels. Sediment can be delivered to the aquatic system as surface erosion (mostly fine sediment) generated from harvest units, skid trails, and roads or stream crossings within the riparian area. It can also be delivered as landslides or debris torrents (coarse and fine sediments), whether initiated naturally or in harvested areas on unstable slopes. Additional discussion of surface erosion and landslides is provided in Section 4.6, Geomorphology, Soils, and Sediment.

Timber harvest activities can alter watershed conditions by changing both quantity and size distribution of sediment delivery to streams. Streamside buffer strips can significantly reduce the amount of coarse sediment that reaches a stream, by filtering it through the vegetation. Similarly, buffer strips can limit the amount of fine sediment that reaches a stream from surface erosion by physically obstructing or inhibiting the movement of the sediment into the water. The ability of riparian buffer strips to control sediment inputs in this manner depends on several site characteristics, including the presence of vegetation or organic litter, slope, soil type, and drainage characteristics.

Landslides are important to riparian areas as a natural disturbance mechanism and are episodic sources of large woody debris, as well as fine and coarse sediment in streams. They are part of the natural processes that create and/or maintain riparian functions. Debris slides are the most common landslides on steep forestlands. More intense types of slides include debris torrents and debris flows, which may follow existing stream channels. Major storms can increase the rate and intensity of landslides. Sidle et al. (1985) summarized several studies indicating that slope stability depends partly on reinforcement from tree roots, especially when soils are partly or completely saturated. In addition to having significant impacts on the stream channel, debris torrents can also affect riparian buffer functions and streamside forests when bank scour removes streamside vegetation.

The stability of streambanks is largely determined by the size, type, and cohesion of the soil profile; vegetation cover; root mass; and the amount of bedload carried by the channel (Sullivan et al. 1987). Riparian vegetation can provide hydraulic roughness that dissipates stream energy during high or overbank flows, which further reduces bank erosion. In most cases, vegetation immediately adjacent to a stream channel is most important in maintaining bank integrity (Forest Ecosystem Management Assessment Team 1993).

However, in wide valleys with shifting stream channels, vegetation throughout the floodplain or channel migration zone may also be important over longer time periods.

4.3.3.2 Current Management Direction

Procedures 14-004-150 (five Westside HCP Planning Units) and 14-004-160 (the Olympic Experimental State Forest HCP Planning Unit) for Identifying and Protecting Riparian and Wetland Management Zones have been developed to implement the Forest Resource Plan policy and Habitat Conservation Plan (HCP) conservation strategy. Currently, the Riparian Conservation Strategy for the HCP has not been completely implemented. Procedure 14-004-150 is interim until the permanent procedure is developed and approved by the Federal Services. A permanent strategy is currently under development and review by DNR and Federal Services staff (Washington DNR 2004). Under the current interim procedure, timber harvest is not allowed within Riparian Management Zones except for yarding corridors, road-stream crossings, and road-building. Other management activities can only occur with specific approval by the State Lands Assistant. Additional details concerning DNR riparian policies and Procedures 14-004-150 and 14-004-160 can be found in Appendix C.

4.3.3.3 Current Riparian Conditions

As described in Section 4.2 (Forest Structure and Vegetation), stand developmental stages can be a useful measure for describing forest structural conditions, including those found in riparian stands. Figure 4.3-1 and Table 4.3-1 depict the distribution of stand development stages in the Riparian land class for the five westside HCP Planning Units and the Olympic Experimental State Forest. The Riparian land class includes stream and wetland riparian buffers plus their associated wind buffers. Under the Habitat Conservation Plan some locations require wind buffers; for the purpose of uniform analysis, wind buffers are assumed to be required. The stand development stages are described in detail in Appendix B.

Historically, Pacific Northwest forests (including riparian areas) were a mosaic of different forest types and ages. Large areas of “old growth” forest were common (Franklin et al. 1981), which is interpreted in this EIS to mean forest stands in the fully functioning stand development stage. However, compared to upland forests, riparian areas are more frequently disturbed by fluvial processes and can have more diverse stands than upland areas (Agee 1988). The National Marine Fisheries Service (1996) considers watersheds with riparian areas at least 50 percent similar to the “potential natural community” as being “properly functioning.” Those between 25 to 50 percent similar are considered “at-risk,” and those with less than 25 percent are considered “not properly functioning.” Such ratings tend to be relative, not absolute. There is also substantial variability in what constitutes a natural community, depending upon the nature and distribution of the riparian communities within a given stream reach and the localized disturbance history.

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Olympic Experimental State Forest. The Riparian land class includes stream and wetland riparian buffers plus their associated wind buffers. Under the Habitat Conservation Plan, some locations require wind buffers; for the purpose of uniform analysis, wind buffers are assumed to be required. The stand development stages are described in detail in Appendix B.

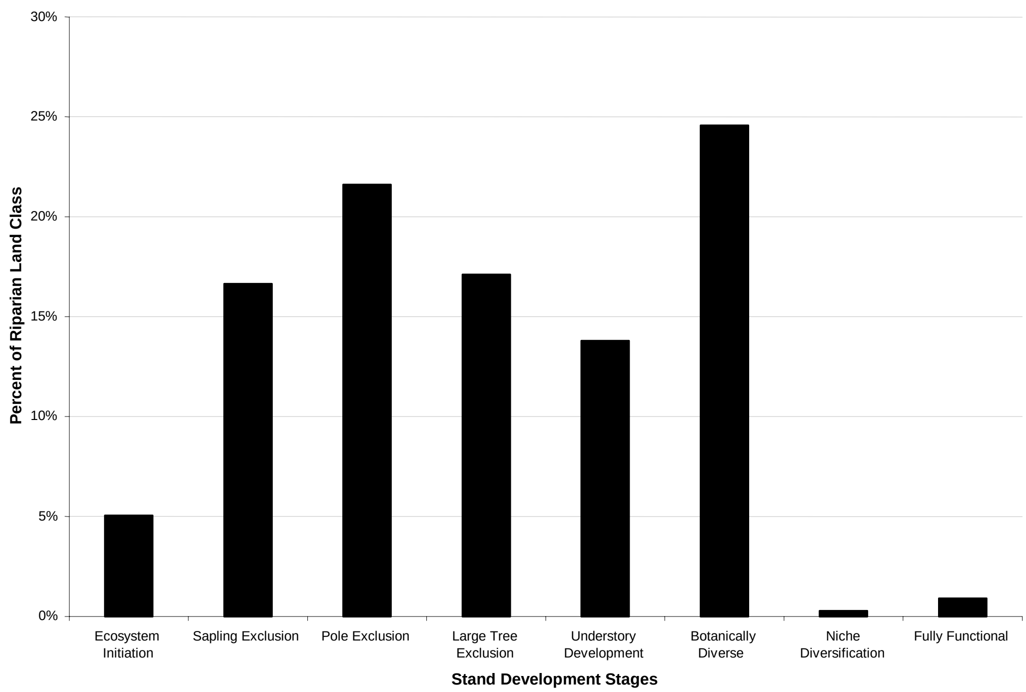

Figure 4.3-1. Distribution of Stand Development Stages within the Riparian Land Class on DNR Forested Trust Lands

Data Source: Model output data – stand development stages

Table 4.3-1. Distribution of Stand Development Stages within Riparian Areas[1/] Among the Five Westside HCP Planning Units and the Olympic Experimental State Forest

Stand Development Stage	North Puget	South Puget	Columbia	South Coast	Olympic Experimental State Forest	Straits	Total
Ecosystem Initiation	5.4%	5.1%	4.7%	4.8%	5.3%	4.9%	5.0%
Sapling Exclusion	14.6%	14.7%	12.4%	13.7%	25.0%	13.6%	16.6%
Pole Exclusion	16.4%	22.2%	22.3%	16.4%	29.6%	18.3%	21.6%
Large Tree Exclusion	15.5%	14.3%	26.6%	26.8%	5.5%	14.0%	17.1%
Understory Development	18.1%	15.5%	11.5%	19.1%	6.3%	20.7%	13.8%
Botanically Diverse	27.9%	28.1%	21.6%	19.1%	26.3%	28.3%	24.6%
Niche Diversification	0.2%	0.1%	0.1%	0.0%	0.7%	0.1%	0.3%
Fully Functional	1.8%	0.0%	0.9%	0.1%	1.3%	0.0%	0.9%
Total Stream-Associated Riparian Acres[2/]	**78,143**	**28,509**	**78,202**	**72,893**	**61,497**	**16,064**	**335,308**
Total Riparian Land Class Acres[3/]	**92,724**	**34,606**	**86,443**	**80,966**	**111,308**	**20,684**	**426,731**

Data Source: Model output data – stand development stages.
1/ Percentages based upon the total Riparian land class acreage, which include modeled buffers for riparian areas adjacent to types 1-4 streams and wetlands plus associated wind buffers. Definitions are based on Carey et al. 1996.
2/ Acreage does not include wetland and wind buffer areas.
3/ The Riparian land class includes stream-associated riparian areas, wetland areas, and wind buffer areas.

In general, riparian areas within the five Westside HCP Planning Unit and the Olympic Experimental State Forest are currently dominated by the competitive exclusion developmental stages (sapling, pole, and large tree), but also have a large component within the botanically diverse developmental stage. Within the five Westside HCP Planning Units and the Olympic Experimental State Forest, 46 to 61 percent of the Riparian land class on forested trust lands consists of single-canopy forest, including sapling, pole, and large tree exclusion stages (Table 4.3-1 and Figure 4.3-1). Multi-layered stands occur on about 34 to 49 percent of the Riparian land class in the five Westside HCP Planning Units and the Olympic Experimental State Forest, including understory development, botanically diverse, niche diversification, and fully functional stages. Notably, the amount of the fully functional stage, which is most prevalent in pristine riparian areas, is less than one percent of the Riparian land class.

Two ranges of tree sizes are of particular importance for riparian areas: large and very large trees. Within the large tree exclusion and understory development stages, dominant trees are 20 to 29 inches in diameter at breast height, but a few very large trees (greater than 30 inches diameter at breast height) may be present. Under the large tree exclusion stage, stands have a single canopy and closure is greater than 70 percent. The understory development stage represents the transition between single and multi-canopy forest and generally has a larger proportion of very large trees, as well as poles and saplings, which each may make up 10at least five percent or more of these stands, although pole and sapling densities are low except in canopy gaps, which results in canopy closure levels of less than 70 percent.

Dominant trees in these stand development stages are sufficiently large to provide functional large woody debris and shade to streams of moderate or smaller size (up to about 60 feet in width), based upon a relationship observed by Bilby and Ward (1989). Approximately 31 percent of the Riparian land class on forested trust lands are in stand development stages containing large trees with a range of 12 (Olympic Experimental State Forest) to 46 (South Coast) percent among the different HCP Planning Units.

The botanical diversity, niche diversification, and fully functional stand development stages contain “very large” trees (more than 30 inches diameter at breast height). Very large trees are needed to supply large woody debris and shade to larger streams and rivers or are needed in the outer portions of the Riparian Management Zones. At increasing distances from a stream, a tree must be larger and taller to effectively supply large woody debris to a stream (McDade et al. 1990). A similar relationship occurs for providing shade. The Riparian land class in the HCP Planning Units range from approximately 19 (South Coast) to 30 (North Puget) percent in the botanically diverse, niche diversification, and fully functional stand development stages with an average of about 26 percent for all HCP Planning Units. Stands containing very large trees are present at moderate levels on forested trust lands in most western Washington watersheds. However, nearly all of the stands containing very large trees are in the botanically diverse development stage. Only about 1 percent of the Riparian land class is in the niche diversification and fully functional development stages, which are stages that have a high level of decadence.

Approximately 22 percent of riparian stands in the forested trust lands consist of single-canopy forest in the ecosystem initiation and sapling exclusion stages, which include trees 0 to 9 inches in diameter at breast height. Approximately 30 percent of the riparian stands in the Olympic Experimental State Forest are in these early development stages.

An evaluation of the data for DNR-managed forested trust lands by watershed indicates that approximately 11 percent of the watersheds have Riparian land class areas that are mostly in the ecosystem initiation and sapling exclusion stages, and approximately 37 percent of the watersheds have at least one-quarter of the Riparian land class area in these early development stages. These levels suggest that a substantial amount of riparian area was disturbed prior to the implementation of the Habitat Conservation Plan (DNR 1997), primarily from timber harvest.

In conclusion, the distribution of stand development stages within riparian areas suggests that many moderate to large streams on forested trust lands may have reduced levels of one or more riparian functions under current conditions because of low to moderate levels of large, fully functioning stands; whereas, under historical unmanaged conditions, high levels of these stand types were the norm. These areas are likely to remain in this status for the near future because they contain moderate to high levels of early stand development stages. In contrast, many small to moderately sized streams may be approaching a moderate to high level for some riparian functions, such as potential functional in-stream large woody debris and shade from trees in intermediate development stages, but may have substantial reductions in other riparian functions and lack decadent features important for some wildlife and riparian-dependant species. Overall, riparian areas have a relatively high proportion of early and mid-developmental stages and low proportions of older developmental stages of forest, with a more structurally complex stand structure.

4.3.4 Environmental Effects

The following provides an overview of the general effects of forest management on riparian functions. More details of these general effects can also be found in the Habitat Conservation Plan Environmental Impact Statement (DNR 1996) and the Forest and Fish EIS (Washington Forest Practices Board 2001). The potential effects of the Alternatives are discussed.

4.3.4.1 Forest Management in Riparian Zones

Forest management activities, including road-building and stream crossings, yarding corridors, restoration, vegetation management (both herbicide and fertilization use), and varying levels of timber harvest, will change the forest structure within the riparian areas. The potential for adverse effects to riparian and aquatic functions have been extensively documented (e.g., Meehan 1991; Salo and Cundy 1987). Over the past quarter century, management prescriptions for the restriction and mitigation of forest management in and near riparian zones have been developed to avoid or minimize the potential for adverse effects. Furthermore, forest managers are now developing and implementing techniques to enhance and restore riparian zone functions.

Development of permanent roads removes trees within the road corridor, disturbs streambanks, and may provide a pathway for the transport of water and sediment from the roadway to a stream. Yarding corridors also remove trees, and may contribute to high levels of soil disturbance or compaction along yarding corridors if adequate suspension of logs is not achieved or appropriate mitigation measures are not implemented to reduce adverse effects. Yarding corridors are generally used when cross-stream yarding is more economical and less damaging to the environment than building a road. Maintenance and re-growth of brushy vegetation and trees reduce the risk of adverse effects. Protection of streambank integrity and adequate soil filtering of surface erosion are generally maintained with a fully functioning stand within 30 feet of a stream (Washington Forest Practices Board 2001).

Active timber management in the form of patch cuts and upland regeneration harvests can also affect the risk of windthrow in riparian buffers. Data for windthrow within riparian buffers from seven studies reported in Grizzel and Wolff (1998) had a mean windthrow rate (i.e., proportion of riparian buffer trees to blow down) of about 15 percent for 344 sites in western Washington and Oregon, with maximum windthrow rates ranging from 17 to 100 percent in the different studies. Pollock and Kennard (1998) re-analyzed several windthrow data sets looking at the relationship between buffer width and likelihood of windthrow. They reached the conclusion that buffers of less than 75 feet have a higher probability of suffering appreciable mortality from windthrow than forests with wider buffers. In general, vulnerability to windthrow tends to return to normal a few years after logging (Moore 1977; Steinblums 1978; Andrus and Froelich 1986).

Patch cuts may be used as a commercial activity in upland areas or the outer portions of Riparian Management Zones. This technique may also be implemented within riparian areas as a restoration activity to convert hardwood to conifer stands and as a tool for biodiversity pathways management. Huggard and Vyse (2002) recommended that variable patch cuts less than 2.5 acres in size for enhancing ecological diversity, and also found that windthrow risk declines with patches smaller than that size. Carey et al. (1996) recommended management patches on the order of 0.5 to 1.0 acre in size to mimic natural patterns.

The effects of partial harvest techniques such as variable size patch cuts, single tree selection, and variable density thinning are not fully understood. Non-linear curves depicting the relationship between riparian function and distance from the stream (Washington Forest Practices Board 2001, pages 3-48 and 3-49) are generally based upon fully developed stands (i.e., the fully functioning stand development stage). They suggest that most riparian functions are fully protected within one site potential tree height, a distance equal to the anticipated tree height for the specific site. Because the classification of the stand development stages was based upon generic forest stand characteristics rather than riparian function, the fully functioning stand developmental stage represents fully functioning forest stand structure rather than specific riparian function. Riparian stands need to be not only in the fully functioning stand development stage, but also need to be sufficiently wide to achieve a high level of protection for riparian functions.

Removing trees within the Riparian Management Zone may temporarily reduce the level of the riparian functions described above, but the extent and duration of the reduction depends on where trees are removed, site-specific conditions, the amount of trees removed, and the particular riparian function being considered (Washington Forest Practices Board 2001). The duration of the recovery period can also depend upon the type and amount of mitigation applied during and after harvest activities. Such near-term impacts would have to be evaluated considered against the potential to accelerate functional recovery.

Based upon recent evaluations of riparian function (Washington Forest Practices Board 2001), a complex, multi-storied stand with decadence features and very large trees (i.e., the fully functional stand development stage) within a buffer 0.75 of a site potential tree height in width along a stream (approximately 105 feet for Douglas-fir on site class III soils) would provide complete shade protection and about 90 percent of large woody debris recruitment (Washington Forest Practices Board 2001). Removal of some trees from this hypothetical stand between 75 and 100 feet from the stream would likely reduce some amount and types of large woody debris recruitment, but would have minimal effect on shade. The conversion of hardwood areas in patches greater than about 0.25 acre may result in a higher risk of windthrow (Huggard and Vyse 2002), which could increase the amount of downed wood and in-stream large woody debris, but decrease the standing crop available for future recruitment. However, it is worth noting that many riparian stands are not fully functioning because of their current structural condition and species composition.

The degree to which moderate intensity timber management would affect near-term riparian function is uncertain because few empirical studies have been completed. However, active forest management can change species and stand composition and the number and distribution of larger trees, and accelerate the development of larger trees and more complex stand structures (Carey et al. 1996). Such activities help to restore longer-term riparian functioning but may have some short-term adverse effects.

A riparian stand may not be fully functioning because of current site conditions; previous management activities; or disturbance from fluvial processes, disease, or fire. Carey et al. (1996) proposed that active management of forest stands on a biodiversity pathway using Alternative silvicultural practices can result in full stand function being achieved more rapidly. These Alternative practices may include:

- pre-commercial and modified commercial thinning to stimulate tree growth and understory development;
- planting to supplement natural regeneration;
- retention of large legacy trees; and
- recruitment of down woody debris to terrestrial and aquatic systems and creation of large snags.

The riparian management strategies examined under the Alternatives are described in Chapter 2. Other policies and procedures that affect riparian conditions are described in Appendix C. Each Alternative proposes different levels of harvest activities in riparian areas (Table 4.3-2). During the remaining period of the Habitat Conservation Plan, Alternatives with lower levels of activity, such as Alternatives 1 through 4, are expected to have a higher proportion of riparian area with large and very large trees that are in competitive exclusion stages. In contrast, Alternatives with higher levels of active management, such as the Preferred Alternative, are expected to have more riparian area that will be fully functioning, or be on a trajectory towards full function. Regardless, riparian conditions are expected to improve under all Alternatives relative to current conditions. This is due to changes in stand structure, particularly increases in the amount of stand development stages that include large and very large trees, which are in moderate supply throughout much of the western Washington forested state trust lands (see Figure 4.3-2). The rate of improvement in structurally complex forests overall is similar among the Alternatives. However, active management under the Preferred Alternative is expected to achieve fully functioning stands within 80 to 90 years, rather than approximately 220 years using passive techniques (Carey et al. 1996). Larger and taller trees combined with a complex canopy structure in the riparian zone have a greater likelihood of providing streams with more functional large woody debris, more shade, more leaf and needle litter, and improved microclimate conditions.

Table 4.3-2. Estimated Acres of Forest Management in the Riparian Land Class per Decade among the HCP Planning Units for Each Alternative

	Period	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	PA
Olympic Experimental State Forest (110,000 total acres in Riparian land class)	2004-2013	1,391	3,636	1,979	1,325	8,519	5,169
	2014-2023	1,436	4,440	2,124	1,393	13,360	3,882
	2024-2033	1,949	5,498	5,231	1,634	16,198	6,270
	2034-2043	1,693	6,591	5,917	1,788	14,068	5,435
	2044-2053	1,328	5,786	9,877	1,682	7,773	6,925
	2054-2063	1,637	6,898	7,668	1,668	3,486	9,292
	2064-2067	612	2,335	4,614	818	643	2,807
	Mean	**1,570**	**5,498**	**5,845**	**1,611**	**10,007**	**6,216**
Five Westside Planning Units (excludes OESF; 315,000 total acres in Riparian land class)	2004-2013	5,714	10,798	11,568	14,061	17,957	14,010
	2014-2023	7,902	13,144	17,414	13,637	25,922	39,779
	2024-2033	9,791	15,781	17,300	16,717	35,545	24,130
	2034-2043	7,321	13,118	15,688	18,871	17,531	22,860
	2044-2053	7,150	14,615	16,782	20,884	15,453	29,955
	2054-2063	7,582	14,055	11,489	24,997	15,448	25,725
	2064-2067	2,652	3,897	4,238	9,563	4,511	13,714
	Mean	**7,518**	**13,345**	**14,763**	**18,552**	**20,683**	**26,589**

Data Source: Model output data – timber flow levels.
OESF = Olympic Experimental State Forest
PA = Preferred Alternative

Model results suggest a variety of thinning activities, some of which remove up to 50 percent of the basal area of a stand, are needed to speed the development of stands in large tree exclusion stages and to structurally complex and fully functioning stands. The Preferred Alternative addresses this need through infrequent, relatively heavy thinning activities. This may occasionally take the form of one pre-commercial thinning when the stand is in the sapling exclusion stage, but more typically may include one commercial thinning when the stand is in the pole or large tree exclusion stage. Commercial thinning is likely to be done in conjunction with an upland harvest activity.

Over the short term (i.e., the next decade of the Habitat Conservation Plan), little difference is expected in the distribution of stand development stages among the six Alternatives (Figure 4.3-2). The proportion of Riparian land class in stand development stages, including large and very large trees development stages, is expected to increase from about 57 to 62 or 63 percent. Nearly all of this increase is expected in the large tree exclusion and understory development stages. The amount of very large trees is expected to remain at about 25 to 26 percent of the Riparian land class because increased growth expected from stand manipulations would take some time to become fully expressed, and only a small percentage of riparian areas would be treated in the first decade (up to about 4.5 percent of the riparian area).

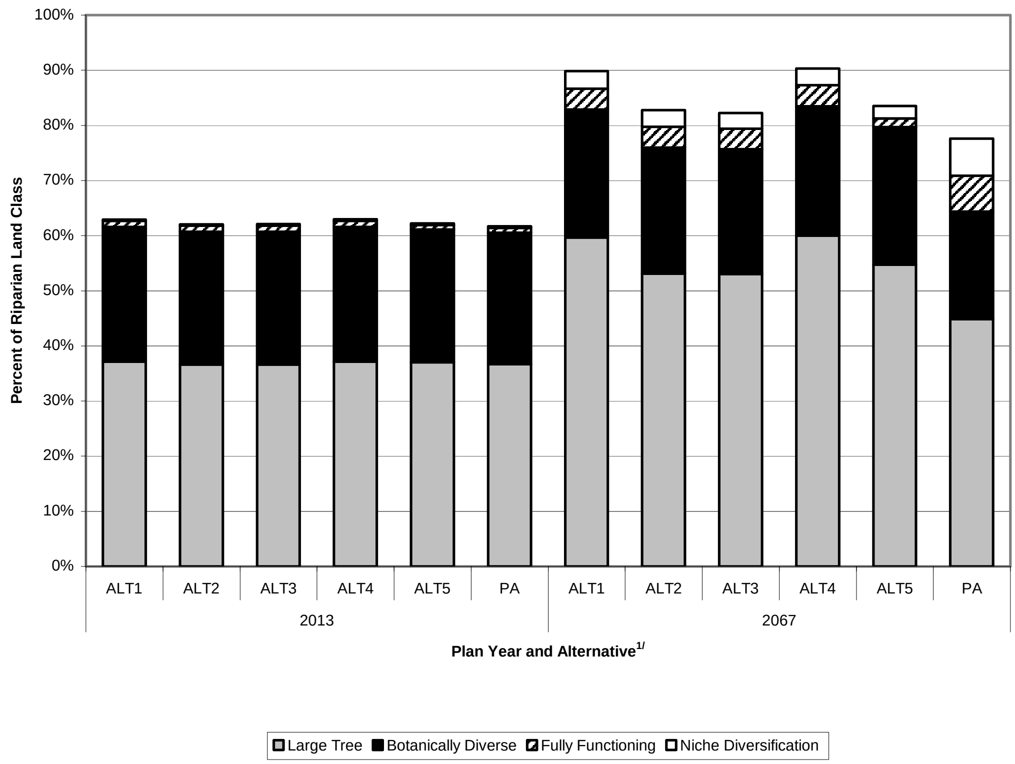

Figure 4.3-2. Percent of the Riparian Land Class that is in Large Tree and Very Large Tree Stand Development Stages[2/] in the Short Term and Long Term

Notes:

1/ Under current conditions, the proportion of the Riparian land class containing large and very large trees is estimated to be approximately 57% of 426,000 acres.

2/ “Large trees” include the large tree exclusion and understory development stages, and “very large trees” include the botanically diverse, niche diversification, and fully functional development stages.

PA = Preferred Alternative

Source: DNR model output data – stand development stages

Differences among the Alternatives are expected to become more substantive over the long term (Figure 4.3-2). The proportion of the Riparian land class with stand development stages containing large tree and very large trees is expected to increase over current conditions from about 57 percent to 78 to 90 percent, depending upon the Alternative. Consequently, the large woody debris recruitment, leaf and needle litter production, and shade conditions would be expected to improve under all Alternatives. Alternatives 1 and 4 are expected to have the highest amount, with about 90 percent of the Riparian land class in these stages. Alternatives 2, 3, and 5 are expected to be intermediate, at about 82 to 83 percent. The Preferred Alternative is expected to have the lowest proportion of the Alternatives, with about 78 percent of the Riparian land class in stand development stages containing large and very large trees.

The modeling results support the qualitative assessment that under the Preferred Alternative, active management of stands in competitive exclusion stages helps to move stands towards development pathways that more rapidly lead to a fully functional, complex stand structural state. Although the Preferred Alternative is expected to have the lowest proportion of stand development stages containing large and very large trees, it is also expected to have the highest proportion of the most complex classes of niche diversification and fully functioning stand development stages. These two complex stages are each expected to comprise about 6 to 7 percent of the Riparian land class. In contrast, Alternatives 1 to 4 are expected to have about 4 percent and 3 percent of the Riparian land class in niche diversification and fully functioning stages, respectively, while Alternative 5 is expected to have about 2 percent in each. The major added feature that distinguishes the fully functional and niche diversification development stages from other multi-canopy stages with very large trees is the presence of higher levels of decadence, such as snags, down coarse woody debris, and epiphytes. Under the Preferred Alternative, the trend towards the increased development of these complex multi-story stands in treated areas is expected to continue after completion of the Habitat Conservation Plan, assuming the conservation strategy is also continued. Under all Alternatives, areas with large and very large trees in competitive exclusion stages would likely achieve full function eventually over time. However, given stand densities within riparian areas and the level of natural or managed disturbance needed for succession through the development stages, Alternatives 1 to 5 may require a very long time to produce substantial amounts of fully functioning riparian forests.

Over the long term, the more intensive biodiversity pathways approach proposed in the Preferred Alternative is expected to yield higher riparian function on more of the Riparian land class than Alternatives 1 to 5, but with the short-term trade-off of having potentially less area with large trees in the Riparian land class. The Preferred Alternative is also expected to have the highest proportion (about 22 percent) in the small tree (saplings and poles) and ecosystem initiation stages over the long term compared to Alternatives 1 through 5, which are expected to have a range of about 10 to 18 percent of the Riparian land class in these stand development stages.

The Habitat Conservation Plan (HCP) was written with specific direction for riparian protection, but was more flexible concerning riparian enhancement activities. The activity levels in the riparian zone for the first decade under all Alternatives (Appendix D) are expected to be within the levels expected for the first decade under the HCP, about 23,000 acres for the five Westside HCP Planning Units and 10,000 acres for the Olympic Experimental State Forest (DNR 1997, IV. 212). Pre-commercial thinning, commercial thinning, partial cuts, single tree selection, and stand conversion were all considered appropriate activities that could be used to maintain or restore riparian functions (DNR 1997, IV. 208). In addition, in their Biological Opinions on the HCP, the Federal Services assumed that a long-term average of about 1 percent of riparian areas available to commercial activities would be harvested on an annual basis, or about once over a 100-year period. This equates to about 10 percent per decade.

Over the seven decades modeled, all of the Alternatives had a long-term average of less than 10 percent of the Riparian land class per decade for both enhancement and commercial activities (Appendix D, Tables D-5a to D-5f). Activity levels ranged from an average of about 2 to 8 percent of the Riparian land class per decade, with Alternative 1 at the lowest level and the Preferred Alternative at the highest level. Consequently, all of the Alternatives are considered to be within the range expected under the HCP because these activities would be less than a long-term average of 10 percent per decade. In addition to the Alternative riparian management intensity, the amount of activity within any given HCP Planning Unit or decade varied in the models because stand conditions, and consequently enhancement or commercial opportunities, vary with time.

Compared to Alternative 1 (No Action), which has a long-term average activity level of about 2 percent per decade, and a maximum HCP Planning Unit/decadal activity level of 4 percent, the Preferred Alternative is expected to have a higher potential risk of adverse effects in some HCP Planning Units and decades. This increase in risk is considered to be low to moderate if mitigation measures (discussed below) are implemented and are effective. The risk of adverse effects under Alternatives 2, 3, and 4, with long-term average activity levels of about 4 to 5 percent and maximum HCP Planning Unit/decadal activity level of about 8 to 11 percent, is only slightly higher than under Alternative 1. Alternative 5, with a long-term average activity level of about 7 percent and maximum HCP Planning Unit/decadal activity level of about 15 percent (Olympic Experimental State Forest Decade 32024 to 2033), has a slightly lower risk than the Preferred Alternative (8 percent).

Modeled activity levels under the Preferred Alternative range up to nearly 20 percent of the Riparian land class in some HCP Planning Units and decades, but overall have a long-term decade average of 8 percent. Individual HCP Planning Units have a long-term average of 6 percent (Olympic Experimental State Forest) to 11 percent (South Coast and Straits). The years 2014 to 2023 are expected to have the highest level of riparian activities, with an average of about 10 percent. Activities in the Columbia (about 16 percent), South Coast (about 14 percent), and Straits (about 20 percent) HCP Planning Units are expected to incur the bulk of the activities during that decade.

Large woody debris recruitment, leaf and needle litter production, and shade conditions would be expected to improve under all Alternatives relative to current conditions. However, relative to Alternative 1, some short-term reduction in leaf and needle litter production and long-term reduction in shade and large woody debris potential may occur from the removal of riparian trees. Generally, this impact would be expected to be relatively minor. Under the Preferred Alternative, localized reductions in leaf and needle litter, shade, and large woody debris recruitment potential could occur in some HCP Planning Units during some decades, but these adverse effects are expected to transition into long-term beneficial effects in the form of more structurally diverse riparian forest. These potential adverse effects would likely be more pronounced in areas where tree removal occurs in the minimal harvest sub-zone. Larger patch cuts could result in a higher risk of windthrow for some riparian trees that would contribute to in-stream and terrestrial down wood levels. Although restoration activities are allowable within all riparian buffer areas under the Habitat Conservation Plan, none of the Alternatives proposes activities within the 25-foot no-harvest buffer along types 1 through 4 streams within the five Westside HCP Planning Units (excluding the Olympic Experimental State Forest), except for yarding corridors, roads, and restoration activities.

The Preferred Alternative is expected to mitigate the localized reductions in large woody debris potential by active development of down woody debris and in-stream large woody debris through the felling of large trees and leaving them in place. The draft riparian strategy currently under development by DNR and the Federal Services includes this technique in locations where these features are lacking (DNR 2004). This active management technique would provide immediate improvements in the availability of these features at places where treatments are implemented. In contrast, Alternatives 1 to 5 would require relatively infrequent natural disturbances (e.g., windthrow, fire, disease, decadence, etc.) to increase downed wood and large woody debris levels.

Ground-based and cable yarding methods could result in low levels of soil compaction and/or rutting and surface erosion along skid trails in the riparian zone. Given the nature of the requirements of the Forest Practices Rules, the Habitat Conservation Plan, and the Riparian Forest Restoration Strategy (DNR 2004), no Alternative is likely to cause substantial adverse effects on streambank stability or sediment filtering capacity. The site-specific assessment of conditions required under Procedure 14-004-160 is expected to identify and avoid or minimize potential streambank stability or sediment-filtering effects within the Olympic Experimental State Forest.

The relative impact to riparian microclimate among the Alternatives is uncertain. Riparian microclimate conditions would likely improve under all Alternatives as the amount of area in stand development stages with small trees declines with time, and the amount of area in development stages with multiple canopies and very large trees increases. The effects of patch cuts, small openings, and thinnings on riparian microclimate are largely unknown. If differences were to occur among the Alternatives, the level and type of riparian disturbance would be the best relative indicator available, with the Preferred Alternative and Alternative 5 having the highest likelihood of expressing any relative difference and Alternatives 1 and 4 having the lowest.

Harvest prescriptions and mitigation measures include avoidance, short-term deferral, specific harvest and yarding method, restoration, active downed wood and large woody debris management, and other measures. Site-specific harvest planning will determine the combination and configuration of restoration activities to best meet stand level objectives and minimize effects to riparian areas and aquatic resources. Such plans would be analyzed at the project level using the expanded State Environmental Policy Act Environmental Checklist. Higher levels of mitigation in the form of monitoring may be necessary for the Preferred Alternative and Alternatives 5, due to relatively higher levels of forest management activity in riparian zones. Monitoring of harvest operations may be necessary to assess the level of impact in future operations and to ensure the thinning activities result in the benefits of accelerated forest development.

The Habitat Conservation Plan's Implementation Agreement (see Appendix C) addresses adaptive management. It directs the DNR to refine "management activities allowed within the Riparian Management Zones … within the first decade of the HCP." As noted previously, the DNR has worked extensively with the Federal Services and the Washington Department of Fish and Wildlife to develop a strategy for management activities within the Riparian Management Zone. When finalized, the DNR will file a State Environmental

Policy Act Environmental Checklist, seeking additional review of the proposal. If there are changes that would require different sus tainable forest management strategies not envisioned today, then the DNR may recommend that the Board of Natural Resources make appropriate changes, that could include re-running the sustainable forestry model and examining the changes' impacts on the sustainable harvest level; this dynamic approach is consistent with the Board's *Sustainable Harvest Calculation Management Principles and Objectives* (see Resolution 1110, Appendix F).

4.4 WILDLIFE

4.4.1 Summary of Effects

This section analyzes the environmental effects on wildlife resources and examines the effects of prospective changes to current policy and procedures under the different Alternatives. The analysis also allows DNR and policy makers to assess relative risks that are illustrated using modeling outputs.

None of the Alternatives, including the Preferred Alternative, proposes changes to the northern spotted owl conservation strategy, as outlined in the Habitat Conservation Plan (HCP) on pages IV.1 to IV.19 and IV.86 to IV.106 (DNR 1997). The HCP Environmental Impact Statement (EIS) is incorporated by reference (DNR 1996) and relied on in this Final EIS. In addition, this Final EIS analyzes the Alternatives in light of the new information on northern spotted owl demography discussed in section 4.4.3 of this document. The analysis also includes a comparison of the Alternatives using three criteria:

- changes in the amount of structurally complex forest;
- the amount of timber harvest in areas designated as Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas; and
- changes in the management of northern spotted owl circles.

Other policy and procedure changes under the Alternatives would influence the amount and distribution of wildlife habitat on western Washington forested state trust lands. The Alternatives would vary in the timing and amount of forest structures they would create, but would not be expected to have any significant adverse environmental effects on wildlife.

The sustainable harvest calculation analysis uses the stand development stages to represent structural diversity and habitat values. (Descriptions of these stand development stages are provided in Appendix B, Section B.2.3.) Changes in the relative amount of forested habitat types are a product of varying rates and intensities of timber harvest under the different Alternatives. Appendix D, Table D-12 presents the modeled proportion of forested trust lands comprising ecosystem initiation, competitive exclusion, and structurally complex forests under each Alternative in the years 2013 (short-term) and 2067 (long-term). Competitive exclusion forests are the most common forest habitat type on forested trust lands, making up 68 percent of the total forested area (Table 4.4-1). Approximately 26 percent of this habitat type occurs in Upland Areas with General Management Objectives. Structurally complex forest makes up about 25 percent of the total area on western Washington forested state trust lands (Table 4.4-1). In the short term and long term, the amount of structurally complex forest is modeled as increasing in all HCP Planning Units under all Alternatives.

The structurally complex forest stages serve as a relative indicator of change in the amount of habitats of management concern. Several examples follow:

- Northern Spotted Owl - Throughout much of their range, northern spotted owls are strongly associated with forested areas that are classified as structurally complex in this Final EIS.
- Marbled Murrelet - The *Marbled Murrelet Recovery Plan* (USFWS 1997) identifies terrestrial (upland) habitat essential for marbled murrelet recovery. The Recovery Plan identifies additional areas on non-federal land where existing habitat should be protected because habitat in federal reserves is insufficient to reverse population declines and maintain a well-distributed population. In the state of Washington, such additional essential habitat occurs on state lands within 40 miles of marine waters. These areas are critical for improving the distribution of the population and suitable habitat, especially in southwestern Washington (USFWS 1997). Effects on forestlands within 40 miles of marine waters, therefore, are of particular concern in determining the effects of the Alternatives on marbled murrelet populations. Of the approximately 340,000 acres of structurally complex forest on forested trust lands (Table 4.4-1), approximately 85 percent occur within 40 miles of marine waters (see Table D-16).
- Deer and Elk - The results from the Washington Forest Landscape Management Project (1996) indicated that the estimated carrying capacities for deer and elk are comparable when either timber production is maximized, or when 30 percent of the watershed is maintained in a fully functional forest stage.

Forest in the competitive exclusion stages is currently the most abundant habitat type on forested trust lands. Under all Alternatives, the majority of timber harvest is expected to occur in this habitat type. Two processes would likely affect the amount of competitive exclusion forest: conversion to ecosystem initiation forest through high-volume timber harvest, and development into structurally complex forest through natural forest succession, as well as forest management activities such as thinning.

Model output data indicate that the amount of competitive exclusion forest on western Washington forested state trust lands would decline under all six Alternatives in both the short term and the long term (Figure 4.4-3). In the short term, results show very little difference in the amount of competitive exclusion forest among the Alternatives (Appendix D, Table D-12). Model outputs indicated that at the end of the planning period, by 2067, all Alternatives would reduce the amount of forestlands in competitive exclusion, ranging from 1 to 8 percent. Under Alternatives 1, 4, and 5, approximately 65 percent of western Washington forested state trust lands would consist of competitive exclusion forest, while Alternatives 2, and 3 would result in about 64 percent. Under the Preferred Alternative, 60 percent of the forested trust lands would consist of competitive exclusion forest (Appendix D, Table D-12).

For the most part, decreases in the amount of competitive exclusion forest correspond to increases in the amount of structurally complex forest. This result suggests that many areas that currently sustain competitive exclusion forest would acquire the characteristics of structurally complex forest over time. The greatest long-term declines in competitive exclusion forest would likely occur under the Preferred Alternative, followed in descending order by Alternatives 1, 4, and 5, and then 2 and 3. Declines in the amount of competitive exclusion forest would not be expected to result in any significant adverse effects to wildlife species overall. No wildlife species are found exclusively in competitive exclusion forests, and decreases in the amount of competitive exclusion forest would nearly be matched by increases in structurally complex forest.

4.4.2 Introduction

This section identifies the potential effects of each forest management Alternative regarding proposed changes to policies and procedures on wildlife species and their habitats. Included is how these effects may differ among the six Alternatives. Appendix C provides an overview of the policies and procedures that govern DNR's management of wildlife resources, as well as those that influence the quality, quantity, and distribution of various wildlife habitats on the forest landscape. The Affected Environment section discusses wildlife habitats and species of special interest that are affected by current forest management. Finally, this section describes how procedural changes under the proposed Alternatives could affect wildlife habitats and populations.

Wildlife-related issues raised during internal DNR and public scoping processes include:

- the amount, quality, and distribution of northern spotted owl habitat over time (and forest structure in general). The status of the northern spotted owl population in southwestern Washington was highlighted as a matter of particular concern;
- the protection of currently suitable habitat for other listed species or species of concern such as the marbled murrelet;
- the maintenance of habitat features that contribute to biological diversity (e.g., snags, dead and down woody material, canopy gaps); and
- the potential for harvest levels to be affected by conservation measures for uncommon habitats.

4.4.3 Affected Environment

4.4.3.1 Habitats

This section describes five general types of wildlife habitat that occur on forested trust lands, provides examples of species associated with these habitats, and describes their prospective and current distribution among Habitat Conservation Plan (HCP) Planning Units.

The five wildlife habitat types addressed in this analysis are:

- ecosystem initiation forest,
- competitive exclusion forest,
- structurally complex forest,
- riparian and wetland habitats, and
- uncommon habitats.

The first three habitat types consist of groupings of stand development stages, which are a method of classifying forest stands according to various levels of structural and vegetative complexity (Johnson and O'Neil 2001). Table 4.2-4 provides the current distribution of stand development stages on forested trust lands. The total acreage of these habitat types by HCP Planning Unit is summarized in Table 4.4-1.

Ecosystem Initiation Forests

Ecosystem initiation forests represent the initial phases of forest development following a major disturbance such as a fire or regeneration harvest. They correspond to the grass/forb and shrub/sapling forest structure classes. Young forest stands with an open canopy and plentiful shrub cover support a diverse assemblage of birds; bird species diversity and overall abundance is highest in stands in the ecosystem initiation stage (Carey et al. 1996).

Ecosystem initiation stands also provide abundant forage for wide-ranging ungulate species (deer and elk). Other species closely associated with this stage include the white-tailed ptarmigan, yellow-breasted chat, and Townsend's vole (Johnson and O'Neil 2001). Structural legacies (e.g., large snags and down logs) retained from the previous stand can increase biological diversity by providing habitat for small mammals, cavity-nesting birds, and terrestrial amphibians (Carey et al. 1996). In managed landscapes, retention of such legacies combined with a management program designed to promote biological diversity may speed the development of more-complex forest ecosystems (Carey and Curtis 1996; Carey et al. 1996; Carey 1998).

Table 4.4-1. Acres of Wildlife Habitat Types among Forested Trust Lands by Habitat Conservation Plan Planning Unit

	HCP Planning Unit						
Habitat Type	**Columbia**	**N. Puget**	**OESF[5/]**	**S. Coast**	**S. Puget**	**Straits**	**Total**
Ecosystem Initiation Forest	18,331	31,540	17,823	16,778	11,607	9,160	105,240
Competitive Exclusion Forest[1/]	189,755	244,178	169,571	173,472	94,661	72,986	944,623
Structurally Complex Forest[2/]	59,444	105,798	69,265	42,681	35,575	28,076	340,841
Total Forested Trust Lands	**267,530**	**381,516**	**256,659**	**232,931**	**141,843**	**110,222**	**1,390,704**
Other Lands (including many uncommon habitats)[3/]	26,124	51,892	13,872	23,544	16,527	7,083	139,042
Riparian Areas and Wetlands[4/]	86,443	92,724	111,308	80,966	34,606	20,684	426,731

Data Source: Model output data – stand development stages.

1/ Includes sapling exclusion, pole exclusion, large tree exclusion, and understory development stages.

2/ Includes botanically diverse, niche diversification, and fully functional stages.

3/ Includes road rights-of-way, lakes and rivers, non-inventoried lands, and non-forested lands (e.g., grasslands, agricultural areas, utility easements, developed lands, beaches, bare rock, snow, and ice).

4/ Riparian areas are defined by buffers along streams, and wetlands include forested and non-forested wetland types. As such, both riparian areas and wetlands overlap other habitat types (including each other) and are not included in total area calculations. See Section 4.9.3 for a discussion of how wetlands were identified for this analysis.

5/ OESF = Olympic Experimental State Forest

Currently, about 8 percent of western Washington forested state trust lands consist of ecosystem initiation forest (Table 4.4-1); about 42 percent of this occurs in Upland Areas with General Management Objectives.

Competitive Exclusion Forests

Forests in the competitive exclusion stages generally have a single, dense canopy layer dominated by trees between 10 and 30 inches or greater in diameter at breast height. Small snags and down logs are often present, the result of suppression mortality as trees compete for available resources. Large decaying logs and stumps may be present as remnants of previous disturbances, such as windstorms or harvests.

In younger competitive exclusion stands, the high density and uniform size of relatively short trees allows only small amounts of sunlight to reach the forest floor, creating sparse understory conditions and low levels of biological diversity. Canopy gaps—either as a result of thinning or natural mortality—allow understory plants to become established. The result is a gradual increase in biological diversity. The competitive exclusion stages have the lowest biodiversity and the least favorable conditions for wildlife when compared to all the stand development stages (Carey et al. 1996). No wildlife species in western Washington are found exclusively in competitive exclusion forests (Carey and Curtis 1996).

Competitive exclusion forests are the most common forest habitat type on DNR-managed forested trust lands, making up 68 percent of the total forested area (Table 4.4-1). Approximately 26 percent of this habitat type occurs in Upland Areas with General Management Objectives. In this analysis, the understory development stage is included in the competitive exclusion stage because it has not yet developed the characteristics associated with structurally complex forests (as discussed below).

Structurally Complex Forests

Structurally complex forests typically feature multiple canopy layers, with the top layer of trees 20 to 30 inches and greater in diameter at breast height. In the more fully developed stages, such as niche diversification and fully functional, snags and down logs play a vital role in providing structural and biological diversity (Appendix B, Section B.2).

Biological diversity in this forest habitat type is promoted by structural complexity along both the vertical axis (i.e., trees of different heights, as well as shrubs and herbaceous plants) and the horizontal axis (e.g., gaps in the forest canopy) (Carey et al. 1996; Franklin et al. 2002). A diversity of plant species and growth forms in structurally complex forest provides niches for a wide variety of wildlife species. For example, structurally complex forests have an understory of small trees, shrubs, ferns, and herbs, providing foraging opportunities for herbivores and breeding habitat for ground-nesting birds (Carey et al. 1996). Large snags and down logs in the more fully developed stages of this class (or in other stages, if present as legacies) may provide suitable habitat conditions for a variety of species of conservation interest, including nest sites for northern spotted owls, roost sites for bats, and den sites for Pacific fishers. Very large trees may also provide nest sites for other wildlife species, including bald eagles and marbled murrelets.

Structurally complex forest makes up about 25 percent of the total forested area on DNR-managed forested trust lands (Table 4.4-1). Among the HCP Planning Units, the North Puget HCP Planning Unit supports the highest proportion (28 percent) and the South Coast

HCP Planning Unit supports the lowest (18 percent) of this forest habitat type. Currently, about 20 percent of the structurally complex forest on forested trust lands occurs in Upland Areas with General Management Objectives; the other 80 percent occur in Riparian and Wetland Areas or Uplands with Specific Management Objectives (which includes the entire Olympic Experimental State Forest). Including all western Washington forested state trust lands in deferred status, approximately 22 percent of all forested trust lands are managed under general management objectives (Table 4.4-1).

Riparian and Wetland Habitats

Water plays a significant role in the development of landforms and vegetation in riparian and wetland areas, which are defined more fully in Sections 4.3 and 4.9, respectively. Riparian habitats range from headwater streams and seeps to broad, flat river valleys. Wetlands include both forested and non-forested types. Numerous wildlife species use riparian and wetland habitats to fulfill all or portions of their life requisites such as breeding, foraging, resting, and traveling from one geographical area to another. Examples of species associated with these habitat types include beaver, mink, river otter, waterfowl, herons, and most amphibian species. In addition, several threatened, endangered, and sensitive species depend on riparian and wetland habitats for some or all of their life requisites (see Appendix D, Table D-11). Riparian and wetland habitats occur throughout all the five Westside HCP Planning Units and the Olympic Experimental State Forest, and encompass about 31 percent of the DNR-managed forested trust lands (Table 4.4-1).

Uncommon Habitats

While the great majority of forested trust lands supports forests of various structural classes, uncommon habitats also play a significant role in providing the life requisites of many wildlife species. Cliffs and talus, for example, provide habitat for species such as peregrine falcons, pikas, mountain goats, and Larch Mountain salamanders. Native grasslands serve as breeding and foraging areas for numerous bird and mammal species, and support host plants for certain rare butterfly species. Oak woodlands warrant specific consideration in the DNR Habitat Conservation Plan (HCP) due to the rarity of this habitat type and its role in supporting some uncommon wildlife species such as the Lewis' woodpecker and western gray squirrel. Available data distinguish between forested and non-forested areas but do not identify individual uncommon habitats on forested trust lands. "Other Lands" identified in Table 4.4-1 include such non-forested land cover types as grasslands, agricultural areas, utility easements, developed lands, beaches, bare rock, snow, and ice. Also included in the total acreage of "Other Lands" are road rights-of-way (58,000 acres total), lakes and rivers (9,000 acres total), and recently acquired lands that have not yet been inventoried.

4.4.3.2 Species of Interest

Most species of interest in this Final Environmental Impact Statement are those with a regulatory status that indicates particular concern for their viability, either off or on DNR-managed forested trust lands, such as species classified as threatened, endangered, or sensitive under Washington Administrative Code 232-12-297.

The northern spotted owl and marbled murrelet receive particular attention due to their listing status under the federal Endangered Species Act, their close association with structurally complex forest, and their occurrence on western Washington forested state trust lands. Other species of management interest are deer and elk, which are game species of cultural significance to tribal and other hunters, and are also valuable prey species for wolves and other large predators. Salmonids are addressed in Section 4.10, Fish. The 1997 Habitat Conservation Plan and associated Environmental Impact Statement (DNR 1997, 1996) are the primary sources of information about species addressed in this section. Where changes have occurred in the regulatory status of an individual species, or in the understanding of its habitat associations and population status, information is updated accordingly in the subsections below.

Northern Spotted Owl

Throughout much of their range, northern spotted owls are strongly associated with forested areas that are classified as structurally complex in this Final Environmental Impact Statement. Northern spotted owl habitat requirements are addressed in DNR's Habitat Conservation Plan (HCP) through the provision of Nesting, Roosting, and Foraging Management Areas and in Dispersal Management Areas. Nesting, roosting, and foraging habitat corresponds roughly with forested areas that are classified as structurally complex. Dispersal habitat is likely met in closed-canopy stands in the pole and large tree exclusion, and understory development stages, which are all part of the competitive exclusion stage (Section 4.2, Table 4.2-4) in addition to all the stages that make up structurally complex forest.

Notably, the stand development stages in this document are defined using a different set of criteria than the habitat definitions described in the Habitat Conservation Plan (HCP). When the HCP was signed in 1997, forest structure was identified primarily by the age of the stand. However, as new data and science have become available, stand age has become somewhat less important as a measure of structural development because it does not incorporate physical attributes or structural components important for characterizing habitat. These structural components include snags, understory development, and down woody debris. This analysis uses a stand development stage model instead of age to better represent structural diversity and habitat values. Structurally complex forests and nesting, roosting, and foraging habitat are similar enough that, for this analysis, structurally complex forest can serve as an index to the relative changes in the amounts of nesting, roosting, and foraging habitat over time under the proposed Alternatives.

The Role of Forested Trust Lands in Northern Spotted Owl Conservation

Federal lands were determined to be the key for northern spotted owl conservation, whereas non-federal lands were expected to complement the effort for species stabilization and recovery (USDI 1992). The U.S. Fish and Wildlife Service designated spotted owl critical habitat solely on federal lands (USDI 1992).

Several analyses published in early 1990s discussed the contribution of federal and non-federal lands in northern spotted owl conservation:

1. The final draft Recovery Plan for the Northern Spotted Owl (USDI 1992) recommended establishment of conservation areas on federal lands as the primary means for achieving recovery of the northern spotted owl. It also discussed the management recommendations for the areas where federal lands alone would be insufficient to achieve the recovery objectives.
2. The Forest Ecosystem Management Assessment Team northern spotted owl viability panel assessed the Northwest Forest Plan management options and predicted an 83 percent likelihood that habitat conditions would provide for well-distributed, stable populations of northern spotted owls on federal lands (USDA et al. 1993).
3. The report of the Spotted Owl Advisory Group to the Washington Forest Practices Board (Hanson et al. 1993) identified the important non-federal landscapes for essential northern spotted owl habitats on non-federal lands in Washington (the term “essential habitat” is different from the “critical habitat” as defined in the Endangered Species Act), and provided recommendations for site- and landscape-specific plans. These important landscapes were named Spotted Owl Special Emphasis Areas.
4. The Re-analysis Team (Holthausen et al. 1995) conducted additional analysis on persistence of the northern spotted owl population on the Olympic Peninsula and concluded that “it is likely but not assured, that a stable population would be maintained on portions of the Olympic National Forest and the core area of the national park in absence of any non-federal contribution of habitat.”

DNR considered all these analyses when developing the northern spotted owl conservation strategy in the Habitat Conservation Plan.

About 8 percent of the known northern spotted owl site centers in the state of Washington recorded in the Washington Department of Fish and Wildlife database as a result of 10 years of inventory surveys (1986 to 1995), occurred on DNR-managed forested trust lands in 1996 (USDI 1997) (Figure 4.4-1). (Washington Department of Fish and Wildlife Status 1, 2, or 3 northern spotted owl sites represent reproductive pair, pair – status unknown, and territorial single sites, respectively.)

These site centers were distributed among federal and DNR-managed forested trust lands as follows: in western Washington there were 389 site centers on federal land and 35 on forested trust lands; on the Olympic Peninsula, there were 203 site centers on federal land and 25 on forested trust lands; and in eastern Washington, 227 site centers were on federal land and 16 on forested trust lands.

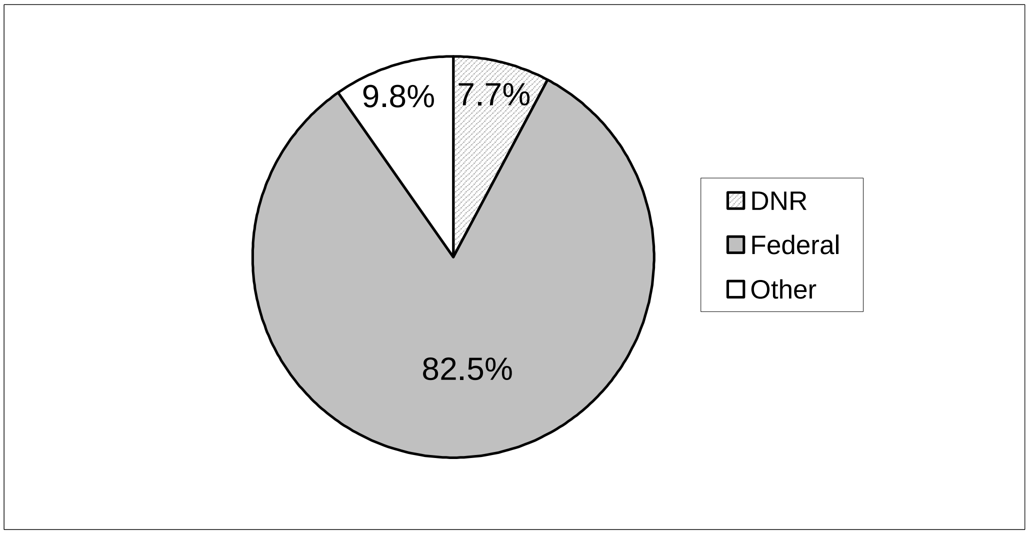

Figure 4.4-1. Percentage of Known Territorial Northern Spotted Owl Site Centers (WDFW Status 1, 2, 3) by Ownership in Washington in 1996

About 12 percent of the potentially suitable northern spotted owl habitat in the state of Washington in 1996 was on DNR-managed forested trust lands (USDI 1997) (Figure 4.4-2). “Suitable habitat” was defined as a mix of habitat qualities that provide for some or all of the life needs of the northern spotted owl, and this definition did not include habitat that only meets dispersal function.

In 1996, there were 145 known territorial northern spotted owl site centers (Status 1, 2 or 3) that influenced forested trust lands in the five Westside HCP Planning Units (i.e., these sites occurred either on or within a median home range radius of forested trust lands); 42 additional sites were projected to exist. In the three Eastside HCP Planning Units, there were 78 known northern spotted owl circles (Status 1, 2 or 3) that contained forested trust lands; 23 unknown site centers were projected to exist within the median home range radius of forested trust lands. There were 69 known northern spotted owl sites within 2.7 miles of forested trust lands in the Olympic Experimental State Forest (DNR 1996).

In general, areas with larger continuous habitat patches, which support clusters of 20 or more northern spotted owls, were considered to have the likelihood of being self-sustaining (Thomas et al. 1990). A plausible assumption was made in the Habitat Conservation Plan (HCP) Draft Environmental Impact Statement (EIS) that many of the owl habitats on federal reserves would act as source areas (in which the reproductive rate of the population exceeds the mortality rate). Forested trust lands within 4 miles of the federal reserves that provide habitat for northern spotted owls would probably act more often like sink areas (in which the mortality rate exceeds the reproduction rate and thus the persistence of the owls there relies on the emigrants from the source areas) because of the

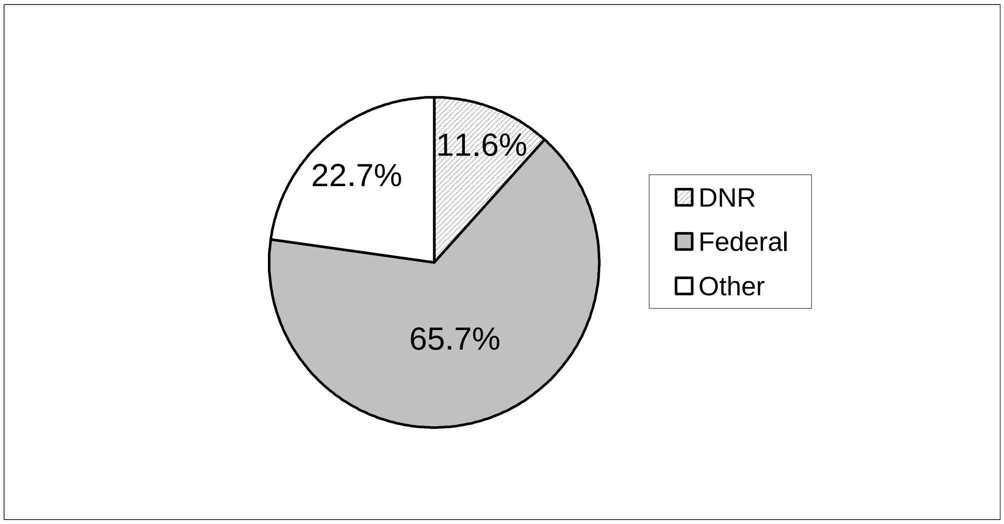

Figure 4.4-2. Percentage of Suitable Northern Spotted Owl Habitat by Ownership in Washington in 1996

small amount of forested trust lands in suitable habitat and because of its fragmentation. They can still provide demographic support to the population, at least occasionally.

The recommendations of the northern spotted owl Recovery Team (USDI 1992) and the Spotted Owl Advisory Group (Hanson et al. 1993) were taken into consideration during the designation of the Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas near federal lands. These areas were established primarily within 4 miles of the federal lands. The designation was supposed to provide habitat that makes a significant contribution to demographic support, maintenance of species distribution, and facilitation of dispersal. Based on the analyses conducted for the HCP, potential negative effects to individual northern spotted owls outside those areas were not expected to result in significant adverse effects to recovery efforts for the northern spotted owl population in western Washington (DNR 1996).

In the Biological Opinion for the HCP (USDI 1997), it was assumed that all suitable habitat inside northern spotted owl circles outside of the Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas would be harvested within the first decade of the HCP. However, an important commitment made by the DNR in the HCP was to consider U.S. Fish and Wildlife Service recommendations when harvesting northern spotted owl habitat outside of designated Nesting, Roosting, and Foraging Management Areas during the first decade of the HCP. The DNR, Washington Department of Fish and Wildlife, and U.S. Fish and Wildlife Service Interagency Technical Group developed a northern spotted owl Site Prioritization Schedule in October 1997. Emphasis and recommendations centered on Category 1 northern spotted owl circles (i.e., circles that overlap harvestable Nesting, Roosting, and Foraging Management Areas; Spotted Owl Special Emphasis Areas outside of Nesting, Roosting, and Foraging Management Areas; and circles that are outside of both Spotted Owl Special Emphasis Areas and Nesting, Roosting, and Foraging Management Areas). These northern spotted owl circles were identified as potentially having a valuable short-term contribution to the population. A total of 234 site centers were considered “at risk.” Of these, the Interagency Technical Group designated 66 “critical owl circles,” which the U.S. Fish and Wildlife Service asked the DNR to protect during the HCP’s first decade (USFWS et al. 1997).

The DNR committed to provide additional protection for the highest priority 56 northern spotted owl circles of the 66 circles the U.S. Fish and Wildlife Service identified. These 56 owl circles became known as “Memorandum #1 owl circles,” after the January 1998, HCP Implementation Memorandum #1 which deferred harvests in these circles until 2007 (the end of the HCP’s first decade). Outside of the Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas and outside of the Memorandum #1 northern spotted owl circles, management activities within all other northern spotted owl circles could proceed if they were consistent with the timber sale design commitments in the HCP (IV.9-10, DNR 1997).

Beyond Memorandum #1, DNR Procedure 14-004-120 provided protection from harvesting of suitable habitat within all Status 1 reproductive owl circles and within four specific northern spotted owl circles in Southwest Washington (*Management Activities Within Spotted Owl Nest Patches, Circles, Designated Nesting, Roosting, and Foraging, and Dispersal Management Areas,* dated August 1999).

Proposed changes to this procedure as outlined in the Preferred Alternative (see Appendix F) include a strategy that is intended to provide habitat that makes a significant contribution to demographic support, the maintenance of distribution, and the facilitation of dispersal. This strategy is designed to create a landscape in which active forest management plays a role in the development and maintenance of the structural characteristics that constitute such habitat over both the short term and long term as new habitat develops (see Chapter 2, Section 2.6.3.5 for additional discussion). Currently, 28 Owl Memorandum #1 circles are identified as overlapping western Washington forested state trust lands, along with 78 Status 1 reproductive circles and 4 southwestern Washington northern spotted owl circles. A total of 11 northern spotted owl circles have been identified in southwestern Washington; however, 7 of the 11 owl circles are included above in either the Owl Memorandum #1 northern spotted owl circles or Status 1 reproductive circles. Timber harvest activities within the habitat portion of these circles is deferred for the first decade of HCP implementation.

In Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas, the HCP requires DNR to identify at least 50 percent of designated habitat management area as the “threshold habitat target” within each watershed. However, the HCP allows harvests in watersheds designated as Nesting, Roosting, and Foraging Management Areas that do not yet contain the 50 percent threshold, if those harvest activities do not increase the amount of time that would be required for the target amount of Nesting, Roosting, and Foraging goal (50 percent habitat threshold) to be attained if all the stands in that watershed were left unmanaged (IV.8-9, DNR 1997).

NEW DATA ON NORTHERN SPOTTED OWL DEMOGRAPHY

When the Habitat Conservation Plan (HCP) was completed in 1997, several studies had described northern spotted owl populations that were declining in many parts of their range, but the magnitude of these declines was a matter of much debate (Anderson and Burnham 1992; Thomas et al. 1993; Burnham et al. 1994; Bart 1995).

The annual rate of population change ("λ," where λ=1 refers to a stable population and λ< 1 refers to a declining population) used in the HCP Draft Environmental Impact Statement (EIS) analyses were those presented in Burnham et al (1994) in the Final Supplemental EIS for the Northwest Forest Plan.

Two long-term demographic study areas used in the federal monitoring program for the northern spotted owl, that applied to Washington northern spotted owl provinces, were used in the HCP analysis—the Olympic Peninsula study area and the Cle Elum study area. The value of λ from the Cle Elum study area was used to define the northern spotted owl population status in the Eastside HCP Planning Units. It was estimates as 0.924—a negative 7.6 percent annual rate of change; the 95 percent confidence intervals of λ were 0.8610 and 0.987. The annual rate of population change on the Olympic Peninsula was 0.9472, a 5.3 percent decline per year. For the Westside HCP Planning Units, the value of λ was averaged for the two study areas to give a population change of 0.9356—an annual rate of decline of 6.4 percent. The 95 percent confidence intervals for the westside were 0.8789 and 0.9922. As discussed in the Final Supplemental EIS for the Northwest Forest Plan (USDA and USDI 1994), such a rapid rate of decline seemed inconsistent with the observations from population density studies at that time. The upper limits of the confidence intervals were considered to be closer to the reality than the midpoint. They equaled an annual rate of decline of 0.8 percent for the westside and 1.3 percent for the eastside. DNR used these upper limits in their HCP analyses.

Additional research since 1996 has provided further evidence that northern spotted owl populations are continuing to decline. Analysis by Franklin et al. (1999) resulted in a point estimate for the Cle Elum study area for the period 1989 to 1998 of λ = 0.9406 (juvenile survival was not corrected for emigration) with lower and upper 95 percent confidence intervals of 0.8963 and 0.9848, respectively. The point estimate for the Olympic Peninsula study area for the period 1987 to 1998 was λ=0.8763 (juvenile survival was not corrected for emigration) with lower and upper 95 percent confidence intervals of 0.8449 and 0.9077, respectively. A derivation of λ for the Westside HCP Planning Units, calculated as an average from the Cle Elum and Olympic Peninsula point estimates, would be 0.9085. These data confirmed the northern spotted owl population decline with greater statistical power because of the larger samples used in the analyses.

Preliminary results from the last northern spotted owl demography workshop held in January 2004 (Anthony et al. 2004) concluded that northern spotted owl populations on many of the study areas decline even more rapidly compared to the rates from the 1999 report. The estimates of the population rate of change were especially low for the state of Washington, indicating a decline of 7.5 percent per year for the entire period of study

(1987 to 2003). For comparison, the decline in Oregon was 2.8 percent per year and in California 2.2 percent per year. The annual rate of population change was calculated differently in 2004 than in the previous demography reports (Burnham et al. 1994; Franklin et al. 1999). The main difference between the two methods is that the earlier λ estimates (λ_{PM}) were computed from projection matrices using age-specific survival and fecundity from juvenile, subadult, and adult owls, assuming a stable distribution, while the current λ estimate (λ_{RJS}) refers to the population of territorial owls only and takes into account the combination of gains and losses to the population by direct estimation from the capture-recapture data. The opinion of the authors of the 2004 report is that λ_{PM} is biased low (which means it estimates greater population decline) and only λ_{RJS} should be used.

According to the 2004 report, the populations on the Cle Elum, Wenatchee, and Mt. Rainier study areas declined substantially over the last decade. The population sizes were approximately 40 to 60 percent of initial populations in the Cle Elum and Wenatchee study areas. The Olympic Peninsula population in 2002 was approximately 70 to 80 percent of initial populations. “Initial populations” here refers to the time the demography studies started, which for these areas is late 1980s and early 1990s.

Anthony et al. (2004) did not provide analyses on the causes for the recent rapid decline. The report only suggested the possible reasons for the dramatic decline in Washington study areas: 1) high density of barred owls, 2) loss of habitat due to wildfire, 3) logging of northern spotted owl habitat on state and private lands, 4) forest defoliation caused by insect infestations, and 5) advancing forest succession toward climax for communities (e.g., *Abies spp*.) in the absence of wildfires. Related to the fifth reason above, the natural progression of a stand to climax (that is, stands that evolve in the absence of major disturbance) results in forests that are no longer northern spotted owl habitat.

More definitive information of the causes of decline is anticipated in the U.S. Fish and Wildlife Service 5-year status report for northern spotted owl, which will be available later this year (2004).

Marbled Murrelet

Reflecting the lack of certainty about the specific habitat needs of marbled murrelets, the Habitat Conservation Plan (HCP) defined an interim conservation strategy for this species. The interim strategy for marbled murrelets involves habitat relationship studies designed to identify higher quality habitats that have the greatest potential to support nesting murrelets. These studies have not been completed in all five Westside HCP Planning Units and the Olympic Experimental State Forest; therefore, analyses in this Final Environmental Impact Statement (EIS) take a more general approach, using structurally complex forest as an indicator for suitable nesting habitat for marbled murrelets.

Analyses conducted for DNR’s HCP EIS (DNR 1996) indicate that most forest stands greater than 110 years of age have sufficient numbers of nesting platforms to support murrelets. Model output data for 2004 show that most forests classified as structurally complex are at least 90 years old, so it is likely that there is considerable overlap between structurally complex forest and murrelet nesting habitat.

The Marbled Murrelet Recovery Plan (USFWS 1997) identifies terrestrial (upland) habitat essential for marbled murrelet recovery. The Recovery Plan identifies additional areas on non-federal land where existing habitat should be protected because habitat in federal reserves is insufficient to reverse population declines and maintain a well-distributed population. In the state of Washington, such additional essential habitat occurs on state lands within 40 miles of marine waters. These areas are critical for improving the distribution of the population and suitable habitat, especially in southwestern Washington (USFWS 1997). Effects on forestlands within 40 miles of marine waters, therefore, are of particular concern in determining the effects of the Alternatives on marbled murrelet populations.

Of the approximately 341,000 acres of structurally complex forest on forested trust lands (Table 4.4-1), approximately 84 percent of this forest development stage occurs within 40 miles of marine waters. Relative to all DNR-managed forested trust lands, the estimated proportion of structurally complex forest within 40 miles of marine waters is 21 percent (see Appendix D, Table D-16). The DNR currently identifies three types of marbled murrelet habitat:

1. Forest stands identified as habitat as a result of DNR's marbled murrelet habitat relationship study (referred to as "reclassified habitat");
2. Occupied forest sites identified in the Washington Department of Fish and Wildlife point database as a result of DNR's marbled murrelet-habitat relationship study and field surveys (referred to as "occupied habitat"); and
3. Occupied forest stands defined as the occupied stand and all reclassified habitat located within one-half mile of the occupied forest stand.

In the absence of more specific information on the long-term conservation strategy, it is assumed for this analysis that all marbled murrelet occupied sites, reclassified habitat, and occupied forest stands will be maintained in a long-term deferred status. The assumption for the remainder of the forest stands will be changed from a deferred status to an un-deferred status. The net effect of these assumptions will be that 55 percent (approximately 81,000 acres) of identified marbled murrelet reclassified habitat will be maintained in a long-term deferred status, and the remainder placed into the Riparian and Wetland Areas or Upland Areas with Specific Objectives land classes, depending on the proximity to Riparian Areas. None of the marbled murrelet reclassified habitat or occupied forest stands will be placed in Upland Areas with General Objectives, the land class with the fewest harvest restrictions. It is assumed for this analysis that all marbled murrelet reclassified habitat will be deferred until a long-term strategy is developed.

The HCP long-term strategy was intended to help meet objectives of the federal Marbled Murrelet Recovery Plan (USFWS 1997), and to "...make a significant contribution to maintaining and protecting marbled murrelet populations in western Washington…" (DNR 1997, p. IV.44).

The HCP provided a high level discussion of the long-term strategy, including the "...general factors that would likely be considered... [and] …an idea of the kinds of approaches expected..." Three forest-related factors were thought to be primary negative influences on murrelet populations:

1. Loss of nesting habitat mainly due to timber harvest;
2. The speculation that predation at nest sites is a major impact to recruitment of young birds into the population and to adult survival rates; and
3. The suspicion that logging-related disturbance of nesting birds significantly reduces nest success.

DNR then presented a series of considerations that were thought to be important to developing a conservation strategy in the context of those primary factors and assumptions that marbled murrelets had limited dispersal abilities and may be unable to colonize new breeding habitat. Those considerations generally belonged in one of the following categories: 1) stand-level issues at marbled murrelet breeding areas; 2) landscape-level issues; and 3) issues of conservation biogeography.

Nine HCP Planning Units comprise forested trust lands under the HCP; marbled murrelets inhabit all five westside HCP Planning Units and the Olympic Experimental State Forest. Information-gathering and marginal habitat release are in progress in the North and South Puget HCP Planning Units, and have been substantially completed in the Olympic Peninsula (Straits and Olympic Experimental State Forest HCP Planning Units) and southwest Washington (South Coast and Columbia HCP Planning Units). As agreed to in the HCP (DNR 1997, p. IV.40), DNR and the U.S. Fish and Wildlife Service are initiating the process of developing the long-term marbled murrelet conservation strategy for these four HCP Planning Units, which encompass part of Conservation Zone 1 and all of Zone 2 designated in the Recovery Plan (USFWS 1997).

Land ownership patterns, densities of marbled murrelets at sea, and DNR inland survey results vary dramatically among the HCP Planning Units. The Olympic Peninsula is approximately 2.8 million acres, the majority of which (1.6 million acres) are federal lands in the Olympic National Park and Olympic National Forest. DNR manages approximately 380,000 acres of land in this particular area. DNR-managed forested trust lands in the Olympic Experimental State Forest HCP Planning Unit (270,000 acres) are spread across a fairly broad (approximately 20 mile) coastal plain and the foothills of the Olympic Mountains, in contrast to those in the Straits HCP Planning Unit (112,000 acres) that are confined to a narrow band of non-federal land between the Olympics and the Pacific Ocean. The western portions of the Columbia and South Coast HCP Planning Units are dominated by private lands (mostly commercial forest), with federal lands mostly peripheral to the marbled murrelet's inland range. South of the Olympic Peninsula and within the range of the marbled murrelet, these two HCP Planning Units comprise approximately 3.5 million acres, of which about 10 percent is forested trust lands managed by DNR.

Marbled murrelet activity recorded during DNR inland surveys was greatest in the Olympic Experimental State Forest HCP Planning Unit, with 6,909 marbled murrelet detections recorded on 34 percent of 4,584 surveys. Next, in the Straits HCP Planning

Unit, 1,060 detections were recorded on 14 percent of 2,736 surveys. The fewest detections occurred in the southwest Washington HCP Planning Units (Columbia and South Coast) where 1,124 detections were recorded on 6 percent of 3,332 surveys.

Other Threatened, Endangered, and Sensitive Species

Appendix D, Table D-11 lists the threatened, endangered, and sensitive species that are known or suspected to occur on DNR-managed forested trust lands. This table identifies each species' state and federal listing status, and the habitats with which it is associated.

DNR procedures provide specific direction for the management of habitat for species of interest, including threatened, endangered, and sensitive species (see Appendix C).

Deer and Elk

As noted above, black-tailed deer and Roosevelt elk are game species of cultural significance to tribal and other hunters, and are also valuable prey species for wolves and other large predators. As large and mobile animals, deer and elk can use different habitat elements in different forest types. Open habitats (e.g., ecosystem initiation forest) often provide foraging opportunities for these species. Studies in northwestern Washington have found that elk use thinned stands more than clearcuts for foraging. Closed-canopy forest may provide seclusion from human harassment (Cook et al. 1998). Both forage areas and cover can be provided by structurally complex forests. Understory vegetation provides forage while older trees in the overstory provide substrates for lichen production, decrease on-the-ground snow accumulation, and are sources of cover (Carey et al. 1996).

Habitat suitability models for deer and elk in western Washington and Oregon consider many factors, including quality of cover habitat, size and spacing of forage and cover areas, and road density (Witmer and deCalesta 1985; Wisdom et al. 1986). While an assessment of impacts to all the factors that contribute to habitat effectiveness for deer and elk is beyond the scope of this programmatic assessment, it is possible to indirectly address one key factor—size and spacing of forage and cover—by examining the proportion of forage habitat on the landscape.

Several studies of deer and elk have noted a decreased use of forage habitat when it is farther away from cover (Wisdom et al. 1986). As the proportion of forage habitat in a given area increases above 50 percent, the amount of forage in proximity to effective cover habitat will by necessity decrease. On the other hand, inadequate forage also reduces the capability of an area to support deer and elk. In areas managed for timber production, the Washington State Department of Fish and Wildlife has recommended that 30 to 60 percent of the landscape should consist of forage habitat (WDFW 1996). Data available for this analysis can be analyzed at three scales: all western Washington forested state trust lands, the five Westside HCP Planning Units and the Olympic Experimental State Forest, and watersheds. Of these, watersheds provide a suitable landscape scale for DNR to analyze foraging habitat, because they come closest to matching the area over which deer and elk may range during a season (Jenkins and Starkey 1990).

For this analysis, watersheds in which 30 to 60 percent of the forested area consists of structurally complex forest (i.e., the botanically diverse, niche development stage, and fully functional stages), and the ecosystem initiation stage, are considered to provide suitable habitat for deer and elk. While these forest stand development stages all provide forage, there are nutritional quality and quantity differences between ecosystem initiation and more structurally complex forest stages. Structurally complex forests provide higher quality forage than ecosystem initiation areas (Hanley et al. 1989).

The results from the Washington Forest Landscape Management Project (Carey et al. 1996) indicated that the estimated carrying capacities for deer and elk are comparable when either timber production is maximized or when 30 percent of the watershed is maintained in a fully functional forest stage. Currently, there are 144 watersheds in which foraging habitat makes up 30 to 60 percent of forested trust lands (Table 4.4-2). This amounts to 44 percent of the 324 western Washington forested state trust land watersheds. Estimated proportions of western Washington forested state trust lands composed of structurally complex forest increase over time under all Alternatives (Table D-14 in Appendix D), ranging from 29 percent under the Preferred Alternative to 23 percent under Alternative 5.

Table 4.4-2. Number of Watersheds[1/] Supporting Percentages of Deer and Elk Foraging Habitat Among Westside HCP Planning Units

	Number of Watersheds						
Percentage of Foraging Habitat[2/]	**Columbia**	**N. Puget**	**OESF[3/]**	**S. Coast**	**S. Puget**	**Straits**	**Total**
≤30% Forage	39	37	9	37	13	7	**142**
30%-60% Forage	20	50	20	12	22	20	**144**
>60% Forage	7	13	2	5	11	0	**38**
Total	**66**	**100**	**31**	**54**	**46**	**27**	**324**
Percent in 30%-60% range	30%	50%	65%	22%	48%	74%	**44%**

Data Source: Model output data – stand development stages.

1/ The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations, and percent totals are based on the total acres of forested trust land per WAU.

2/ Forest development stages that provide deer and elk forage include structurally complex forest (i.e., botanically diverse, niche development stage, and fully functional stage), and ecosystem initiation.

3/ OESF = Olympic Experimental State Forest

4.4.4 Environmental Effects

Changes to policies, procedures, and management intensities proposed in the Alternatives would be expected to affect wildlife species and the habitats with which they are associated. Effects of proposed changes in the policies and procedures that govern timber harvest and the protection of riparian and wetland areas are described in Sections 4.2, 4.3, and 4.9, respectively. The subsections below describe the potential effects on wildlife anticipated from the revisions to DNR policies and procedures, and from changes in harvest levels proposed in the Alternatives.

The Forest Resource Plan and the Habitat Conservation Plan (HCP) are two documents that help establish the goals and objectives for DNR management of forested trust lands. The proposed Alternatives represent various means of achieving these ends. Based on the extent and type of timber harvest proposed under the Alternatives, some Alternatives may achieve the desired goals sooner or later than others.

4.4.4.1 Habitats

This section addresses changes in the amount or quality of the five general wildlife habitat types under each Alternative, and how such changes may affect wildlife species associated with these habitats. Changes in the relative amount of forested habitat types are a product of varying rates and intensities of timber harvest under the different Alternatives. Appendix D, Table D-12 presents the modeled proportion of western Washington forested state trust lands comprising ecosystem initiation, competitive exclusion, and structurally complex forests under each Alternative in the years 2013 (short term) and 2067 (long term).

The acreage and location of riparian and wetland areas and uncommon habitats are not expected to change under any of the Alternatives, but the quality of the habitat provided by these areas would be expected to vary as a result of different amounts of harvest activity and intensity.

Ecosystem Initiation Forest Habitat

In a managed forest landscape, the amount of ecosystem initiation forest habitat depends primarily on the amount and intensity of regeneration harvest activity. Alternatives with higher levels of regeneration harvest would produce greater amounts of ecosystem initiation forest. Conversely, Alternatives with lower acreages of regeneration harvest would result in less of this habitat type, as less area would be harvested in any given time period.

This trend is evident in the model output for the six Alternatives. In both the short term and the long term, the amount of ecosystem initiation forest expected under Alternative 1 (No Action), and Alternative 4 would remain slightly below the levels expected under the other Alternatives (Figure 4.4-3, Appendix D, Table D-12). In both the short term and the long term, the greatest amount of this habitat type would occur under Alternative 5, under which the greatest amount of high-intensity harvest would be expected to occur. In the short-term, the Preferred Alternative would generate similar levels as Alternative 5 (13 percent versus 12 percent), but level off to at or below levels under Alternative 5 in the long term.

Overall, all six Alternatives would result in similar amounts of ecosystem initiation forest in both time frames, and no significant difference would be expected among the effects of the Alternatives on wildlife species associated with this forest type. This may not hold true within certain HCP Planning Units in some time periods. For example, model results for Alternative 4 suggest that 28 percent of the Straits HCP Planning Unit under general management objectives would consist of this habitat type in 2013, whereas Alternatives 2 and 3 would consist of 16 and 18 percent, respectively. Alternatives 5 and the Preferred Alternative results predict that more than 25 percent of the Straits Planning HCP Unit would consist of ecosystem initiation forest in 2013 (Appendix D, Table D-8).

No strict thresholds have been identified for an acceptable amount of ecosystem initiation forest habitat in a given landscape. However, elevated amounts of this habitat type indicate an increased potential risk of habitat fragmentation among closed-canopy forest types (e.g., structurally complex).

Carey et al. (1996) note that some forest bird species reach their greatest abundance and diversity in forest stages with high shrub cover, particularly ecosystem initiation forest. Long-term increases in the amount of ecosystem initiation forest on the landscape would likely result in localized increases in populations of these species. This would occur with corresponding decreases in the amount of competitive exclusion forest, which is characterized by low abundance and diversity among these species. Deer and elk would also be expected to benefit from the increased availability of foraging habitat in proximity to competitive exclusion and structurally complex forest (both of which provide cover).

Competitive Exclusion Stages

Forest in the competitive exclusion stages is currently the most abundant habitat type on DNR-managed forested trust lands. Under all Alternatives, the majority of timber harvest is expected to occur in this habitat type. Two processes would likely affect the amount of competitive exclusion forest: conversion to ecosystem initiation forest through high-volume timber harvest, and development into structurally complex forest through natural forest succession and forest management activities such as thinning.

Model output data indicate that the amount of competitive exclusion forest on forested trust lands would decline under all six Alternatives in both the short term and the long term (Figure 4.4-3). In the short term, results show very little difference in the amount of competitive exclusion forest among the Alternatives (Appendix D, Table D-12). Model outputs indicated that at the end of the planning period (by 2067), all Alternatives would reduce the amount of forestlands in competitive exclusion. Under Alternatives 1, 4, and 5, approximately 65 percent of forested trust lands would consist of competitive exclusion forest, while Alternatives 2 and 3 would result in about 64 percent. Under the Preferred Alternative, 60 percent of the forested trust lands would consist of competitive exclusion forest (Appendix D, Table D-12).

For the most part, decreases in the amount of competitive exclusion forest correspond to increases in the amount of structurally complex forest. This result suggests that many areas that currently sustain competitive exclusion forest would acquire the characteristics of structurally complex forest over time. The greatest long-term declines in competitive exclusion forest would likely occur under the Preferred Alternative, followed in descending order by Alternatives 1, 4, and 5, and then 2 and 3.

The change in these closed-canopy competitive exclusion forest stands into more diverse, structurally complex forests would occur only as the canopy opens up. The tree canopy of a forest stand opens as a tall tree or some smaller trees die, or as a tree gets taller and allows sunlight to reach the forest floor below its high branches. Trees in the canopy and sub-canopy die for a number of reasons. The principal reasons include lack of nutrient and light resources due to competition among trees, and natural disturbances such as wind, fire, insects, and disease.

Declines in the amount of competitive exclusion forest would not be expected to result in any significant adverse effects to wildlife species overall. No wildlife species are found exclusively in competitive exclusion forests, and decreases in the amount of competitive exclusion forest would nearly be matched by increases in structurally complex forest.

Additionally, retrospective studies of vertebrate communities in intensively managed commercial forests (e.g., Aubry et al. 1997) and natural forests (e.g., Ruggiero et al. 1991) show broadly similar species lists. Thus, no wildlife species would be expected to experience habitat reductions, and overall wildlife diversity may increase with the increased amounts of forest habitat types that generally support greater abundance and diversity of wildlife species (ecosystem initiation and structurally complex) (Carey et al. 1996).

Structurally Complex Forest

In the short term, changes in the amount of structurally complex forest under all Alternatives would largely be the result of different levels of management intensity. Alternatives with more high-volume timber harvests (i.e., Alternative 5) would be expected to result in less of this habitat type than those with more areas deferred from harvest (Alternative 1), or those with longer rotation lengths (Alternative 4). Under the latter two Alternatives, in any given time period, fewer structurally complex stands would be subject to regeneration harvest. These Alternatives, therefore, would show greater acreage of complex forest relative to an Alternative that emphasizes intensive regeneration harvest.

In the long term, the amount of structurally complex forest would also depend on the forests' growth and development, which would in turn be influenced by their harvest history. For example, competitive exclusion stands that have been heavily thinned can be expected to acquire the characteristics of structurally complex forest sooner than those that are left alone (Carey et al. 1996; Thysell and Carey 2000). Also see Chapter 2, Section 2.6.3.4 for additional discussion on thinning levels and multi-canopy development over time.

Model output supports the concept that heavier thinning (i.e., over 50 percent of the basal area) would promote the development of structurally complex forest that provide snag and down wood levels associated with fully functional forests. It is worthwhile to emphasize that the model will not control actual stand prescriptions; on-the-ground evaluation of the stand will determine the appropriate thinning strategy with no presumption that it will be 50 percent of the basal area or any other default number. In both the short term and the long term, the Preferred Alternative results in the greatest amount of structurally complex forest on forested trust lands (Figure 4.4-3, and Appendix D, Table D-12). All other Alternatives also result in net increases in both the short term and the long term, but to a lesser degree. Alternative 5 exhibits the smallest increases in both time periods.

For the most part, this overall pattern is repeated at the individual HCP Planning Unit scale. The main exception is the South Puget HCP Planning Unit, where among the proposed Alternatives, the Preferred Alternative appears to yield some of the greatest increases in structurally complex forest in the long term. The Preferred Alternative also proposes the most acres of timber harvest in the South Puget HCP Planning Unit, as well as the greatest decline in competitive exclusion forest.

These findings suggest that a biodiversity pathway management approach appears to be compatible with maximizing the amount of structurally complex forest, at least in some areas. Alternative 5 proposes more traditional thinning prescriptions and appears to yield the second-highest harvest levels in the South Puget HCP Planning Unit. However, it appears Alternative 5 would result in the smallest increases in structurally complex forest in this unit in almost all time periods. For a discussion of changes in the amount of structurally complex forest in the Olympic Experimental State Forest under the six Alternatives, see the analysis of northern spotted owl nesting, roosting, and foraging habitat availability in Section 4.4.4.2 below.

Based on model outputs, actively managed stands appear to result in the greatest increases in fully functional forest stages, or those characterized by the highest amounts of snags and downed trees. Alternatives 1 and 4 closely follow the Preferred Alternative in providing structurally complex forest. However, an examination of the two stand development stages that are characterized by abundant woody debris (niche diversification, and fully functional), shows the Preferred Alternative to exceed Alternatives 1 and 4 in developing these complex forests. It therefore appears that the biodiversity pathway techniques employed by the Preferred Alternative would likely provide improvements in forest diversity comparable to a more “hands-off” approach, while increasing timber flow from forested trust lands (see Figure 4.2-2, and Appendix D, Table D-12).

Riparian and Wetland Habitats

Effects to species associated with riparian habitats under the different Alternatives would result from timber harvest activities in Riparian Management Zones and from changes in riparian habitat conditions. Increased levels of harvest activity in the riparian areas increase the potential for disturbing wildlife species that use these areas, and of altering habitat features upon which they depend. Active management can also accelerate the rate at which a stand reaches structurally complex forest stages. Short-term impacts are to be considered with the understanding of long-term benefits. Over time, development of structurally complex forest dominated by large trees improves the ability of riparian areas to play a vital role in the health of stream ecosystems and terrestrial ecosystems.

Section 4.3, Riparian Areas, presents the effects of forest management activities on riparian areas under the six Alternatives. During the remaining period of the Habitat Conservation Plan (HCP), Alternatives with lower levels of activity, such as Alternatives 1 through 4, are expected to have a higher proportion of riparian area with large and very large trees that are in competitive exclusion stages. In contrast, Alternatives with higher levels of active management, such as the Preferred Alternative, are expected to have more riparian area that will be fully functioning, or be on a trajectory towards full function. Regardless, riparian conditions are expected to improve under all Alternatives relative to current conditions. This is due to changes in stand structure, particularly increases in the amount of stand development stages that include large and very large trees, which are in moderate supply throughout much of the western Washington forested state trust lands (see Figure 4.3-2). Within riparian areas, the rate of improvement in structurally complex forests overall is similar among the Alternatives. However, active management under the Preferred Alternative is expected to achieve fully functioning stands within 80 to 90 years, rather than approximately 220 years under passive techniques (Carey et al. 1996).

Over the short term (i.e., the next decade of the HCP), little difference is expected in the distribution of stand development stages among the six Alternatives (Figure 4.3-2). The proportion of Riparian land class in stand development stages that include large and very large trees is expected to increase from about 57 percent to 62 or 63 percent, with the vast majority of this increase expected in the large tree exclusion and understory development stages. The amount of stages with very large trees is expected to remain at about 25 to 26 percent of the Riparian land class because increased growth expected from stand manipulations would take some time to become fully expressed, and only a small percentage of riparian areas would be treated in the first decade (up to about 4.5 percent of the riparian area).

Differences among the Alternatives are expected to become more substantive over the long term (Figure 4.3-2). The proportion of the Riparian land class with large tree and very large tree is expected to increase over current conditions from about 57 percent under current conditions to 78 percent to 90 percent of the Riparian land class, depending upon the Alternative (Figure 4.3-2). Alternatives 1 and 4 are expected to have the highest amount, with about 90 percent of the Riparian land class in these stages. Alternatives 2, 3, and 5 are expected to have about 82 to 83 percent of the Riparian land class. The Preferred Alternative is expected to have the lowest proportion of the Alternatives, with about 78 percent of the Riparian land class that contain large and very large trees (Figure 4.3-2).

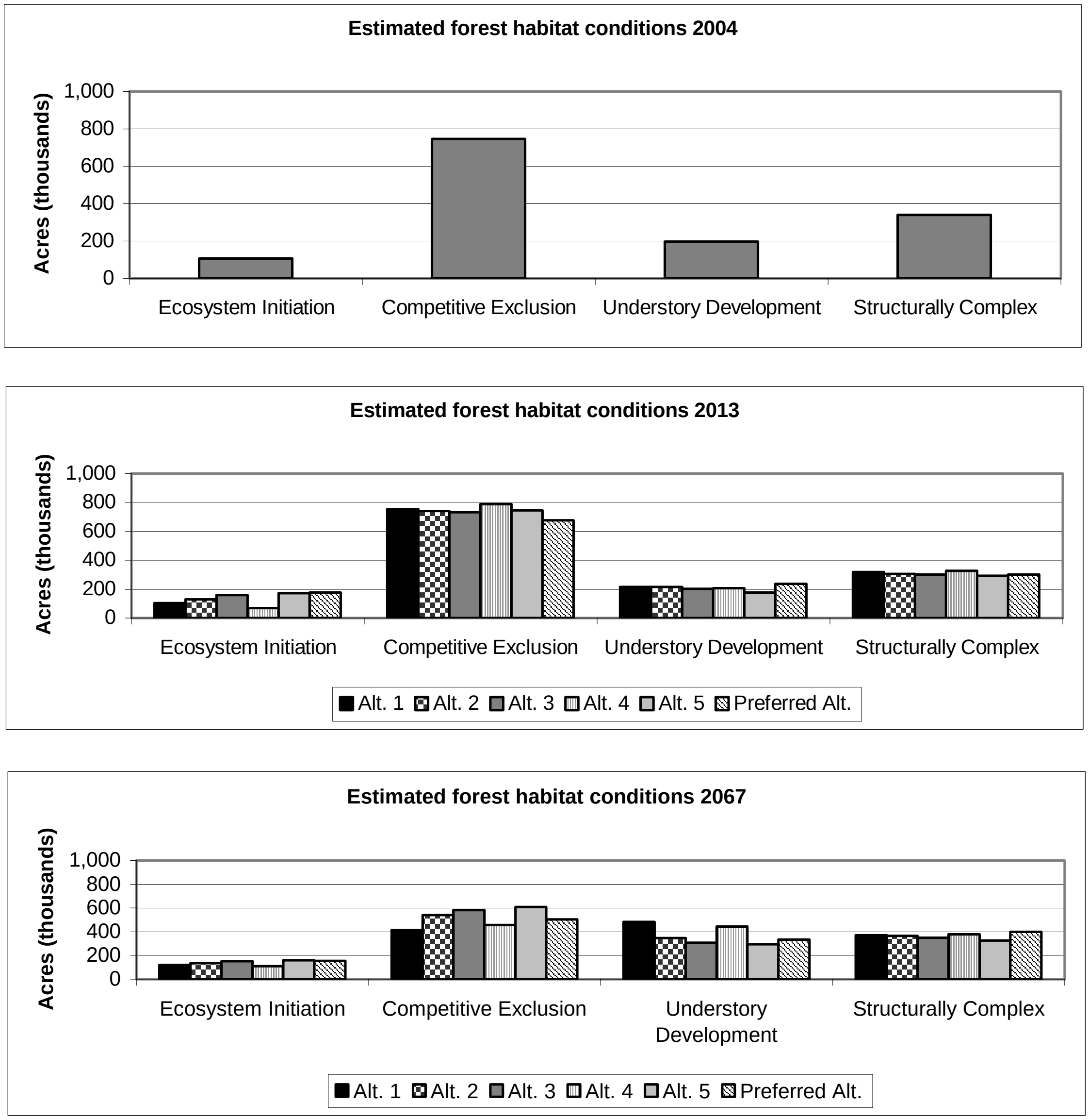

Figure 4.4-3. Current (2004) and Estimated Future Amounts of Forested Habitat Types on Forested Trust Lands under Each Alternative

Although the Preferred Alternative is expected to have the lowest proportion of stand development stages that include large and very large trees modeled as competitive exclusion, it is also expected to have the highest proportion of the most complex classes of niche diversification and fully functioning stand development stages. These two stand development stages will each comprise about 6 to 7 percent of the Riparian land class. In contrast, Alternatives 1 to 4 are expected to have about 4 percent and 3 percent of the Riparian land class in niche diversification and fully functioning stages, respectively, and Alternative 5 is expected to have about 2 percent in each (Figure 4.3-2). The modeling results support the qualitative assessment that under the Preferred Alternative, active management of stands in competitive exclusion stages helps to move stands towards development pathways that more rapidly lead to a fully functional stand structural state compared to more passive management.

Although the Preferred Alternative would be expected to result in the least amount of area with very large trees, this Alternative would likely result in a slightly higher amount (13 percent) of Riparian land class area in fully functional or niche diversification forest stand development stages compared to the other Alternatives. Alternative 5 would be expected to result in the lowest amount (approximately 4 percent) (Figure 4.3-3). The major added feature that distinguishes the fully functional and niche diversification development stages from other multi-canopy stages with very large trees is the presence of higher levels of decadence, such as snags, down coarse woody debris, and epiphytes. Consequently, over the long term, the more intensive biodiversity pathways approach proposed in the Preferred Alternative would likely yield higher riparian function on more of the Riparian land class than Alternatives 1 to 5, but with the trade-off of having potentially less area with large trees in the Riparian land class in the short to mid term. Areas with very large trees would likely achieve full function eventually over time. However, given stand densities within riparian areas and the level of natural or managed disturbance needed for succession through the development stages, Alternatives 1 to 5 may take a very long time to produce substantial amounts of fully functioning riparian forests.

Effects to species associated with wetland habitats would largely depend on changes in the ability of those areas to provide suitable habitat. Changes in water quality or hydrologic regime, for instance, may have negative effects on amphibian species that use wetlands for breeding. Loss of water during spring and summer, when eggs are laid and larvae develop, may eliminate some species from a particular site. On the other hand, a change to year-round standing water may allow the introduction of predators and competitors such as bullfrogs and fish. However, given that the site-specific policy objectives (no net loss of wetlands and protection of wetland functions) control individual silvicultural activities, it is not likely that there would be a material effect on wetland functions.

Section 4.9, Wetlands, addresses the effects of forest management on wetlands and the potential for the Alternatives to affect wetland quality. This discussion is summarized below. The difference in environmental effects to wetlands under all Alternatives would be a function of both the acres of trees harvested and the amount of related activities.

Under all Alternatives, non-forested wetlands would be protected with a no-harvest buffer. Timber harvest in surrounding forests may indirectly affect adjacent habitats by changing microclimatic conditions such as temperature, light, and hydrologic regimes. Some disturbance, localized clearing or loss of wetland acreage, may also occur (though no net loss of wetlands would occur per Forest Resource Plan Policy No. 21). In contrast, thinning (down to 120 square feet of basal area) would be allowed in forested wetlands under all of the Alternatives. Alternatives that result in a proportionally greater amount of harvest within the Riparian land class would have a greater potential for effects to forested wetlands that occur within Riparian Management Zone boundaries.

Table 4.9-1 provides a summary of the average harvest by decade in the riparian and wetland areas for each Alternative. In riparian and wetland areas, Alternative 1 has the lowest level of activities, with an average of about 2 percent of acres disturbed per decade. Therefore, Alternative 1 would have the lowest potential to affect wetlands and riparian areas. This is followed by Alternative 2 with 4 percent per decade, Alternatives 3 and 4 with 5 percent, and Alternative 5 with 7 percent. The Preferred Alternative would have the highest level of harvest-related activities in riparian areas, with an average of 8 percent of acres disturbed per decade, the result of thinning to develop structurally diverse stands. Therefore, the Preferred Alternative would have the highest potential to affect wetlands and riparian areas, followed closely by Alternative 5.

Uncommon Habitats

Under all Action Alternatives, legacy and reserve tree requirements in DNR Procedure 14-006-090 would be replaced with language implementing the protection of large structurally unique trees and snags described in the Habitat Conservation Plan (HCP). The current administrative requirement to retain 7 percent of the pre-harvest trees per acre would remain in place under Alternative 1 (No Action), and would be changed to the HCP's requirement of at least eight trees per acre under the other Alternatives. Procedure 14-006-090 addresses retention of legacy trees in regeneration harvest areas. Thus, although Alternatives 2 through the Preferred Alternative may marginally reduce the number of legacy trees that would be retained in regeneration harvest (assuming most stands selected for regeneration harvest have approximately 120 trees per acre greater than 12 inches diameter at breast height, the size specified in Procedure 14-006-090), they would be expected to result in a similar number of legacy tree retention overall. The Action Alternatives would pose no significant environmental impacts beyond existing conditions and those anticipated in the HCP Environmental Impact Statement (EIS). Further, the proposed change authorizes field foresters to adjust the numbers upwards to reflect local needs.

Retention of biological legacies (snags, down trees, and other woody debris) is an essential component of a management program designed to accelerate forest ecosystem development (Carey et al. 1996). Increased retention of legacy trees would be expected to increase habitat availability for many wildlife species (e.g., marbled murrelet, northern spotted owls, a number of bat species, and cavity-nesting birds such as pileated woodpecker and Vaux's swift) and help accelerate the rate at which structurally complex forest would develop in the planning area.

Of the other uncommon habitats addressed in this analysis, most are non-forested areas such as cliffs, caves, talus fields, and balds (grass- or moss-dominated forest openings), the amount of which is not expected to change in response to timber harvest activities. Oak woodlands are also considered uncommon habitats. The native Oregon white oak is considered a non-commercial tree species, and as such is not included in timber harvest calculations under any of the Alternatives. Effects to uncommon habitats may occur, however, as a result of logging in adjacent commercial forest stands.

DNR procedures provide direction for protecting these habitats where they have been identified. Not all areas have been identified, however, and small patches (e.g., talus patches less than 1 acre, cliffs less than 25 feet high) receive no specific protection. Timber harvest in adjacent stands, therefore, carries the potential risk that personnel or equipment may damage these habitats, or disturb species that rely on them. Timber harvest may also indirectly affect adjacent habitats by changing microclimatic conditions such as temperature, light, and water movement. Road construction may also harm these habitats, although procedures direct DNR to avoid road construction through talus fields and balds where practicable.

The amount of timber harvest anticipated under each Alternative serves as an indicator of the relative risk of potential adverse effects to uncommon habitats. A higher rate of harvest suggests a greater potential risk of damage or disturbance to these habitats and associated species. Table D-4 (Appendix D) summarizes the average harvest per decade under each Alternative. Overall, the greatest area of harvest is anticipated under Alternative 5, followed in descending order by Alternatives 3, 2, 4, the Preferred Alternative, and Alternative 1. The amount of road construction is expected to be similar under all Alternatives. Though different levels of harvest are anticipated on lands adjacent to those containing uncommon habitats, no significant environmental effects beyond those described in the HCP EIS are anticipated under any of the Alternatives when compared with Alternative 1 (No Action).

4.4.4.2 Species of Interest

Northern Spotted Owl

None of the Alternatives, including the Preferred Alternative, propose changes to the northern spotted owl conservation strategy, as outlined in the Habitat Conservation Plan (HCP) on pages IV.1 to IV.19 and IV.86 to IV.106 (DNR 1997). The HCP Environmental Impact Statement (EIS) is incorporated by reference (DNR 1996) and relied on in this Final EIS. In addition, this Final EIS analyzes the Alternatives in light of the new information on northern spotted owl demography discussed in Section 4.4.3 of this chapter. The analysis also includes a comparison of the Alternatives using three criteria:

- changes in the amount of structurally complex forest;
- the amount of timber harvest in areas designated as Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas; and
- changes in the management of northern spotted owl circles.

Based on this analysis, none of the Alternatives is expected to have significant adverse impacts that were not already evaluated in the HCP EIS and agreed to by the Federal Services.

CHANGES IN THE AMOUNT OF NESTING, ROOSTING, FORAGING, AND DISPERSAL HABITAT

As noted above, for this analysis, forested areas classified as structurally complex forest serve as an indicator for nesting, roosting, foraging, and dispersal habitat. A qualitative discussion of the potential for the Alternatives to affect the amount and distribution of structurally complex forest among the Habitat Conservation Plan (HCP) Planning Units is presented in Section 4.4.4.1 above.

Alternatives with less intensive timber harvest would be expected to result in marginally greater amounts of structurally complex forest in the short term, because comparatively few areas that currently provide structurally complex forest would be subject to heavy thinning or regeneration harvest. Results indicate that Alternative 1 (No Action) and Alternative 4 would result in slightly greater overall increases in the amount of structurally complex forest in the short term; however, the Preferred Alternative would produce more structurally complex forest beginning in 2031, particularly in the niche diversification and fully functional stand development stages (see Appendix D, Table D-12). Alternative 5 would result in the smallest short- and long-term increases.

The amount of structurally complex forest in the Olympic Experimental State Forest merits particular attention because this HCP Planning Unit has different management strategies than the other HCP Planning Units. Modeled changes in the amount of structurally complex forest cannot be used to judge whether management goals have been met, but they do allow a comparison of the relative rates at which desired habitat may develop under each Alternative. Alternative 4 would result in the greatest short-term increases in the amount of structurally complex forest in the Olympic Experimental State Forest, exceeding 26 percent of that HCP Planning Unit by 2013. Alternative 5 would provide the fewest number of acres during the same time period with 18 percent of the land base in structurally complex forest. The greatest long-term gains are modeled for Alternative 4, under which structurally complex forest would exceed 29 percent of the area of the Olympic Experimental State Forest by 2067. Alternatives 1, 2, and 3 would produce similar long-term gains at approximately 28 percent, followed by the Preferred Alternative with about 27 percent. Alternative 5 would produce the least amount of structurally complex forest by 2067, with about 16 percent of the Olympic Experimental State Forest HCP Planning Unit (Appendix D, Table D-8).

In Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas, intensive management under the biodiversity pathway approach of the Preferred Alternative would also be expected to result in long-term increases in structurally complex forest. Model results support this expectation. While the six Alternatives differ only slightly in the amount of structurally complex forest in Nesting, Roosting, and Foraging Management Areas in the short term, long-term increases modeled for the Preferred Alternative surpass all other Alternatives (Table 4.4-3). The less-intensive approaches of Alternatives 1 (excluding more areas from timber harvest) and 4 (managing for longer rotation lengths) would result in slightly smaller increases than the Preferred Alternative. Compared to Alternatives 1 and 4, however, the Preferred Alternative would result in

Table 4.4-3. Acres of Structurally Complex Forests in Designated Nesting, Roosting, Foraging, and Dispersal Management Areas in 2067

	Current Conditions	Alternative 1	2	3	4	5	PA
Nesting, Roosting, and Foraging Habitat Areas	53,816	60,218	55,603	55,144	58,158	53,706	64,420
Dispersal Habitat Areas	30,578	30,857	29,262	28,414	32,335	27,694	40,244

Data Source: Model output data – standard development stages.
PA = Preferred Alternative

approximately twice as much niche diversification and fully functional forest stages, the most complex two stand development stages, in designated Nesting, Roosting, and Foraging Management Areas.

In comparison to nesting, roosting, and foraging habitat, dispersal habitat would increase compared to current conditions only under the Preferred Alternative and Alternatives 1 and 4. The development of structurally complex forest in areas that receive little or no timber harvest would be expected to be higher than those Alternatives with more harvest; however, model results indicate that the Preferred Alternative would provide nearly twice as much nesting, roosting, and foraging habitat compared to the other Alternatives. Therefore, biodiversity pathway approaches within Dispersal Management Areas appear to provide higher quality habitat over a larger area (Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas), with a relative increase of 18 percent over the long term (Appendix D, Table D-13).

All six Alternatives would result in a slight short-term decrease in the availability of structurally complex forest within designated Nesting, Roosting, and Foraging Management Areas ranging from 3 percent to 11 percent; however, in the long term, all provide increases except for Alternative 5 (Appendix D, Table D-13). Differences among the Alternatives are small in the short term, ranging from a reduction of 5 to 11 percent.

Alternatives 1 and 4 show decreases of 6 and 5 percent, respectfully, while Alternatives 2, 3, and the Preferred Alternative show reductions of 10 to 11 percent. The Preferred Alternative is the only Alternative that shows an increase, beginning in 2031.

TIMBER HARVEST IN AREAS DESIGNATED AS NESTING, ROOSTING, AND FORAGING MANAGEMENT AREAS

None of the Alternatives would allow activities that would reduce the amount of nesting, roosting, and foraging habitat in below-threshold watersheds. Alternative 1 would be expected to result in the lowest levels of harvest activities in designated Nesting, Roosting, and Foraging Management Areas, and Alternative 5 the most. Model results support this expectation (Table 4.4-4). Alternative 5 would result in the highest level of forest management activity in areas designated as Nesting, Roosting, and Foraging Management Areas, with an average of 16 percent of such areas harvested per decade. Under all of the

Table 4.4-4. Average Percent of Designated Nesting, Roosting, and Foraging Management Areas Harvested under Each Alternative per Decade at Various Harvest Volume Classes, Compared to the Average Harvest Rate in All Areas

	Average Percent of Designated Nesting, Roosting, and Foraging Management Areas by Area Impacted per Decade by Harvest Type				
	Volume Removal Class				
Alternative	**Low-Volume Removal Harvest[1/]**	**Medium-Volume Removal Harvest[2/]**	**High-Volume Removal Harvest[3/]**	**Total**	**Average Percent of Total Forested Trust Lands Harvested per Decade**
1	0%	0%	1%	**1%**	11%
2	3%	2%	7%	**12%**	16%
3	2%	0%	8%	**10%**	17%
4	3%	2%	3%	**8%**	15%
5	7%	2%	7%	**16%**	24%
PA	1%	2%	8%	**11%**	14%

Data Source: Model output data – timber flow levels.
1/ Less than 11 thousand board feet per acre volume harvests
2/ Between 11 and 20 thousand board feet per acre volume harvests
3/ Greater than 20 thousand board feet per acre volume harvests
PA = Preferred Alternative

Alternatives, designated Nesting, Roosting, and Foraging Management Areas would be harvested at a lower rate than the rate for all lands. Alternative 1 is expected to have the least harvest in designated Nesting, Roosting, and Foraging Management Areas.

Alternative 4, with an older average minimum regeneration age and a relatively low rate of harvest overall, results in the second lowest harvest rate in designated Nesting, Roosting, and Foraging Management Areas. Alternatives 2 and 3 result in similar moderate amounts, and Alternative 2 is exceeded only by Alternative 5.

The greatest amount of high-volume removal harvest activity in designated Nesting, Roosting, and Foraging Management Areas would occur under Alternatives 3 and the Preferred Alternative, followed (in descending order) very closely by Alternatives 2 and 5. Alternatives 4 and 1 have the lowest levels of high-volume removal harvests in Nesting, Roosting, and Foraging Management Areas. Notably, the majority of harvest in designated Nesting, Roosting, and Foraging Management Areas under the Preferred Alternative consist of biodiversity thinnings, and would, therefore, be designed to improve habitat conditions, and increase the potential of a stand to becoming nesting, roosting, and foraging habitat sooner.

Effects to Northern Spotted Owl Circles Outside Nesting, Roosting, and Foraging, and Dispersal Management Areas

Under all six Alternatives, habitat within “Memorandum #1” northern spotted owl circles would be released in 2007 for timber harvest consistent with the objectives and strategies of the Habitat Conservation Plan (HCP). This represents no policy change because Memorandum #1 would have released these circles in 2007 (the end of the first decade of implementation of the HCP). Status 1 reproductive circles outside the Olympic Experimental State Forest would also be released in 2007 under Alternatives 3 through 5 and the Preferred Alternative, and would be released in 2004 under Alternative 2. Status 1 reproductive circles in the Olympic Experimental State Forest are not deferred under any of the Alternatives except the No Action. The four northern spotted owl circles in southwest Washington will be released in 2006 under all Alternatives except the No Action. Under Alternative 1 (No Action), timber harvest deferrals in Status 1 reproductive and southwest Washington circles are modeled as long-term deferrals. DNR and the Washington State Department of Fish and Wildlife developed an agreement for managing harvest activities in the four southwest Washington circles. This agreement is scheduled to remain in effect until 2006.

The release of northern spotted owl circles from the various administrative restrictions in 2007 (as it is assumed by the Preferred Alternative) will not automatically result in harvest of all suitable northern spotted owl habitat. Out of the entire area of the northern spotted owl circles that overlap with forested trust lands in the five Westside HCP Planning Units and the Olympic Experimental State Forest (296,200 acres):

1. DNR would entirely protect about 83,200 acres as part of the long-term deferral. This means they would not be harvested over the term of the HCP.
2. Out of the remaining 213,000 acres that are not deferred, 74,000 acres would be under restrictions that apply to riparian zones and wetlands, and 94,300 acres would be under restrictions that apply to Uplands with Specific Objectives (e.g., Nesting, Roosting, Foraging, and Dispersal Management Areas, unstable slopes, etc.). These restrictions would result in full or partial retention of northern spotted owl habitat.

Therefore, approximately 44,700 acres within the released northern spotted owl circles would be available for regeneration harvest once the above-mentioned northern spotted owl circles are released (Figure 4.4-4). The general harvest restrictions apply for these acres (leave trees retention, wind buffers, etc.).

Consequently, DNR is currently far below the level of harvest that was anticipated by the 1997 HCP for the first decade of its implementation. Cumulatively, through 2007, harvest levels will be lower than the levels evaluated in the HCP Biological Opinion.

WORST-CASE ANALYSIS – NORTHERN SPOTTED OWL

The Habitat Conservation Plan (HCP) Draft Environmental Impact Statement (EIS) analyses conducted in 1996 used two main variables to assess the level of take and to project the future recovery of the subspecies on forested trust lands—the annual population rate of change and the extent of improvement of owl habitat on federal lands. The initial expectations in the HCP and the Northwest Forest Plan were that the northern spotted owl populations would decline during the initial decades of the each plan’s implementation, after which the populations would eventually stabilize at a new equilibrium level as the

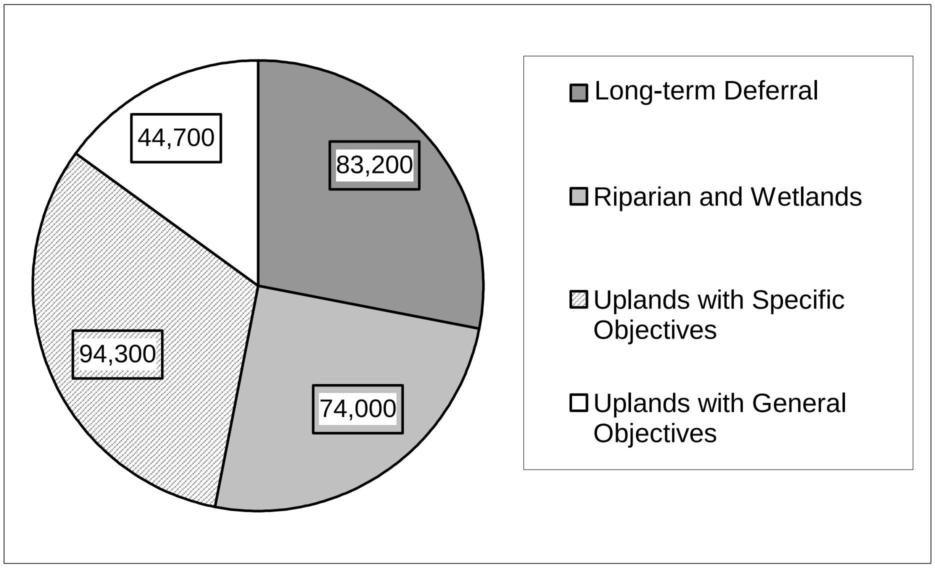

Figure 4.4-4. Projected Distribution of the Forested Trust Lands by Land Class and Deferral within Owl Circles that Would be Released from Protection Prior to 2007

habitat in northern spotted owl conservation areas developed. The most recent information on the northern spotted owl population trends (Anthony et al. 2004) shows a more accelerated decline in population numbers in the state of Washington than expected. At the same time, there is no consensus among the scientists about the major causes of this accelerated decline, and there are no data on the exact degree of northern spotted owl habitat improvement on federal lands.

Thus, the question in light of this worse-than-expected population decline is whether the Alternatives remain within the range of impacts previously studied when the DNR adopted

its HCP, and if not, what additional impacts may result from the Alternatives. Resolving this question with scientific certainty is not possible, due to the lack of information about the causes of the accelerated decline and the status of northern spotted owl habitat on federal lands. It is not possible for DNR to obtain the information that may solve the existing scientific uncertainty because:

1. The analysis of the causes of population decline could not be conducted solely by DNR because of the small segment of the population occurring on forested trust lands. This type of analysis should consider the entire population in Washington State and involve all land ownerships.

2. The data on the northern spotted owl habitat improvement on federal lands are supposed to be provided as part of the Northern Spotted Owl Effectiveness Monitoring Program for the Northwest Forest Plan (Lint et al. 1999). The habitat map development and evaluation has been initiated, but there are still no available results for the

Washington physiographic provinces (Lint et al. 2004). It is also not reasonable to wait for the release of the U.S. Fish and Wildlife Service 5-year review of the spotted owl status, which is scheduled for the end of 2004, because although it is expected to provide more information on the potential reasons for the population decline, it is unlikely that the report will analyze directly whether the relative significance of non-federal lands' contribution, and particularly the relative significance of DNR-managed forested trust lands to northern spotted owl conservation, has changed. This information would be relevant in determining whether the analysis in the HCP and its EIS remains an accurate assessment of environmental impacts to the northern spotted owl, in the face of the new information on the rate of population decline.

Because of the lack of sufficient information to allow us to assess the level of impacts of the Alternatives on the northern spotted owl, and following the requirements of the State Environmental Policy Act rules on dealing with scientific uncertainty, a worst-case analysis is presented below. The following elements of the worst-case scenario are analyzed individually in terms of likelihood to occur, and together for severity of the threat they represent today.

1. Assume that northern spotted owl habitat loss is the major cause of the northern spotted owl population decline.

This was the major threat in the past and the primary reason to list the subspecies in 1990. Currently, with the establishment of system of protected areas under the Northwest Forest Plan, the implementation of the Forest Practices rules, and the habitat protection provided by DNR's and several other HCPs, it is unlikely that this is the major reason for population decline. However, limited habitat resulting from the aggressive harvests in 1970s and 1980s continues to be a significant problem.

Current studies on the barred owl invasion suggest that barred owls may be the major cause for the northern spotted owls' recent population decline (Gremel 2001, 2003; Forsman et al. 2003; Kelly et al. 2003; Lint et al. 2003; Pearson and Livezey 2003). In the last few years, barred owl detections have increased rapidly in the Pacific Northwest, with the major threat that barred owls may be out-competing northern spotted owls for limited resources (e.g., prey, habitat). Direct encounters and hybridization are considered relatively rare events (Hamer et al. 1994; Kelly et al. 2003) and therefore minor threats at this time. Pearson and Livezey (2003) stated that northern spotted owl site occupancy appeared to be more affected by the presence of barred owls than by land management allocations; however, they suspect that the human-caused loss of old forest might reduce the ability of northern spotted owls to compete successfully with barred owls.

2. Assume that the northern spotted owl habitat on federal lands did not improve in the last decade.

This is highly unlikely. According to the recent data from Bureau of Land Management and U.S. Fish and Wildlife Service (Bown 2004; Cadwell 2004), the amount of reserved land is greater than in 1994 and the federal timber harvest has been lower than anticipated in the Northwest Forest Plan. The percentage of habitat removal due to land management was 2.11 percent, and the removal due to natural disturbance was 3.03 percent for the period 1994 to 2003 (Bown 2004). Additionally, the U.S. Fish and Wildlife Service estimated that 600,000 acres of late-successional forest developed per decade, although this is not necessarily northern spotted owl habitat (Bown 2004).

The role of the federal lands is crucial for the persistence and recovery of the subspecies. Although the Recovery Plan for the Northern Spotted Owl recommended involvement of federal, state, and private sectors as the most effective approach, it placed strong emphasis on the need for appropriate federal land management as a basis for recovery (USDI 1992).

Even if the above worst-case scenarios proved to be true, the Alternatives proposed, including those that revise Procedure 14-004-120, are highly unlikely to have greater adverse impacts to northern spotted owl populations than those evaluated in the HCP. The forested trust lands currently support only the sink sub-populations, and are likely to continue to support only sink sub-populations at least into the next decade. Given the amount, quality, and fragmentation (primarily as a result of current DNR land ownership patterns) of northern spotted owl habitat on forested trust lands, it is reasonable to assume, that the recent northern spotted owl population trend on forested trust lands is similar to or worse than the trend on federal land (HCP Draft EIS, DNR 1996; data from the DNR internal annual monitoring reports for the Olympic Experimental State Forest and Eastside HCP Planning Units; personal communications from Scott Horton and Eric Forsman, for the Olympic Experimental State Forest and the Westside HCP Planning Units). DNR continues to have very limited ability to contribute to the demographic support for the northern spotted owl populations on federal lands. This is especially true for lands outside of Nesting, Roosting, Foraging, and Dispersal Management Areas under the HCP, where the DNR's HCP strategy was never to preserve individual northern spotted owl site centers that are long distances from federal lands. The primary means of providing demographic support continues to be through the Nesting, Roosting, Foraging, and Dispersal Management Area conservation commitments under the DNR's HCP.

The HCP Draft EIS concluded that the primary means of benefiting the northern spotted owl recovery would be through the development of sufficient amount and quality of nesting, roosting, foraging, and dispersal habitat in the designated habitat management areas. The removal of the northern spotted owl habitat *outside* the designated management areas was included in the analyses for take of northern spotted owls (HCP EIS, DNR 1996). The HCP's Biological Opinion (USDI 1997) assumed that all suitable habitat in the owl circles outside of the Nesting, Roosting, Foraging, and Dispersal Management Areas would be harvested within the first decade of the HCP. The severity of the threat as a result of harvesting outside designated northern spotted owl nesting, roosting, foraging, and dispersal habitat was assessed and accepted by the Federal Services. Risks associated with the loss of reproductive northern spotted owls outside those northern spotted owl management areas were considered acceptable in light of gains in long-term habitat availability; these risks were not anticipated to jeopardize the continued existence of northern spotted owls. Hence, the northern spotted owl circles outside Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas were not anticipated to contribute to the recovery of the species. Recently, facing the more rapid decline in population numbers on federal land and state lands, it is even less likely that they will provide demographic support because of the following reasons: 1) they are least likely to remain occupied compared to the larger contiguous blocks of protected habitat in the Nesting, Roosting, and Foraging Management Areas and the Dispersal Management Areas, and 2) the circles that remain occupied become even more isolated due to the decreased density of the northern spotted owl population.

The primary contribution of forested trust lands to the northern spotted owl conservation effort comes through the protection and/or development of suitable habitat in the designated Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas. The HCP has a landscape-level focus on population dynamics, rather than relying on the protection of individual northern spotted owls. Currently, the Nesting, Roosting, and Foraging Management Areas are most likely to also support only the sink sub-populations, because of the low numbers of northern spotted owls in these areas, and the fact that in most of the Nesting, Roosting, and Foraging Management Areas, the functional northern spotted owl habitat has not yet achieved the targeted levels. The Nesting, Roosting, and Foraging Management Areas are intended to provide demographic support to the federal populations in the long term (Biological Opinion, p.63).

Alternatives 1 and 4 consider only habitat enhancement activities in the non-habitat portion of the designated habitat. Alternatives 1 and 4 have a passive management approach whereby thinnings in the non-habitat portion are traditional, i.e. the thinnings typically remove smaller trees and leave approximately 70 percent of the stands after harvest (see Chapter 2, Section 2.6.3.4). This management would result in development of structurally complex forest through natural succession in the non-habitat portion. It would also result in stands remaining in the competitive exclusion stage longer in the non-habitat portion. Alternative 4 is very similar, with the exception of proposed longer rotations in the non-habitat portion that would result in older but still even-aged stands. Alternatives 2, 3, and 5 would implement more harvest activities in the non-habitat portion, meaning they include traditional thinnings and regeneration harvests. The Preferred Alternative includes a management approach for designated Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas in the form of variable density thinnings in alternating rotations of 100 to 140 and 50 to 70 years (see Chapter 2, Section 2.6.3.4). In the long term, this would result in significantly greater amounts of structurally complex forest than would result from passive management (see Table 4.4-3). Even though the structurally complex forest does not directly correspond to nesting, roosting, and foraging habitat, the increase correlates to the amount and quality of nesting, roosting, foraging, and dispersal habitat. Consequently, this type of management would have the most positive influence on the creation of functional nesting, roosting, foraging, and dispersal habitat in the designated management areas, and thus be most beneficial to the northern spotted owl conservation in the long term.

Marbled Murrelet

The analyses for the Final Environmental Impact Statement (EIS) do not attempt to assess site-specific management, but rather are designed to support broad policy level decision-making for western Washington by Habitat Conservation Plan (HCP) Planning Unit. Table B.2.6-1 in Appendix B lists the land deferrals for marbled murrelet management; however, it is not intended as a policy position for murrelet management, but is meant to show a summary of the assumptions related to these deferrals. Under the 1997 HCP, DNR committed to the development of a long-term conservation strategy for marbled murrelet habitat as part of a five-step process (DNR 1997, pp IV.39-45). In the interim, until inventory surveys are completed, the DNR defers timber harvest activities in all unsurveyed reclassified marbled murrelet habitat on western Washington forested state trust lands.

Schedules for deferral and release of marbled murrelet habitat were used to make assumptions for the range of Alternatives; however, it is presumed that all habitat provisions will remain until a long-term strategy is in place. Marbled murrelet habitat management would be determined through a long-term conservation strategy developed by DNR's scientific staff working in collaboration with the Federal Services, Washington Department of Fish and Wildlife, and other scientific specialists. Once the long-term strategy is developed, its implementation and possible effects on the sustainable harvest level will be examined.

All Alternatives are consistent with implementation of the HCP conservation strategy for marbled murrelets. The variables are the amount of structurally complex forest (the habitat most likely to provide suitable nesting habitat) on western Washington forested state trust lands and timing of when such habitat would appear on the landscape. Section 4.4.4.1 provides a qualitative assessment of the potential for the Alternatives to affect the quantity and distribution of structurally complex forest on forested trust lands. In the short term, Alternatives 1 and 4 are expected to maintain slightly greater amounts of structurally complex forest on forested trust lands than the other Alternatives, and Alternative 5 the least. However, the differences between Alternatives are initially small because it takes time and or active stand management for structurally complex forest to develop. In the long term, structurally complex forest is expected to increase over current levels for all Alternatives except Alternative 5, which is projected to show a small decline. The Preferred Alternative is projected to have the largest percentage of structurally complex forest, 29 percent of the land base, followed by Alternatives 1 and 4 with 27, Alternative 2 with 26, Alternative 3 with 25, and Alternative 5 with 23 (Figure 4.2-4 and Appendix D, Table D-12). Of particular note, more than one-third of structurally complex forests under the Preferred Alternative, or 10 percent of the landbase, is expected to develop into either niche diversification or fully functional forest by 2067. That is a large improvement over current conditions and represents more than twice the improvement in the forest development in those stages as seen in any of the other Alternatives.

The amount of structurally complex forest habitat within 40 miles of marine waters is of particular concern, because the great majority of known marbled murrelet nest sites occur within this distance band (U.S. Fish and Wildlife Service 1997). Appendix D, Table D-16, presents the results of this analysis. In keeping with general trends among the Alternatives across the land base, structurally complex forests increase by 2067 for the Alternatives, except Alternatives 3 and 5. The Preferred Alternative shows the greatest gains in structurally complex forest, with Alternatives 4, 1, and 2 showing slightly lesser gains, in that order (Appendix D, Table D-14).

Other Threatened, Endangered, and Sensitive Species

Other than the northern spotted owl and legacy and reserve tree procedures, none of the Alternatives proposes changes in the policies or procedures that directly address threatened, endangered, and sensitive species. Therefore, differences among the Alternatives would arise from differences in the amount or quality of the habitats with which these species are associated. The availability of such habitats is not expected to change in response to timber harvest activities, but habitat quality can be affected by the harvest of adjacent stands. Harvest activities in adjoining forest stands may affect species viability by flushing adults from nests or dens and leaving the young exposed to an increased risk of predation or starvation.

Analysis of effects to most other species of management concern focuses on the differences in the amount of timber harvest modeled under each Alternative, and the potential effects to the habitats with which they are associated, within the Habitat Conservation Plan (HCP) Planning Units where the species may occur. Greater detail about effects to species associated with structurally complex forest, riparian, wetland, and uncommon habitats can be found in Section 4.4.4.1. Table 4.4-5 lists the criteria by which effects of the Alternatives were evaluated for each species (evaluation criteria are based on the habitat associations and distribution information in Appendix D, Table D-11), and ranks the Alternatives with respect to these criteria. Alternatives with the least potential to result in adverse effects are listed first, followed by those with increasing potential for adverse effects.

Two species, Pacific fisher and Canada lynx, receive additional discussion below. In the case of the lynx, only a few watersheds in the North Puget HCP Planning Unit contain suitable habitat.

Pacific fishers are associated with structurally complex forest, particularly at low elevations. Timber harvest that reduces canopy cover and the availability of large snags and coarse woody debris may decrease the potential for a landscape to support this species

Table 4.4-5. Criteria for Evaluation of the Effects to Threatened, Endangered, and Sensitive Species Other Than Northern Spotted Owl and Marbled Murrelet

Species	Evaluation Criteria [1/] (HCP Planning Units Where Effects May Occur)	Relative Ranking by Alternative[2/]
Mardon Skipper	Effects to uncommon habitats (South Puget and South Coast)	1 4 3 2 PA 5
Oregon Silverspot Butterfly	Effects to uncommon habitats (South Coast)	1 4 2 3 PA 5
Larch Mountain Salamander	(a) Effects to uncommon habitats (b) Amount of structurally complex forest in 2013 (North Puget, South Puget, and Columbia)	(a) 1 4 2 3 PA 5 (b) 1 4 2 3 PA 5
Oregon Spotted Frog	Effects to wetlands (South Puget and Columbia)	1 4 2 3 5 PA
Western Pond Turtle	Effects to wetlands (North Puget, South Puget, Columbia, and South Coast)	1 4 2 3 5 PA
Common Loon	Amount of timber harvest (all HCP Planning Units except Columbia)	1 4 2 3 PA 5
Aleutian Canada Goose	Effects to wetlands (North Puget, South Puget, Columbia, and South Coast)	1 PA 4 2 3 5
Bald Eagle	Amount of structurally complex forest, (a) short-term and (b) long-term (all HCP Planning Units)	(a) 4 1 2 3 PA 5 (b) PA 4 1 2 3 5
Peregrine Falcon	(a) Amount of timber harvest activity; (b) effects to wetlands (all HCP Planning Units)	(a) 1 4 2 3 5 PA (b) 1 PA 4 2 3 5
Sandhill Crane	Effects to wetlands (Columbia)	1 4 2 3 5 PA
Western Gray Squirrel	Amount of timber harvest (South Puget and Columbia)	PA 1 2 3 4 5
Gray Wolf	Amount of timber harvest (North Puget, South Puget, and Columbia)	1 PA 2 4 3 5
Grizzly Bear	Amount of timber harvest (North Puget and South Puget)	1 4 3 2 5 PA
Pacific Fisher	Amount of structurally complex forest in low-elevation watersheds [3/5/]	PA 3 1 2 4 5
Canada Lynx	Harvest activity in high-elevation watersheds[4/5/] (North Puget, South Puget, and Columbia)	PA 5 2 3 4 1
Columbian White-Tailed Deer	Effects to riparian areas (Columbia)	1 4 2 3 5 PA

Notes:
[1/] See Appendix D, Table D-11 for the habitat association and distribution information that serves as the basis for these evaluation criteria.
[2/] Alternatives with the least potential to result in adverse effects are listed first, followed by those with increasing potential for adverse effects.
[3/] Defined as watersheds where >50% of forested trust lands are in the western hemlock or sitka spruce vegetation zones.
[4/] Defined as watersheds where >1% of forested trust lands are in the alpine or parkland vegetation zone, and >30% are in any combination of the parkland, mountain hemlock, and Pacific silver fir zones.
[5/] The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.
PA= Preferred Alternative
Data Source: Model output data – stand development stages.

(Lewis and Stinson 1998). In western Washington, most low-elevation forest falls in the western hemlock or Sitka spruce potential vegetation zones, which are also the most productive zones for timber (see Section 4.2 for a discussion of vegetation zones). None of the Alternatives contains any specific provisions for the protection of low-elevation forest, and most would be expected to emphasize timber production from these areas; however, extensive acreage is dedicated to conservation benefits or other resource protection

objectives that provide direct and indirect benefits to a number of species. The amount of forest management activities may potentially be offset by the relatively faster development of structurally complex forest in these more productive areas. The rate and amount would vary by Alternatives. Model results support this assumption, predicting greater increases in the availability of structurally complex forest in low-elevation areas compared to overall (Appendix D, Table D-15).

An analysis of the net change in the availability of structurally complex forest in watersheds that are dominated by low-elevation vegetation shows a pattern similar to that modeled for structurally complex forest overall (Appendix D, Table D-14 and D-15; compare to Appendix D, Table D-12). In both analyses, increases from current conditions result in all time periods under all Alternatives, with the greatest short- term increases anticipated under Alternatives 1 and 4, and greatest long-term increase occurring under the Preferred Alternative.

No significant impacts beyond the effects anticipated in the HCP Environmental Impact Statement (EIS) or the Forest Practices EIS are expected to low-elevation structurally complex forests, or by association, Pacific fisher and its habitat. Canada lynx are associated with high-elevation areas in the state of Washington. Most western Washington forested state trust lands are in lower elevation areas; only 10 watersheds (all in the North Puget HCP Planning Unit) meet the criterion of at least 1 percent of forested trust lands in the alpine or parkland zone. Additionally, these watersheds contain some area in mountain hemlock and/or Pacific silver fir zones. Dense, young forest with abundant understory is primary habitat for the Canada lynx's main prey—the snowshoe hare—and thus provides foraging habitat for the lynx; therefore, timber harvest, especially thinnings within competitive exclusion stands, in watersheds in high-elevation areas would likely create greater numbers of young forest stands and may improve foraging opportunities in some areas where forage is lacking for the Canada lynx. Snowshoe hare prefer the dense cover of coniferous and mixed forests; abundant understory cover is important. Coniferous swamps and second-growth areas that are adjacent to mature forests, and alder fens and conifer bogs, are also utilized.

Any benefits of providing additional forage habitat may be offset by disturbance to these animals during harvest activities (of particular concern if lynx are breeding in the vicinity), and possible reductions in the availability of down woody debris, which provides cover and denning sites. Model results (Appendix D, Table D-17) indicate that the greatest amount of timber harvest in high-elevation watersheds is anticipated under Alternative 5, followed in descending order by Alternatives 3, 2, 4, Preferred Alternative, and Alternative 1. The proportion of forested trust land harvested in these watersheds per decade ranges from 3.6 percent (Alternative 1) to 5.6 percent (Alternative 5), well below the proportions modeled for all forested trust lands (see Table 4.9-1). No significant adverse impacts are therefore anticipated to Canada lynx under Alternatives 2 through 5 and the Preferred Alternative relative to Alternative 1 (No Action).

Deer and Elk

Effects of the Alternatives on deer and elk can be evaluated by comparing the number of watersheds in which the amount of deer and elk foraging habitat on forested trust lands is between 30 and 60 percent of the total forested trust lands. This proportion of foraging habitat ensures ample foraging opportunities for these species, without compromising the availability of densely forested areas that provide cover. For this analysis, ecosystem initiation forest and structurally complex forest are considered to provide foraging habitat. Currently, the majority of forested trust lands are in competitive exclusion forest that does not provide foraging habitat. Thus, Alternatives that result in the greatest amount of open or structurally complex forest—or both—would be expected to provide the greatest improvements in habitat conditions for these species. Estimated proportions of western Washington forested state trust lands comprised of structurally complex forest increase over time under all Alternatives (Appendix D, Table D-12). The Preferred Alternative is anticipated to result in 29 percent of the landscape converting to structurally complex forest by 2067.

In the short term, most Alternatives would reduce the number of watersheds in which foraging habitat is between 30 and 60 percent. However, through 2067, all Alternatives show an increase in the number of watersheds providing suitable foraging habitat (Table 4.4-6). Alternative 4, followed by the Preferred Alternative would result in the greatest improvements.

Alternative 4, which employs a more passive management approach to resource protection, results in the smallest increase in 2013, likely associated with the decrease in the amount of ecosystem initiation forest. Alternatives 2, 3, and 5 result in smaller increases that are through 2013, while the largest short-term increase is modeled as occurring under the Preferred Alternative.

By 2067, the nominal duration of the Habitat Conservation Plan, Alternative 4 would result in the greatest increase in the number of watersheds with 30 to 60 percent foraging habitat, followed in descending order by the Preferred Alternative, and Alternatives, 3, 2, 1, and 5 (Table 4.4-6). Despite differences in the amount of deer and elk foraging habitat created, significant environmental impacts beyond existing conditions are not anticipated in any of the six Alternatives. With the exception of Alternative 5, all projected gains in foraging habitat for deer and elk for all other Alternatives are comparable or greater than those projected for Alternative 1 (No Action).

Table 4.4-6. Change Over Time Relative to the Current (2004) Number of Watersheds[1/] in which 30 to 60 Percent of Forested Trust Lands Would Provide Deer and Elk Foraging Habitat, under Each Alternative

	Change In Number of Watersheds With 30% to 60% Forage		
Alternative	**Year 2013**	**Year 2031**	**Year 2067**
1	-13	-21	20
2	-9	-1	19
3	1	1	22
4	-22	-2	29
5	-14	1	10
Preferred Alternative	7	7	23

Data Source: Model output data – stand development stages.
[1/] The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations, and percent totals are based on the total acres of forested trust lands per WAU.

4.5 AIR QUALITY

4.5.1 Summary of Effects

This section analyzes the environmental effects on air quality. The analysis examines the effects of prospective changes to current policy and procedures, and uses the modeling outputs to inform the public and decision-makers of the relative differences in potential environmental impacts. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

None of the proposed Alternatives would create new policies or procedures related to air quality. Impacts related to air quality would result from the projected forest management activities associated with each of the Alternatives.

The Alternatives differ slightly in their effects to air quality, but none of the Alternatives has the potential for significant environmental impacts relative to current conditions, beyond those anticipated in the Habitat Conservation Plan (HCP) Environmental Impact Statement (EIS). Air pollution from dust would be mitigated by dust abatement measures under all Alternatives, and the total amount of prescribed burning would likely continue to be below the level anticipated in the HCP.

4.5.2 Affected Environment

Air quality is regulated by the federal Clean Air Act, which requires the U.S. Environmental Protection Agency to set national ambient air quality standards for pollutants considered harmful to public health and the environment. “Ambient air” refers to that portion of the atmosphere, external to buildings, to which the general public has access. An air quality standard establishes values for maximum acceptable concentration, exposure time, and frequency of occurrence of one or more air contaminants in the ambient air. Ambient air quality standards have been set for six principal pollutants: carbon monoxide, nitrogen dioxide, ozone, lead, particulate matter, and sulfur dioxide.

Prescribed burning on forestland is regulated by DNR’s Resource Protection Division, which requires a permit for burning. DNR’s smoke management plan provides regulatory direction, operating procedures, and information regarding the management of smoke and fuels on the forestlands of Washington. The plan coordinates and facilitates the statewide regulation of prescribed burning on forested trust lands, as well as on federally managed forestlands and participating tribal lands. The plan is designed to meet the requirements of the Washington State Clean Air Act.

Other activities on DNR-managed forested trust lands that may affect air quality are regulated by regional agencies responsible for enforcing air quality laws in Washington. These agencies regulate a wide range of air pollution sources. They also monitor air quality.

The main sources of air pollution in western Washington include motor vehicles (55 percent), industrial (13 percent), and wood stoves (9 percent). Approximately 4 percent is generated from outdoor burning, a portion of which comes from forest management activities (Washington State Department of Ecology 2003). Air quality in western

Washington is generally good or moderate, although some areas do not meet federal standards on some days. Air quality has improved greatly since 1987, when Washington violated air quality standards on 150 days. This figure dropped to 7 in 1999 (Washington State Department of Ecology 2003).

4.5.2.1 Silvicultural Burning

Broadcast burning is the practice of burning logging slash scattered throughout a recently harvested unit to prepare the site for planting and/or to reduce dangerous fuel loads. Between 1997 and 2002, approximately 15 acres of DNR-managed forested trust lands were broadcast-burned each year to reduce slash, considerably less than the 500 to 1,000 acres anticipated in the Habitat Conservation Plan (HCP) Environmental Impact Statement (EIS) (DNR 1996).

During this same period, approximately 269 acres per year of pile burning took place. This is the practice of reducing logging slash by collecting the slash in piles and burning the piles. By burning under wetter conditions, usually in the spring, fewer particulates are emitted than would be the case if the same fuels burned in a wildfire. Particulate emissions from wildfires are, on average, three to four times higher than from prescribed burning (DNR 1996). Wildfire risk is discussed in Section 4.2 (Forest Structure and Vegetation).

4.5.2.2 Air-Borne Dust

The use of logging roads during dry periods generates air-borne dust. Air-borne dust is regulated through road maintenance standards of the Washington Forest Practices Board (Washington Administrative Code 222-24) and safety standards of the Washington Department of Labor and Industries (Washington Administrative Code 296-54). The amount of air-borne dust is a function of road use and surfacing material. Gravel can reduce dust (Washington State Department of Ecology 2001), as can water and chemical dust (DNR 1996) suppressants. In general, the adverse effects of air-borne dust are localized and short term (DNR 1996).

4.5.2.3 Forestland and Air Quality

One of the ecological benefits of forested trust lands is the enhancement of air quality. Plants enhance air quality by emitting oxygen and consuming carbon dioxide, the gas most associated with global warming. (see Section 4.2 for a discussion of the carbon cycle and carbon sequestration.) In addition, trees retard the spread of air-borne particulates by trapping the material on their leaf surfaces and by slowing the wind speed to the point that particulates cannot remain suspended. Timber-harvesting temporarily removes the air quality benefits provided by trees (DNR 1996).

4.5.3 Environmental Effects

Impacts related to air quality would be minor under all Alternatives. Traffic on dirt roads would add dust to the air, and prescribed burning and wildfires would add smoke. The dust and smoke could produce eye and respiratory discomfort to people working, living, or recreating in the area. Smoke, especially from wildfires, could adversely affect air quality over a wide area, which could include urban areas.

Alternative 3 is projected to harvest more timber than the other Alternatives, followed by Alternatives 5, 2, the Preferred Alternative, and Alternatives 1 and 4, in that order. Alternative 3 is projected to harvest more in some decades than Alternatives 2, 5, and the Preferred Alternative and less in other decades, but the overall level is higher (refer to Figure 4.2-1). Alternatives 1 and 4 would harvest the least amount of timber in all decades. Harvest activity is likely to result in more traffic by log trucks and vehicles driven by other forest workers. Alternative 3 would, therefore, have a greater potential to generate dust than the other Alternatives. Alternatives 1 and 4 are projected to have the lowest harvest levels over the planning period, and would, therefore, have a lower potential to generate dust. Alternatives 2 and 5 and the Preferred Alternative are intermediate. Air pollution from dust would be mitigated by dust abatement measures under all Alternatives.

The use of prescribed burning to prepare a site for planting is projected to be similar to current levels under all of the Alternatives. It is likely to be slightly lower under Alternatives 1, 4, and the Preferred Alternative and slightly higher under Alternatives 2, 3, and 5. Any burning would be regulated by the Washington State Smoke Management Plan. Few or no additional adverse effects on air quality are anticipated to result from prescribed burning for site preparation under any of the proposed Alternatives. Policy No. 10 of the Forest Resource Plan directs DNR to take preventive measures to reduce extreme fire hazards on forested trust lands. This is not anticipated to result in many acres of prescribed burning on the westside due to cool and wet weather patterns that generally prevail. The sum of all prescribed burning is likely to continue to be far below the level anticipated in the Habitat Conservation Plan regardless of which Alternative is selected.

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4.6 GEOMORPHOLOGY, SOILS, AND SEDIMENT

4.6.1 Summary of Effects

This section analyzes the environmental effects on geomorphology, soils, and sediment. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

Significant increases in landslide frequency or severity and loss of soil productivity relative to current conditions, beyond those anticipated in the Habitat Conservation Plan (HCP) Environmental Impact Statement (EIS), are not anticipated under any of the Alternatives. Increased soil erosion may occur in certain intensely managed areas as road use increases. Further discussion of relative impacts among the HCP Planning Units and for individual watersheds is included in Cumulative Effects (Section 4.15). The Alternatives are ranked according to percent of uplands impacted per decade by intensity of harvest type (Table 4.6-8). By this ranking, Alternative 5 carries the highest potential overall relative impact, followed by Alternatives 2, 3, the Preferred Alternative, 4, and 1.

The public comments requested that the Final EIS review the differences between Alternatives with regard to forest roads. Section 4.6 presents information relevant to road impacts. In general, it is not expected that the number of road miles or road density will vary as a result of the implementation of any of the proposed Alternatives. While the Final EIS Alternatives propose different harvest timings and locations, the basic road network statewide will evolve to the end condition, over time, virtually independent of which Alternative is chosen. Road-spacing is mostly dependent on topography. Topography drives the type of logging system used to achieve the desired silvicultural objectives, which in turn dictates optimal yarding distance to road-spacing combinations. This is illustrated by Table 4.6-3, Road Density by Deferral Class under the Preferred Alternative in 2004. The table shows that there are small differences between road density in areas that would be deferred from harvest under the Preferred Alternative and the areas that would allow activity.

Road impacts for all the Alternatives should be well within the range anticipated by the HCP due to the relationship to the total acres harvested. As indicated in Table 4.6-4, harvest levels in each of activity types for each of the Alternatives are within those expected under the HCP and analyzed in the HCP Draft and Final EIS. The HCP Draft EIS (DNR 1996) analyzes effects related to sediment (p. 4-163) and stream flow (p. 4-170). Mitigation in the form of Riparian Management Zones, management for hydrologically mature forest in the significant rain-on-snow zones, wetland protection, and road management planning (identified above) are detailed in those sections.

The Washington Forest Practices Rules Final EIS (DNR 2001) also presents an analysis of the effects of sediment, peak flows, roads in riparian areas and wetlands on water quality and on fish. A discussion of sediment is contained in Section 3.2 (p. 3-7), which discusses road surface erosion and road-related landslides. The evaluation of the Alternatives in this analysis offers the 2001 rules package that provides measures necessary to address impacts due to road-related sedimentation (p. 3-16). These mitigation measures include implementation of road maintenance and abandonment plans and the adaptive management program. In addition, Appendix F in the Final EIS for the Forest Practices Rules discusses the effects of road construction and maintenance and describes recommended and accepted practices for building and maintaining roads. It states that, "Roads built following Forest Practices Rules that provide specific direction and recommended Best Management Practices (BMPs) from the literature have the lowest risk of causing sediment delivery" (p. F-2). As stated above, all of the Alternatives will meet the requirements as specified in the Forest Practices Rules.

4.6.2 Introduction

Geomorphology, soils, and sediment in western Washington are products of interactions among the geology, climate, and ecosystems. Timber harvest can have environmental effects on these systems. Issues related to geomorphology, soils, and sediment identified during scoping include sediment movement and soil productivity. Evaluation of sediment movement and deposition is important to understand the potential ecological impacts. Sediment, if delivered to streams can result in adverse effects to fish and aquatic habitat, and loss of soil productivity in both upland and riparian areas. Sediment movement can be increased beyond background levels as a result of forest management activities, including timber harvest and road-building and use.

As discussed in Forest Practices Rules Final Environmental Impact Statement (EIS), Section 3 (Washington Forest Practices Board 2001), mass wasting, or the gravity-induced down-slope movement of loose soil and rock, may deliver large volumes of sediment to streams. This may result in pool filling and loss of rearing habitat for fish. Surface erosion also delivers sediment to streams, which may result in degradation of spawning habitat.

Soil is an important resource because it provides the medium for the growth of trees and other vegetation, and is a key factor in the productivity of forests.

Effects on mass wasting, surface erosion, and soil productivity are examined in this section through the comparison of current conditions and environmental sensitivities to relative projected harvest levels among the six Alternatives.

4.6.3 Affected Environment

The following descriptions of the affected environment with respect to mass wasting, surface erosion, and soil productivity were synthesized largely from information presented in the 1997 Habitat Conservation Plan (HCP) (DNR 1997) and the 2001 Forest Practices Rules Environmental Impact Statement (EIS) (Washington Forest Practices Board 2001). These were supplemented with peer-reviewed references and data generated from the Alternatives modeling analysis. DNR evaluates slope stability and other geomorphologic interactions during site-specific timber sale design. A significant part of the evaluation is the use of the expanded Environmental Checklist (see Section 4.15, Cumulative Effects), which adds approximately 100 additional questions to the original checklist. These questions focus on environmental issues associated with forest management. An understanding of interactions among geology, climate, and ecosystems can lead to balanced actions that minimize significant adverse environmental impacts. Characterizing landforms and ecosystem processes, both biotic and abiotic, increases conservation benefits while meeting fiduciary responsibilities.

A number of processes are important in understanding the potential for significant adverse environmental impacts. These include mass wasting, surface erosion, and changes in soil productivity, which are discussed below.

4.6.3.1 Mass Wasting

Management activities that potentially increase the risk of mass wasting include road building and timber harvest (Washington Forest Practices Board 2001). Careful harvest and road planning can reduce the risk of mass wasting due to management activities and its effects. Sediment produced as a result of forest management activities can be delivered to the aquatic system from episodic landslides initiated and adjacent to harvested areas.

Mass wasting events provide episodic sources of fine and coarse sediment and organic debris to the aquatic systems in western Washington. Various types of landslide detachments and processes can be considered mass wasting. Some are deep-seated, in which most of the area of the slide plane or zone lies beneath the maximum rooting depth of forest trees, sometimes to depths of tens or hundreds of feet. Others are shallow-rapid, in which the landslide plane or zone is within the maximum rooting depth of forest trees. Further distinctions can be made based on the failure mechanism and composition of the resulting mass wasting event or landslide.

Landslides are the result of failure of the cohesive and frictional strength of the slope material (e.g., vegetation, soil, subsurface deposits). This loss of material strength can be caused by a variety of factors, including loss of root strength, increased pore-water pressure, or inherently low shear strength of subsurface materials. Slope length, shape, and aspect are also natural variables that influence landslide risk for a given slope. Mass wasting events generally correlate with high precipitation events, changes in drainage, removal of vegetation, removal of material downslope of the failure, or loading of material into an unstable slope. Additionally, streambanks may be susceptible to bank undercutting or failure if streamside vegetation is removed (in the event that no stream buffer exists). See the Forest Practices Rules Final Environmental Impact Statement (EIS), page 3-10 (Washington Forest Practices Board 2001) for further discussion.

Root strength studies (e.g., Wu et al. 1979; Wu and Swanston 1980; Ziemer 1981) have led to a semi-quantitative understanding of the impact of decreasing root strength on slope stability. A relatively recent study (Dhakal and Sidle 2003) indicates that thinning and retaining vigorous understory vegetation should reduce landslide volumes and frequencies over regeneration harvest activities.

The role of mass wasting in aquatic systems is described in more detail in the Forest Practices Rules Final EIS (pages 3-7 through 3-25, Washington Forest Practices Board 2001). Potential impacts from road-building and timber harvest are minimized through effective planning, design, and review of appropriate harvest practices on all non-federal lands in Washington with special requirements on unstable or potentially unstable slopes.

Removal of timber can cause increases in the availability of atmospheric water to contribute to increases in groundwater and surface runoff (primarily as peak flows), as discussed in Section 4.7 (Hydrology). The evapotranspiration and interception properties of the forest change through the removal of some or all of the forest canopy. Increases in groundwater levels, and duration of seasonal high groundwater conditions, can contribute to higher porewater pressures, and thereby potentially destabilize slopes. Increased storm and seasonal runoff can result in increased peak flows, stream incision, and undercutting of potentially unstable slopes (CMER 2004). Because of these potential effects, the effects of timber harvest and road-building on groundwater recharge and stream flow will be analyzed for each planning area where slope stability may be affected by these increases.

4.6.3.2 Surface Erosion

Generally, forest vegetation stabilizes soils, reduces soil erosion, and slows sediment transport to streams, thereby minimizing the impact of sedimentation on water quality. However, surface erosion from roads, harvest units, and skid trails tends to be a chronic source of fine sediment to the drainage network, as well as an episodic source of coarse sediment. Chronic sources of fine sediment can have potentially significant adverse effects on the physical habitat of the aquatic system and certain lifestages of aquatic biota, degrade water quality, and affect soil productivity in both riparian and upland areas.

Road-related surface erosion and delivery of fine sediments to streams is a concern because of the thousands of miles of forest roads that exist to transport harvested timber in forested regions of western Washington. Surface erosion is affected by slope gradient and shape, soil texture properties (density, cohesion, sorting, etc.), parent material, precipitation, groundwater movement, vegetation cover, and human activities. Rates of sediment delivery to streams, predominantly from timber haul (heavy truck traffic) but also public use of unpaved roads, is correlated to traffic volume, design and maintenance of the road and associated drainage structures, and the location of the road relative to streams (USDA Forest Service 2001; Rashin et al. 1999; Reid and Dunne 1984). The amount and types of traffic and road maintenance practices also influence delivery. For a detailed discussion of transportation infrastructure on forested trust lands, see Chapter 4, Section 4.11.3, Public Utilities and Services.

Harvest activities such as ground-based skidding or cable yarding can cause soil disturbance. Streamside vegetation and hillslope roughness can trap sediment, controlling the amount that reaches the stream system. These filtering capabilities are affected by timber harvest within and adjacent to streamside buffers. However, additional harvest materials left on the forest floor can help offset decreases in filtering capability adjacent to the streamside buffer. See the Forest Practices Rules Final EIS (page 3-9, Washington Forest Practices Board 2001) and the Habitat Conservation Plan Final EIS (DNR 1996, Sections 4.2.3, 4.4.2, and 4.6).

4.6.3.3 Soil Productivity

Soil productivity is a soil's capacity to support vegetation. Long-term productivity is a soil's capacity to sustain the natural growth potential of plants over time (Section 4.6 of the Habitat Conservation Plan [HCP] Final Environmental Impact Statement [EIS]). Forest management relies on soil productivity to help provide conservation benefits and to support a productive forest ecosystem that provides financial support to the beneficiaries.

Soil productivity is a function of a variety of parameters, both within the soil and external to it. Internal parameters include bulk density or porosity; amount of organic matter; and levels of carbon, nitrogen, and other beneficial minerals; as well as the presence of organisms within the soil (e.g., earthworms, mycorrhizal fungi) that aerate the soil or allow the uptake of nutrients from the soil by plants. External conditions, such as microclimate, slope aspect, and precipitation will also influence internal conditions of soil temperature and soil moisture.

Timber harvest and road-building can affect soil productivity. Factors involved include harvest location relative to sensitive soils and soil moisture; type, area, and frequency of disturbance related to harvest; the amount of large wood left on site; reforestation methods; and fertilization. Disturbance from felling, yarding, and skid trails can cause soil compaction, which can affect soil productivity (page 3-9, Washington Forest Practices Board 2001). Burning and mechanical clearing have the potential to reduce soil productivity for sensitive soils.

Productivity can be degraded or improved by forest management in a variety of ways (USDA Forest Service 2002b; Heninger et al. 2002; Miller et al. 1992). Removal of trees and site preparation can increase soil temperature and erosion; yarding and felling can compact soils or remove organic layers if trees are pushed or dragged along the ground surface; and burning can change the mineralogy of soil, decrease nutrient content, and create hydrophobic conditions. Adverse impacts may be amended or masked by fertilization. Fertilization and control of undesirable vegetation may improve the productivity of desirable species. Gessel et al. (1990) summarized four decades of fertilization studies in Pacific Northwest Douglas-fir forests, demonstrating the response of Douglas-fir to fertilization, especially nitrogen fertilization, in western Washington and Oregon.

Soil development in most forestlands of western Washington has been occurring for at least the last 10,000 years following glacial retreat, occasionally disrupted by landslide events, mudflows, volcanic eruptions, or flooding (Franklin and Dyrness 1988). However, accelerated rates of mass wasting have the potential to impact local soil productivity. Soil disturbance as a result of mass failure generally transports productive soil layers in which most of the organic material, available nutrients, and beneficial mycorrhizal associations reside. Disruption and removal of productive soil layers can occur as they are transported downslope and are mixed with other material. Depending on the species desired and type of landslides initiated, increased frequency of mass wasting may affect soil productivity by removal, disruption, and transport of near-surface soil layers. Red alder is a nitrogen-fixing species that can establish itself in soils with minimal development, while establishment of productive stands of conifers generally requires several decades for natural succession on young soils (Franklin and Dyrness 1988). If bedrock is exposed, a local loss of productivity would occur in the area of bedrock exposure that would require a significantly longer time for the development of productive soil with adequate rooting depth than in the runout and deposition zones.

STAND MANAGEMENT METHODS

The methods used to manage forest stands can affect soil health and productivity. Ground-based systems and cable systems without full suspension have the greatest potential to increase compaction or surface erosion, which can decrease soil productivity for some soils.

Forest fertilization can improve harvest yields and may improve forest health for some sites. Fertilization includes both aerial and ground applications. Other practices such as site preparation and vegetation management are important management tools to either protect or increase harvest yields. Site preparation includes a variety of techniques, such as aerial and ground herbicide applications, broadcast burns, ground mechanical treatments, and pile and burn. Vegetation management includes aerial and ground herbicide applications, and mechanical and hand vegetative control methods. Forest Resource Plan policies regarding Silviculture, Policies 30 through 34, guide the application of these practices.

4.6.3.4 Existing Conditions on Western Washington Forested State Trust Lands

Mass Wasting

Deep-seated landslides have been identified on less than 3 percent of forested trust lands in western Washington (Table 4.6-1). Areas identified through slope stability modeling as having a high potential for shallow-rapid landslides represent between 6 and 21 percent, by HCP Planning Unit, and overall approximately 12 percent of forested trust lands in western Washington (Table 4.6-2). If correctly identified, these areas are more susceptible to mass wasting under certain types of forest management and require additional investigation before forest management may be planned to occur on them compared to most harvest areas. The North Puget HCP Planning Unit has the greatest overall amount of area identified or classified as potentially unstable, while the Olympic Experimental State Forest contains the greatest percentage as a proportion of all lands in that HCP Planning Unit. See Appendix E, Tables E-29 and E-30, for a ranking of watersheds with greater than 5 percent DNR ownership by the percentage of land classified as “high” and “moderate” (respectively) for potential shallow-rapid slope instability (based on the SMORPH model).

Table 4.6-1. Areas of Mapped Landslides and Potentially Unstable Slopes on Forested Trust Lands, by HCP Planning Unit

HCP Planning Unit	Total Acres in HCP Planning Unit	Acres of Identified Landslides[1/]	Acres of Landslides that Have Occurred[2/]	Acres Modeled as High for Potential Slope Instability[3/]
Columbia	267,530	8,282	171	16,525
North Puget	381,516	13,476	2,146	52,388
OESF	256,659	2,886	1,646	53,296
South Coast	232,931	5,478	261	23,254
South Puget	141,846	890	3,252	11,560
Straits	110,222	1,851	3	14,157
Westside Total	**1,390,704**	**32,864**	**7,479**	**171,181**

Data Sources:
[1/] DNR Geoslide Geographic Information System Data; only deep-seated landslides.
[2/] DNR Landslide Geographic Information System Data; both deep-seated and shallow-rapid landslides.
[3/] DNR SMORPH Geographic Information System Data (10-meter slope stability model); predicted (modeled) shallow-rapid landslides.
OESF = Olympic Experimental State Forest

Table 4.6-2. Areas of Mapped Landslides and Potentially Unstable Slopes on Forested Trust Lands as a Proportion of Total Forested Trust Lands in Western Washington, by HCP Planning Unit

HCP Planning Unit	Area of Mapped Landslides[1/]	Area Modeled as High for Potential Slope Instability[2/]
Columbia	3.2%	6.2%
North Puget	4.1%	13.7%
OESF	1.8%	20.8%
South Coast	2.5%	10.0%
South Puget	2.9%	8.1%
Straits	1.7%	12.8%
Westside Total	**2.9%**	**12.3%**

Data Sources:
[1/] DNR Geoslide and Landslide Geographic Information System Data, including both deep-seated and shallow-rapid landslides.
[2/] DNR SMORPH Geographic Information System Data (10-meter slope stability model); predicted (modeled) shallow-rapid landslides.
OESF = Olympic Experimental State Forest

Surface Erosion

ROADS AND THE ALTERNATIVES

Forest roads are an integral part of forest management (Habitat Conservation Plan, page IV.62-68). DNR has an important and considerable task of repairing and maintaining approximately 14,000 miles of forest roads statewide. It is expected that roads will be added and deleted to meet financial, social, and environmental objectives.

It is not expected that the number of road miles or road density will vary as a result of the implementation of any of the proposed Alternatives. Below is a discussion of DNR's obligations for roads management, and an analysis of DNR's road network, both present and future. An analysis of differences among the Alternatives with respect to levels of surface erosion and truck traffic resulting from harvest levels proposed under different Alternatives can be found in this section, and in Chapter 4, Section 4.11, respectively.

The Alternatives and the Habitat Conservation Plan

The basic structure of Habitat Conservation Plan (HCP) commitments for forest roads is stated in the *Riparian Conservation Strategy for the Five Westside Planning Units*, Part IV, Section D. DNR committed to the following principles for road network management:

1. Minimization of active road density;
2. Site-specific assessments of alternative harvesting systems that require less road construction;
3. A base line inventory of roads and stream crossings;
4. A prioritized system for road decommissioning, upgrading, and maintenance; and
5. Identification of fish blockages caused by stream crossing structures, and a prioritized approach to repair or removal.

In addition, RCW 76.09, the Forest Practices Act, regulates DNR. This Act contains many sections designed to provide regulations for protection of the environment. The Forest and Fish regulations were passed into law after DNR's Habitat Conservation Plan agreement, and have significantly raised the level of environmental protection with respect to road management, unstable slopes, and fish blockage repair. Additionally, each road that is constructed is further evaluated under the State Environmental Policy Act as a part of DNR's review of timber sale projects occurring on state lands.

There have been a number of accomplishments related to roads management since the HCP was implemented, including:

1. Baseline inventory of roads completed in December 1999;
2. Inventory of all stream crossings and assessment and prioritization of culvert blockages completed in April 2001;
3. 223 fish blockages repaired or abandoned;
4. 907 miles of road decommissioned or abandoned;
5. HCP guidelines for assessment of potentially unstable slopes completed in September 2003; and

6. As of December 31, 2003, approximately 75 percent of HCP Planning Unit roads completed under approved Road Maintenance and Abandonment Plans according to Forest and Fish regulations. The law requires DNR to be 60 percent complete.

Harvest Timings

While the Final Environmental Impact Statement (EIS) Alternatives propose different harvest timings and locations, the basic road network statewide will evolve to the end condition, over time, virtually independent of which Alternative is chosen. As stated in DNR's HCP, "In considering road densities, it is assumed that the current emphasis on small staggered settings with green-up requirements, and partial-cut silvicultural systems designed to achieve environmental objectives will continue. These systems will, by their nature, result in more extensive road systems, which will be active for longer periods of time. While expansion is inevitable, as new areas are accessed, DNR's goal will be to reduce the additional amount of new roads needed through careful planning, and control the overall size of the network by effective abandonment" (Part IV section D, page 66).

DNR carefully weighs the impacts of roads with regards to environmental protection, public use, and forestland management needs. Where appropriate, roads are abandoned. Also where appropriate, DNR uses alternative harvest systems. A specific road density target was not set in the HCP because such a target would compromise the environmental and economic management of DNR's road networks.

Road-spacing is mostly dependent on topography. Topography drives the type of logging system used to achieve the desired silvicultural objectives, which in turn dictates optimal yarding distance to road-spacing combinations.

Road Density

Below is a road density analysis for western Washington forested trust lands using the distribution of deferral classes that would be implemented for the Preferred Alternative. Acreages in each deferral classification differ by Alternative, but road densities by deferral class are analogous for all Alternatives.

Table 4.6-3 shows the distribution of roads and their density on western Washington forested trust lands, including Natural Area Preserves and Natural Resource Conservation Areas. The data identify density (expressed in average number of road miles per square mile.

The analysis shows that there is a small difference in road density on the average for lands that are currently on-base versus what is in short-term deferral. It also identifies that while there are areas that are in long-term deferral, such lands will often already contain roads necessary to manage nearby forested trust lands.

Table 4.6-3. Road Density Analysis by Deferral Class under the Preferred Alternative in 2004

Deferral Class	Miles	Acres	Density: Road miles/square mile[1/]
Short-term deferral (2004 – 2013)	1,428	302,439	3.02
Long-term deferral (>2013)	703	213,049	0.47
On-base	5,896	875,216	4.31
Total	**8,027**	**1,390,704**	

1/ Calculated by dividing total road miles in each deferral class by the number of square miles in those classes.
Data Source: DNR Forest Practices Transportation Layer.

The HCP estimated a range of annual harvest activity for the six Westside HCP Planning Units (including the Olympic Experimental State Forest). It anticipated a range from almost 23,000 acres to more than 31,000 acres.

Regeneration harvest acreage under the Preferred Alternative are between 71 percent and 90 percent of what was anticipated in the HCP. The number of acres thinned under the Preferred Alternative is between 35 percent and 52 percent of that anticipated under the HCP. The Preferred Alternative regenerates and thins substantially fewer acres than projected by the HCP.

Road impacts for all the Alternatives should be well within the range anticipated by the HCP due to the relationship to the total acres harvested.

Sedimentation

As indicated in Table 4.6-3, much of DNR’s current land base is already actively managed and already accessed by roads. DNR’s road network is spread across all forested trust lands irrespective of the current “on-” or “off-” base options for harvest scenarios. Further, DNR’s road network is managed for multiple use. Timber harvest is only part of the road management equation; recreation, silviculture, and wildfire, etc. play important roles in road strategies and traffic load, all of which are factors in the sediment production and delivery processes.

Although harvest levels are partially related to overall traffic levels on forest roads, truck traffic or road length are unlikely to be the main causes of sedimentation. Sedimentation processes that occur in managed forests are complex and are the result of several factors.

In assessing road surface erosion, sedimentation processes are more of a complex factor than the number of truck miles driven on the roads. Topography, aspect, surface materials, construction/maintenance techniques, proximity to riparian area, micro-climates, time of year, storm events, and public use, etc. play a role in sedimentation. It would be inaccurate to assert that if the number of trucks on a road were reduced, then sediment delivery to fish-bearing water would therefore also be necessarily reduced. Roads that have not yet been updated to be in compliance with the Forest Practices Rules are at greater risk for sediment production than those that have been updated. One of the objectives of the Road Maintenance and Abandonment Plans is to have roads constructed in a manner that prevents the delivery of sediment to stream, regardless of levels of truck traffic.

DNR has performed analyses of its road management and road-related impacts in the context of the existing road network and uses. Analysis of the overarching strategies from the Habitat Conservation Plan (HCP) and the Forest and Fish (Washington Forest Practices) Rules are outlined below.

As indicated in Table 4.6-4, harvest levels in the activity types for each Alternative are within those expected under the HCP and analyzed in the HCP Draft and Final Environmental Impact Statement (EIS). The HCP Draft EIS (DNR 1996) analyzes effects related to sediment (p. 4-163) and stream flow (p. 4-170). Mitigation in the form of Riparian Management Zones, management for hydrologically mature forest in the significant rain-on-snow zones, wetland protection, and road management planning (identified above) are discussed in those sections.

The Washington Forest Practices Rules Final EIS (DNR 2001) also presents an analysis of the effects of sediment, peak flows, and roads in riparian areas and wetlands on water quality and on fish. Sediment is discussed in Section 3.2 of the Forest Practices Rules Final EIS (p. 3-7), which includes road surface erosion and road-related landslides.

Table 4.6-4. Summary of Activity Levels: Acres by Harvest Type

	HCP Expected Annual Activity Levels[1/] (acres)			**Alternatives**					
Activity[2/]	**Five Westside HCP Planning Units**	**OESF**	**Total**	**1**	**2**	**3**	**4**	**5**	**PA**
Regeneration Harvests[C]	14,000-16,500	300-1,500	14,300-18,000	8,300	12,700	14,200	7,800	13,400	13,000
Salvage[C]	0	150-250	150-250						
Seed Tree[C]	50-100	0-30	50-130						
Shelterwood[B]	100-500	30-100	130-600	800	2,100	900	3,800	3,400	1,900
Selective[3/,B]	2,000-3,000	800-1,130	2,800-4,130						
Commercial Thinning[A]	3,000-4,500	2,500-3,500	5,500-8,000	5,200	5,400	7,100	8,000	13,600	2,500
Total Acres	**19,150-24,600**	**3,780-6,510**	**22,930-31,110**	**14,400**	**20,200**	**22,200**	**19,700**	**30,300**	**17,400**

PA = Preferred Alternative

1/ Taken from Table IV.15 in HCP (p. IV.211, DNR 1997), titled "Estimated amount of forest land management activities on DNR-managed lands in the area covered by the HCP during the first decade of the HCP."

2/ Activity types are taken directly from HCP (p. IV.204).

3/ Selective cuts include variable density thinnings

A. Characterized in the Draft EIS(DNR 2003) as a Type "A" harvest (Appendix B, p. B-43)

B. Characterized in the Draft EIS (DNR 2003) as a Type "B" harvest (Appendix B, p. B-43)

C. Characterized in the Draft EIS (DNR 2003) as a Type "C" harvest (Appendix B, p. B-43)

Data Source: DNR model outputs.

The evaluation of Alternatives in this analysis offers the 2001 rules package that provides measures necessary to address impacts due to road-related sedimentation (p. 3-16). These mitigation measures include implementation of road maintenance and abandonment plans and the adaptive management program. In addition, Appendix F in the Final EIS for the Forest Practices Rules discusses the effects of road construction and maintenance and describes recommended and accepted practices for building and maintaining roads. It states that, “Roads built following Forest Practices Rules that provide specific direction and recommended “best management practices” from the literature have the lowest risk of causing sediment delivery” (p. F-2). As stated above, all of the Alternatives will meet the requirements as specified in the Forest Practices Rules.

Soil Productivity

All soils data presented in Tables 4.6-5 and 4.6-6 are based on the DNR soils layer, which is based on the Private Forest Land Grading system and subsequent soil surveys completed

Table 4.6-5. Site Class, Compaction Potential, Fertilizer Response, and Burn Damage Potential by Land Classification (Percent Area)

Land Classification	Uplands with General Objectives	Riparian	Uplands with Specific Objectives	Average Westside
Moist Soil Compaction Potential				
High	70	67	59	64
Low	4	4	6	5
Medium	22	22	27	24
N/A	0	1	2	1
No Data	3	5	7	5
Variable	0	1	0	1
Fertilizer Response				
High	17	9	13	13
Low	34	19	9	18
Medium	23	15	15	17
No Data	26	56	63	51
Burn Damage Potential				
High	18	16	27	22
Low	48	49	34	42
Medium	30	28	30	29
N/A	1	2	2	2
No Data	3	5	7	5
Variable	0	0	0	0
Site Class (Site Index)				
I (143)	6	4	2	4
II (127)	44	30	21	30
III (109)	38	45	46	44
IV (89)	10	17	24	18
V (69)	2	4	8	5

Data Source: DNR Soils Layer.

Table 4.6-6. Site Class, Compaction Potential, Fertilizer Response, and Burn Damage Potential by Planning Unit (Percent Area)

	Percent Area by HCP Planning Unit						
	Columbia	**N. Puget**	**OESF[1/]**	**S. Coast**	**S. Puget**	**Straits**	**Westside**
Compaction Potential							
High	60	75	64	94	30	22	64
Low	1	3	No data	1	24	13	5
Medium	28	11	34	4	43	57	24
N/A	0	4	0	0	1	1	1
No Data	9	7	2	1	3	7	5
Variable	2	0	0	0	0	0	1
Fertilizer Response							
High	14	6	No data	3	29	62	13
Low	36	3	No data	57	11	1	18
Medium	27	18	0	16	26	24	17
No Data	23	72	100	24	34	12	51
Burn Damage Potential							
High	14	32	No data	3	60	43	22
Low	51	6	76	84	19	12	42
Medium	23	51	22	11	17	38	29
N/A	0	4	0	0	1	1	2
No Data	9	7	2	1	3	7	5
Variable	2	0	0	0	0	0	0
Site Class (Site Index)							
I (143)	3	4	1	10	1	0	0
II (127)	37	25	14	60	22	9	9
III (109)	38	40	61	28	49	57	57
IV (89)	18	20	21	2	25	30	30
V (69)	3	11	3	1	3	4	4

Data Source: DNR Soils Layer.
[1/] OESF = Olympic Experimental State Forest

in 1980. Each of the attributes of the data (displayed in Tables 4.6-2 and 4.6-3) has its own criteria that characterize soils as high, medium, or low "potential" for that category. Additional information (metadata for this dataset) can be found at http://www3.wadnr.gov/dnrapp6/dataweb/metadata/soils.htm.

Almost two-thirds of western Washington forested state trust lands can be characterized as having a high potential for soil compaction (Table 4.6-5). Additionally, almost half of the DNR-managed forested trust lands have been evaluated for response to fertilization. Of the lands evaluated, approximately 70 percent have a low-to-medium response rate to fertilization and only about 30 percent have a high response rate. While 42 percent of western Washington forested state trust lands have a low potential for burn damage, approximately 22 percent have a high potential.

SITE INDEX CLASSIFICATION

Site index is a measure of soil productivity, expressed as the height of the dominant trees in a stand at a given age. These indices are grouped into site classes (I through V), each of which corresponds with a range in tree heights. Class I corresponds with the tallest trees, and therefore generally the most productive soils. Class V corresponds with shorter trees, and therefore generally the least productive soils. Less than 5 percent of forested trust lands is classified as Class I (the most productive class) (Table 4.6-5). Throughout forested trust lands, most areas are classified in site classes II and III. Less than 5 percent is classified as Class V (the least productive class). This information is broken down by Habitat Conservation Plan planning unit in Table 4.6-6.

FERTILIZER RESPONSE AND SITE PREPARATION

Table 4.6-6 also shows the fertilizer response of soils on western Washington forested state trust lands where data are available. The fertilizer response of a given soil is the growth response of trees in that soil to a given application of fertilizer (nitrogen). Some forest soils allow a greater tree growth response than others to the application of fertilizer. The forested trust lands evaluated are approximately equally distributed among low, medium, and high for fertilizer response. Since 1993, between 2,251 and 20,944 acres of western Washington forested state trust lands were treated each year to increase productivity. As shown in Table 4.6-7, the maximum area that fertilizer was applied to in a given year was 10,811 acres. Since 2000, fertilizer use has decreased to approximately 300 acres per year of biosolid fertilizer application.

Acres of forested trust lands on which various site preparation methods were applied varied from 75 to 5,900 acres between 1993 and 2002 (Table 4-6.7). Since 1993, vegetation management techniques have been applied to a minimum of 2,176 acres in 1994 and a maximum of 13,305 acres in 2001.

Table 4.6-7. Area of Fertilization, Site Preparation, or Vegetation Management in Western Washington Forested State Trust Lands between 1993 and 2002 (acres)

Year Completed	Area Fertilized	Area of Site Preparation	Area of Vegetation Management	Total Area Treated
1993	<1	146	7,070	**7,216**
1994	<1	75	2,176	**2,251**
1995	20	165	4,478	**4,663**
1996	762	173	3,960	**4,895**
1997	711	1,130	7,329	**9,170**
1998	683	972	8,967	**10,622**
1999	10,811	1,699	8,434	**20,944**
2000	2,697	5,900	8,818	**17,415**
2001	366	4,993	13,305	**18,664**
2002	299	3,906	3,721	**7,926**

Data Source: DNR Planning and Tracking database.
Area fertilized includes both application of biosolids and aerial fertilizer application in North Puget and South Puget Habitat Conservation Plan Planning Units. Area fertilized updated from e-mail communication from Carol Thayer, 7/24/03.

4.6.4 Environmental Effects

Potential environmental impacts of the Alternatives on geomorphologic processes, sediment delivery, and soils are discussed in terms of changes to harvest levels and management. Effects on hydrology, water quality and fish are further discussed in Sections 4.7 (Hydrology), 4.8 (Water Quality), and 4.10 (Fish), respectively.

4.6.3.5 Comparison of Alternatives

Impacts to forest soils on western Washington forested state trust lands that may result from implementation of the various Alternatives are analyzed in terms of the potential for displacement and loss of soil through mass wasting, potential for changes in surface erosion, and potential for changes in soil productivity.

Common to all Alternatives is the existing and projected future roaded area on forested trust lands. All road maintenance and abandonment will be accomplished following 2001 Forest Practices Rules, and DNR policies and procedures for all Alternatives. Over the time period of this analysis, no significant differences in the rate of change, or total roaded area, are expected among the Alternatives (as discussed earlier in this section). In addition, changes in the practices related to road location or construction will occur independent of this action.

Mass Wasting

Management of Potentially Unstable Slopes

No current policies or procedures would change under any of the Alternatives with respect to the management of potentially unstable slopes. Continued careful planning is necessary for all Alternatives, as discussed in Appendix C, Section C.4.

DNR is currently guided in the process of identifying, delineating, and managing potentially unstable slopes by the Habitat Conservation Plan (HCP) and the state Forest Practices Rules. In the HCP, DNR commits to not increase the frequency and severity of landsliding. Under the Forest Practices Rules, DNR is committed by law to assess the effects of harvest on defined landforms and site conditions prone to instability. In order to evaluate feasible mitigation options, DNR will assess risk for sales with slope stability concerns (see *Mitigation and Monitoring* below). In anticipation of Class IV special application classification under the Forest Practices Rules, DNR prepares geotechnical reports to address these issues as outlined under Washington Administrative Code (WAC) 222-10-030. A Class IV special permit is required when a timber sale is conducted on potentially unstable slopes or landforms that have the potential to deliver sediment or debris to a public resource, or that have the potential to threaten public safety (WAC 222-16-050(d)).

In managing forested trust lands, timber harvest activities, by their very nature, create disturbances to the soil and hydrologic processes through existing and new roads, landings, skid trails, slash burns, etc. It has been demonstrated that logging activities can generate sediment that, if delivered to the aquatic ecosystem in significant quantities, can degrade habitat for fish and other species.

DNR's obligations under the HCP are to conduct effectiveness monitoring for the riparian conservation strategy and determine how to harvest timber and meet conservation objectives by minimizing sediment runoff and attempting to prevent increases in the severity and frequency of landslides. The objective is to manage sediment inputs to levels that do not produce significant adverse effects on aquatic and terrestrial ecosystems. Because forest roads are a major source of sediment, DNR Forest Practices has published Best Management Practices in Section 3 of the Forest Practices Board Manual outlining in detail Best Management Practices for road construction, maintenance, and abandonment.

THE ALTERNATIVES

Relative landslide risk among the Alternatives is evaluated based on the intensity of management in upland areas where the potential for mass wasting exists, rather than an analysis of harvest projected to occur in unstable areas. This analysis approach was taken for two main reasons. There are uncertainties in the potential for mass wasting on forested trust lands in areas identified by the SMORPH model created by DNR Forest Practices to predict areas of high, medium, and low potential for slope instability, and very few known unstable slopes are currently mapped. In addition, DNR has not determined site-specific harvest locations. This Final Environmental Impact Statement (EIS) is an analysis of a non-project action, an evaluation of the policy implications of various sustainable harvest levels. Project level (e.g., individual timber sales) environmental analyses will assess site-specific factors during project design. For instance, project design decisions are made at the operational timber sale design level by foresters and geologists in the field; such actions are evaluated using the extended Environmental Checklist designed by the DNR to better analyze forest management.

Table 4.6-8 is used to help characterize the type of potential harvests on lands where unstable slopes are likely to occur. This is seen as a surrogate, appropriate for non-project analysis. The Uplands with Specific Objectives land class contains lands for which DNR manages a number of sensitive resources. These include, but are not limited to, northern spotted owl nesting, roosting, foraging, and dispersal habitat; rain-on-snow management areas; and potentially unstable slopes. The modeling process, however, does not retain specificity about where within the land class a specific resource is contained. Despite this, it is assumed for the purpose of this analysis that overall harvest in the land class by Alternative is a reasonable surrogate for, and is proportional to, the harvests that could actually occur in areas of potential slope instability.

In addition, harvests in the Uplands with Specific Objectives land class are reported by volume of timber per acre (low, medium, and high) that would be removed. In upland areas, it can be generally assumed that: 1) low-volume removal harvests will be light traditional thinnings, 2) medium-volume removal harvests will be heavy traditional thinnings, and 3) high-volume removal harvests will be regeneration harvests.

Table 4.6-8. Harvest in Uplands with Specific Objectives by Alternative

Alternative	Average Percent of Uplands with Specific Objectives by Area Impacted per Decade by Harvest Type: Low Volume Removal Harvest[1/]	Medium Volume Removal Harvest[2/]	High Volume Removal Harvest[3/]	Total
1	3%	<1%	5%	8%
2	4%	2%	10%	16%
3	4%	1%	11%	15%
4	5%	2%	5%	12%
5	12%	4%	11%	26%
PA	1%	2%	9%	12%

PA = Preferred Alternative
Data Source: Model output data – timber flow levels.
1/ Less than 11 thousand board feet per acre volume harvests
2/ Between 11 and 20 thousand board feet per acre volume harvests
3/ Greater than 20 thousand board feet per acre volume harvests

These generalizations, however, will vary some by Alternative depending upon the types of harvest being emphasized. For example, in the Preferred Alternative, biodiversity management harvests such as variable density thinnings and patch cuts could be either medium- or high-volume removal harvests, depending on the standing volume in that stand. In short, this analysis of differences among Alternatives in level of activity in areas that may contain potentially unstable slopes is appropriate only as a relative measure, and should not be mistaken as an analysis of potentially unstable slopes that will be harvested by each of the Alternatives if implemented.

Assuming that: 1) in areas with potential for mass wasting any decreases in root strength may contribute to landslide risk, and 2) regeneration harvest has a greater risk of triggering landslides than thinning in areas of slope instability, a partially grouped ranking of the proposed Alternatives from highest to lowest potential for increased risk associated with mass wasting (based on Table 4.6-8) is: Alternative 5 (highest); Alternatives 2 and 3 (intermediate high); the Preferred Alternative (intermediate); Alternative 4 (intermediate-low); and Alternative 1 (lowest).

All of the Alternatives may require mitigation and monitoring to ensure that obligations under Forest Practices Rules and the Habitat Conservation Plan are maintained. The procedure for assessing slope stability would not change under any of the Alternatives. However, the level of resources necessary to assess risk, and conduct monitoring and other types of mitigation would increase under Alternatives 2, 3, 5, and the Preferred Alternative, compared to Alternatives 1 and 4, due to their increased levels of proposed activities in potentially unstable areas.

MITIGATION AND MONITORING

The riparian conservation strategy for the five Westside HCP Planning Units (excluding the Olympic Experimental State Forest) had several objectives, including mitigating potential effects of landslides on the aquatic ecosystem. Slope geomorphologic models, landslide history, and information on soils and geology will continue to be used to identify landslide prone areas. The DNR procedure for assessing slope stability

(PR 14-004-050) requires field verification of potential mass wasting with qualified staff. During field reconnaissance, site data are gathered on a variety of factors, including the nature of the geology (soils and rock), size of effected area, slope, and hydrologic conditions. Potential downslope effects on various resources and public safety may also be evaluated as appropriate based on site factors, including loss of fish habitat for listed species; loss of downslope timber values; domestic water use; and developments such as highways, houses, pipelines, etc. Currently, DNR conducts qualitative risk analyses of harvest activities on potentially unstable ground on a timber-sale-by-timber-sale basis.

Mitigation of slope and soil disturbance may include alternative operational techniques such as intermediate suspension, contract requirements for full suspension, or helicopter harvest (which would have the added benefit of limiting or eliminating road construction). Mitigation also may include sale boundary layout to avoid areas of instability where operational techniques are determined to be unsuccessful in preventing mass wasting or surface erosion. Where groundwater recharge may contribute to slope instability, reduced harvest densities may be applied. Existing roads will be maintained or abandoned under the stringent road maintenance and abandonment provisions of the Forest Practices Rules. New roads will be constructed following requirements of the Forest Practices Rules.

Implementation monitoring of managed land is ongoing. A pilot project has been completed examining the evaluation of slope stability in timber sale planning and to establish a baseline for testing the effectiveness of associated mitigation recommendations. Annually, a report is submitted to the National Oceanic and Atmospheric Administration Fisheries and U.S. Fish and Wildlife Service (Federal Services), which has in past years included levels of compliance with unstable slopes management requirements under the riparian conservation strategy contained in the Habitat Conservation Plan (HCP).

Long-term effectiveness monitoring will be implemented to measure sediment delivery from roads and harvest activities. Monitoring may include some of the following elements.

Best Management Practices can be evaluated using paired studies on site or road segment scale to measure impacts on the aquatic ecosystem. Where there are no public resources at risk, paired studies can be used to test various thinning methods in order to determine if harvests can be conducted on moderate- to low-risk landslide-prone areas. The research findings will then be integrated into the ongoing implementation of the HCP. DNR is in the process of developing these studies at this time.

If monitoring demonstrates that landslide frequency or severity may be increasing under current policies, modifications to harvest plans will be made, and harvest may be reduced accordingly. Based on results, the assumption would likely be made that greater amounts of land disturbance, and greater areas of more intense disturbance, will increase the potential for landslide risk that will need to be addressed. Potential increases to landslide risk can be addressed either with reduced harvest, modifications to proposed harvest methods, or other mitigation that would depend on the information gathered from monitoring and site conditions.

Monitoring and reporting will also be done for the Board of Natural Resources. On March 2nd, 2004, the Board of Natural Resources passed Resolution No. 1110, which authorizes the DNR to prepare the Final Environmental Impact Statement for Sustainable Forest Management of State Trust Lands in Western Washington. Section 4 (L) of the resolution states: "The Department shall annually report to the Board of Natural Resources its assessment of the environmental and economic results of implementing the Preferred Alternative. The Department shall employ a structured monitoring and reporting program."

Surface Erosion

Road use is assumed to be a function of the amount of timber hauled. Effects from public road use for recreation and other public use of forested trust lands are expected to be constant for all Alternatives. Higher timber volumes can be assumed to require more truck trips and, therefore, potentially increase the contribution of surface erosion caused by roads. Specifically, Alternative 5, with the highest levels of management intensity by acreage, would be expected to require more planning and maintenance to appropriately address surface erosion, followed by Alternatives 3 and 2; the Preferred Alternative; and Alternatives 1 and 4. For levels of logging traffic by Alternative, see the discussion of Transportation Infrastructure in Chapter 4, Section 4.11.4. Sediment delivery to streams is discussed in Section 4.7 (Hydrology), Section 4.8 (Water Quality), and Section 4.10 (Fish). Due to implementation of DNR's Habitat Conservation Plan (HCP) and requirements for Road Maintenance and Abandonment Plans under the Forest Practices Rules, it is expected that substantial improvements in road management and surface erosion will continue into the future. No significant adverse impacts to surface erosion beyond those anticipated under the HCP Environmental Impact Statement (EIS) or Forest Practices Rules EIS are expected under any of the Alternatives.

Soil Productivity

The goal of successful sustainable forest management is to meet conservation objectives and fiduciary responsibilities without degradation of soil. Intergeneration equity requires actions that protect and maintain current and future forest functions (Burger and Kelting 1998). For this reason, soil conservation and maintenance or improvement of soil productivity should be inherent qualities of sustainable forest management. If site productivity declines appreciably, the harvestable timber volume per acre may decline over time. If this were to happen, the risk of not meeting all sustainable forest management goals would increase.

Factors that may influence soil productivity among the Alternatives are management strategies, and management intensity. See Chapter 2 and Appendix C for a description of the variations in these parameters among Alternatives. In general, more intensive management may lead to a greater risk of soil compaction and surface erosion. As shown in Table D-4, Alternative 5 has the highest levels of management intensity and total harvest area and would be expected to have the highest risk of potentially decreasing soil productivity, followed by Alternatives 3 and 2; the Preferred Alternative; and Alternatives 4 and 1. Alternatives 3 and 2 have similar, relatively high levels of both high-volume harvest and total harvest. The Preferred Alternative has less total disturbance than Alternatives 3 and 2 but a similar amount of high-volume harvest. Alternatives 4 and 1 have less high-volume harvest than the other Alternatives, with Alternative 1 having the lowest high-volume and total harvest. However, the increased use of fertilizers for

Alternatives 5 and the Preferred Alternative may mitigate potential losses of productivity due to increased management intensity, except for soil compaction. When designing and implementing harvest activities on highly compatible soils, locations of skid trails can be carefully planned by foresters in the process of setting up timber sales, and appropriate yarding techniques should be used to prevent or minimize compaction.

4.7 HYDROLOGY

4.7.1 Summary of Effects

This section analyzes the environmental effects on hydrology. The analysis examines the potential effects of proposed changes to policy and procedures and uses the modeling outputs to inform the public and decision-makers of the relative differences in potential environmental impacts. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

Procedure 14-004-060, which prohibits harvest of hydrologically mature forest in the rain-on-snow and snow zones where the mature forest type makes up less than 66 percent of these zones, would not change under any of the Alternatives. Consequently, significant changes in peak flows due to harvest activities would continue to be avoided under all of the Alternatives. The Habitat Conservation Plan Environmental Impact Statement (DNR 1996) provides more detailed analyses of the effectiveness of the measures laid out in Procedure 14-004-060 and other procedures in minimizing potential adverse effects to peak flows from harvest activities (see Sections 4.2.3, 4.4.3, and 4.8).

4.7.2 Introduction

The hydrology of a watershed includes the amount, intensity, and timing of water movement. Watershed hydrology is affected by climate, vegetation, other physical and biological factors, and watershed management. Changes in peak flows, or the highest expected volume of surface water flowing in a stream, can affect streambank stability and channel morphology, water quality, salmonid habitat, sensitive plant species, and the built environment (via flooding). Peak flows, which can become large floods, can adversely affect public safety and infrastructure.

During scoping, the main issue for hydrologic resources was identified as peak flows. Forest management can affect runoff and subsurface stormflow, and therefore change the timing and magnitude of peak flows through timber harvest and road construction (Section 3.3 of the Forest Practices Rules Environmental Impact Statement, pages 3-27 through 3-33 [Washington Forest Practices Board 2001] and Section 4.8 of the Habitat Conservation Plan Environmental Impact Statement, pages 4-509 through 4-524 [DNR 1996]). The amount and location of roads and timber harvest can affect the timing and quantity of runoff, subsurface stormflow, and peak flows. Soil compaction, such as may result from the operation of heavy machinery on some soil types, can reduce soil permeability, thereby contributing to peak surface water flows.

4.7.3 Affected Environment

Much of the information presented in this section is drawn from the Draft and Final Habitat Conservation Plan (HCP) Environmental Impact Statement (EIS) (pages 4-139 through 4-180, 4-243 through 4-305, 4-509 through 4-524, and Glossary page 6 [DNR 1996] and the Forest Practices Rules EIS (pages 3-27 through 3-33, Washington Forest Practices Board 2001). Refer to these documents for additional information related to hydrological effects on the environment.

The principal influences on surface water movement are climate, soils, geology, topography, and vegetation (Section 3.3 of the Forest Practices Rules EIS, pages 3-27 through 3-33 [Washington Forest Practices Board 2001]). Precipitation is controlled by climate and is not significantly influenced by forests or their management. Loss of water to the atmosphere by evaporation and transpiration of plants can be influenced by forest management. Water movement in natural streams is a function of water volume, channel geometry, and channel slope or gradient. In unmanaged forest areas, the most common disturbance to stream hydrology is trees and other vegetation entering streams. In places where this debris is temporarily stabilized, it influences sediment storage, hydraulics, and channel morphology (Montgomery et al. 2003).

4.7.3.1 Existing Conditions on Western Washington Forested State Trust Lands

For the purposes of this analysis, water Types 1 through 4 were identified. Stream types were updated for the model to better estimate the amount of fish-bearing streams on the forested trust lands based on DNR field foresters' reports and other known studies (Bahls and Ereth 1994, DNR 1995, Mobbs and Jones 1995). All waters originally mapped as Type 5 and all streams of unknown classification (Type 9) were grouped into Type 4. All Type 4 streams were reclassified as Type 3 streams. Streams originally classified as Types 1, 2, and 3 were kept in their respective categories. As a result, stream miles by type (as displayed in Table 4.7-1) do not match those referenced in the Habitat Conservation Plan (HCP) Environmental Impact Statement (EIS) (DNR 1996, page 4-250).

Based on this water typing system, nearly 70 percent of streams in western Washington are classified as non-fish-bearing, Type 4 streams (Table 4.7-1). Relatively few are rated high quality for beneficial uses. Approximately 5 percent of streams in the region are classified as Type 1 or 2. Less than 30 percent are Type 3 streams.

The largest peak flows in western Washington occur after rain-on-snow events (rainstorms that partially or completely melt snowpacks). The significant rain-on-snow zones (generally defined as an elevation zone) are where rain-on-snow events occur several times during the winter, typically at elevations of 1,000 to 3,000 feet above sea level. During rain-on-snow events, rainfall saturates existing snowpacks and causes rapid melting, leading to large volumes of runoff during relatively short periods of time. See Section 3.3 of Forest Practices Rules EIS (Washington Forest Practices Board 2001).

These events reach their greatest magnitude on forested lands in hydrologically immature forests (i.e., young trees), where the lack of a dense canopy allows greater snow accumulation and subsequent rapid melting (Washington Forest Practices Board 2001, Section 3.3, pages 3-29 through 31). In contrast, hydrologically mature stands approach the hydrologic processes and outputs (e.g., water yield, peak flows) expected in a mature stand under the same climatic and site conditions. Hydrologically mature forests are defined in the HCP as well-stocked conifer stands at 25 years or older (DNR 1996, Glossary, page 6). Snow accumulation and rate of melt are generally slower in hydrologically mature forests.

Table 4.7-1. Lengths of Streams on Forested Trust Lands by Stream Type and HCP Planning Unit

HCP Planning Unit	Length of Streams (miles)				Total
	Type 1	Type 2	Type 3	Type 4	
Columbia	101	7	715	2,519	**3,343**
North Puget	154	52	1,144	1,744	**3,093**
Olympic Experimental State Forest	156	55	816	1,772	**2,799**
South Coast	78	25	711	2,102	**2,915**
South Puget	41	14	271	845	**1,171**
Straits	21	17	210	383	**631**
Total	**551**	**170**	**3,867**	**9,364**	**13,952**

Data Source: DNR hydro layer data.

Hydrologically immature forests within significant rain-on-snow/sub-basin zones (i.e., those areas managed for rain-on-snow according to DNR Procedure 14-004-060) cover approximately 20 percent of the DNR-managed forested trust lands (Table 4.7-2). The data presented in Table 4.7.2 provide a general characterization of the current hydrologic maturity of the forested trust lands. In addition, rain-on-snow zones in many of these watersheds also include land classified as non-forested. Peak flows have the potential to be greater in non-forested areas than in forested areas in rain-on-snow zones.

Section 4.15, Cumulative Effects, provides additional information on the status of hydrologic maturity and on the sensitivity of the Alternatives, organized by individual watersheds.

4.7.4 Environmental Effects

4.7.4.1 Comparison of Alternatives

Procedure 14-004-060, which prohibits harvest of hydrologically mature forest in rain-on-snow and snow zones where the mature forest type makes up less than 66 percent of these zones, would not change under any of the Alternatives. Consequently, significant changes in peak flows due to harvest activities would continue to be avoided under all of the Alternatives. The Habitat Conservation Plan (HCP) Environmental Impact Statement (EIS) (DNR 1996) provides more detailed analyses of the effectiveness of the measures laid out in Procedure 14-004-060 and other procedures in minimizing potential adverse effects to peak flows from harvest activities (see Sections 4.2.3, 4.4.2, and 4.8, pages 4-139 through 4-180, 4-243 through 4-305, and 4-509 through 4-524). For this analysis, new road construction is assumed to be similar under all Alternatives. Consequently, the impacts from the road network would be essentially the same under all Alternatives (see Section 4.6).

Table 4.7-2. Areas of Hydrologic Maturity and Immaturity in Significant Rain-on-Snow/Sub-Basin Zones by Westside HCP Planning Unit (Current 2004)

HCP Planning Unit	Hydrologically Mature Forest in Rain-on-Snow Zones		Hydrologically Immature Forest in Rain-on-Snow Zones		Total Forest in Rain-on-Snow Zones (Acres)
	Acres	Percent	Acres	Percent	
Columbia	56,979	77	16,849	23	**73,828**
North Puget	62,541	84	11,685	16	**74,226**
OESF[1/]	20,988	58	15,205	42	**36,193**
South Coast	6,257	98	125	2	**6,382**
South Puget	36,710	86	5,734	14	**42,444**
Straits	2,998	97	87	3	**3,084**
Total	**186,474**	**79**	**49,684**	**21**	**236,157**

Data Source: DNR GIS overlay data.
[1/] OESF = Olympic Experimental State Forest

The potential for any of the Alternatives to result in significant adverse impacts to peak flows, therefore, would most likely result from soil compaction associated with timber harvest activities in riparian areas.

Under Alternative 1 (No Action), timber harvest would not be allowed in riparian areas except for access development (i.e., roads and yarding corridors). Therefore, no change in peak flows would be expected under this Alternative.

The impacts of Alternatives 2 and 3 with respect to changes in riparian procedures would be minor and would not affect peak flows. Over the long term, harvest in the middle and outer zones would result in more diverse stand conditions, which may mitigate potential peak flows.

Alternative 4 would not change the restrictions on allowable activities in Riparian Management Zones. No additional impact on peak flows would be anticipated under Alternative 4, compared to Alternative 1 (No Action).

Alternative 5 would allow more harvest in Riparian Management Zones than Alternatives 1, 2, 3, or 4. If ground-based yarding were implemented in these riparian areas, small areas within the Riparian Management Zones would be compacted, which could result in relatively small, highly localized, short-term increases in peak flows. Given the dynamic nature of hydrologic regimes, these changes to peak flows would not likely be detectable at a watershed scale.

The Preferred Alternative would allow moderate harvest activities within riparian areas than the other Alternatives. The area of disturbance in the Riparian land classification is estimated to be similar to Alternative 5, but there would be greater amount of variable density thinning and patch cuts in these areas (see high volume removal harvest column in Table 4.2-15). Depending on yarding methods, this Alternative could affect localized peak flows. Yarding systems that suspend logs, such as helicopter and cable with full suspension, would not cause soil compaction, and would therefore not affect peak flows. However, if ground-based yarding were implemented at the proposed rate, sufficient soil compaction may occur in some areas to cause localized increases in peak flows. Similar to Alternative 5, short-term localized increases would not likely be detectable at the watershed scale.

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4.8 WATER QUALITY

4.8.1 Summary of Effects

This section analyzes the environmental effects on water quality, and examines the current policy and procedures and the prospective changes. The analysis uses the modeling outputs to inform the public and decision-makers of the relative differences in potential environmental impacts of the Alternatives. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

None of the Alternatives would increase the risk of water quality degradation in the long term. Existing procedures adequately protect water resources. Short-term, localized sedimentation may increase in some areas immediately following harvest, but the vegetation in the inner and no-harvest portion of the Riparian Management Zones would prevent most sediment from entering streams. Over the long term, improved riparian function would likely lead to improved water quality on DNR forested trust lands.

In the short term, additional planning and implementation resources would be required to prevent sediment delivery to streams as a function of greater harvest in the Riparian Management Zones under Alternatives 2 and 3, and, to a greater extent, under Alternative 5 and the Preferred Alternative. However, in the long term, riparian function across the land base is expected to improve more rapidly under the Preferred Alternative than any other Alternative proposed, as discussed in Section 4.3 (Riparian).

4.8.2 Introduction

Water quality is a function of several variables, including sediment input, organic input, hydrology, levels of contaminants (including forest chemicals such as pesticides, herbicides, and fertilizers), and temperature. Each of these variables is dependent upon several factors, including local weather and climate, stream morphology, sources of erosion, levels of chemical use and pathways for migration of contaminants, filtering and binding capacity for contaminants of vegetation and organic material, and amounts and types of vegetation near streams.

Streams at lower elevations are likely to have higher temperatures than streams at high elevations. However, groundwater discharge may regulate temperature in smaller streams. Shading provided by vegetation helps maintain low water temperatures. Stream temperature may rise as a result of timber harvest in areas adjacent to streams due to effects of increased solar radiation. The link between stream temperature and upslope clearcuts is less certain. Finally, vegetation in riparian areas and in the watershed in general can reduce sediment input and overland flow of water, reducing peak flows, as discussed in Section 4.7, Hydrology. See also Section 3.6 of the Forest Practices Rules Final Environmental Impact Statement (Washington Forest Practices Board 2001).

Good water quality enables beneficial uses, such as fish habitat and recreation. The main issue identified for water quality during scoping was the potential adverse effects to water quality caused by forest management activities. Specifically, increases in-stream water temperature and sediment delivery to streams and the introduction of forest chemicals (i.e., pesticides, herbicides, and fertilizers) to the aquatic environment were identified as key issues. Changes to these parameters can affect aquatic habitat, recreation, and other beneficial uses.

4.8.3 Affected Environment

This section draws on the discussion in the Habitat Conservation Plan Environmental Impact Statement (DNR 1996) and Forest Practices Rules Environmental Impact Statement (Washington Forest Practices Board 2001) to describe the regulatory background and water quality conditions in western Washington. Refer to these documents for additional information related to water quality effects on the environment.

Temperature

Surface water temperature plays an integral role in the biological productivity of streams. Section 3.6 of the Forest Practices Rules Environmental Impact Statement (Washington Forest Practices Board 2001), as well as other recent studies (Sidhar et al. 2004; Bartholow 2000; Johnson and Jones 2000), described how the temperature of surface water is modified by forest management. Streamside vegetation prevents extreme daily fluctuation in temperature during low flows and high solar energy input by providing shade and absorbing energy. Dissolved oxygen concentrations are higher with lower temperatures, which benefits many aquatic biota. Low stream temperatures are critical for the survival of various fish species. When changes in water temperature occur as a result of timber harvesting, they are typically noted in small rivers and streams.

Sediment

Sedimentation accounts for significant water quality deterioration in forested lands in the state of Washington (Section 4.8, page 4-509, Habitat Conservation Plan Environmental Impact Statement [DNR 1996]). Sediment affects water quality in several ways. It creates a muddy (turbid) condition that restricts light in the stream environment. Nutrients combined with, or attached to, the sediment particles are added to surface water. Oxygen-demanding materials associated with sediment can reduce dissolved oxygen content. Sedimentation may also introduce harmful minerals and chemicals into surface water. Biological effects of increased turbidity may include a decrease in primary productivity of algae and periphyton because of decreased light penetration. Declines in primary productivity can adversely affect the productivity of higher trophic levels such as macroinvertebrates and fish. Siltation and turbidity have also been shown to affect fish adversely at every stage in their life cycle.

The amount of sediment that reaches a stream depends primarily on two processes: the availability of sediment and the ability of sediment to travel from its source to the stream. Sediment is produced through mass wasting and surface erosion, as described in Section 4.6, Geomorphology, Soils, and Sediment, and in Section 4.15, Cumulative Effects.

The ability of sediment to travel from its source to streams could be affected through changes in harvest in riparian areas. In general, the vegetation in riparian areas serves as a filter, removing sediment before it reaches a water body. In most cases, vegetation immediately adjacent to a stream channel is most important in maintaining bank integrity (Forest Ecosystem Management Assessment Team 1993). Protection of streambank integrity and adequate soil filtering of surface erosion is generally maintained with a fully functioning stand within 30 feet of a stream.

Forest Chemicals

Chemicals used in forest management include a variety of herbicides, fertilizers, and pesticides introduced to the forest environment to control or halt the proliferation of nuisance organisms or to improve soil productivity. Fertilizers used between 1993 and 2002 in the region include urea (aerial applications) and biosolids (ground applications). The following herbicides were also applied (aerially and by ground application): 2,4-D Ester, Accord, Arsenal, Garlon 4, Oust, Roundup, Transline, and Velpar L. Chemicals used in the forest environment can become water contaminants if they are transported to surface waters (or groundwater). They can also be directly applied to surface waters by overspray and spills. Contamination usually results from the lack of spray buffers or from applications over dry or ephemeral streams.

According to DNR records, between 1993 and 2002, herbicides were applied to approximately 70,000 acres within DNR-managed forested trust lands (Table 4.8-1). Ground applications of herbicides were applied in every HCP Planning Unit, while aerial applications occurred in all areas except the Olympic Experimental State Forest and the Straits HCP Planning Unit. Fertilization applications were less common, with aerial fertilization occurring only in the North Puget HCP Planning Unit. Ground fertilization occurred only in the North Puget HCP Planning Unit and, to a very limited extent, in the South Puget HCP Planning Unit (less than 100 acres).

Pesticide application rates on forested trust lands were infrequent (one to two applications every 40 to 60 years). Less than 5 percent of forested trust lands have been treated with chemicals during the last decade. This 10-year application history suggests that herbicides are the most common forest chemicals applied in the forested trust lands. These relative levels of use are likely to continue into the future.

Several monitoring studies designed to evaluate the effects to water quality from fertilization applications in western Washington and similar nearby forested lands have been conducted (Bisson 1988; Cline 1973; Moore 1974; McCall 1970; Ryan 1984; Ryan and Donda 1989). In general, the results of these studies show that significant short-term increases of urea, ammonia, nitrate, nitrite, and phosphorus typically following applications of urea and phosphorus-rich fertilizer. However, none of these studies found concentrations that exceeded water quality standards. Likewise, accelerated eutrophication (water pollution caused by excessive plant nutrients), which can lead to oxygen depletion, was not detected. Similarly, concentrations generally returned to pre-fertilization levels within 40 days (McCall 1970; Ryan and Donda 1989). Relatively large, localized increases were attributed to aerial fertilizer applications directly into tributary streams (Ryan 1984; Bisson 1988). Large precipitation events are correlated with increased nitrates measured in streams, caused by flushing of forested soils and delivery of chemicals to streams in storm runoff (Perrin 1976).

Table 4.8-1. Extent of Fertilization (Aerial and Ground) and Herbicide Application (Aerial and Ground) by Year in Forested Trust Lands

Year Completed	Area of Aerial Fertilization (Acres)	Area of Aerial Herbicides (Acres)	Area of Ground Fertilization (Acres)	Area of Ground Herbicides (Acres)	Total Area Treated (Acres)
1993	<1	1,449	<1	5,766	**7,215**
1994	<1	685	<1	1,491	**2,176**
1995	<1	1,436	<1	3,041	**4,478**
1996	<1	1,096	368	2,864	**4,328**
1997	20	2,874	381	2,926	**6,201**
1998	82	2,778	278	4,586	**7,724**
1999	2,888	3,882	456	2,946	**10,172**
2000	2,405	4,384	186	2,627	**9,602**
2001	<1	6,062	366	4,126	**10,554**
2002	<1	2,483	299	1,838	**4,620**
Total	**5,396**	**27,130**	**2,334**	**32,211**	**67,070**

Source: DNR Planning and Tracking database and e-mail communication from Carol Thayer, 7/24/03. Fertilization occurred in North Puget and South Puget HCP Planning Units.

Contaminants, such as fertilizers or herbicides that reach forest streams, can be flushed into larger water bodies. Some of these contaminants may be broken down by natural processes, such as ultraviolet radiation or digestion by organisms. In general, sufficient levels of increased nutrients can cause algae blooms in lakes and stagnant water bodies, causing eutrophication and resulting decreases in dissolved oxygen, potentially harming fish. Dissolved oxygen levels are further addressed with respect to forested trust lands in Section 4.10 (Fish) and Section 4.15 (Cumulative Effects).

Groundwater

Groundwater includes all water below the ground surface. Groundwater is not as sensitive to water quality degradation from forest management as surface water. In general, the quality of groundwater in aquifers depends more on aquifer and local geology than on forest influences. Activities in forest watersheds can affect groundwater quality, if they cover a large proportion of the watershed, and depending on the type and timing of the activity. See Section 4.8 of the Habitat Conservation Plan Environmental Impact Statement (DNR 1996) and Section 3.6 of the Forest Practices Rules Environmental Impact Statement (Washington Forest Practices Board 2001).

Subsurface flows, an important component of groundwater, are sensitive to immediate precipitation. Applying forest chemicals, for example, immediately prior to a rainstorm would increase the probability of degrading groundwater quality, if a sufficient portion of the watershed were treated. Groundwater contamination by forest chemicals can also occur through contaminated surface water recharge. As a result of the natural soil filters, groundwater recharged from forestland is generally of good quality.

4.8.3.2 Existing Water Quality

The Washington State Forest Practices Rules comply with the Clean Water Act to meet state water quality standards for surface waters and groundwater (Table 4.8-2). Water quality standards are set to provide for the protection of designated uses, including public water supply; wildlife habitat; and salmon spawning, rearing, and migration.

Section 303(d) of the federal Clean Water Act requires the state of Washington periodically to prepare a list of all surface waters in the state for which beneficial uses of the water are impaired by pollutants. As of 1998, about 2 percent of all the waters in Washington were identified as impaired. Segments of almost 250 streams were listed in western Washington in 1998 (see Appendix D). It is possible that other unmeasured water bodies also exceed water quality standards.

Table 4.8-2. Washington State Water Quality Standards for the Major Non-Chemical Parameters of Concern[1/]

Water Quality Parameter	Washington State Standard (Class AA, Excellent)	Washington State Standard (Class A, Good)
Temperature	Shall not exceed 16.0°C due to human activities. When natural conditions exceed 16°C, no temperature increase greater than 0.3°C is allowed. Incremental temperature changes from nonpoint source activities shall not exceed 2.8°C.	Shall not exceed 18.0°C due to human activities. When natural conditions exceed 18°C, no temperature increase greater than 0.3°C is allowed. Incremental temperature changes from nonpoint source activities shall not exceed 2.8°C.
Sediment	In regard to forest practices, implementation of approved Best Management Practices will meet narrative water quality criteria such as support characteristic water uses, aesthetic values, etc.	Same as Class AA.
Turbidity[2/]	Shall not exceed 5 nephelometric turbidity units (NTUs) over background when the background level is 50 NTUs or less, nor increase more than 10% of background when the background level is 50 NTUs or more.	Same as Class AA.

1/ New water quality standards have been proposed and are currently in a draft status. The new standards for temperature would be lower and more specific to fish populations (Department of Ecology 2003).

2/ Nephelometric turbidity units are the measurement units of turbidity using a nephelometer (light reflected surfaces of particles in suspension that are at right angles to the light source). 0 NTUs is clear and free of particles. >999 NTUs is essentially opaque.

NTU = nephelometric turbidity unit

Data Source: Forest Practices Rules Environmental Impact Statement (Washington Forest Practices Board 2001).

As stated in Section 4.8, page 4-509 of the Habitat Conservation Plan Environmental Impact Statement (DNR 1996), in general, the forests in western Washington contain waters of high quality. The primary water quality problem on forestlands throughout the state is temperature. Elevated water temperature generally occurs in areas where timber harvest or development has removed trees adjacent to rivers and streams, taking away shade, which is necessary to keep the water temperature low and healthy for fish. Other problems include erosion from road-building, construction, and agriculture, which increases sediment in streams (Forest Practices Rules Final Environmental Impact Statement, Section 3.6, page 3-106). A discussion of temperature and water quality problems on forested trust lands is also included in Section 4.15 (Cumulative Effects).

4.8.4 Environmental Effects

4.8.4.1 Comparison of Alternatives

Temperature

Stream temperature can be affected by the amount of shade provided by streamside vegetation. The Alternatives differ with respect to the level of harvest within the Riparian Management Zones. Refer to Section 4.3.4 (Riparian Environmental Effects) for details on the potential effects of the proposed Alternatives on stream shading. As described in that section, shade levels would generally improve under all Alternatives because all Alternatives would have a 25-foot no-harvest buffer, and would allow less harvest in the remainder of the Riparian Management Zone than allowed prior to implementation of the Habitat Conservation Plan riparian strategies. More large trees would develop (at differing amounts) under all Alternatives compared with current conditions. Improved shade levels would result in decreased stream temperatures, which would benefit most aquatic biota in these streams. Differences among the Alternatives in the amount of harvest allowed in Riparian Management Zones would lead to variations in anticipated effects on stream temperature. Relative to Alternative 1, some short-term reduction in shade may result from the removal of riparian trees under Alternatives 2, 3, 5, and the Preferred Alternative. However, across the land base, fully functioning riparian conditions, including increased shade in riparian areas from large trees, and therefore temperature reductions, would be expected more rapidly (80 to 90 years) with the Preferred Alternative than with the other Alternatives.

Sediment

Increased harvest would increase the risk of surface erosion from road use and other harvest-related activities, as well as the risk of mass wasting. The risk of sediment delivery to streams from surface erosion and mass wasting would be mitigated both by the use of existing policies and procedures, including appropriate road Best Management Practices, as well as the conservation of riparian sediment filtering functions, as discussed below and in the Riparian Section (4.3). The risk of sediment delivery from mass wasting would also be mitigated by existing policies and procedures and monitoring, as discussed in Section 4.6.4. Other than restoration activities, roads, and yarding corridors, none of the Alternatives proposes activities within the 25-foot no-harvest zone. The adjoining 75 feet is the minimal harvest zone that would include restricted activities that vary among Alternatives. This level of Riparian Management Zone protection reduces the differences in sediment delivery among Alternatives. Under Alternatives 1 and 4, the current riparian procedures would continue to be implemented and only riparian and stream restoration work and access development (roads and yarding corridors) would be allowed in Riparian Management Zones. These Alternatives would result in the same levels of sediment production described under current conditions and would not affect the filtering capacity of the Riparian Management Zone.

Alternatives 2 and 3 would allow more harvest in Riparian Management Zones and upland areas than Alternatives 1 and 4. The additional harvest in Alternatives 2 and 3 may lead to minor, localized increases in sediment caused by ground-based logging or, to a lesser extent, cable yarding and other ground disturbances. The increase in associated activities, such as road travel, could also contribute to the potential for increases in surface erosion. Surface erosion would be mitigated through the implementation of appropriate practices under these Alternatives. As a result, sediment production would not be significantly different from Alternatives 1 and 4.

Alternative 5 and the Preferred Alternative would involve increased management and, therefore, increased risk of surface erosion compared to Alternatives 1, 2, 3, and 4. The additional harvest modeled under Alternative 5 the Preferred Alternative may lead to minor, localized increases in sediment. Additionally, the increase in associated activities could also contribute to the potential for increases in surface erosion. The surface erosion would be mitigated through the implementation of appropriate policies and procedures under these Alternatives. The impacts that Alternative 5 and the Preferred Alternative would have on sediment delivery would likely be relatively minor as long as the no-harvest inner zone remains in place to filter sediment.

The Preferred Alternative proposes management levels by area across all land classes greater only than Alternative 1, the Alternative with the lowest overall management level. The Preferred Alternative however, proposes higher levels of management activities in riparian areas than is proposed under any of the other Alternatives, with most activities being high volume removals. Total area disturbance in the Riparian land class would be similar to Alternative 5 (Table 4.2-15). However, most of the disturbance would be from heavy thinnings designed to speed the development of structurally complex forest, while under Alternative 5, most disturbance in riparian areas would be as a result of light thinnings. Similar to Alternative 5, minor, localized and short-term sediment increases would be expected following harvest in these areas. The potential for surface erosion would be mitigated through the implementation of appropriate policies and procedures under this Alternative. The impacts that the Preferred Alternative and Alternative 5 would have on sediment delivery would likely be relatively minor as long as the no-harvest inner zone remains in place to filter sediment, and road-related Best Management Practices are functional and appropriate.

The potential for blowdown in Riparian Management Zones could be slightly greater than Alternative 5, because of increased levels of variable density thinning and patch cuts in the Riparian Management Zones. If blowdown occurs, root balls could be dislodged, leading to increased sediment. Potential adverse effects from increased harvest levels would be mitigated by using appropriate harvest and reforestation methods to prevent surface erosion, and by the riparian no harvest zone. However, openings greater than 1 acre can increase the risk of blowdown, which could affect the inner zone (Carey et al. 1996).

In the short term, additional planning and implementation resources would be required to prevent sediment delivery to streams as a function of greater harvest in the Riparian

Management Zones under Alternatives 2 and 3, and, to a greater extent, under Alternative 5 and the Preferred Alternative. However, in the long term, riparian function across the land base is expected to improve more rapidly under the Preferred Alternative than any other Alternative proposed, as discussed in Section 4.3 (Riparian).

Forest Chemicals

Fertilization levels would also differ under the Alternatives (Table 4.8-3). Alternatives 1, 2, 3, and 4, would include little to no fertilization. Alternative 5 would involve increased management intensity and would include fertilization treatments. The Preferred Alternative would include fertilization, but less frequently than under Alternative 5. Despite the relative differences in fertilization, these Alternatives would be consistent with existing forest policies and procedures, described in the Habitat Conservation Plan and Forest Practices Rules Environmental Impact Statement.

These policies and related mitigation measures were established, in part, to protect water quality. For example, mitigation measures exist to reduce the likelihood of accidental aerial applications directly to streams, the leading cause of water quality degradation from forest chemicals (see Appendix C for a discussion of policies and procedures). As a result, none of the Alternatives would likely result in significant adverse effects to water quality caused by forest chemicals.

Table 4.8-3. Fertilization Intensity by Alternative

	Alternatives					
Approach to Fertilization	**1**	**2**	**3**	**4**	**5**	**PA**
Little or none	X	X	X	X		
Available for specific forest types and sites					X	
Budget-limited for specific forest types and sites						X

PA = Preferred Alternative

4.9 WETLANDS

4.9.1 Summary of Effects

This section analyzes the environmental effects on wetland resources. The analysis uses the modeling outputs to inform the public and decision-makers of the relative differences in potential environmental impacts. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

DNR Forest Resource Plan Policy No. 21 states, “the Department will allow no overall net loss of naturally occurring wetland acreage and function.” The procedure (PR 14-004-110 Wetland Management) governs harvest activities in and around wetlands and is not proposed to change under the Alternatives.

The approximate delineation method, an approved approach to determine wetland boundaries, primarily uses maps and aerial photographs. However, not all wetlands, particularly forested wetlands, are visible on aerial photographs. Also, the Habitat Conservation Plan and its Environmental Impact Statement acknowledges that wetlands less than 0.25 acre may be affected by forest management activities. Thus, the difference in environmental impacts to wetlands under the proposed Alternatives would be a function of the acreage to be harvested and the amount of related activities under each Alternative. Over all, Alternative 1 would result in the lowest level of disturbance (an average of 11 percent per decade), followed by the Preferred Alternative, then Alternatives 4, 2, 3, and 5 (at 14, 15, 16, 17 percent, respectively). Alternative 5 would disturb the most acres, an average of 24 percent per decade, and would have the greatest affect on wetlands.

4.9.2 Introduction

Wetlands are defined as those “areas that are inundated or saturated with surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (Washington Administrative Code 222-16-010, Code of Federal Regulations 230.41a (1), U.S. Army Corps of Engineers Experimental Laboratory 1987). Wetlands are generally valued for the hydrologic, biogeochemical, and habitat functions that they perform. The primary environmental issue that relates to wetlands is the potential loss of wetland area or functions on forested trust lands due to forest management activities, including timber harvest and road construction.

4.9.3 Affected Environment

The policies and regulations that govern the management of wetlands on forested trust lands can be found in Appendix C.

4.9.3.1 Wetlands in Forested Trust Lands

Two sources of Geographic Information System data were used to identify acres of wetland in forested trust lands. The first source is FPWET, a DNR layer derived from National Wetlands Inventory data. National Wetlands Inventory, of the U.S. Fish and Wildlife Service, produces information on the characteristics, extent, and status of the nation’s wetlands and deepwater habitats. The wetland maps are based on stereoscopic analysis of aerial photographs and are useful in identifying the general location and extent of wetlands. However, this wetland inventory is not based on site visits. National Wetlands Inventory is generally thought to underestimate the extent of forested wetlands.

The second data source is from the DNR Forest Resource Inventory System. The land types of the areas reviewed were identified photographically by DNR foresters and had various levels of field review. Because the review was based primarily on photographic interpretation, it could also underestimate the extent of forested and small wetlands. Both data sources were used to identify the extent of wetlands mapped in DNR forested trust lands. Where there was a conflict between the two layers regarding wetland type, the DNR Forest Resource Inventory System was used to determine the wetland status.

Approximately 1.5 percent of the land in forested trust lands is mapped as wetland. Of that, 44 percent is mapped as forested and 56 percent is mapped as non-forested. As discussed above, the actual acres of wetland may be higher because the identification was done primarily by using aerial photographs.

The six Habitat Conservation Plan Planning Units range between 0.7 and 2.5 percent wetland (Columbia – 0.7 percent, North Puget – 1.2 percent, Olympic Experimental State Forest – 1.4 percent, South Coast – 2.5 percent, South Puget – 1.7 percent, and Straits – 1.9 percent).

4.9.3.2 Wetland Functions

Wetlands are ecologically important because of functions related to water quality, floodwater retention, groundwater recharge, and habitat for many kinds of organisms:

- **Hydrologic functions** include discharge of water to downstream systems, low-flow augmentation and flood-peak attenuation, surface and subsurface water storage, water dissipation through transpiration, and sediment retention.

  Benefits: stabilization of streamflow, floodwater attenuation, improved water quality.
- **Biogeochemical functions** include organic carbon production and export, cycling of elements and compounds, and maintenance of conditions, including soils that support diverse plant communities.

  Benefits: food chain support, toxicant and nutrient recycling, natural waste treatment, substrate for habitat diversity.
- **Habitat functions** include maintenance of characteristic habitat structures, habitat interspersion and connectivity, and vegetative community composition.

  Benefits: essential habitat for amphibians and aquatic invertebrates, utilization for nesting and feeding by numerous bird and mammal species, food web support, human aesthetic enjoyment, connectivity for wildlife movement, and refugia during environmental fluctuations.

Timber harvest activities in or around wetlands may result in loss of wetland area and wetland function.

4.9.4 Environmental Effects

The Alternatives considered in this analysis do not propose to change any policies or procedures for managing forested wetlands, non-forested wetlands, or Wetland Management Zones. In all Alternatives, harvest and harvest-related activities would occur in forested wetlands outside Riparian Management Zones, and light access development and maintenance would be allowed in the Wetland Management Zones, when necessary. However, differences between Alternatives in policies and procedures for managing Riparian Management Zones would affect the forested wetlands within the Riparian Management Zone boundaries.

Potential effects to wetland functions are discussed below. Functions vary considerably among wetlands, and functions and impacts might not affect every wetland. Also, there are limited data available on wetland hydrology or the impacts of harvest on wetlands, specifically in the Pacific Northwest. Most of the studies available have been done in other parts of the country, and generalizations related to harvest activities in the Pacific Northwest should be stated with caution. Brief descriptions on the impacts to wetland functions are provided below; more detail is available in the Habitat Conservation Plan Environmental Impact Statement (DNR 1996).

4.9.4.1 Direct Effects

Forested Wetlands

Tree-harvesting, especially clearcutting, in wetland sites can alter wetland hydrology and raise the elevation of the water table. Timber harvest has also been found to increase the range of week-to-week water level fluctuations (Verry 1997).

Changes in hydrologic patterns of wetland sites can directly influence plant species and growth within the wetland site. Excessive water in the substrate stops root growth and microbial activity, and can lead to unfavorable biochemical activity (Verry 1997). As discussed in the Habitat Conservation Plan (HCP) Environmental Impact Statement (EIS) (DNR 1996), wetlands provide important habitat for plants and receive disproportionately high use by wildlife. Changes in vegetation and substrate can have positive or negative impacts on specific species.

The altered water table and associated streamflow relationship, over large areas, could increase localized runoff and flooding. These effects can be short term, and cease once a site becomes revegetated with emergent, shrub, or forest vegetation (Grigal and Brooks 1997). In some cases, an elevated water table resulting from timber harvest in a forested wetland could preclude the re-establishment of trees in the long term. Because there are little data on forested wetland hydrological response to timber harvest in the Pacific Northwest, this represents an unknown risk. An inability to regenerate trees would be considered a loss of function in a forested wetland. As discussed in the HCP EIS (DNR 1996), wetlands perform an important function in augmenting streamflow during low-flow periods and in moderating flows during storm events.

Water quality of wetland sites can be measurably affected by harvest activities, although effects can be transient depending on the activities (Shepard 1994). Harvest and associated activities (road-building and use) can deliver sediment to wetlands, diminish water quality, and lead to the filling of wetland sites. Nutrient pathways within wetlands can also be affected. Nutrients are removed directly from wetlands during harvest, and increases in export of nutrients can occur after harvesting.

The timing and method used to extract products from the forest can significantly influence effects on wetlands. Heavy equipment use in wetlands usually has concentrated impacts in specific areas that can alter soil properties locally. Additionally, soil rutting and compaction from timber-harvest activities can reduce infiltration, redirect flow, and alter pathways by which water moves through and from wetlands (Grigal and Brooks 1997).

Tree harvesting and associated activities can also affect wetland sites and adjacent or nearby land by potentially altering hydrology; changing nutrient pathways; delivering sediment (which can diminish water quality); changing species composition, growth, and structure; and reducing shading. These factors could result in some loss in wetland functions. While the hydrologic and biogeochemical functions begin to return as soon as tree revegetation occurs, habitat functions can require more time and forest regrowth to return.

The Forest Resource Plan policies and HCP strategies were developed to reduce the potential effects of harvest to forested wetland functions. Maintaining and perpetuating a windfirm stand with a minimum basal area of 120 square feet per acre should maintain at least 95 percent of the evapotranspiration and prevent large changes to hydrology (DNR 1996). Retaining these trees would also reduce the loss of habitat. Minimizing disturbance as directed in the Forest Resource Plan and HCP reduces potential impacts to water quality and other functions through reduction of sedimentation, retention of soil conditions, and cycling of nutrients. Thus, timber harvest impacts to forested wetlands are reduced while still allowing DNR to meet its other management objectives.

Another potential impact to forested wetlands is related to the wetland inventory done before a harvest. The Forest Practices Rules do not require an on-site survey to delineate all wetlands, but call for approximate determination of the wetland boundaries within the proposed harvest area. Forested wetlands and wetlands smaller than 0.25 acre are difficult to identify through aerial photographs, are not always accurately located on maps, and are sometimes difficult to distinguish on the ground, especially during the dry season. Therefore, a functioning wetland could be misidentified as non-wetland during the planning and/or harvest activities.

While efforts are made to prevent this type of error, a wetland could be harvested as non-wetland. In this case, the wetland would not receive the protection of minimized disturbance as directed in the Forest Practices Rules and HCP, and as discussed above. The wetlands would be expected to experience at least short-term loss in wetland area and/or functions. While the hydrologic and biogeochemical functions can return if there is tree revegetation, the habitat functions can require more time and forest regrowth to return.

Wetland Management Zones (Non-Forested Wetlands and their Associated Buffers)

There are no proposed changes in the policies and procedures for Wetland Management Zones. The non-forested wetlands and buffer could experience disturbance, localized clearing, and possibly loss of wetland acreage. The impacts to wetland functions would be similar to impacts discussed above for forested wetlands. If an activity results in the loss of wetland acreage, on-site and in-kind, equal-acreage mitigation would be required.

As with forested wetlands, approximate determination of the wetland boundaries within the proposed harvest area is required for non-forested wetlands. While there is still potential to misidentify non-forested wetlands during this process, it is less likely because they are easier to recognize. If non-forested wetlands are not correctly identified and buffered, they would not receive the protection of Wetland Management Zone designation and would experience the effects described under Forested Wetlands.

Road Construction

Construction of roads can have the greatest direct impact on wetlands because it permanently removes the area from the wetlands, thereby eliminating the associated biological functions and potential for future tree growth from the impacted area. Additionally, crossing wetlands with roads and without adequate provision for cross-drainage can lead to flooding on the upslope side and subtle drainage changes on the downslope side of crossings (Stoeckeler 1967; Boelter and Close 1974).

The Forest Practices Manual requires accurate delineation of wetland boundaries for the portions of any wetland where road construction could result in filling or draining more than 0.1 acre. This would ensure that all potential losses of wetland acreage are identified. Avoidance of wetlands during road planning is a primary method for preventing effects to wetlands. Where the wetlands cannot be avoided, the Forest Resource Plan requires no net loss of wetland acreage or function.

The Forest Resource Plan and Habitat Conservation Plan require on-site and in-kind, equal-acreage mitigation for wetland losses. By implementing this mitigation, there should be no significant net effect to the acreage or hydrologic and biochemical function of wetlands in the site. There can be a reduction in habitat for some species by building a road.

4.9.4.2 Indirect Effects

A less obvious impact to wetlands is the indirect impact of harvest in adjacent acreage. Harvest of adjacent acres may affect the water quality and hydrologic functions through increased sedimentation and changes in the local hydrology. Harvest also could have an effect on habitat functions.

The buffers required for forested trust lands and Olympic Experimental State Forest wetlands were selected to protect the wetlands from impacts of forestry activities. In the Forest Practices Rules Final Environmental Impact Statement (Washington Forest Practices Board 2001), several references were cited to show that, in general, a buffer width of 100 feet or greater has been found to provide protection from impacts to the water quality and hydrologic functions. Discussions in that document also noted that a larger buffer would be needed to fully protect fish and wildlife habitat functions. The buffers required by the Forest Resource Plan for forested trust lands are 100 feet or larger. Therefore, harvest effects to hydrologic and biogeochemical functions in non-forested wetlands should be prevented and effects to wetland habitat functions should be minor.

4.9.4.3 Comparison of Alternatives

The potential impacts described above are types of impacts that could result from harvest or harvest-related activities occurring in wetlands. None of the Alternatives proposes any changes in the policies and procedures for management of harvest or harvest activities in wetlands or wetlands buffers. The difference in environmental impacts to wetlands under the proposed Alternatives would be a function of the acreage to be harvested and the amount of related activities under each Alternative. Overall, Alternative 1 would result in the lowest level of disturbance (an average of 11 percent per decade), followed by the Preferred Alternative, then Alternatives 4, 2, 3, and 5 (at 14, 15, 16, 17 percent, respectively). Alternative 5 would disturb the most acres, an average of 24 percent per decade, and would have the greatest effect on wetlands.

The first comparison considered is the percentage of riparian and wetland area disturbed in each Alternative. Because wetlands and wetland buffers were not separated from the stream data in the model, the Riparian land class is used to compare Alternatives. The Riparian land class includes streams, stream buffers, wetlands, and wetland buffers. While this classification includes land that is not wetland, it allows for a relative comparison of activities in areas that are likely to contain wetlands.

The second comparison considered is harvest activity outside Riparian Areas that may affect wetlands. These two types of areas are Upland Areas with General Management Objectives and Upland Areas with Specific Management Objectives, such as protection of unstable areas and Habitat Conservation Plan-identified species habitat or visual corridors. A higher level of harvest activity in either of these non-riparian areas would be expected to have a higher potential to affect wetlands, through direct harvesting and related activities such as road-building. Table 4.9-1 summarizes the average harvest per decade by Alternative by land class.

Activities in the Riparian Land Class

For each Alternative, the amount and type of harvest proposed for riparian areas is different. The impacts to the Riparian land class for each Alternative are discussed in detail in Riparian Areas (Section 4.3). Table 4.9-1 provides a summary of the average harvest by decade in the riparian and wetland areas for each Alternative.

Table 4.9-1. Average Percent of Acres in each Land Class Harvested per Decade

	Percent of Area of Land Class Harvested per Decade			
Alternative	**Riparian and Wetland Areas (percent)**	**Uplands with Specific Objectives[1/] (percent)**	**Uplands with General Objectives (percent)**	**Total All Classes (percent)**
1	2	11	20	**11**
2	4	22	21	**16**
3	5	21	26	**17**
4	5	16	25	**15**
5	7	37	27	**24**
PA	8	17	16	**14**

DNR source: Model output data – timber flow levels.

1/ Includes uplands with protection for unstable areas and Habitat Conservation Plan-identified species habitat, and visual corridors.

PA = Preferred Alternative

In riparian areas, Alternative 1 has the lowest level of activities, with an average of about 2 percent of acres disturbed per decade. Therefore, Alternative 1 would have the lowest potential to affect wetlands. This is followed by Alternative 2 with 4 percent per decade, Alternatives 3 and 4 with 5 percent, and Alternative 5 with 7 percent. The Preferred Alternative would have the highest level of harvest-related activities in Riparian Areas, with an average of 8 percent of acres disturbed per decade, which is the result of thinning to develop structurally diverse stands. Therefore, the Preferred Alternative would have the highest potential to affect wetlands in Riparian Areas, followed closely by Alternative 5.

Activities in the Upland Land Classes

In Upland Areas with Special Management Objectives, Alternative 1 has the lowest level of activities, with an average of about 11 percent of acres disturbed per decade. Therefore, Alternative 1 would have the lowest potential to affect wetlands in this land class. This is followed by Alternative 4 with 16 percent per decade and the Preferred Alternative with 17 percent per decade. Alternatives 2 and 3 would disturb 22 and 21 percent, respectively. Alternative 5 would have the highest level of harvest-related activities, with an average of 37 percent of acres disturbed per decade. Therefore, Alternatives 5 would have the highest potential to affect wetlands in the Upland Areas with Special Management Objectives and Alternative 1 the least.

In the Upland Areas with General Management Objectives, the Preferred Alternative (16 percent disturbance per decade) would have the lowest potential to affect wetlands. This is followed by Alternatives 1, 2, 4, 3, and 5, at about 20, 21, 25, 26, and 27 percent disturbance per decade, respectively. Alternative 5 would have the highest level of activities; therefore, Alternatives 5 would have the highest potential to affect wetlands in the Upland Areas with General Management Objectives, but the difference between Alternatives 1 through 5 is not as large as is the case in Uplands with Specific Objectives.

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4.10 FISH

4.10.1 Summary of Effects

This section analyzes the environmental effects on fish. The analysis examines the current policy and procedures and uses the modeling outputs to inform the public and decision-makers of the relative differences in potential environmental impacts. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

In general, the effects would be expected to follow those described in Section 4.3, Riparian Areas. Over the long term, all Alternatives would be expected to result in improved riparian and aquatic conditions for fish because of increased riparian function associated with continued growth or restoration of riparian stands. Larger and taller riparian tree stands with multiple canopy layers are expected to increase shade levels, functional in-stream large woody debris, leaf and needle litter, and improvements to coarse and fine sediment input and hydrologic regimes. In part, this would result by recovery from current degraded conditions in many areas caused by practices prior to the Habitat Conservation Plan rather than enhancement of natural conditions.

Relative to Alternative 1 and other Alternatives, the Preferred Alternative is expected to have more beneficial effects by increasing the rate at which riparian stands transition to structurally diverse, fully functioning stands. However, the Preferred Alternative also includes more intensive management of riparian areas for habitat enhancement. Under the Preferred Alternative, management activities would include a moderate level of infrequent, but heavy thinning activities designed to promote structural diversity in competitive exclusion stands that currently dominate in riparian areas. The current and proposed policies and procedures are designed to avoid, minimize, and mitigate for forest management practices on forested trust lands that have the potential to adversely effect the aquatic habitat features described below. On a relative basis, the slightly higher activity levels proposed under Alternative 5 and the Preferred Alternative suggest a slightly higher risk of adverse effects from forest management activities if mitigation measures are followed. Regardless of Alternative, the potential for adverse effects appear to be within levels anticipated under the Habitat Conservation Plan.

4.10.2 Introduction

Fish species are important natural resources that have ecological, economic, and cultural significance in the state of Washington. Pacific salmon and trout are good indicators of a properly functioning aquatic ecosystem, because they require cool, clean water; complex channel structures and substrates (beds under water bodies); and low levels of fine sediment (Bjornn and Reiser 1991). In addition, Pacific salmon and trout populations have provided for viable commercial and sport fishing industries. During the scoping process for sustainable forestry and associated harvest level, concerns were expressed about how the Alternatives would affect water quality, riparian areas, and aquatic habitat, including aquatic species. There were concerns about the potential effects of road maintenance, possible new road-building, and road abandonment.

For the purpose of this project, DNR forested trust lands are estimated to include approximately 13,950 miles of streams. About one-third (4,590 miles) of these streams are fish-bearing Type 1 to 3 streams[1]. The remaining streams do not support fish, but can influence downstream conditions through the transport of water, nutrients, leaf and needle litter, sediment, and woody debris. Numerous factors affect fish population numbers, which can be highly dynamic. Many of these factors are unrelated to forest practices on forested trust lands. Consequently, this analysis focuses on fish habitat rather than population numbers.

The effects analysis presented in Section 4.10.3 relies heavily on analyses presented earlier in this document including:

- Riparian Areas (Section 4.3)
- Geomorphology, Soils, and Sediment (Section 4.6)
- Hydrology (Section 4.7)
- Water Quality (Section 4.8)

The fish effects analysis synthesizes the pertinent components of the above analyses. These sections evaluate the components of the aquatic environment described below in Section 4.10.3 and the major issues developed during the scoping process.

4.10.3 Affected Environment

4.10.3.1 Priority Species

Fish species selected as the focus of this analysis include chinook, sockeye (kokanee), coho, and chum salmon; steelhead (rainbow); coastal cutthroat; and bull and Dolly Varden trout. These species were selected because, with the exception of Dolly Varden trout, they are listed as threatened under the federal Endangered Species Act or are a candidate species (coho salmon). All of the species mentioned have commercial or sport harvest value and are known to be sensitive to forest management activities. See page 3-121 of the Forest Practices Rules Final Environmental Impact Statement (Washington Forest Practices Board 2001) for additional details regarding these species.

The status of listed salmon species in Washington is currently undergoing re-assessment under the Endangered Species Act. In September 2001, the U.S. District Court in Eugene, Oregon, determined that the National Oceanic and Atmospheric Administration Fisheries Service could not split Oregon coast coho salmon into two components, hatchery and wild, and only list one component (wild fish) under the Endangered Species Act. While this decision did not specifically affect any listed salmon other than Oregon coast coho, the decision did prompt the Fisheries Service to re-assess the listing status and critical habitat designations for salmon species throughout much of the Pacific coast.

[1] The current DNR Geographic Information System layer for streams is believed to underestimate the amount of Type 3 streams. Consequently, for the purposes of the sustainable harvest calculations, stream types in the DNR Geographic Information System stream layer were modified by upgrading Type 9 and Type 5 streams to Type 4, and Type 4 streams to Type 3 (see Appendix B).

In addition to these re-assessments, the Fisheries Service is also considering how to treat hatchery populations identified in the Endangered Species Act listing determinations. The draft results of these determinations are expected to be published in mid-2004. Within the proposed rule (69 FR 33102, June 14, 2004), the Fisheries Service indicated that most anadromous salmon species listed in the Endangered Species Act would likely remain listed with their current status. The proposed rule would affect the status of the lower Columbia River coho evolutionarily significant unit located in southwestern Washington and portions of northern Oregon by downgrading from a candidate to threatened species status. The status of all other salmonid species that might be affected by activities on forested trust lands would not change under the proposed rule.

Regardless of potential changes in the Endangered Species Act status of these species, it is unlikely that the status of freshwater habitat conditions considered degraded in many westside watersheds has improved substantially since the Fisheries Service Endangered Species Act Status Reviews (see NOAA Fisheries [2003a] for a comprehensive list). The Habitat Conservation Plan (DNR 1997) has been in place only since 1997. Consequently, monitoring has not been conducted sufficiently long enough to demonstrate significant improvements in habitat conditions (DNR 2002b). Improvements in ocean conditions during the last few years have resulted in increased adult returns of Pacific Northwest salmon. However, these increases may also be influenced by other conservation efforts in the region (NOAA Fisheries 2003b).

A basic understanding of the life history and habitat requirements of Pacific salmon and trout is important for recognizing the type and level of effects that may result from a land-use activity such as timber harvest. The following represents a brief overview of salmon and trout life history. Additional details of species-specific traits can be found on pages 3-120 through 3-129 in the Forest Practices Rules Final Environmental Impact Statement (Washington Forest Practices Board 2001).

The life cycle of Pacific salmon and trout can be divided into seven distinct phases or lifestages: upstream migration, spawning, egg incubation, fry emergence, juvenile rearing, smolt outmigration, and marine rearing. One commonly recognized variation in life history traits for Pacific salmon and steelhead is the duration of freshwater rearing and the type of habitat that is used. It is the freshwater rearing period that is most vulnerable to land-use practices, including forest practices. Consequently, those species of fish with the longer stream-rearing periods are more likely to be adversely affected by forest practices.

Spring chinook salmon, coho salmon, and steelhead juveniles typically spend 1 or 2 years rearing in streams prior to migrating to the sea. Similarly, sockeye salmon usually spend a year rearing in a lake prior to their migration. In contrast, fall chinook and chum salmon migrate to the ocean as fry (small sub-yearling fish). Chum salmon usually complete their migration shortly after emergence (Wydoski and Whitney 1979), while fall chinook may have a prolonged migration period that occurs throughout the summer (Dawley et al. 1986). Five of the species (kokanee, rainbow, cutthroat, bull, and Dolly Varden trout) have life history forms that do not have a marine phase. They live their entire lives in freshwater.

During the period of freshwater rearing, Pacific salmon and trout have life-stage and species-specific habitat requirements for spawning and rearing. Important aspects to spawning habitat include substrate size (size of pebbles, rocks, and composition of the bottom of the stream or water body), water depth, and water velocity (Bjornn and Reiser 1991). In general, the larger species utilize larger substrates and deeper and faster water. Tail-outs to pools (the downstream end where the pool changes to a riffle or run) that meet criteria for these features are generally considered optimal spawning areas because stream structure maximizes the passage of oxygenated water through redds (nests dug by the fish in the substrate). However, runs and riffles are also used during spawning.

Following emergence from the redd, salmon and trout fry typically use shallow and slow-moving areas of a stream. Optimal depths and velocities increase as the fish grow, but preferred areas are usually associated with some form of cover, usually pools with large woody debris or boulders. Differences among the species are apparent in the degree of flexibility for utilizing riffles, runs, and other habitat features. Drifting insect larvae and benthic macroinvertebrates account for the majority of food items eaten by juvenile salmon and trout within streams.

In contrast to other salmon species, sockeye fry migrate to a lake shortly after emergence where shallow nearshore areas are preferred habitat. As sockeye fry grow, they begin to move offshore and have a characteristic diurnal vertical migration timed for utilization of zooplankton food sources.

4.10.3.2 Aquatic Ecosystem (Habitat Components)

Key physical components of the aquatic ecosystem include channel morphology or structure (floodplains, streambanks, channels), water quality, and water quantity. Habitat complexity is created and maintained by rocks, sediment, large woody debris, and favorable water quantity and quality. Upland and riparian areas influence aquatic ecosystems by supplying sediment, woody debris, and water. Disturbances such as landslides and floods are important mechanisms for delivery of wood, rocks, and pebbles that contribute to the streambed.

Natural channels are complex and contain a mixture of habitats differing in depth, velocity, and cover (Bisson et al. 1987). They are formed during storm events that have associated water flows that mobilize sediment in the channel bed (Murphy 1995). The hydrology, or the way water moves through the watershed, combined with its geology, hillslope characteristics, and riparian vegetation determine the nature of stream channel morphology (Sullivan et al. 1987, Beschta et al. 1995). Therefore, activities in these areas would be expected to affect the shape and form of the stream channel. For example, substantial increases in volume and frequency of peak flows can cause streambed scour and bank erosion. A large sediment supply may cause aggradation (i.e., filling and raising the streambed level by sediment deposition) and widening of the stream channel, pool filling, and a reduction in gravel quality (Madej 1982). Upslope activities (e.g., timber harvest, land clearing, and road development) can change channel morphology by altering the amount of sediment or water contributed to the streams. This, in turn, can disrupt the balance of sediment input and downstream movement in a stream reach (Sullivan et al. 1987).

Streams that lack a balance between pools and riffles (i.e., too few pools) are often less productive for salmon and trout than streams that have more complex structure. Pools are used as holding and resting areas for adult fish prior to spawning, deep water cover for protection, and cool water refugia during low-flow summer months. Riffles are important for re-oxygenation of water and habitat for food organisms such as aquatic macroinvertebrates (Gregory and Bisson 1997). Intensive timber harvest next to the water body has been reported to decrease pool depth, surface area, and the general diversity of pool character (Ralph et al. 1994). Possible mechanisms include decreased occurrence of large woody debris, which can help to form and stabilize pools, and filling of remaining pools with bed material.

The following describes components to the aquatic ecosystem that are influenced by forest practices. These include coarse sediment, fine sediment, hydrology, large woody debris, leaf/needle litter recruitment, floodplains and off-channel features, water temperature, forest chemicals (contaminants), and fish passage.

Coarse Sediment. Bedload material is necessary to provide substrate for cover and spawning habitat for fish. However, increased levels of coarse sediment bedload above background levels can lead to streambank instability, pool filling, and changes in the water transport capacity of the channel (Spence et al. 1996). Higher flows are required to mobilize larger sediment sizes. Consequently, the recovery period for streams with severe coarse sediment aggradation could range from decades to 100 years or more. The major factors influencing the excessive delivery of sediment to a stream include the intensity and location of streambank erosion, mass-wasting events, and road and culvert failures.

Fine Sediment. Fine sediment can degrade the quality of fish habitat by increasing water turbidity that restricts sunlight penetration. Sediment can also fill the pores between the gravel and prevent the flow of oxygen-rich water to fish eggs that may be deposited there (Bjornn and Reiser 1991). Fine sediments and larger particles such as sand-sized fractions can also smother fish eggs and developing young in the gravel, clog pores or breathing surfaces of aquatic insects, physically smother them, or decrease available habitat (Spence et al. 1996; Washington Forest Practices Board 2001).

Biological effects of increased turbidity may include a decrease in primary productivity of algae and periphyton due to the decrease in light penetration. Declines in primary productivity can adversely affect the productivity of higher trophic levels such as macroinvertebrates and fish (Gregory et al. 1987). Turbidity can also interfere with feeding behavior or cause gill damage in fish (Hicks et al. 1991), but may provide some benefits. For example, it can provide cover from predators (Gregory and Levings 1998).

Important factors related to forest management activities that can influence the excessive delivery of fine sediment to a stream include the presence of wetlands (see Section 4.9) and adequate streamside vegetation to filter fine sediment from hillslopes and road surface erosion (see Section 4.6).

Hydrology. The amount of water provided to aquatic ecosystems at critical times is important for sustaining fish and other aquatic species. Many fish species and populations have become adapted to natural flow cycles for feeding, spawning, migration, and survival needs. The timing, magnitude, and duration of peak and low flows must be sufficient to create and maintain riparian and aquatic habitat. Wetland areas are also an important component to hydrology by storing water and later releasing it directly to streams or through groundwater. In general, low- or base-level streamflows that occur during the late summer often limit habitat for rearing juvenile salmon and trout. High winter flows and floods that scour the streambed can be detrimental to eggs or young fish that may be incubating in the stream gravels. Rain-on-snow events are a common reason for flooding and streambed scour on the west of the Cascade Mountains and can be influenced by management activities such as timber harvest and roads (see Section 4.7).

Large Woody Debris. Large woody debris includes trees and tree pieces greater than 4 inches in diameter and 6 feet long (Keller and Swanson 1979; Bilby and Ward 1989). While large woody debris is considered one of the most important components of high-quality fish habitat (Marcus et al. 1990), the value of a particular piece of large woody debris in providing aquatic habitat depends on the stream size, tree species, and numerous other factors (see Section 4.3). Large woody debris provides food and building materials for many aquatic life forms and is important for stream nutrient cycling, macroinvertebrate productivity, and cover for juvenile and adult fish (Marcus et al. 1990). Large woody debris is also the primary channel-forming element in some channel types and affects many aspects of channel structure including stream roughness, sediment storage, water retention, energy dissipation, and fish habitat (Lisle 1986; Swanson et al. 1987; Marcus et al. 1990; Martin and Robinson 1998). Pools formed by stable accumulations of large woody debris provide important habitat for rearing salmon and trout, particularly in winter (Heifetz et al. 1986; Murphy et al. 1986).

Field studies in streams flowing through old Douglas-fir forests in coastal Oregon and Washington have shown that the number of woody debris pieces varies by channel width and size of debris under undisturbed conditions (Bilby and Ward 1989; Washington Forest Practices Board 1995). Coniferous wood (e.g., Douglas-fir or cedar) is more resistant to decay than deciduous wood (e.g., alder). Therefore, coniferous wood has a greater longevity in a stream (Cummins 1994 as cited in Spence et al. 1996).

In general, information on large woody debris must be viewed from the perspective of past timber harvest activity in an area, historical floods that have removed or redistributed large woody debris, and the activities that were performed to actively remove large woody debris (Maser and Sedell 1994). Long-term potential large woody debris recruitment from existing mature or old forest riparian zones would be anticipated to be higher than younger or recently clearcut areas (see Section 4.3.3.1, Riparian Functions).

Leaf and Needle Recruitment. The abundance and diversity of macroinvertebrate food sources to salmonids is dependent upon the primary algae and detrital food sources. Forest harvest activities affect the food chain by changing the relative macroinvertebrate production between herbivores and detritivores (Gregory et al. 1987). Many bacterial and macroinvertebrate species rely directly on detrital material from disintegrating leaf and needle litter, branches, and stems from the surrounding riparian zone vegetation. Some estimates indicate that leaf and needle recruitment may provide up to 60 percent of the total energy input to stream communities (Richardson 1992). In streams containing spawning habitat for Pacific salmon, significant influxes of nutrients from the marine environment occur during the decomposition of fish carcasses (Bilby et al. 1996).

Other macroinvertebrate species rely on aquatic algae that primarily use dissolved chemical nutrients (which are partially derived from decomposed litter, carcasses, and other sources), require solar radiation, and are affected by the amount of shade present in a stream reach. Although shade is important for maintaining cool water temperatures, more shade or complete shading does not always maximize aquatic productivity. The availability of in-stream algae can be a limiting factor in some streams. Algae and other sources of vegetable matter are at the lowest level of the food chain and important to higher trophic level production such as fish. High levels of shade can result in low levels of algae production even if adequate nutrient sources are present (Gregory et al. 1987). Under unmanaged conditions, forested lands generally have low light and low primary productivity in low-order streams with high canopy cover. In contrast, primary productivity in wide, high order streams is generally unaffected by riparian management because light penetration occurs even under mature riparian conditions (Gregory et al. 1987).

Floodplains and Off-Channel Habitat. Floodplains and off-channel areas are important components of aquatic habitat that provide side channels, wall-base channels, backwater alcoves, ponds, and wetlands. They also provide important habitat seasonally to particular life stages of fish as well as input of organic matter and large woody debris. Floodplains and off-channel habitat are protected under the Habitat Conservation Plan by establishing Riparian Management Zones that begin at the outer edge of the 100-year floodplain.

Water Quality (Temperature and Dissolved Oxygen). Water temperature plays an integral role in the biological productivity of streams and is an important factor influencing dissolved oxygen levels. Water temperature and dissolved oxygen levels can affect all aspects of salmon and trout life in fresh water including:

- incubation and egg survival in-stream gravel;
- emergence, feeding, and growth of fry and juvenile fish;
- outmigration of young fish;
- adult migration, holding and resting; and
- pre-spawning and spawning activities.

In coldwater species such as salmon and trout, water temperatures in the range of 70°F (about 21°C) or greater can cause death within hours or days (Oregon Department of Environmental Quality 1995). In general, water temperatures of 53° to 58°F (11.8° to 14.6°C) have been found to provide a properly functioning condition for juvenile salmon and trout. However, bull trout require much lower temperatures during spawning (39° to 50°F [4 to 10°C]) and egg incubation (34° to 43°F [1 to 6°C]) (Oregon Department of Environmental Quality 1995).

Increases in water temperature in forest streams can often be traced to a reduction in shade-producing riparian vegetation along fish-bearing and tributary streams that supply water to other fish-bearing streams (see Riparian Areas, Section 4.3). Long-term sublethal temperature effects can be detrimental to the overall health of a population, as can short-term acute effects of warm water temperatures on coldwater aquatic species. Heat stress may accumulate such that increased exposure for juvenile fish results in an environment in which growth is reduced or the inability to meet increased metabolic (energy) demands increases their susceptibility to disease (Oregon Department of Environmental Quality 1995).

Forest Chemicals. Water quality contaminants (e.g., petroleum products, chemicals, fertilizers, herbicides, sewage, and heavy metals) can severely impair aquatic ecosystems either by sublethal (e.g., reduced growth) or lethal effects (e.g., fish kills). The water quality contaminants considered herein are pesticides and herbicides used to prevent tree diseases and deter pest plant species that compete with trees for nutrients, space, and light.

Fish Passage. Upstream migration of adult salmon, steelhead, and trout to spawning areas or redistribution of rearing fish to potential habitat in upstream areas can be impeded or blocked by a number of different mechanisms. These mechanisms can include water temperature, dissolved oxygen, turbidity, and natural and man-made physical barriers (Reiser and Bjornn 1979).

Stream crossings by forest roads are the most common passage barrier influenced by forest practices. Barriers such as culverts used at stream crossings can prevent passage due to high water velocities, restricted depths, excessive elevation of the culvert (too high above stream level) for successful entry, size and length, and other factors. Shallow water depths from conditions such as low flow can also impede or prevent passage by causing riffles between pools to become completely dry or lack sufficient depth for passage. Similarly, some debris jams can prevent or delay upstream passage (Reiser and Bjornn 1979).

4.10.4 Environmental Effects

The changes proposed to policies and procedures under the Alternatives are described in Chapter 2. Other policies and procedures that affect fish and riparian conditions are described in Appendix C. Policy or procedural changes would directly or indirectly affect fish or fish habitat by modifying the intensity and frequency of harvest activities in areas (primarily riparian areas) that are available to harvest. Potential changes include those related to trust ownership groups, harvest flow, value- versus volume-based control of timber harvest, minimum forest stand regeneration age, and northern spotted owl conservation management strategies.

4.10.4.1 Alternatives Analysis by Habitat Component

Coarse Sediment. Excessive coarse sediment entering streams is commonly the result of forest management activities on unstable slopes or failures at road-stream crossings. All of the Alternatives would avoid activities on unstable slopes and are expected to have similar amounts of new road construction using modern construction standards. Consequently, no significant difference is expected among the Alternatives relative to coarse sediment entering streams. Please see Geomorphology, Soils, and Sediment (Section 4.6) for additional details.

Fine Sediment. Although restoration activities are allowable throughout the riparian buffer under the Habitat Conservation Plan (Pages IV.59-60), none of the Alternatives proposes activities within the 25-foot no-harvest buffer along Types 1 through 4 streams, except for yarding corridors and roads. Consequently, none of the Alternatives are likely to have a significant adverse effect on streambank stability or sediment filtering capacity from surface erosion as long as appropriate mitigation measures are also implemented, such as Road Maintenance and Abandonment Plans and full suspension yarding within the no-harvest zone. Please see Geomorphology, Soils, and Sediment (Section 4.6) and Riparian Areas (Section 4.3) for additional details.

Hydrology. The effects of the Alternatives on hydrology were analyzed based upon the potential changes in the amount of hydrologically mature forest in the rain-on-snow zone and amount of harvest in the riparian areas. Constraints to harvest in the rain-on-snow zone are the same under all Alternatives. Consequently, none of the Alternatives allows harvest of hydrologically mature forest in rain-on-snow zones below critical levels (66 percent of the zone). Even at the higher harvest levels in the riparian zone expected under Alternative 5 and the Preferred Alternative, detectable adverse effects to the local peak flows of the waterbody are unlikely.

Large Woody Debris. The potential of adding more large woody debris is expected to improve under all of the Alternatives. Over the short term, all of the Alternatives are expected to produce about the same amount of riparian area included in stand development stages with large and very large trees, i.e., trees more than 20 inches in diameter (about 61 to 62 percent of the Riparian land class).

Over the long term, Alternatives 1 and 4 are expected to result in the highest amount of riparian area (about 90 percent of the Riparian land class) in stand development stages with large or very large trees, followed in descending order by Alternatives 2, 3, and 5 (about 82 to 83 percent of the Riparian land class), and the Preferred Alternative (about 78 percent). Although the Preferred Alternative is predicted to have the lowest area of stand development stages with large and very large trees among the Alternatives, it is also predicted to result in the highest amount (about 13 percent) of Riparian land class area in niche diversification and fully functioning stand development stages, while Alternative 5 is predicted to have the lowest amount (about 4 percent).

The major feature that distinguishes these two stand development stages from other stages with large and very large trees is the presence of multiple canopy layers and higher levels of decadence such as snags, down coarse woody debris, and epiphytes. Alternatives 1 and

4, which are expected to have the highest area of stand development stages with large and very large trees, are predicted to have about 7 percent of Riparian land class area in niche diversification and fully functioning stand development stages. Consequently, over the long term, the Preferred Alternative is expected to produce higher riparian function on more of the Riparian land class relative to Alternative 1, but with the trade-off of having less area of stand development stages with large and very large trees in the Riparian land class during the Habitat Conservation Plan period.

Based upon the model outputs, the potential for adverse effects to fish resources from all Alternatives for the first decade is expected to be minimal in all HCP Planning Units because harvest activity levels are relatively low, at less than 8 percent of the Riparian land class, and average about 7 percent or less for all decades and HCP Planning Units. The differences would generally be minor except under the Preferred Alternative and Alternative 5. Under these Alternatives, large woody debris recruitment potential in some HCP Planning Units could be slightly lower during some decades because of the relatively high level of activity, to as much as about 20 percent of the Riparian land class during a decade, primarily from heavy thinning activities. Under Alternative 5, riparian timber harvest in the Olympic Experimental State Forest is expected to result in disturbance levels as high as approximately 15 percent in an individual decade. Unlike Alternative 5, the Preferred Alternative would likely produce more acres of niche diversification and fully functioning riparian stands over the long term and place more stands on a trajectory towards full function because of more intensive active silvicultural management designed to increase the structural complexity of riparian stands. In addition, the biodiversity pathway treatments proposed under the Preferred Alternative include activities to create downed wood (i.e., fall and leave in place large trees), which can also act as in-stream large woody debris if targeted for the stream corridor. However, the Preferred Alternative would also likely result in fewer riparian acres of large and very large trees within the Habitat Conservation Plan planning period. Those areas with large and very large trees that do not receive the treatments proposed under the Preferred Alternative may require substantially longer periods (over 100 years) to achieve full riparian function (Carey et al. 1996).

Additional details concerning large woody debris recruitment and the likely effects of the Alternatives can be found in Section 4.3 (Riparian Areas).

Floodplains and Off-Channel Habitat. Protection of floodplains and off-channel habitat is not expected to differ among the proposed Alternatives. Harvest activities prior to implementation of the Habitat Conservation Plan sometimes resulted in the harvest of trees right to the stream edge and did not consider protection to floodplains and off-channel habitat. Consequently, these areas are expected to improve under all Alternatives, while riparian vegetation in these areas grows. Active management under Alternatives 2, 3, 5, and the Preferred Alternative could result in thinning or hardwood conversion activities, but these activities are not expected in floodplains, off-channel habitat, or the 25-foot no-harvest zone required in the five Westside HCP Planning Units.

Water Quality. Increases in water temperatures along forest streams can often be traced to a reduction in shade-producing riparian vegetation (see Riparian Areas, Section 4.3). Water temperatures in forested trust lands would likely be maintained or improved over the long term under all Alternatives. The presence of very large trees is important for maintaining stream shade and cool water temperatures, particularly for larger streams. Over the short term, all Alternatives are expected to result in about the same amount of area in stand development stages with large and very large trees. Over the long term, Alternatives 1 and 4 are expected to have the highest amount of riparian area in stand development stages with large and very large trees, followed in descending order by Alternatives 2, 3, and 5. The Preferred Alternative is expected to have the lowest amount of the Riparian land class in stands dominated by large and very large trees, but is also expected to have the largest area in structurally complex stand developmental stages.

Improvements in stream shade anticipated under Alternative 5 and the Preferred Alternative may be slightly less than under Alternatives 1 through 4 over the short term because of the harvest of riparian trees and potentially greater numbers of yarding corridors. Harvest activities in upland land classes is expected to average about 18 percent per decade under Alternative 5 compared to about 9 to 13 percent for the other Alternatives. Consequently, the need for cross-stream yarding and yarding corridors may be higher for Alternative 5, but not the Preferred Alternative, which is near the lower end of the range of upland harvest levels. However, Alternative 5 and the Preferred Alternative could result in slightly lower levels of stream shading in some HCP Planning Units during some decades, because of the higher level of disturbance, as much as approximately 15 percent of the Riparian land class during a given decade under Alternative 5 and as much as 20 percent under the Preferred Alternative. The short-term reductions in shade that might occur form tree removals in the riparian zone under the Preferred Alternative are primarily designed for long-term enhancement of riparian stands and are expected to result in relatively high levels of shade over the long term.

Additional details concerning water quality and the likely effects of the Alternatives can be found in Water Quality (Section 4.8) and Riparian Areas (Section 4.3).

Forest Chemicals. Little or no use of forest chemicals such as fertilizers and herbicides is expected under Alternatives 1 through 4. Alternative 5 and the Preferred Alternative propose higher use in terms of frequency and amounts. However, mitigation measures implemented by DNR, such as manual application in riparian zones, exist to reduce the likelihood of forest chemicals entering streams. Consequently, none of the Alternatives is expected to result in significant adverse affects to water quality and the associated fish resource from forest chemicals. Please see Water Quality (Section 4.8) for additional details.

Leaf and Needle Recruitment. Relative to current conditions, leaf and needle litter recruitment to streams would be expected to increase in the long term under all of the Alternatives due to growth of trees in the riparian zone. However, relative to Alternative 1, the improvement in leaf and needle litter production may be slightly less under Alternatives with higher activity levels because of the harvest of some riparian trees and potentially greater numbers of yarding corridors. The amounts of these activities are expected to be generally minor, although the risk of adverse effects may be slightly higher under Alternative 5 and the Preferred Alternative due to slightly higher riparian activity levels. Over the long term, riparian areas treated under the biological pathways approach of the Preferred Alternative are expected to more rapidly achieve fully functioning stand characteristics, including higher levels of leaf and needle recruitment in comparison to stands that remain in competitive exclusion stages for long periods.

Fish Passage. The amount of new road construction needed for stand access is expected to be similar under all Alternatives. New roads and any stream crossings needed would be built using current standards that require adequate fish passage. Replacement of sub-standard stream crossings that are considered passage problems will occur as part of DNR's road maintenance and abandonment program. Fish passage at man-made structures would be expected to improve over time under all of the Alternatives.

4.11 PUBLIC UTILITIES AND SERVICES

4.11.1 Summary of Effects

This analysis considers the potential effects of the Alternatives on harvest volumes. Volume directly affects revenue to the beneficiaries and some beneficiaries partially fund public utilities and services with timber revenue. This section also considers the potential effects of the proposed Alternatives on transportation infrastructure. The analysis uses the modeling outputs to inform the public and decision-makers of the relative differences in potential environmental impacts. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

The Alternatives provide a wide array of direct economic benefits to the beneficiaries. In other words, the relationship between the Alternatives is not consistent across all beneficiaries. Projected annual average harvest levels are, for example, highest for agricultural school grant lands under the Preferred Alternative, but highest for university grant lands under Alternative 5. This variation is also evident for western Washington forested state trust lands when projected harvest levels are viewed by county. Projected forested state trust lands harvest levels are, for example, highest under Alternative 5 in Wahkiakum County, but highest under Alternative 3 in Skamania County. These modeling outputs do not provide precise harvest schedules, but they can represent a likely distribution of harvest levels over time at the county level. While they provide an indication of the possible distribution of harvest by county, it is difficult to predict what effect this variation would have on the built environment.

Potential effects on transportation infrastructure would vary by Alternative, with larger projected harvest volumes resulting in increased logging truck traffic. Alternatives with larger projected harvest volumes would, however, also result in more revenue available for maintenance and improvements to public utilities and services. Potential transportation impacts would occur within the context of total forest management activity within the state of Washington and surrounding regions. Current DNR harvests represent about 13 percent of total western Washington harvest. Logging companies harvesting timber from forested trust lands must meet Washington State Department of Transportation weight requirements and pay taxes that support road improvements. DNR regularly meets with local government officials and engineers to discuss the effects of logging-related traffic (DNR 1992b). These measures would help mitigate potential impacts associated with increased road traffic. As a result, none of the Alternatives is expected to result in any probable significant adverse environmental impacts on transportation infrastructure.

4.11.2 Introduction

This section provides an overview of the potential effects of the proposed Alternatives on public utilities and services. Public utilities and services were not directly raised as issues during scoping, but some issues were raised with respect to revenue generation from management of forested trust lands. These include concerns with predictable and reliable flows of revenue to trust beneficiaries.

The potential effects of the Alternatives on harvest volumes, and therefore trust revenues, are considered here in general terms because these revenues are mainly used by beneficiaries to fund public utilities and services, particularly schools. The potential effects of the proposed Alternatives on transportation infrastructure are also discussed in this section.

4.11.3 Affected Environment

4.11.3.1 Forested State Trust Lands and Trust Beneficiaries

There are three types of forested state trust land: federal grant, state forest (formerly known as Forest Board), and community college forest reserve. These three types of lands are discussed in the following sections.

Federal Grant Lands

The Omnibus Enabling Act of 1889 set aside 2 square miles out of every 36 (2 sections in each township) in the state to provide financial support for the common schools. The Act also granted additional sections of land to other state institutions. These lands, known as “federal grant lands,” consist of eight specific trusts, including:

- **Agricultural school** lands, which support Washington State University in Pullman.
- **Capitol building** lands, which support the construction of state office buildings on the capitol campus in Olympia.
- **Charitable, educational, penal, and reformatory institutions** lands, which support these public institutions.
- **Common school** lands, which support the construction of public schools.
- **Normal school** lands, originally designated to support the state teachers colleges, which have become the regional universities: Western Washington University, Central Washington University, Eastern Washington University, and The Evergreen State College.
- **Scientific school** lands, which support Washington State University.
- **University original** lands, which support the University of Washington. Only a small amount of that acreage remains.
- **University transfer** lands, which were originally part of the charitable, educational, penal, and reformatory institutions trust but were designated by the state legislature to provide additional support to the University of Washington.

Approximately 844,000 of the 2.2 million acres of federal grant trust lands in the state of Washington in 2001 were located in westside counties (Table 4.11-1). Approximately 92 percent (773,000 acres) of the federal grant trust lands in westside counties were forested (Table 4.11-1). These acreages are shown by trust in Table 4.11-1. The common school lands accounted for about 508,000, or 66 percent, of forested federal grant trust acres in western Washington.

Table 4.11-1. Trust Lands Managed by DNR, by Trust Beneficiary

	Total Acres[1/]	Total Forested Acres[1/]	Westside Acres[2/3/]	Westside Forested Acres[4/]
Federal Grant Trust Lands				
Agricultural School Grant (Washington State University)	70,733	56,783	27,579	26,210
Capitol Building Grant	108,281	100,290	91,715	85,460
Charitable, Educational, Penal, and Reformatory Institutions Grant	70,278	40,141	29,289	26,810
Common School, Indemnity, and Escheat Grants	1,746,020	1,103,452	560,377	508,307
Normal School Grant (Eastern Washington University, Central Washington University, Western Washington University, and The Evergreen State College)	64,304	57,005	34,757	32,549
Scientific School Grant (Washington State University)	80,455	68,549	56,268	52,995
University Grants (University of Washington) Original and Transferred	86,806	56,954	43,723	41,130
Federal Grant Trust Land Total	**2,226,877**	**1,483,174**	**843,708**	**773,461**
State Forest Lands				
Purchase and Transfer	625,178	595,241	603,025	563,604
Community College Forest Reserve[5/]				
Community College Forest Reserve Lands	3,339	3,339	3,339	3,079
Total for all Trust Lands	**2,852,055**	**2,078,415**	**1,446,733**	**1,337,065**

Data Sources:
[1/] DNR 2001 (various tables).
[2/] DNR Geographic Information System data 2003.
[3/] DNR Geographic Information System data identifies 79,672 acres in 9 other categories: Administrative Site, Tidelands - 2nd Class, Land Bank, CEP&RI Transferred, Under Contract to Private Party, Natural Area Preserve, Natural Resources Conservation Area, Non-specific Non-fiduciary Trust, and Water Pollution Control Division Trust Land.
[4/] These data compiled from the OPTIONS model identify 50,558 acres in the 9 other categories identified in footnote 3.
[5/] Lands managed per Revised Code of Washington (RCW) 79.02.420, which specifies the management of, and disposition of revenues from, these lands.
Note: Numbers rounded; when added may not equal total.

Annual westside timber harvest is presented by trust beneficiary for Fiscal Year 1998 to Fiscal Year 2002 in Table 4.11-2. Total westside harvest ranged from 412 million board feet in Fiscal Year 2002 to 542 million board feet in Fiscal Year 1999, with an annual average of 479 million board feet. Federal grant trust land accounted for approximately 41 percent of the average annual total. State forest lands accounted for about 58 percent, with community college forest reserve lands and other comprising the remaining 1 percent.

Table 4.11-2. Annual Westside Timber Harvest by Trust Beneficiary, Fiscal Year 1998 to Fiscal Year 2002 (million board feet)[1/]

	Fiscal Year[2/]					
	1998	1999	2000	2001	2002	5-year Average
Federal Grant Trust Lands						
Agricultural School Grant (Washington State University)	8.8	9.9	6.6	4.3	4.1	6.8
Capitol Building Grant[3/]	21.7	23.9	34.2	21.0	30.7	26.3
Charitable, Educational, Penal, and Reformatory Institutions Grant	9.1	11.8	10.7	10.6	11.0	10.6
Common School, Indemnity, and Escheat Grants[3/]	136.4	142.4	137.2	112.4	87.5	123.2
Normal School Grant (Eastern Washington University, Central Washington University, Western Washington University, and The Evergreen State College)[3/]	7.1	2.9	10.2	6.4	11.9	7.7
Scientific School Grant (Washington State University)	22.3	28.0	16.0	17.3	15.3	19.8
University Grants (University of Washington) Original and Transferred[3/]	4.6	6.1	0.8	6.5	2.6	4.1
Federal Grant Trust Land Total	**210.1**	**225.0**	**215.7**	**178.5**	**163.1**	**198.5**
State Forest Lands						
Purchase and Transfer[3/]	266.1	314.6	305.2	249.5	244.5	276.0
Community and Technical College Reserve						
College Reserve	1.8	0.3	0.0	0.8	1.3	0.8
Other	0.5	2.4	4.4	6.7	3.3	3.5
Total for all Beneficiaries	**478.5**	**542.3**	**525.3**	**435.5**	**412.2**	**478.8**

Notes:
1/ Timber is sold before it is harvested. Timber sale contracts average 2 years in length, with timber harvest schedules determined by individual purchasers. Revenues are generated when timber is harvested.
2/ DNR's Fiscal Year extends from July 1 through June 30. Fiscal Year 2002, for example, extended from July 1, 2001, through June 30, 2002.
3/ All harvest volume for state forest purchase lands designated as university repayment and state forest repayment are included in the state forest purchase total.
Data Source: DNR Report TSC312.

Federal grant trust lands located in westside counties generated an annual average income of $83.2 million between Fiscal Year 1998 and Fiscal Year 2002, with the common school grant lands accounting for 63 percent or $52.6 million of this total (Table 4.11-3). Total annual income generated by federal grant trust lands in westside counties has fluctuated over the last 5 years, ranging from $52.1 million in Fiscal Year 2002 to $104.2 million in Fiscal Year 1998 (Table 4.11-3).

Table 4.11-3. Annual Westside Timber Income Generated by Trust Beneficiary, Fiscal Year 1998 to Fiscal Year 2002 ($ million)[1/]

	Fiscal Year[2/]					
	1998	**1999**	**2000**	**2001**	**2002**	**5-year Average**
Federal Grant Beneficiaries[3/]						
Agricultural School Grant (Washington State University)	3.9	4.1	2.4	1.5	1.0	2.6
Capitol Building Grant[4/]	8.4	9.2	11.3	6.6	9.7	9.0
Charitable, Educational, Penal, and Reformatory Institutions Grant	4.4	4.9	4.5	3.4	3.8	4.2
Common School, Indemnity, and Escheat Grants[4/]	69.4	66.0	55.6	44.8	27.2	52.6
Normal School Grant (Eastern Washington University, Central Washington University, Western Washington University, and The Evergreen State College)[4/]	5.5	3.6	7.0	4.3	5.2	5.1
Scientific School Grant (Washington State University)	9.2	11.7	5.7	5.6	4.0	7.2
University Grants (University of Washington) Original and Transferred[5/]	3.6	4.2	1.4	2.0	1.3	2.5
Federal Grant Beneficiaries Total	**104.2**	**103.7**	**87.9**	**68.2**	**52.1**	**83.2**
State Forest Beneficiaries						
Purchase and Transfer[4/5/]	124.9	136.1	114.9	86.8	77.7	108.1
Community College Forest Reserve						
Community College Forest Reserve Lands	0.2	0.0	0.0	0.1	0.2	0.1
Total for all Beneficiaries	**229.3**	**239.8**	**202.8**	**155.0**	**130.0**	**191.4**

Data Source: DNR Report TSC312.
[1/] Annual income figures are adjusted for inflation and presented in 2002 dollars.
[2/] DNR's Fiscal Year extends from July 1 through June 30. Fiscal Year 2002, for example, extended from July 1, 2001 through June 30, 2002.
[3/] Gross timber revenue before reduction for management funds (Resource Management Cost Account and Forest Development Account).
[4/] Revenue from state forest purchase lands designated state forest repayment are split:12.67% to school grant; 4.83% to capitol grant; 15.45% to normal grant, and 67.05% to state forest.
[5/] Revenue from state forest purchase lands designated university repayment are split: 32.14% to university grant and 67.86% to state forest.

On average, statewide DNR timber sale revenue accounted for approximately 73 percent of annual federal grant trust land income between Fiscal Years 1998 and 2002. This percentage ranged from 61.5 percent in Fiscal Year 2001 to 85.1 percent in Fiscal Year 1998. Timber sale revenue as a share of annual federal grant trust lands income declined between Fiscal Years 1998 and 2001, but increased from 61.5 percent in Fiscal Year 2001 to 71.2 percent in Fiscal Year 2002 (Table 4.11-4). The decline between Fiscal Years 1998 and 2001 was particularly notable for the common school grant, which saw timber sale revenue decrease from 82.3 percent of total trust revenue in 1998 to just 53.5 percent in Fiscal Year 2001 (Table 4.11-4). About half of this decline is the result of increases in non-timber revenue resulting from the purchase of timberlands by the legislature for

Table 4.11-4. Timber Sale Revenue as a Proportion of Total Annual Trust Income by Trust Beneficiary, Fiscal Year 1998 to Fiscal Year 2002 (Percent)

	Fiscal Year					
	1998	**1999**	**2000**	**2001**	**2002**	**5-year Average**
Federal Grant Trust Lands						
Agricultural School Grant (Washington State University)	95.8	94.8	93.5	83.4	86.5	90.8
Capitol Building Grant	96.0	97.5	98.1	98.2	96.1	97.2
Charitable, Educational, Penal, and Reformatory Institutions Grant	80.3	78.3	81.8	71.4	82.1	78.8
Common School, Indemnity, and Escheat Grants	82.3	68.8	64.6	53.5	62.4	66.3
Normal School Grant (Eastern Washington University, Central Washington University, Western Washington University, and The Evergreen State College)	95.3	96.4	98.5	98.0	96.6	96.9
Scientific School Grant (Washington State University)	93.4	95.0	94.0	86.2	82.2	90.2
University Grants (University of Washington) Original and Transferred	90.7	93.8	80.3	88.8	81.8	87.1
Federal Grant Trust Land Total	**85.1**	**75.5**	**71.7**	**61.5**	**71.2**	**73.0**
State Forest Lands						
Purchase and Transfer	98.9	99.4	99.5	99.4	98.0	99.0
Total for all Trust Lands	**91.3**	**86.7**	**83.3**	**76.7**	**83.0**	**84.2**

Data Sources: DNR 1998, 1999, 2000, 2001, 2002a.

Note: DNR's Fiscal Year extends from July 1 through June 30. Fiscal Year 2002, for example, extended from July 1, 2001, through June 30, 2002.

transfer out of trust ownership into parks and other non-consumptive uses through the trust land transfer program. This program is limited to the common school, indemnity, and Escheat grants lands.

State Forest Lands

Overview

Beginning in the 1930s, the state acquired about 620,000 acres of forestlands that had been privately owned. Most of these lands had been logged and abandoned, and reverted to county ownership for non-payment of taxes. The predominant attitude toward the state's forest during the early part of the last century was much different than it is today. After the timber was removed from privately owned lands either by harvest, fire, or both, the remaining land had little or no economic value. After harvesting, many landowners abandoned the lands and stopped paying taxes. These tax delinquent lands reverted to the counties who were unable to sell the land because there was no market. The counties were even less able than the private sector to manage them. Most of these lands, then in bad condition, simply sat idle. The state Legislature, concerned about reforestation of these lands to provide future timber supply, provided legislative direction on how to manage and authorize these lands in the 1921 Reforestation Act. These "state forest lands," formerly known as Forest Board lands, are defined in RCW 79.02.010(10).

In 1923, the Legislature authorized the use of utility bonds of $200,000 to acquire forestland and to pay for reforestation. The bonds were to be repaid from management revenues from these lands rather than the state's general fund. The Legislature authorized the acquisition of state forest purchase lands for not more than $6.00 per acre for forested lands and $2.00 per acre for logged over lands. These lands are known as state forest purchase lands.

In 1927, the Legislature passed a law providing that the counties could transfer tax delinquent forestlands to the state to be managed as state forests. No lands were transferred until 1935, when the Legislature passed legislation requiring the counties to transfer tax delinquent land suitable for forestry uses to the state to be managed in trust as part of the state forest system. These lands are also known as state forest transfer lands.

In that year (1935), the Legislature authorized an additional $300,000 in utility bonds to acquire additional state forest purchase lands. However, the amount that could be paid for these lands was reduced to $1.00 for logged over lands and $3.00 for forested lands. The Legislature authorized issuance of additional bonds each biennium through 1949.

DISTRIBUTION OF STATE FOREST REVENUES

Below is a description of the state statutes governing the distribution of revenues raised by DNR on state forest lands.

State Forest Transfer Revenues

RCW 79.64.110 provides direction for the distribution of any moneys derived from state forest lands, and RCW 79.64.110 (1) directs the distribution of revenues generated from state forest transfer lands. RCW 79.64.110 (1)(a) reads as follows:

> The expense incurred by the state for administration, reforestation, and protection, not to exceed twenty-five percent, which rate of percentage shall be determined by the board, must be returned to the forest development account in the State General Fund.

The Board of Natural Resources has set the current Forest Development Account deduction at 22 percent, and the remaining 78 percent is distributed to the counties per RCW 79.64.110 (1)(b):

> Any balance remaining must be paid to the county in which the land is located to be paid, distributed, and prorated, except as otherwise provided in this section, to the various funds in the same manner as general taxes are paid and distributed during the year of payment.

Most counties (the exceptions are Skamania and Wahkiakum Counties – see RCW 79.64.110 (1)(c) below) are required to distribute the revenue they receive from State Forest Transfer lands to the various taxing districts in the same manner (paid, distributed, and prorated) as general property taxes are distributed. The actual distribution of revenue from a timber sale depends on which taxing districts the harvest is located in and the tax rates during the year that harvest occurred.

In 2003, the average distribution of property taxes statewide was 55.8 percent to schools, 17.5 percent to the counties general fund (including roads), 13.8 percent to cities and towns, and 13 percent to various local taxing districts (ports, fire, library, hospital, emergency medical, and parks) (Washington State Department of Revenue 2004). The average distribution varies from county to county and from year to year. The proportion of state forest transfer revenue distributed to schools is an offset to State General Fund expenditures; that is, the moneys received by the schools from the State General Fund are reduced by the amount they receive from state forest transfer lands.

RCW 79.64.110 (1)(c) provides an exception, and reads as follows:

> Any balance remaining, paid to a county with a population of less than sixteen thousand, must first be applied to the reduction of any indebtedness existing in the current expense fund of the county during the year of payment.

Of the 19 counties that receive State Forest Transfer revenues, only 2 have populations of less than 16,000: Skamania and Wahkiakum Counties. For these two counties, the county's portion of revenues from State Forest Transfer Lands is distributed first to the counties current expense fund to pay any existing indebtedness. Any excess is distributed in accordance with the general property taxes distribution. All of the revenue to Wahkiakum County and most of that to Skamania County has gone to their general fund. The result is that these counties retain more revenue, rather than having a large portion offset by the comparable withholding of State General Fund revenues to schools. In addition, they have more control over how those revenues are expended.

State Forest Purchase Revenues

RCW 79.64.110 (2) directs the distribution of revenues generated from State Forest Purchase lands. RCW 79.64.100 (2)(a) reads as follows:

> Fifty percent shall be placed in the forest development account.

Unlike the management fund deduction for the state forest transfer lands, the deduction for state forest purchase lands is a fixed amount rather than a maximum.

The remaining 50 percent is distributed to the counties per RCW 79.64.110 (2)(b):

> Fifty percent shall be prorated and distributed to the State General Fund, to be dedicated for the benefit of the public schools, and the county in which the land is located according to the relative proportions of tax levies of all taxing districts in the county. The portion to be distributed to the State General Fund shall be based on the regular school levy rate under RCW 84.52.065 and the levy rate for any maintenance and operation special school levies. With regard to the portion to be distributed to the counties, the department shall certify to the state treasurer the amounts to be distributed within seven working days of receipt of the money. The state treasurer shall distribute funds to the counties four times per month, with no more than ten days between each payment date. The money distributed to the

county must be paid, distributed, and prorated to the various other funds in the same manner as general taxes are paid and distributed during the year of payment.

The portion distributed directly to the general fund is prorated based on the regular school, and maintenance and operation special school levies. The money distributed to the county is distributed to the taxing districts other than the schools in the same manner (paid, distributed, and prorated) as property taxes are distributed.

While the distribution of the revenues remaining after the forest development account deduction may seem different for the purchase and transfer lands, in fact only the administrative route is different, and the resulting distribution is the same. This is because the proportion distributed to the schools for state forest transfer is an offset to general fund revenue, while the state forest purchase portion is transferred directly to the State General Fund.

Revenues Generated from State Forest Lands

There were approximately 625,000 acres of state forest lands in the state of Washington in 2001, with the majority (603,000 acres) located in westside counties (Table 4.11-1). State forest lands (purchase and transfer) located in westside counties generated an average annual income of $108.1 million between Fiscal Year 1998 and Fiscal Year 2002, about 56 percent of the total income generated by DNR on western Washington forested trust lands (Table 4.11-3). Total annual income generated by state forest lands has fluctuated over the last 5 years, ranging from $77.7 million in 2002 to $136.1 million in 1999 (Table 4.11-3). On average, timber sale revenue accounted for 99.0 percent of statewide annual state forest lands income between Fiscal Years 1998 and 2002 and stayed relatively constant over this period (Table 4.11-4).

Revenue to beneficiaries (County and General Fund) from state forest (purchase and transfer) lands are presented by county for Fiscal Years 1998 through 2002 in Table 4.11-5. In contrast to the state forest revenue data summarized in Table 4.11-3, these data are for all revenue sources, not just timber. These data show that revenues can fluctuate quite dramatically from year-to-year, with the westside county total ranging from $59.2 million in Fiscal Year 2002 to $110.8 million in Fiscal Year 1999 (Table 4.11-5). Total annual average payments from Fiscal Years 1998 through 2002 ranged from $0.8 million in Kitsap County to $10.5 million in Skagit County.

Annual average revenue data from all sources for 1998 through 2002 are compared with annual average general property taxes for the same period in Table 4.11-6. Total state forest revenues are compared with general property taxes by county because, with the exception of Skamania and Wahkiakum Counties, revenues are distributed as regular property taxes where the revenue is generated and during the years the revenues are generated. It should, however, be noted that the state forest income data are by fiscal year, while the general property tax data are presented for calendar years. Total forest income represents approximately 2 percent of total general property taxes for the 17 westside

Table 4.11-5. Revenue from all Sources to Beneficiaries (County and General Fund) from State Forest Lands in Westside Counties ($ million)[1/2]

County	1998	1999	2000	2001	2002	5-year Average
			Fiscal Year			
Clallam	9.6	13.5	7.3	6.0	5.4	8.4
Clark	5.6	8.0	4.3	2.3	3.2	4.7
Cowlitz	3.0	2.5	3.4	2.1	3.8	3.0
Grays Harbor	4.5	2.9	4.8	3.6	4.5	4.1
Jefferson	0.5	2.5	1.4	1.6	0.8	1.4
King	2.8	1.9	2.7	1.4	1.7	2.1
Kitsap	1.6	0.9	0.3	1.1	0.1	0.8
Lewis	10.2	18.4	13.1	5.3	2.7	9.9
Mason	3.0	2.2	2.8	2.0	1.8	2.4
Pacific	3.8	7.9	4.4	2.9	3.4	4.5
Pierce	1.1	1.8	0.6	1.1	1.8	1.3
Skagit	11.2	12.7	11.4	6.3	10.8	10.5
Skamania	1.4	3.8	2.0	1.2	0.3	1.7
Snohomish	9.5	9.4	13.9	13.4	5.7	10.4
Thurston	12.6	10.8	9.4	9.7	6.3	9.8
Wahkiakum	5.2	2.2	1.8	0.9	3.0	2.6
Whatcom	7.2	9.5	2.6	6.9	3.9	6.0
Total	**93.0**	**110.8**	**86.2**	**68.0**	**59.2**	**83.4**

Source DNR Annual Reports.

1/ In contrast to the state forest revenue data summarized in Table 4.11-3, these data are for all revenue sources, not just timber, but do not include revenue to the management fund (forest development account). These data also include revenue transferred directly to State General Fund.

2/ Annual income figures are adjusted for inflation and presented in 2002 dollars.

counties combined (Table 4.11-6). This percentage varies considerably by county, ranging from less than 1 percent of general property taxes in King, Kitsap, and Pierce Counties to more than 100 percent in Wahkiakum County (Table 4.11-6).

Community College Forest Reserve

In addition to federal grant and state forest lands, DNR also manages a small amount (3,339 acres) of forestlands for community colleges (Table 4.11-1). These lands are addressed in the 1992 Forest Plan, and are managed per RCW 79.02.420, which specifies the management of, and disposition of revenues from, these lands.

Table 4.11-6. Annual Average Total State Forest Income as a Proportion of Annual Average General Property Taxes by Westside County, 1998 to 2002

County	$ Million: State Forest Income Average FY 1998-2002[1/2/]	$ Million: General Property Taxes Average CY 1998-2002[2/3/]	Ratio of State Forest Revenues to General Property Taxes
Clallam	8.4	41.0	20.4%
Clark	4.7	308.6	1.5%
Cowlitz	3.0	77.9	3.8%
Grays Harbor	4.1	46.8	8.7%
Jefferson	1.4	29.8	4.6%
King	2.1	2,164.8	0.1%
Kitsap	0.8	198.0	0.4%
Lewis	9.9	48.6	20.4%
Mason	2.4	44.5	5.3%
Pacific	4.5	19.0	23.5%
Pierce	1.3	617.7	0.2%
Skagit	10.5	100.8	10.4%
Skamania[4/]	1.7	7.4	23.6%
Snohomish	10.4	575.0	1.8%
Thurston	9.8	184.9	5.3%
Wahkiakum[4/]	2.6	2.5	105.0%
Whatcom	6.0	150.1	4.0%
Total	**83.4**	**4,617.4**	**1.8%**

Source: DNR Annual Reports 1998, 1999, 2000, 2001, and 2002a; Washington Department of Revenue 2004.
FY = Fiscal Year; CY = Calendar Year
1/ In contrast to the state forest revenue data summarized in Table 4.11-3, these data are for all revenue sources, not just timber, do not include revenues to the management fund (FDA). These data also include revenue transferred directly to State General Fund.
2/ Annual income figures are adjusted for inflation and presented in 2002 dollars.
3/ General property tax collection including delinquent payments in year received.
4/ Revenues to counties with a population of less than 16,000 are applied to the county's current expense fund.

4.11.3.2 Transportation Infrastructure

The Final Environmental Impact Statement (EIS) for the DNR Forest Resource Plan indicated that DNR operated about 12,000 miles of roads (throughout both western and eastern Washington), building approximately 60 miles of new road each year. About 7,500 miles of these roads are used for transportation, with another 3,600 miles maintained only for fire prevention and management. Current estimates from the DNR Forest Practices Transportation Layer (2004) indicate there are 14,000 statewide road miles on DNR-managed lands, with just over 8,000 miles of road in western Washington (see Road Density Analysis in Chapter 4, Section 4.6.3 on Geomorphology, Soils, and Sediment). DNR decommissions roads that are no longer needed.

Timber harvest, fire control, and recreation activities all generate traffic on DNR forest roads. The largest single source of traffic is associated with DNR's management of forested trust lands, although recreation access may be the largest use in some areas. Traffic from these activities extends from the network of DNR and private forest roads onto county roads, as well as state and interstate highways. County and state roads are affected to varying degrees by logging trucks and other traffic generated from timber harvesting on forested trust lands, as well as timber harvesting on other types of land ownership.

Timber harvest data are presented by westside county for forested trust lands in Table 4.11-7.

This table also presents forested trust land harvest as a percentage of total harvest (state, federal, and private) by county. Data are presented for 2002, with the annual average for 1998 to 2002 also provided. Harvest volumes from all lands in 2002 were lower than the 1998 to 2002 average for all but four westside counties. Harvest volumes from trust lands in 2002 were higher than the 1998 to 2002 average in 7 of the 19 westside counties (Table 4.11-7). These data are all presented by calendar year.

Table 4.11-7. Forested Trust Lands Compared to Total Timber Harvest in Western Washington by County, Calendar Year 1997 to Calendar Year 2002 (million board feet)

	2002			1998-2002 Average		
County	**Forested Trust Land Harvest**	**Total Harvest[1/]**	**State as a % of Total**	**Forested Trust Land Harvest**	**Total Harvest[1/]**	**State as a % of Total**
Clallam	19.0	206.9	9.2	35.5	246.9	14.4
Clark	17.7	52.4	33.8	22.9	76.1	30.1
Cowlitz	29.1	217.3	13.4	30.0	254.4	11.8
Grays Harbor	41.6	502.7	8.3	38.2	500.0	7.6
Island	0.0	2.3	0.0	0.0	14.0	0.0
Jefferson	19.0	73.6	25.8	15.4	71.8	21.5
King	19.0	91.0	20.9	13.2	141.1	9.3
Kitsap	0.4	19.1	2.0	2.8	28.4	9.7
Lewis	13.2	452.8	2.9	47.3	442.6	10.7
Mason	20.2	134.9	14.9	20.2	167.3	12.1
Pacific	25.8	265.3	9.7	37.0	294.5	12.6
Pierce	20.1	165.3	12.2	15.9	211.9	7.5
San Juan	0.0	0.6	0.0	0.0	1.9	0.0
Skagit	57.0	124.3	45.9	45.0	146.1	30.8
Skamania	0.8	32.0	2.6	11.6	42.3	27.3
Snohomish	40.1	90.8	44.2	41.4	120.6	34.3
Thurston	26.2	97.6	26.9	45.3	114.0	39.8
Wahkiakum	15.6	69.0	22.6	15.1	86.9	17.4
Whatcom	33.0	106.3	31.0	30.2	93.9	32.2
Total Westside Counties	**397.8**	**2,704.1**	**14.7**	**467.0**	**3,054.8**	**15.3**

Data Source: DNR Washington Timber Harvest Reports 1998, 1999, 2000, 2001, and 2002a.
[1/] The total timber harvest volumes presented in this table include timber harvest from all land ownerships, including Native American, Forest Industry, Large Private, Small Private, State (DNR-managed lands), Other Non-federal National Forest, and Other Federal.

Assuming an average load per logging truck of 4.5 thousand board feet suggests that harvest from all lands in Grays Harbor County in 2002, for example, generated about 111,700 logging truck trips. Using the same assumption, harvest from state lands in Snohomish County in the same year generated about 20,200 logging truck trips. It should be noted that each logging truck trip consists of two parts: one way with a full load, and one way empty.

4.11.4 Environmental Effects

4.11.4.1 Forested Trust Land and Trust Beneficiaries

This section summarizes projected harvest levels by Alternative. It compares these with annual average harvest levels over the past 5 years to offer some insight into the potential effects of the proposed Alternatives on trust revenues. This analysis allows for comparison among Alternatives, and provides some indication of their relative value. It does not, however, attempt to project future revenues. Actual revenues will be determined by a number of factors, including prices for timber that are determined in the wider marketplace. While projected annual average harvest allows a comparison among Alternatives, it does not take into account variations in harvest costs among Alternatives. Potential purchasers factor expected harvest costs into the amount they bid for a particular timber sale, with higher cost sales receiving lower bids. As a result, it should be noted that while projected harvest levels allow some comparison among Alternatives, increases in harvest do not necessarily represent a commensurate increase in revenue.

Projected 2004 to 2013 annual average harvests are presented, by trust beneficiary and Alternative, in Table 4.11-8. The largest projected total harvest would occur under Alternative 3, with a total harvest of about 663 million board feet, followed by Alternative 5 (648.3 million board feet), the Preferred Alternative (636.1 million board feet), Alternative 2 (536.7 million board feet), Alternative 4 (410.9 million board feet), and Alternative 1 (396.2 million board feet). Projected average annual harvests for 2004 through 2013 for Alternatives 2, 3, 5, and the Preferred Alternative are higher than the actual average annual harvest from 1998 to 2002.

The largest amount of harvest would occur on state forest lands and common school, indemnity, and escheat grant lands under all Alternatives. State forest lands range from 45 percent of the total projected volume under the Preferred Alternative, to 54 percent under Alternative 3. The common school, indemnity, and escheat grant lands range from 27 percent of the projected total under Alternative 3 to 33 percent under Alternative 2. Projected average annual harvests for the common school, indemnity, and escheat grant lands are higher than the 1998 to 2002 annual average for all Alternatives, with the exception of Alternatives 1 and 4.

Table 4.11-8. Projected Annual Average Westside Harvest by Trust Beneficiary and by Alternative, 2004 to 2013 (million board feet)

		Alternative					
Trust Beneficiary	**5-Year Westside Annual Average[1/]**	**1**	**2**	**3**	**4**	**5**	**PA**
Federal Grant Trust Lands							
Agricultural School Grant (Washington State University)	6.8	9.3	9.1	7.7	12.2	11.4	16.8
Capitol Building Grant	26.3	33.9	39.5	47.2	29.1	57.6	57.8
Charitable, Educational, Penal, and Reformatory Institutions Grant	10.6	14.2	15.2	17.2	11.6	16.3	19.4
Common School, Indemnity, and Escheat Grants	123.2	114.3	176.2	182.2	120.3	203.5	198.1
Normal School Grant (Eastern Washington University, Central Washington University, Western Washington University, and The Evergreen State College)	7.7	6.4	11.7	11.2	7.4	12.6	9.5
Scientific School Grant (Washington State University)	19.8	22.7	21.9	28.1	22.9	26.7	31.6
University Grants (University of Washington) Original and Transferred	4.1	2.1	12.8	10.0	4.2	14.5	12.5
Federal Grant Trust Land Total	**198.5**	**202.9**	**286.3**	**303.7**	**207.7**	**342.6**	**345.6**
State Forest Lands							
Purchase and Transfer	276.0	192.0	249.6	359.1	202.1	305.2	289.4
Community and Technical College Reserve							
College Reserve	0.8	1.4	0.9	0.3	1.2	0.5	1.1
Total	**478.8**	**396.2**	**536.7**	**663.1**	**410.9**	**648.3**	**636.1**

PA = Preferred Alternative
[1/] This is the annual average for forested trust lands in westside counties for 1998 to 2002 (for individual years, see Table 4.11-2). These data are by fiscal year. Projected annual average harvest data are by calendar year.
Data Source: Model output data – timber flow levels.

Federal Grant Lands

Projected annual average harvest levels for 2004 to 2013 on federal grant lands are higher than the 1998 to 2002 actual annual average under all Alternatives (Table 4.11-8). Projected annual average harvest levels over this period range from 202.9 million board feet under Alternative 1 to 345.6 million board feet under the Preferred Alternative. There is some variation by beneficiary. Projected harvest levels are, for example, highest under the Preferred Alternative for the agricultural school grant; capitol building grant; charitable, educational, penal, and reformatory institutions grant; and scientific school grant lands. Projected harvest levels are highest for the remaining three federal grant land groups (common school, indemnity, and escheat grant; normal school grantl; and university grant) under Alternative 5 (Table 4.11-8).

State Forest Lands

Unlike federal grant trust land revenues, which are distributed to the same beneficiary regardless of where the harvest takes place, revenues from state forest lands are distributed based on the taxing district in which the harvested land is located. With the exception of Skamania and Wahkiakum Counties, revenues to the counties are distributed based on the distribution of general property taxes, where the revenue was generated, and within the year the revenues were generated. Within a county, sales may benefit one taxing district or another based on the sale location. Because a local taxing district only benefits when harvest occurs on land within that taxing district, it may only benefit once or twice per rotation. As a result, revenue distribution to counties and to junior taxing districts within those counties is expected to vary from year-to-year under all of the proposed Alternatives and is difficult to accurately predict. In addition, about half of the revenues to counties benefit the state's general fund either directly (purchase lands) or as an offset to State General Funds to the schools (transfer lands). Therefore, not only is it difficult to predict where harvest will occur in the future, it is also difficult to predict what effect this revenue would have on the built environment.

The following discussion of projected average annual state forest land harvest by county allows a relative comparison to be made by Alternative and county. These modeling results do not provide precise harvest schedules, but they can represent a likely distribution of harvest levels over time at the county level. More precise short-term harvest schedules will be developed through operational level planning.

Projected annual average harvest levels for 2004 to 2013 for state forest lands are higher than the 1998 to 2002 annual average under Alternatives 3 and 5 and the Preferred Alternative. The geographic distribution of the projected harvest over this period would vary by Alternative. Projected harvest under Alternative 3 is largest in Thurston County (44.6 million board feet) followed by Clallam (39.7 million board feet) and Lewis (35.3 million board feet) counties (Table 4.11-9). Under Alternative 5, projected harvest is largest in Clallam County (66.3 million board feet) followed by Skagit (36.5 million board feet) and Snohomish (26.6 million board feet) counties. Projected harvest under the Preferred Alternative is largest in Skagit County (49.1 million board feet) followed by Clallam (45.7 million board feet) and Snohomish (27 million board feet) counties. Projected harvest under Alternatives 2 and 4 is highest in Skagit County, followed by Snohomish and Thurston counties. Under Alternative 1, projected harvest levels are highest in Skagit County, followed by Thurston and Snohomish Counties (Table 4.11-9).

The ratio of annual average state forest revenues to general property taxes from 1998 through 2002 varied by county and also by year (Tables 4.11-5 and 4.11-6). Annual average ratios over this period ranged from less than 1 percent of general property taxes in King, Kitsap, and Pierce Counties to more than 100 percent in Wahkiakum County. This ratio was also above 20 percent in Clallam, Lewis, Pacific, and Skamania Counties (Table 4.11-6). Projected annual average harvest levels for 2004 through 2013

Table 4.11-9. Projected Annual Average Harvest on State Forest Lands[1/] by County and Alternative, 2004 to 2013 (million board feet)

County	5-year Annual Average[2/]	Alternative 1	2	3	4	5	PA
Clallam	29.1	12.7	25.5	39.7	20.3	66.3	45.7
Clark	13.1	12.3	14.7	28.3	10.0	15.9	12.4
Cowlitz	8.4	4.8	6.0	11.2	5.0	5.8	4.9
Grays Harbor[3/]	21.8	11.3	10.2	22.5	8.5	14.7	15.5
Jefferson	3.6	5.3	6.2	15.6	3.3	7.2	6.1
King	5.6	8.9	7.8	6.3	5.6	10.8	10.5
Kitsap	2.1	2.8	2.7	5.8	2.4	3.2	2.1
Lewis	29.1	16.9	22.1	35.3	19.1	23.6	19.5
Mason	6.9	8.3	8.9	30.1	7.3	9.8	5.0
Pacific[4/]	18.2	6.0	10.8	12.7	13.3	14.4	16.9
Pierce[4/]	3.9	6.0	7.5	5.1	2.0	7.3	9.4
Skagit	31.9	30.0	35.2	27.7	31.8	36.5	49.1
Skamania	5.5	5.4	16.9	28.5	3.0	20.4	25.9
Snohomish	33.9	22.9	27.7	18.9	27.1	26.6	27.0
Thurston[3/]	38.2	23.5	27.2	44.6	24.3	22.1	18.9
Wahkiakum	7.1	3.6	5.1	8.7	5.8	6.9	5.7
Whatcom	17.7	11.3	15.1	18.2	13.5	14.0	14.9
Total	**276.0**	**192.0**	**249.6**	**359.1**	**202.1**	**305.2**	**289.4**

PA = Preferred Alternative
[1/] State Forest lands per RCW 79.02.010(10) are formerly known as Forest Board Lands.
[2/] This is the annual average for CY 1998 to CY 2002 as historical state forest harvest by county is not available by Fiscal Year.
[3/] Five-year annual average includes all volume harvested from Forest Board Purchase lands designated as Forest Board Repayment Lands within the county
[4/] Five-year annual average includes all volume harvested from Forest Board Purchase lands designated as University Repayment Lands within county
Data Source: Model output data – timber flow levels; DNR 2002a

for these counties vary substantially by Alternative. Projected harvest levels in Wahkiakum County range from 3.6 million board feet under Alternative 1 to 6.9 million board feet under Alternative 5. In Clallam County, projected harvest levels range from 12.7 million board feet under Alternative 1 to 66.3 million board feet under Alternative 5. Projected harvest levels in Lewis County range from 16.9 million board feet under Alternative 1 to 35.3 million board feet under Alternative 3. In Pacific County, projected harvest ranges from 6 million board feet under Alternative 1 to 16.9 million board feet under the Preferred Alternative. Projected harvest in Skamania County ranges from 3 million board feet under Alternative 4 to 28.5 million board feet under Alternative 3 (Table 4.11-9).

The relationship between projected annual average harvest levels for 2004 through 2013 and actual annual harvest levels between 1998 and 2002 also varies by county and Alternative. In Clallam County, annual average projected harvest levels would be higher than actual annual average 1998 to 2002 harvest levels under Alternatives 3 and 5 and the Preferred Alternative, and lower than the actual annual average under the other Alternatives. In Lewis and Wahkiakum Counties, projected annual average harvest levels would be lower than actual levels under all Alternatives, with the exception of Alternative 3. Projected annual average harvest levels would be lower than actual 1998 to

2002 levels under all Alternatives in Pacific County. In Skamania County, projected annual average harvest levels would be higher under all of the Alternatives, with the exceptions of Alternatives 1 and 4 (Table 4.11-9).

4.11.4.2 Transportation Infrastructure

The following analysis considers projected average annual harvest by Alternative and county as a general indication of the relative potential impact of the proposed Alternatives on transportation infrastructure. Assuming an average load of 4.5 thousand board feet per logging truck, Alternatives with larger projected harvest volumes would result in more logging traffic with larger associated potential effects to transportation infrastructure. The following discussion of projected average annual harvest by county allows a relative comparison to be made by Alternative and county, but does not attempt to quantify these potential effects in terms of projected infrastructure improvement costs. Although, as previously noted, the modeling results do not produce precise harvest schedules; the results can represent a likely distribution of harvest levels over time at the county level. More precise short-term harvest schedules will be developed through operational level planning.

Projected annual average harvest is presented by county for 2004 to 2013 in Table 4.11-10. These data are based on general projected harvest location for forest grant lands, as well as state forest lands. Alternative 3 would result in the largest total average annual volume harvested, followed by Alternative 5, the Preferred Alternative, Alternatives 2, 4, and 1 in that order. Total projected average annual harvest for 2004 to 2013 is higher than the 1998 to 2002 annual average under Alternatives 2, 3, and 5, as well as the Preferred Alternative. Based on an estimated 4.5 thousand board feet/logging truck, the number of logging trips generated by the proposed Alternatives would range from approximately 88,000 under Alternative 1 to 147,200 under Alternative 3, compared to a 1998 to 2002 annual average of approximately 103,800. The Preferred Alternative would generate an average of approximately 141,600 trips a year over this period (Table 4.11-11).

The geographic distribution of the projected harvest and associated logging truck traffic over this period would vary by Alternative. Under Alternative 5 and the Preferred Alternative, annual average projected harvest is largest in Clallam County, with Alternative 5 and the Preferred Alternative generating about 26,000 and 18,900 logging trips, respectively. Projected harvest under Alternative 3 is largest in Mason and Lewis Counties, with an estimated annual average 13,800 and 13,500 logging trips, respectively. Under Alternatives 1 and 4, annual average projected harvest is largest in Skagit and Snohomish Counties, with Alternatives 1 and 4 generating about 10,100 and 11,200 logging trips in Skagit County, respectively. Projected harvest under Alternative 2 is largest in Jefferson and Skagit Counties, with an estimated annual average 11,900 and 11,200 logging trips, respectively (Table 4.11-11).

Table 4.11-10. Projected Annual Average Harvest by Westside County, by Alternative, 2004 to 2013 (million board feet)

County	5-YearAnnual Average[1/]	Alternative					
		1	2	3	4	5	PA
Clallam	35.5	22.6	38.0	56.3	28.4	116.9	84.9
Clark	22.9	30.5	36.0	56.0	23.2	34.0	40.3
Cowlitz	30.0	32.6	28.4	45.6	27.3	30.9	29.5
Grays Harbor	38.2	25.1	45.4	52.4	35.2	38.7	44.2
Jefferson	15.4	9.9	54.4	56.3	10.7	67.8	30.2
King	13.2	14.2	12.6	14.7	8.7	25.5	23.8
Kitsap	2.8	5.9	5.1	9.8	3.8	5.9	4.0
Lewis	47.3	41.1	48.7	63.3	34.0	56.0	49.4
Mason	20.2	28.9	25.7	58.9	21.5	29.7	17.9
Pacific	37.0	15.0	23.0	25.4	35.2	32.8	61.0
Pierce	15.9	12.8	12.8	8.7	4.5	17.6	16.1
San Juan	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Skagit	45.0	42.9	48.7	33.9	47.2	45.9	64.3
Skamania	11.6	10.7	30.0	44.3	6.8	41.5	41.4
Snohomish	41.4	41.4	45.4	29.1	42.9	35.0	47.3
Thurston	45.3	29.9	36.8	55.9	30.8	28.3	25.6
Wahkiakum	15.1	7.9	8.1	18.8	21.6	13.4	29.8
Whatcom	30.2	24.9	37.7	33.7	29.2	28.5	26.4
Total	**467.0**	**396.3**	**536.8**	**663.1**	**411.0**	**648.4**	**636.1**

PA = Preferred Alternative
[1/] This is the annual average for Calendar Year 1998 to Calendar Year 2002 (see Table 4.11-7) because historical harvest by county is not available by Fiscal Year.
Data Source: Model output data – timber flow levels; DNR 2002a.

Table 4.11-11. Projected Annual Average Logging Truck Traffic by Westside County, by Alternative, 2004 to 2013 (number of trips[1/])

County	5-Year Annual Average[2/]	Alternative					
		1	2	3	4	5	PA
Clallam	7,900	5,000	8,400	12,500	6,300	26,000	18,900
Clark	5,100	6,800	8,000	12,400	5,200	7,600	9,000
Cowlitz	6,700	7,200	6,300	10,100	6,100	6,900	6,600
Grays Harbor	8,500	5,600	10,100	11,600	7,800	8,600	9,800
Jefferson	3,400	2,200	12,100	12,500	2,400	15,100	6,700
King	2,900	3,200	2,800	3,300	1,900	5,700	5,300
Kitsap	600	1,300	1,100	2,200	800	1,300	900
Lewis	10,500	9,100	10,800	14,100	7,600	12,400	11,000
Mason	4,500	6,400	5,700	13,100	4,800	6,600	4,000
Pacific	8,200	3,300	5,100	5,600	7,800	7,300	13,600
Pierce	3,500	2,800	2,800	1,900	1,000	3,900	3,600
San Juan	0	0	0	0	0	0	0
Skagit	10,000	9,500	10,800	7,500	10,500	10,200	14,300
Skamania	2,600	2,400	6,700	9,800	1,500	9,200	9,200
Snohomish	9,200	9,200	10,100	6,500	9,500	7,800	10,500
Thurston	10,100	6,600	8,200	12,400	6,800	6,300	5,700
Wahkiakum	3,400	1,800	1,800	4,200	4,800	3,000	6,600
Whatcom	6,700	5,500	8,400	7,500	6,500	6,300	5,900
Total	**103,800**	**87,900**	**119,200**	**147,200**	**91,300**	**144,200**	**141,600**

PA = Preferred Alternative
[1/] Logging truck traffic is an estimate of logging trips based on an average truckload of 4.5 thousand board feet per truck.
[2/] This is based on the annual average for Calendar Year 1998 to Calendar Year 2002 (see Table 4.11-7).
Data Sources: Model output data – timber flow levels; DNR 2002a.

State and county roads are affected to varying degrees by logging trucks and other traffic associated with timber harvest activities. The Washington State Department of Transportation and the affected counties maintain state and county roads with monies from gasoline taxes, as well as property taxes in the case of county roads. Existing roads on forested trust lands are improved as part of DNR's road development program as traffic conditions warrant. Similarly, public roads are improved when required by increased traffic (DNR 1992b).

Logging companies harvesting timber from forested trust lands must meet Washington State Department of Transportation weight requirements and pay taxes that support road improvements. These taxes include state and federal motor fuel taxes, which currently total 41.4 cents per gallon. The federal portion of these taxes is earmarked for federal highway projects, with most returned to the state to build and maintain interstate highways. State motor fuel taxes are also used for highway purposes only. Timber companies also pay Access Road Revolving Fund fees to the DNR, which pay for forest road maintenance.

DNR regularly meets with local government officials and engineers to discuss the effects of logging-related traffic (DNR 1992b). These measures would help mitigate potential impacts associated with increased road traffic.

4.12 CULTURAL RESOURCES

4.12.1 Summary of Effects

This section analyzes the environmental effects on cultural resources. The analysis examines the effects of prospective changes to current policy, and uses the modeling outputs to inform the public and decision-makers of the relative differences in potential environmental impacts. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

While there are relative differences among the Alternatives, none is expected to result in any probable significant adverse environmental impacts to cultural resources relative to current conditions. Forest Resource Plan Policy No. 24 requires protection of such resources, and DNR is committed to consulting with Native American tribes and other interested parties about areas of cultural importance to them. These two forms of mitigation are expected to minimize risk to cultural resources.

4.12.2 Introduction

Cultural resources are districts, sites, buildings, structures, and objects that contain evidence of past human activities or that play an active part in the traditional cultures of the disparate ethnic groups that comprise Washington’s populace. Legislative bodies at the federal and state levels have recognized cultural resources as important for the education and inspiration of future generations of Americans, whatever their backgrounds.

4.12.3 Affected Environment

4.12.3.1 Archaeological Overview of Western Washington

Despite nearly a century of scientific research in the region, the archaeology of western Washington is not well understood. This is particularly true of the foothill and lower mountain settings where most forested trust lands can be found. What is known about the prehistoric archaeology of the region is biased toward the lowlands, particularly coastlines, where most development occurs and, therefore, where most archaeological surveys have been conducted. Not all forested trust lands have been intensively surveyed for archaeological resources. The same is true for nearby lands of the National Forests. Most sites in these forests have been found along streams or on high ridges, but this may be due in part to a tendency for land managers to survey what they consider high probability areas more intensively than lower probability slopes.

For a background summary of cultural resources in western Washington, see Appendix D, Section D.7.

4.12.4 Environmental Effects

Timber harvesting can have a severe negative impact on cultural resource sites. Culturally modified trees, if not recognized before harvest, can be cut down and destroyed. Historic equipment may be damaged or moved from its original location, changing its context and association. Archaeological sites, both historic and prehistoric, are likely to be severely damaged by the movement of logging equipment, dragging of logs, and piling of slash into burn piles. Although lithic scatters will not be entirely destroyed and may retain some scientific or cultural value, the relative positions of artifacts and most if not all cultural features, such as hearths, rock alignments, food processing facilities, and remains of dwellings are likely to be disturbed beyond recognition.

Although preharvest archaeological surveys will identify many sites that can be protected by avoidance, surveys do not find 100 percent of all sites, and avoidance can sometimes be incomplete, so impacts can still occur.

Cultural uses of forestlands by Indian tribes can be affected by timber harvests. On the negative side, elimination of old timber stands, or exposing important spirit questing or sacred sites to view by cutting surrounding trees reduces people’s ability to use such sites and may eliminate them altogether as components of the living culture. Logging in lowlands eliminates cedar trees, which are the source of basket making and ceremonial materials; culturally important plants that grow in mature forest stands may become less abundant. On the positive side, timber harvesting, like the traditional burning of forests, encourages the growth of berry-producing species and provides forage for game animals. Cedar is also promoted on many forested trust lands by the removal of competing tree species.

4.12.4.1 DNR Cultural Resource Protection Procedures

To avoid adverse impacts on cultural resources, DNR follows procedures derived from Section 106 of the National Historic Preservation Act (U.S.C. 470 et seq.). First, during the field layout or compliance stage or a timber sale, staff identify known sites and areas with high site potential by using DNR’s Total Resource Application Cross-Reference System and soliciting input from Native American groups and others with specialized cultural resource knowledge.

Second, lands identified as having a high probability for containing potential cultural resources are subjected to archaeological survey at 25-foot intervals. Cultural resource finds are confirmed, documented with the State Office of Archaeology and Historic Preservation, and, as appropriate, the affected Native American tribe is notified. DNR frequently enters into memoranda of agreement with tribal governments to protect traditional cultural properties and maintain tribal access to resources and localities important to the continued practice of their traditional cultures.

These procedures greatly reduce the probability that timber harvest activities will negatively affect cultural resources. They do not, however, entirely eliminate those effects for two reasons. First, only potential cultural resources and high probability areas are surveyed, leaving sites that might occur in lower probability areas unprotected. Second, archaeological surveys, particularly in forested environments, sometimes are not able to locate existing cultural resources, which lie hidden under vegetation and/or soil. Despite conscientious efforts by DNR staff, some cultural resource sites may be missed by surveys and sites may be damaged by timber harvest practices. However, DNR protection practices reduce the potential of impacts to cultural resources to the point that impacts from all Alternatives are expected to be minor.

4.12.4.2 Approach to Analysis

Although impacts to cultural resources would be minor under all Alternatives, potential effects to resources vary by Alternative. The level of effort needed to protect these resources also varies, and to a greater degree than the anticipated effects.

It is not possible to assess the actual impact each sustainable harvest Alternative would have on cultural resources or the level of effort that would needed to protect these resources. This is because only a fraction of forested trust lands have been surveyed for cultural resources to date. It is also because this is a programmatic analysis, which does not identify specific land parcels for harvest. This analysis is, therefore, qualitative and addresses differing probabilities for encountering and affecting cultural resources based on the frequency of cut and the extent to which stream corridors are affected.

4.12.4.3 Analysis Criteria

The archaeological site records maintained at the Washington Office of Archaeology and Historic Preservation were reviewed to obtain a general impression of the types of prehistoric archaeological sites found in each of the planning units and their environmental settings. That analysis demonstrated that between 90 and 95 percent of documented sites in each area were located within about 400 yards of a stream, river, lake, or body of saltwater (i.e., partially within areas designated in the Habitat Conservation Plan as Wetland Management Zone and Riparian Management Zone).

Sites found near streams include culturally modified cedars, village sites, shell middens, open camps, lithic scatters, rock shelters, cemeteries, and petroglyphs. Rock shelters, quarry sites, huckleberry processing sites, and a few lithic scatters occurred at greater distances from water. Many earlier logging sites, particularly skid roads and large stumps with springboard cuts, are also most likely to be preserved in these settings. Consequently, Alternatives that propose more harvest activity in streamside environments would require a greater level of effort to protect potential cultural resources, and would have a greater probability to affect cultural resources that may be missed by archaeological surveys. They are, therefore, ranked higher in impact and level of effort.

Stands greater than 150 years old are more likely to still contain culturally modified trees, never-disturbed archaeological sites, and huckleberry processing features. Older stands are also more likely to be used by Native American tribes for traditional cultural practices and may need to be addressed in memoranda of agreement with the affected tribes. Alternatives that propose more harvest in old forest stands are, therefore, ranked as having a greater potential to affect cultural resources and to require greater effort to protect these resources.

Harvest frequency is used as a criterion because the more frequently an area is logged, the more damage may occur to archaeological sites that may remain undiscovered following archaeological surveys. Alternatives with higher harvest frequencies are, therefore, ranked as having a higher potential to affect cultural resources.

4.12.4.4 Results of the Analysis, by Alternative

Table 4.12-1 presents the results of analysis of the six sustainable harvest Alternatives according to their potential impact on cultural resources. This may also be read as the relative level of effort that would be required under each Alternative to protect cultural resources using archaeological surveys, site documentation, and consultation and memorandums of agreement developed with Native American tribes.

In Table 4.12.1, columns describing streamside effects, harvest of old forest stands, and harvest frequency provide rationale for the ranking. Impact ranking under each criterion is given in parentheses. Overall rank is an ordering of the total ranks of all three criteria. In making this calculation, the weight of streamside effects is considered to be double that of the other two criteria. The Alternative with the highest rank is expected to have the least potential impact on cultural resources and require the lowest level of effort to protect such resources.

Alternative 5, which has the second-highest level of disturbance of riparian areas, some protection of old forests, and the highest frequency of harvest, is expected to have the greatest potential impact on cultural resources and to require the greatest level of effort to

Table 4.12-1. Ranking of Alternatives According to Their Effect on Cultural Resources[1/]

Alternative	Streamside Effects[2/]	Harvest of Older Stands[3/]	Harvest Frequency	Rank
1	Disturbance at 2 % of area per decade (1)	No additional stipulations (4)	60 yr (2)	1
2	Disturbance at 4 % of area per decade (2)	No additional stipulations (4)	60 yr (2)	3
3	Disturbance at 5% of area per decade (3)	No additional stipulations (4)	60 yr (2)	4
4	Same as 3 (3)	Harvest of >150 year stands deferred (1)	80 yr (1)	1
5	Disturbance at 7 % of area per decade (5)	10 to 15% to be maintained in old forest conditions (2)	40 yr (6)	6
Preferred Alternative	Disturbance at 8% of area per decade (6)	10 to 15% to be maintained in old forest conditions (2)	60 yr (2)	5

Data Source: Evaluations of Alternatives, Section 2.6.
1/ A rank of 1 equals lowest potential for impacts.
2/ Based on Table 4.9-1.
3/ Old forest research areas are deferred and 20 percent of Olympic Experimental State Forest lands are maintained in old forest conditions in all Alternatives.

protect these resources. Alternatives 1 and 4 are expected to have the least potential impact and require the least effort for cultural resource protection. Alternative 4 protects old forests, moderately protects riparian environments, and would have the longest harvest interval. Alternative 1 permits the least disturbance of riparian environments, but has a higher harvest frequency and provides no additional protection for older forests. The

Preferred Alternative would have the second greatest potential impact on cultural resources and thus would require a higher level of effort to protect cultural resources than would Alternatives 1 through 4.

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4.13 RECREATION

4.13.1 Summary of Effects

This section analyzes the potential effects of the Alternatives on recreation. The analysis uses the modeling outputs to inform the public and decision-makers of the relative differences in potential environmental impacts. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

Environmental impacts on recreation resources are assessed in relation to harvest level. More intensive harvest would have a larger impact on the landscape, potentially affecting the quality of recreation experiences in adjacent and nearby areas. Potential effects on recreation may be mitigated on a case-by-case basis during operational planning prior to the initiation of harvest activities. Potential effects may be mitigated by employing harvest systems that minimize potential visual effects and by relocating or rerouting affected recreation facilities, particularly trails, as appropriate. All of the Alternatives would meet the requirements of DNR policies and procedures that address recreation and public access (Policies No. 25 and 29). As a result, none of the Alternatives are expected to result in any probable significant adverse environmental impacts to recreation.

The effects of the proposed Alternatives on fish and wildlife could, in turn, affect recreational fishing and hunting on forested trust lands. Fishing and hunting opportunities on forested trust lands could be positively affected to the extent that improvements in habitat and habitat suitability contribute to greater numbers of fish and game populations in some or all of the planning units. The potential effects on fish and wildlife are discussed in more detail in Sections 4.10 and 4.3, respectively.

4.13.2 Affected Environment

Approximately 40 percent of all uplands in the state of Washington are publicly owned, with the federal government managing 12.9 million acres or 28 percent of the state (Interagency Committee for Outdoor Recreation 2002). Statewide, DNR manages about 2.9 million acres of trust lands, with about 1.4 million forested acres located in westside counties. These state trust lands are managed for the support of trust beneficiaries with recreation being a secondary use allowed under the Multiple Use Act (Chapter 79.68 RCW, recodified at Laws of 2003, Ch. 334, sec. 555(2)). The Multiple Use Act allows for recreational use as long as the uses do not damage resources and the use is compatible with trust management responsibilities (Forest Resource Plan Policy No. 29 [DNR 1992a]).

DNR generally provides public access for multiple uses on forested trust lands. There are, however, situations where DNR controls vehicular or other access. Public access may be closed, restricted, or limited to protect public safety; to prevent theft, vandalism, and garbage dumping; to protect soils, water quality, plants, and animals; or meet other Forest Resource Plan or Habitat Conservation Plan (HCP) objectives (Forest Resource Plan Policy No. 25 [DNR 1992b]).

A recent assessment of outdoor recreation in the state of Washington found that residents participated in at least 170 different types of outdoor recreation in 15 major categories (Interagency Committee for Outdoor Recreation 2002). Population growth of about

20 percent over the last decade has resulted in increased numbers of people engaged in recreation, even though the percent of the population actively participating in outdoor recreation declined over this period. More than half of the state's population currently participates in some form of outdoor recreation. Roughly half of outdoor recreation activity in the state is local, with the other half shared between state, federal, and private providers.

Outdoor recreation activities that occur on state lands include walking/hiking, horseback riding, off-road vehicle use, picnicking, camping, hunting, fishing, and more. The Interagency Committee for Outdoor Recreation assessment found that 53 percent of the state's population participated in the walking/hiking recreation category, with 20 percent picnicking, 13 percent camping, 13 percent fishing, 9 percent using off-road vehicles, and 6 percent hunting/shooting (Interagency Committee for Outdoor Recreation 2002).

Participation in all of these activities, with the exception of fishing and hunting/shooting, is projected to increase over the next 20 years. Increases over the next 10 years are expected to range from 5 to 10 percent for camping to 20 percent for picnicking. The numbers of people fishing and hunting/shooting are projected to decrease by 5 percent and 15 percent, respectively, over the same period (Interagency Committee for Outdoor Recreation 2003).

Westside trust lands that receive significant public use include Capitol Forest in Thurston County, Tahuya State Forest in Mason County, Yacolt Burn State Forest in Skamania County, and Tiger Mountain State Forest in King County. Recreation facilities in these locations include campgrounds, picnic areas, hiking trails, off-road vehicle trails, and interpretive facilities (Interagency Committee for Outdoor Recreation 2003, pages 45-46).

The existing DNR road system receives heavy recreation-related use, providing the public with access to specific recreation areas, such as trailheads, campgrounds, and picnic areas. In addition, a large portion of recreational users of trust lands use the road system as the primary focus of their recreational activity—driving the road systems and occasionally dispersing across the landscape to hunt, birdwatch, gather mushrooms or berries, or engage in some other non-facility oriented activity. A recent survey, for example, estimated that approximately 50 percent of back road and "off of road" fuel use in the state of Washington was for uses other than off-road motorized activities (off-road vehicles and snowmobiling) and non-motorized activities (hiking, mountain biking, cross-county skiing, and horseback riding). The other back road and off of road uses that made up about 50 percent of total fuel use included hunting, driving, sightseeing, camping, and fishing (Hebert Research, Inc. 2003).

Statewide, DNR manages about 1,150 miles of recreation trails. Approximately 840 miles or 73 percent of these trails are located on western Washington forested state trust lands, with 347 miles (41 percent of westside total) designated as multiple-use motorized trails. The remaining miles are designated multiple-use, non-motorized (34 percent), hiker only (13 percent), and winter (12 percent) (Table 4.13-1).

Roughly 457 miles of the westside trails (54 percent) are located in the South Puget Sound area, which includes Mason, Pierce, King, and Kitsap Counties and the Tahuya, Green Mountain, Tiger Mountain, and Tahoma State Forests.

DNR also manages some westside lands as Natural Area Preserves and Natural Resource Conservation Areas to protect examples of undisturbed ecosystems, rare plant and animal species, and unique geologic features. These areas, which are off base for harvest, help support trust management objectives by managing and conserving habitat for HCP species, where appropriate.

Natural Area Preserves are generally available only for educational and scientific access. Natural Resource Conservation Areas are available for low impact recreation, such as nature study, walking, and day hiking, as well as for research and education. Mt. Si Natural Resource Conservation Area in King County, for example, is an important hiking destination (Interagency Committee for Outdoor Recreation 2002).

4.13.3 Environmental Effects

Management objectives under the proposed Alternatives could affect recreation use of forested trust lands in three main ways. First, harvest activities could have primarily negative effects on existing recreation activities in and around harvested areas. This is reflected in the public concerns raised during scoping for this project (Appendix A). Concerns were expressed about the integration of forest management and recreation, and the location of harvest units relative to recreation areas.

The linear nature of the trail system suggests that trail use would be the most likely recreation activity to be affected by increased harvest activities. Trails in active harvest areas are likely to be closed, moved, or decommissioned as a result of harvest activities.

Table 4.13-1. DNR Westside Recreation Trails, By Region (in Miles)

	Central	Northwest	Olympic	Southwest	South Puget Sound	Total
Multiple-Use Motorized	87	30	15	17	199	347
Multiple-Use Non-Motorized	80	43	0	60	102	285
Hiker Only	6	41	4	1	57	109
Winter	0	0	0	0	100	100
Total	**173**	**114**	**19**	**78**	**457**	**842**

Source: Personal communication, Lisa Anderson, 2003.

In addition, trails, campgrounds, picnic areas, and some overlook areas could be negatively affected by noise, dust, and traffic generated during logging activities. Higher harvest volumes would likely increase these potential effects.

Second, higher harvest volumes would also result in more logging truck traffic on DNR roads used by the public for recreation purposes, which could potentially affect a large portion of recreation visitors, depending on the Alternative selected. Estimates of logging truck traffic that would be generated are presented by Alternative in Table 4.11-11 and discussed in Section 4.11.4.2, which discusses potential impacts to transportation infrastructure. Total projected annual average truck traffic generated over the next decade (2004 to 2013) ranges from approximately 90,000 truck trips under Alternative 1, about 85 percent of the annual average for 1998 to 2002, to roughly 147,000 truck trips under

Alternative 3, about 1.4 times the 1998 to 2002 annual average. Approximately 141,000 annual average truck trips would be generated under the Preferred Alternative over this period, 1.36 times the 1998 to 2002 average. Third, the impacts of the proposed Alternatives on fish and wildlife could in turn affect recreational fishing and hunting on forested trust lands.

Although, potential effects on recreation are likely to increase with harvest intensity, this is not necessarily a linear relationship. An increase in the amount of harvest would not necessarily result in a commensurate increase in impacts. In other words, doubling the amount of harvest, for example, would not necessarily result in double the impact. More intensive harvest may, however, result in more complex issues. In addition, potential impacts would vary by user group, with more intensive harvest potentially benefiting some recreation user groups, such as road users, while negatively affecting other groups, such as trail users. The potential impacts of more intensive harvest on road users are also likely to vary by location, with some groups potentially benefiting from new road construction, while increased levels of logging truck traffic on existing roads would negatively affect other groups.

The assessment presented in this environmental analysis is programmatic, meaning that it establishes direction and potential harvest levels for broad land areas rather than scheduling activities on specific patches of land. As a result, it is not possible to identify specific tracts of land or recreational facilities that would be affected by the Alternatives. In addition, the model results for the six Alternatives do not provide a precise schedule of where and when harvest would occur under the different Alternatives. Rather, the results for each Alternative represent one of a number of potential paths to achieve the long-term objectives of that Alternative and are used in this analysis for comparison among Alternatives rather than an accurate prediction of the future.

Given these constraints, the following analysis addresses the effects of the Alternatives in terms of the projected amount of land that would be subject to high-volume removal harvest (defined as harvests removing more than 20 thousand board feet per acre in volume) and the projected amount of open forest under each Alternative. This analysis proceeds from the assumption that more intensive harvest would have larger potential effects during harvest in terms of noise, air, and traffic impacts, as well as the resulting post-harvest impact to the landscape.

Projected harvest under the proposed Alternatives is grouped into three harvest types for the purposes of this analysis. These harvest types, referred to as low-volume, medium-volume, and high-volume removal harvest, represent groupings of silvicultural treatments that produce similar ranges of harvest intensity. Low-volume removal harvest (defined as harvests removing less than 11 thousand board feet per acre in volume) includes silvicultural treatments like small wood thinning. Medium-volume removal harvest (defined as harvests removing between 11 and 20 thousand board feet per acre in volume) includes silvicultural treatments such as variable density thinning, hardwood management, and uneven-aged management. High-volume removal harvest (more than 20 thousand board feet per acre volume harvests) includes regeneration harvests with legacy retention, heavier partial harvest, and some variable density thinnings.

The percent of harvest type (low, medium, or high removal volume) acres by decade is presented by Alternative in Section 4.2, Forest Structure and Vegetation. Average annual acres of high-volume removal harvest are presented by Alternative and decade in Figure 4.13-1. These data indicate that high-volume removal harvest from 2004 to 2013 would occur over larger areas under the Preferred Alternative and Alternative 3. High-volume removal harvest would occur over larger areas under Alternative 5 and the Preferred Alternative for the following two decades (2014-2023 and 2024-2033). High-volume harvest over the remaining decades that make up the 64-year planning period is projected to occur over the largest areas under Alternatives 3 and 2 for each decade. High-volume removal harvest would occur over smaller areas under Alternatives 1 and 4 for all of the decades under consideration (Figure 4.13-1).

These projected levels of harvest provide one general indicator of potential recreation impacts, with Alternatives 3 and 5 and the Preferred Alternative likely to have relatively high impacts compared to Alternatives 1 and 4. Viewed at the planning unit level, high-volume harvest would generally occur over smaller areas under Alternatives 1 and 4 for most decades. The Alternatives with the largest areas of high-volume removal harvest tend to vary from unit-to-unit and by decade.

Viewed in terms of total acres harvested, high-volume removal harvest is generally lower in the South Puget and Straits HCP Planning Units than in the other four units (Figure 4.13-2). In addition, the areas of high-volume removal harvest in the Olympic Experimental State Forest unit are relatively small under Alternatives 4 and 1, compared to the other Alternatives. In other words, the relative differences between Alternatives 4 and 1 and the other Alternatives are much larger in the Olympic Experimental State Forest than they are in the other HCP Planning Units (Figure 4.13-2).

In addition to having larger potential effects during harvest in terms of noise, air, and traffic impacts, more intensive harvest would have a larger impact on the landscape potentially affecting the quality of recreation experiences in adjacent and nearby areas. The amount of high-volume removal harvest viewed in acres by decade (discussed above) provides one perspective on these potential effects. A second perspective is provided by considering the projected amount of open forest. Figure 4.4-3 in Section 4.4 (Wildlife) identifies the percent of total forest area in three different forest structure classes (ecosystem initiation forest, competitive exclusion forest, and structurally complex forest) under each Alternative. Alternatives with greater levels of ecosystem initiation forest would result in greater amounts of open forest.

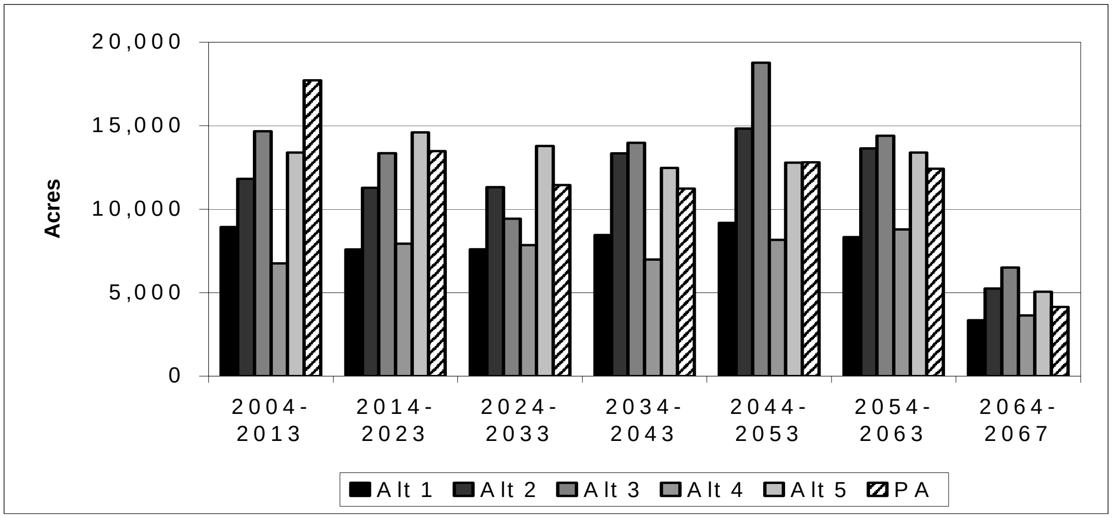

Figure 4.13-1. Average Annual High Volume Removal Harvest Acres, by Alternative and Decade

Notes:

1. High volume removal harvest would likely result in greater than 20 thousand board feet per acre volume harvests.
2. Average annual harvest acres are calculated by dividing total harvest acres per decade by 10 for the six full decades. Average annual acres for 2064 through 2067 were calculated by dividing total acres by 4.

PA = Preferred Alternative

Source: Model output data – timber flow levels.

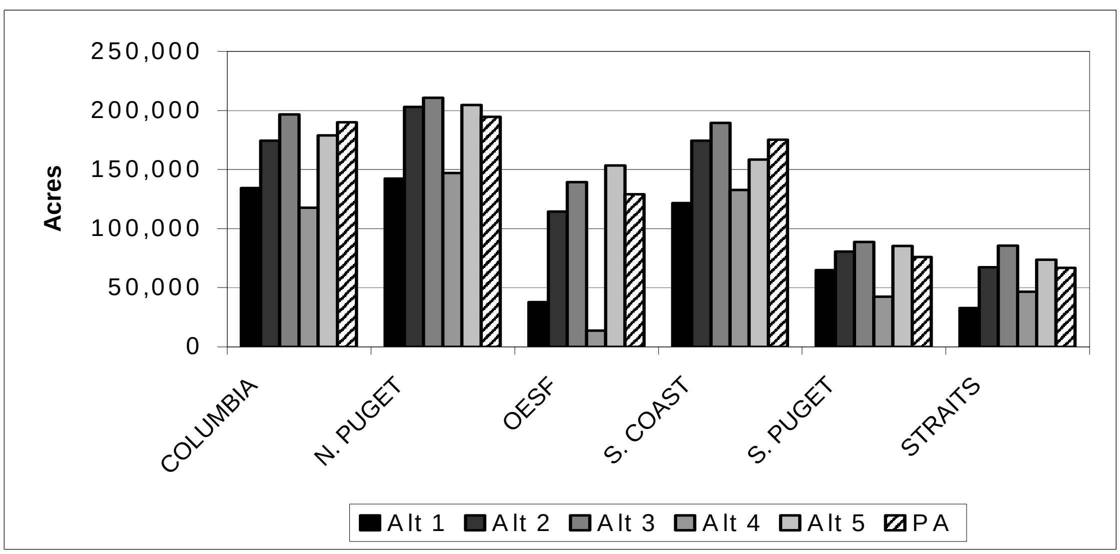

Figure 4.13-2. Total High Volume Removal Harvest Acres by Alternative and HCP Planning Unit

PA = Preferred Alternative

Data Source: Model output data – timber flow levels.

Overall, all six Alternatives would result in similar amounts of ecosystem initiation forest in both the short term and the long term. The amount of ecosystem initiation forest would remain slightly lower in both the short term and the long term under Alternatives 1 and 4 than it would under the other alternatives (Figure 4.4-1). The Preferred Alternative would generate slightly higher levels of this forest type than Alternative 5 in the short term (2013). In the long term (2067), the amount of ecosystem initiation forest would be largest under Alternative 5, followed by the Preferred Alternative and Alternatives 3 and 2, with Alternatives 4 and 1 having the smallest amounts (Figure 4.4-1). This may not, however, hold true within certain planning units in some time periods.

The effects of the proposed Alternatives on fish and wildlife could, in turn, affect recreational fishing and hunting on western Washington forested state trust lands. Fishing and hunting opportunities on forested trust lands could be positively affected to the extent that increased amounts and quality of habitat contribute to greater abundance of fish and game in some or all of the planning units. All six Alternatives would likely result in increases in suitable habitat for deer and elk in the long term. In the short term, all alternatives, except the Preferred Alternative and Alternative 3, would decrease the availability of suitable deer and elk forage. The potential effects on fish and wildlife are discussed in more detail in Sections 4.10 and 4.4, respectively.

Potential effects on recreation may be mitigated on a case-by-case basis during operational planning prior to the initiation of harvest activities. Potential effects may be mitigated by employing harvest systems that minimize potential visual effects and by relocating or rerouting affected recreation facilities, particularly trails, as appropriate. All of the Alternatives would meet the minimum requirements of DNR policies and procedures that address recreation and public access (Policies No. 25 and 29).

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4.14 SCENIC RESOURCES

4.14.1 Summary of Effects

This section analyzes the potential effects of the Alternatives on scenic resources. The analysis uses the modeling outputs to inform the public and decision-makers of the relative differences in potential environmental impacts. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

Lands managed for timber production under all Alternatives would be managed under DNR's visual management procedure (PR 14-004-080), which seeks to minimize potential impacts to scenic resources by managing harvest activities with respect to sensitive viewshed areas. Potential visual effects associated with the proposed Alternatives may be mitigated on a case-by-case basis during operational planning prior to the initiation of harvest activities. Operational planning by the DNR includes policies and procedures related to green-up (growing young trees for a specific time before adjacent trees may be cut), reforestation, and harvest unit size that contribute to the management of forested landscapes. As a result, none of the Alternatives are expected to result in any probable significant adverse environmental impacts on scenic resources.

4.14.2 Introduction

This section addresses the potential effects of the proposed Alternatives on scenic resources. Scenic value concerns raised during public scoping for this project included requests that DNR consider impacts to scenic resources, including size and shape of clearcuts and their location relative to highways.

4.14.3 Affected Environment

DNR manages approximately 1.5 million acres of western Washington state trust lands. Approximately 1.4 million acres of these lands are forested. These lands span vegetation zones from near sea level to mountaintops and include a wide range of landscape types and scenic resources characteristic of western Washington, including coastal and high elevation forests, alpine lakes, and rocky shorelines. High-quality scenery, especially scenery with natural-appearing landscapes, is generally regarded as an important resource that enhances peoples' quality of life and influences the quality of recreation experiences and, in some cases, adjacent property values.

Although DNR primarily manages trust lands to produce income for the various trusts and maintain a healthy ecosystem, visual concerns are also considered. Visual concerns do not, however, apply to all areas. Areas where potential visual concerns exist include major highway corridors, cities and towns, adjacent housing developments, and trails and other recreation areas. DNR's visual management procedure (PR 14-004-080) outlines the guidelines whereby DNR regions locate areas that may be managed to reduce the visual impact of harvest and road-building activities. In cases where visual concerns do apply, management decisions seek a balanced solution among visual impact, income, and ecosystem objectives.

In addition to forested trust lands that are managed for the support of trust beneficiaries, DNR also manages some state trust lands as Natural Area Preserves (26,400 acres) and Natural Resource Conservation Areas (80,500 acres). These lands are managed to preserve the best remaining examples of many ecological communities and to protect outstanding native ecosystems; habitat for endangered, threatened, and sensitive plants and animals; and scenic landscapes. These lands, which are off base for harvest, help support management objectives by managing and conserving habitat for wildlife, where appropriate.

4.14.4 Environmental Effects

The sustainable harvest calculation does not include site-specific harvest plans that can be evaluated for their scenic impacts. Alternatives may, however, include different patterns of harvest at a landscape level. These potential effects are considered in the following paragraphs. Model results for the six Alternatives are not a prediction of where and when harvest would occur under the different Alternatives. Rather, the outputs for each Alternative represent one of a number of potential paths to achieve the long-term objectives of that Alternative.The outputs are also used in this analysis for comparison among Alternatives rather than an accurate prediction of the future. Given these constraints, the following analysis addresses the effects of the potential Alternatives in terms of the projected amount of land that would be subject to more intensive harvest and the projected amount of open forest under each Alternative. Potential negative effects on scenic resources are assumed to increase with harvest intensity.

Projected harvest under the proposed Alternatives is grouped into three harvest types (low-volume, medium-volume, and high-volume removal harvest) for the purposes of analysis. The percent of harvest type acres by decade is presented by Alternative in Section 4.2, Forest Structure and Vegetation. Average annual high-volume removal harvest acres are presented by Alternative and decade in Figure 4.13-1.

These data indicate that high-volume removal harvest from 2004 to 2013 would occur over larger areas under the Preferred Alternative and Alternative 3. High-volume removal harvest would occur over larger areas under Alternative 5 and the Preferred Alternative for the following two decades (2014-2023 and 2024-2033). It is important to note that much of the high-volume harvest under the Preferred Alternative would be heavy thinning, which would have little or no affect on scenic resources. High-volume harvest over the remaining decades that make up the 64-year planning period is projected to occur over the largest areas under Alternatives 3 and 2 for each decade. High-volume removal harvest would occur over smaller areas under Alternatives 1 and 4 for all of the decades under consideration (Figure 4.13-1).

A second perspective is provided by considering the projected amount of open forest. Figure 4.4-3 in Section 4.4 (Wildlife) identifies the percent of total forest area in three groups of forest structure classes (ecosystem initiation forest, competitive exclusion forest, and structurally complex forest) under each Alternative. Alternatives with greater levels of ecosystem initiation forest would result in greater amounts of open forest.

Overall, all six Alternatives would result in similar amounts of ecosystem initiation forest in both the short term and the long term. The amount of ecosystem initiation forest would remain slightly lower in both the short term and the long term under Alternatives 1 and 4 than it would under the other Alternatives (Figure 4.4-1). The Preferred Alternative would generate slightly higher levels of this forest type than Alternative 5 in the short term (2013). In the long term (2067), the amount of ecosystem initiation forest would be largest under Alternative 5, followed by the Preferred Alternative and Alternatives 3 and 2, with Alternatives 4 and 1 having the smallest amounts (Figure 4.4-3). This may not, however, hold true within certain planning units in some time periods.

These broad landscape-level measures provide some indication of the Alternatives that would have a higher potential to affect scenic quality based on the intensity of timber harvest, with Alternatives 5 and 3 and the Preferred Alternative involving more high-volume removal harvest and resulting in larger amounts of open forest. However, lands managed for timber production under all Alternatives would be managed under DNR’s visual management procedure (PR 14-004-080), which seeks to minimize potential impacts to scenic quality by managing harvest activities with respect to sensitive viewshed areas.

Potential visual effects associated with the proposed Alternatives may be mitigated on a case-by-case basis during operational planning prior to the initiation of harvest activities. Operational planning by DNR includes policies and procedures related to green-up, reforestation, and harvest unit size that contribute to the management of forested landscapes.

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4.15 CUMULATIVE EFFECTS

4.15.1 Summary

This section analyses cumulative effects. Cumulative effects are defined under both a broad and narrow definition for this analysis. DNR recognizes that cumulative effects conditions are occurring and have the potential to occur in the future in watersheds where DNR manages western Washington forested trust lands. The analysis examines current forest conditions, wildlife habitats, fish, water resources, and potential impacts of future harvests. DNR’s policies and procedures are in place and implemented to manage and reduce the risk of cumulative effects occurring. The Alternatives with higher levels of activities in the first decade, Alternative 5 and the Preferred Alternative, have a somewhat higher risk of contributing to cumulative effects, especially related to water resources. However, all Alternatives implement various mitigation measures for cumulative effects to forest vegetation, wildlife and water resources. These measures include, but are not limited to, implementation of the Habitat Conservation Plan (HCP) Riparian Management Zones, procedure for management of potential slope instability, visual area management, procedure for adjacency of regeneration harvest units, and leave trees strategy. The expectation is that the overall level of cumulative effects would be reduced under all Alternatives in the future due to the Board forest management policies, DNR's HCP and operational procedures in combination with Forest Practices Rules, the Northwest Forest Plan, and other regional programs, such salmon recovery efforts (Salmon Recovery Funding Resource Board), HCPs developed by private forestry companies (e.g., Plum Creek, Port Blakely, Simpson Timber, West Fork Timber), and utility companies (e.g., City of Seattle, Tacoma Water). These programs should reduce the potential for future cumulative effects by requiring that landowners do their share of mitigation and avoidance. All of the proposed Alternatives would be expected to provide effective mechanisms in policy and procedures to provide mitigation against cumulative effects where DNR manages a portion of the landscape.

4.15.2 Introduction

Cumulative effects are not defined in the Washington State Environmental Policy Act. Here cumulative effects are analyzed using a combination of approaches that consider “other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other action” (National Environmental Policy Act, 40 C.F.R. § 1508.7) and with a narrower definition of “changes to the environment caused by the interaction of natural ecosystem processes with the effects of two or more forest practices” (Forest Practices Rules, Washington Administrative Code 222-12-046). Because forest management activities are regulated under the Forest Practices Act, this definition is useful for purposes of this sustainable harvest calculation. Cumulative effects can result from multiple forest practices conducted over the same time period but dispersed spatially, or from multiple forest practices that are conducted at the same site over time.

The measures used to assess the impacts of cumulative forest practices in this analysis are forest conditions (existing and changes to forest stand development stages and age-classes) and disturbances (in particular, regeneration harvest rates).

This section provides descriptions of current conditions for forest vegetation, wildlife, riparian habitat, fish, hydrology, and water quality within watersheds where there are western Washington forested trust lands. The analysis then focuses in on a select group of watersheds and examines the relative differences among the Alternatives in the regeneration harvest rates within selected watersheds. This section concludes with a summary of the analysis and describes how the forest management policies employed in the Preferred Alternative help to mitigate for potentially significant adverse cumulative effects.

4.15.2.1 Analysis Approach

Landscapes in western Washington are characterized by a multitude of land uses, including forest, urban, suburban, and agricultural. The amount and nature of forests in any landscape is highly variable. Within those areas that are forested, there is a wide range of forest types and conditions with various types of forest structures. The distribution of forest structures over time and space is a reasonable basis for assessing the potential cumulative effects in the forest environment. It is beyond the scope of this non-project Final EIS to characterize precisely all the conditions and land uses. Land uses such as urban, suburban, or agricultural are extremely variable in their environmental effects. The analysis of environmental effects on these land uses would require very site-specific information (e.g., the type of farming practiced and the number of dwellings per acre in a subdivision).

The Alternatives represent different sets of policies and procedures that direct the management strategies applied to the land base. However, the Alternatives also all have in common strategies designed to manage the effects on specific resources. This analysis attempts to characterize how different suites of policies and procedures interact over time and space. All Alternatives are expected to result in changes in forest structure that should result in more structurally complex forests over time.

This cumulative effects analysis uses a semi-quantitative approach that ranks watersheds for several key resource areas. The analysis also examines and extends the impact analysis of multiple harvest activities at the watershed level from the Forest Structure and Vegetation section (Chapter 4, Section 4.2). The term *watershed* represents the Washington State Department of Ecology watershed administrative units (WAU) per March 2002 delineations.

This analysis is a screening tool for discerning the potential for proposed changes in policies and procedures governing forest management activities on forested trust lands to result in adverse cumulative effects on fish, hydrology, water quality, soils, and wildlife. While this analysis does not provide precise site-specific conclusions about the current or future existence of cumulative effects, it does provide information on what types of cumulative effects might occur and *where* these effects would most likely occur. This approach is based on reasonably available information and avoids speculative conclusions.

In this way, information contained in this analysis indicates where additional site-specific analyses in project-level planning may be appropriate.

This cumulative effect analysis evaluates the impacts of the Alternatives on both trust and, in a limited sense, non-trust forest lands. For example, many effects to riparian system may not occur at the point of disturbance but may result in downstream effects. Therefore, assessment of current conditions for a resource was done by examining data at the watershed scale and across ownerships. Several datasets were used in this analysis. Geographic Information System data, in combination with assumptions about activities on private, state, and federal forested lands, were used to examine the disturbance/condition level of both watersheds and five Westside Habitat Conservation Plan HCP Planning Units, as well as the risk that DNR management activities may contribute to significant adverse cumulative effects. Assumptions about activities (such as rotation length and stream buffers) on private and federal forestland were based upon management strategies (HCPs and the Northwest Forest Plan) and state law, including the Forest Practices Rules. The risk of adverse cumulative effects was based on the type of management and the degree of management intensity proposed under each Alternative. For example, watersheds with greater amounts of hydrologically immature forest would likely require more careful tactical and operational-level planning and analysis under Alternatives 3, 5, and the Preferred Alternative than under Alternatives 1 and 4, because more frequent harvest activities are anticipated under Alternatives 3, 5, and the Preferred Alternative. However, if most of the land in one of these watersheds is federal, harvest levels, and, therefore, the risk of adverse cumulative effects, are likely to be much lower than if most of the watershed is privately owned.

Although the screening tool does not provide precise site-specific conclusions about the current or future existence of cumulative effects, available evidence and literature (e.g. Northwest Forest Plan, Endangered Species Act listings, Clean Water Act 303(d) listings, watershed analyses) suggest that cumulative effects are occurring at some locations (watersheds/river basins) throughout each of the HCP Planning Unit areas. However, the programmatic nature of this non-project action (Board policy decisions), the scale of the analysis (1.4 million of western Washington forested trust lands), and limitations of the available landscape-level data suggests to DNR that site-specific cumulative effects determinations are not possible, and could not be accurately determined for this Final Environmental Impact Statement.

For each resource area, watersheds are ranked into quartiles (upper, upper mid, lower mid and lower) according to current conditions (see Appendix E for examples). Current conditions are represented with the best reasonably available data and information. The upper quartile is used to discern the highest relative potential for adverse cumulative effects; the rating is “highest” in a relative sense, not having any absolute or quantitative significance. Ranking a watershed in the upper quartile does not indicate that adverse cumulative effects are occurring or will occur. The upper quartile represents only a screening tool to assist in identifying the current condition of resources in specific watersheds that may be more vulnerable to potential cumulative effects.

Model outputs provide a quantitative approach for assessing how well each Alternative is likely to achieve the Board's goals. Each Alternative was analyzed over all the landscapes and over multi-decade periods. The purpose was to see how the forests and associated habitats changed over time and space. The modeling analysis demonstrated that harvest rates vary by Alternative; therefore, potential cumulative effects are likely to vary within the various resource areas and across landscape over time.

4.15.2.2 Data Sources

Geographic Information System data were used to estimate current conditions across the landscape. This information was used to estimate where current conditions or levels of disturbance potentially place a watershed at higher risk for cumulative effects over the planning period. For example, high resource sensitivity may be identified for a variety of reasons, including, but not limited to, the presence of important and sensitive resources (e.g., bull trout), significant loss or significant disturbance of rare or uncommon habitats (e.g., old forest), or the presence of potentially triggering characteristics (e.g., unstable slopes or sensitive soils) that may materially affect a significant resource.

Vegetation data for this analysis were derived from both DNR sustainable harvest model and the Interagency Vegetation Mapping Project (2002). The primary purpose of the Interagency Vegetation Mapping Project maps is to serve as monitoring tools for the Northwest Forest Plan, which provides management direction for the USDA Forest Service and the USDI Bureau of Land Management. The Interagency Vegetation Mapping Project maps show existing vegetation, canopy cover, size, and cover type for the entire range of the northern spotted owl using satellite imagery from the Landsat Thematic Mapper. The Interagency Vegetation Mapping Project used a regression modeling approach to predict vegetation characteristics from the Landsat data.

Interagency Vegetation Mapping Project data do not identify stand development stages, but the data can be grouped based on tree size classes and percentage of conifer cover. Tree size classes were calculated using quadratic mean diameter, defined as the diameter at breast height of a tree of average basal area for the stand. Quadratic mean diameter was calculated in inches and was based on dominant and co-dominant trees only. The size class models were applied only to areas that met the minimum condition of at least 70 percent total vegetation cover and at least 30 percent conifer cover. Areas that did not meet these two criteria (and thus were not assigned size class values) account for approximately 30 percent of the total area identified as forest vegetation. Size classes (in inches) were grouped as follows: 0 to10, 10 to 20, 20 to 30, and greater than 30. The Interagency Vegetation Mapping Project also identified total green vegetation cover, which includes trees, shrubs, and herbaceous plants. Areas with greater than 30 percent conifer cover were grouped into two classes: less than 70 percent, and 70 percent or more conifer cover.

4.15.2.3 Scale of Analysis

Cumulative effects are discussed at the HCP Planning Unit level. References to the distribution of impacts among watersheds are made, as needed, to explain conditions within a HCP Planning Unit and their component watersheds. Tables summarizing conditions at the watershed level are presented in Appendix E. The analysis focuses on two sets of watersheds: 179 watersheds in which DNR manages at least 5 percent of the watershed, and a subset of these (83 watersheds) in which DNR manages at least 22 percent of the watershed.

4.15.3 Forest Conditions and Wildlife Habitats

This section describes the current forest structure, vegetation, and wildlife habitat conditions in the watersheds where DNR manages western Washington forested trust lands. This section also identifies areas where timber harvest on forested trust lands may appreciably influence the availability of particular wildlife habitats and the species that may be associated with them. As such, some of the tables and discussions below identify areas where certain habitat types represent a small proportion of the total area and where forested trust lands contain a relatively large proportion of the total habitat that exists. In these areas, timber harvest on forested trust lands may carry the risk of reducing the availability of a particular habitat type. Other tables focus on areas where DNR management decisions may contribute to a sizeable increase in the distribution of one habitat type at the expense of others or where DNR timber harvest may provide opportunities to increase habitat diversity in areas dominated by a single habitat type. Analyses in this section are based on three Appendix E tables that list the 179 westside watersheds in which forested trust lands make up at least 5 percent of the total land area. Each of these tables (Appendix E, Tables E-17, E-18, and E-19) identifies the proportion of forested lands in each watershed consisting of a different forested habitat type, and the distribution of that habitat type among different land ownerships. A fourth appendix table, Table E-20, identifies the proportion of each watershed under DNR, federal, private, or other ownership.

The discussions below focus on three forest condition classes (small/open forests, forests with medium/large trees, and forests with very large trees) and one nonforested habitat type (wetlands). Wildlife species associated with the different forest habitat types are discussed in Section 4.4. Although the timber harvest activities addressed in this Environmental Impact Statement are not likely to affect the amount and distribution of a nonforested habitat such as wetlands, habitat quality may be adversely affected by equipment and activities associated with timber harvest (see Section 4.9). Significant regulatory (Forest Practices Act and Rules: RCW 76.09 and WAC 222) and HCP protections exist for wetlands, both forested and non-forested, suggesting that the likelihood of significant impacts to these important habitats is low.

Interagency Vegetation Mapping Project data were used to identify three broad classes of forested vegetation, which roughly approximate the forest habitat types used in other analyses in this Environmental Impact Statement. The small/open forests are most similar to early stages in the stand development, i.e., ecosystem initiation (Table 4.2-4). The “medium-to-large diameter, closed forests” approximate the competitive exclusion stages described in Table 4.2-4, and the “forest with very large trees” are most similar to the structurally complex forest stand development stages (represented by developed understory through old natural forests in Table 4.2-4). Note, however, that the classes in this cumulative effects analysis are defined using different criteria, and are based on a different set of data than the forest structure classes identified in Sections 4.2 and 4.4. Table 4.15-1 lists the criteria used to define the forest structure classes used in this analysis.

The analysis of potential adverse cumulative effects to wildlife species associated with different forest condition classes examines the proportion of the forested area in each watershed comprising each forest condition class. For this analysis, the area identified by Interagency Vegetation Mapping Project data as vegetated areas (excluding agricultural areas) is taken to represent forested areas. As noted above, available data on canopy cover do not distinguish among coniferous, deciduous, shrubby, and herbaceous vegetation, so this analysis likely overestimates the amount of forested habitat in some areas. Also, size class data could be assigned only to areas with at least 70 percent total vegetation cover and at least 30 percent conifer cover. Forest condition class definitions are based on size classes, so areas that do not meet these criteria did not fall into any of the three forest condition classes. This may lead to some underestimation of the amount of forest in the small/open condition, because some recently harvested areas likely have less than 70 percent total vegetation cover and less than 30 percent conifer cover.

4.15.3.1 Current Small/Open Forest

Of the 179 watersheds addressed in this analysis, more than half (107) have between 10 percent and 20 percent of their forested area in small/open forest (Table 4.15-2). Only four watersheds have more than 30 percent small/open forest, and 39 have between 20 and30 percent. Twenty-nine have less than 10 percent of their watershed area in small/open forest. The South Puget Planning Unit has the highest average percentage of this forest condition per watershed, and the Olympic Experimental State Forest has the lowest.

Table 4.15-1. Definitions of Forest Structure Classes Used in this Cumulative Effects Analysis Based on Interagency Vegetation Mapping Project Data

Forest Condition Class	Interagency Vegetation Mapping Project Data Criteria
Forest with small-diameter trees, open forest	Conifer cover[1/] less than 70 percent and quadratic mean diameter less than 10 inches.
Forest with medium- to large-diameter trees, closed forest	All stands with a quadratic mean diameter between 10 and 30 inches, plus stands with conifer cover greater than 70 percent and quadratic mean diameter less than 10 inches.
Forest with very large-diameter trees	All stands with a quadratic mean diameter greater than or equal to 30 inches.

[1/] As defined in Interagency Vegetation Mapping Project data documentation (2002)

Table 4.15-2. Number of Watersheds[1/] With Small/Open Condition Forest by Habitat Conservation Plan Planning Unit

Percent Small/ Open Condition	Columbia	N. Puget	OESF	S. Coast	S. Puget	Straits	Total
<10%	3	10	7	5	0	4	29
10-20%	21	39	15	16	6	10	107
20-30%	12	11	1	3	8	4	39
30-40%	2	1	0	0	1	0	4
Total	**38**	**61**	**23**	**24**	**15**	**18**	**179**
Average[2/]	*19.1%*	*15.6%*	*13.2%*	*15.2%*	*21.9%*	*16.1%*	*16.6%*

Data Source: Cumulative effects forest structure data.
OESF = Olympic Experimental State Forest
[1/] The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.
[2/] Average = average percentage forested area in small/open condition

Of the 22 watersheds with the highest proportion of small/open forest, 7 are in the Columbia HCP Planning Unit, 6 are in North Puget, 6 are in South Puget, and 3 are in the Straits. None of the these 22 watersheds are in the South Coast HCP Planning Unit or the

Olympic Experimental State Forest. The great majority of small/open forest in these watersheds occurs on private lands. See Appendix E, Table E-17 for the percentage of forested area consisting of small/open forest in all 179 watersheds and the distribution of that habitat among different ownership categories.

Table 4.15-3 summarizes the distribution of habitat among ownerships in 26 watersheds that have a combination of a relatively high proportion of small/open forest (greater than 20 percent) and a large percentage (greater than 90 percent) of the total land area in either

Table 4.15-3. Percent of Small/Open Forest and Ownership in Watersheds[1/] with the Highest Future Potential to Become Dominated by Small/Open Forest[2/]

HCP Planning Unit	Number of Watersheds	Average Percent Small/ Open Forest	Average Percent of Watershed Area in Each Ownership			
			DNR	Federal	Private	Other
Columbia	6	25%	9%	0%	88%	3%
N. Puget	8	25%	20%	0%	79%	1%
OESF	1	21%	26%	4%	67%	2%
S. Coast	3	21%	40%	0%	59%	1%
S. Puget	5	23%	48%	0%	47%	5%
Straits	3	26%	27%	0%	71%	2%
Westside	***26***	***24%***	***26%***	***0%***	***71%***	***2%***

Data Source: Cumulative effects forest structure data
OESF = Olympic Experimental State Forest HCP = Habitat Conservation Plan
[1/] The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.
[2/] Potential for domination by small/open condition forest based on the current percent of this forest condition and likely management based on ownership in a given watershed.

private or DNR ownership. The more extensive forest management activities on forested trust lands, as are projected to occur under Alternatives 5, 3, and the Preferred Alternative and to a lesser extent under Alternative 2, combined with similar activities on private lands, may result in a situation where more than 50 percent of the area of these watersheds supports small/open forest. Such a large increase in this habitat type may provide temporary benefits to some wildlife species (e.g., foraging habitat for deer and elk, or breeding habitat for certain birds), but may reduce the availability of other forest types, limiting the habitat for species that rely on other habitat types. The more intensive management in these watersheds under Alternatives 5, 3, and the Preferred Alternative may carry greater relative risk to species that rely on interconnected areas of closed-canopy forest. However, of the three Alternatives mentioned (5, 3, and the Preferred Alternative), the forest management strategies of the Preferred Alternative indicate greater increases in more structurally complex forests over the long term than Alternative 1 (No Action). These increases in larger diameter and more structurally complex forest may mitigate for the potential loss of interconnected closed canopy-forest.

Table 4.15-4 portrays the opposite scenario to Table 4.15-3. It summarizes 20 watersheds in which 10 percent or less of the forested area consists of small/open forest. In addition, less than 30 percent of the total land area is in private ownership, that is, DNR and/or the federal government are the dominant landholders in these watersheds. Over time, passive management of forested trust lands (such as is projected to occur in many areas under Alternatives 1 and 4), combined with passive management of federal lands, would result in declines in the amount of small/open forest in these areas. Conversely, more relatively intensive timber harvest on forested trust lands (for instance, under Alternatives 5, 3, 2, or the Preferred Alternative) may provide appreciable increases in the amount of this habitat type. Table 4.15-4 identifies potential opportunities for DNR to ensure that small/open forest continues to be available in all westside watersheds with an appreciable amount of forested trust lands. Abundant shrubby and herbaceous vegetation in such areas would provide foraging habitat for deer and elk, and support an abundant and diverse assemblage of birds (Carey et al. 1996).

Table 4.15-4. Watersheds[1/] Where Management of Forested Trust Lands May Play a Major Role in the Maintenance of Small/Open Forest

HCP Planning Unit	Number of Watersheds	Average Percent Small/Open Forest	Average Percent of Watershed Area in Each Ownership			
			DNR	**Federal**	**Private**	**Other**
Columbia	2	8%	25%	73%	2%	0%
N. Puget	9	7%	26%	54%	17%	3%
OESF	5	8%	23%	47%	27%	2%
Straits	4	7%	24%	54%	20%	2%
Westside	***20***	***7%***	***25%***	***54%***	***19%***	***2%***

Data Source: Cumulative effects forest structure data
OESF = Olympic Experimental State Forest HCP = Habitat Conservation Plan
[1/] The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.

4.15.3.2 Current Forests with Medium/Large Trees

Nearly three-quarters of the 179 watersheds have at least 40 percent forested land in the forests with medium/large trees (Table 4.15-5).

Table 4.15-6 summarizes the ownership distribution of forests with medium/large trees in the top 25 percent of the watersheds with the highest proportion of forests with medium/large trees. The upper quartile was chosen because this forest condition has the least benefit to a broad range of wildlife species groups (see Section 4.4) and indicates potential forest health impacts (Section 4.2.6). See Appendix E, Table E-18 for the percentage of the forested area with medium/large trees in all 179 watersheds, and the distribution of this forest condition among different ownership categories.

Overall, the average proportion of forested land with medium/large trees on forested trust lands equals the average proportion on private lands. In three HCP Planning Units (North Puget, South Puget, and Straits) the average proportion on forested trust lands exceeds that on private lands. This pattern differs from the ownership pattern for watersheds with high proportions of small/open forest (where private lands are generally the dominant ownership) and forests with very large trees (where federal lands are most common and DNR has the highest proportion of ownership in only 2 of the top 20).

In all of the watersheds with a high proportion of forests with medium/large trees, active forest management may increase habitat diversity within stands and across the landscape. Forests with medium/large trees generally have low levels of structural (and thus wildlife) habitat diversity, and nowhere is this structure class at risk of disappearing from the landscape. All the Alternatives, including Alternative 1 (No Action), project a decrease in the competitive exclusion forest condition on western Washington forested state trust lands. Commercial thinning (as under Alternative 5) may provide temporary benefits to species associated with forest in the small/open condition. Thinning prescriptions designed to enhance structural diversity (as under the Preferred Alternative) may accelerate the

Table 4.15-5. Number of Watersheds[1/] Supporting Various Proportions of Forests with Medium/Large Trees Among HCP Planning Units

	Columbia	N. Puget	OESF	S. Coast	S. Puget	Straits	Total
<20%	2	0	0	0	0	0	**2**
20-40%	9	16	2	9	3	9	**48**
40-60%	23	41	18	11	7	8	**108**
60-80%	4	3	3	4	5	1	**20**
80-100%	0	1	0	0	0	0	**1**
Total	**38**	**61**	**23**	**24**	**15**	**18**	**179**
Average[2/]	*44%*	*45%*	*51%*	*49%*	*49%*	*42%*	***46%***

Data Source: Cumulative effects forest structure data.
OESF = Olympic Experimental State Forest
[1/] The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.
[2/] Average = average percentage area of medium/large condition forest by HCP Planning Unit.

Table 4.15-6. Summary of Watersheds[1/] Supporting the Highest Proportion of Forests with Medium/Large Trees, and the Proportion of the Watershed in Each Ownership Class

HCP Planning Unit	Number of Watersheds	Average Percent of Forest with Medium/Large Trees	Average Percent of Forest with Medium/Large Trees in Different Ownerships			
			DNR	Federal	Private	Other
Columbia	9	60%	38%	20%	41%	1%
N. Puget	11	62%	35%	28%	33%	5%
OESF	9	59%	32%	16%	46%	7%
S. Coast	8	64%	42%	0%	52%	6%
S. Puget	6	62%	54%	8%	20%	18%
Straits	1	60%	69%	8%	22%	0%
Westside	***44***	***61%***	***39%***	***16%***	***39%***	***6%***

Data Source: Cumulative effects forest structure data
OESF = Olympic Experimental State Forest
HCP = Habitat Conservation Plan
[1/] The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.

development of more complex forest structures, providing benefits to wildlife species associated with the latter condition. Alternatives with more passive or traditional silvicultural management approaches, (as under Alternatives 1 and 4 for passive approaches and 2, 3, and 5 for more traditional silvicultural management) are more likely to perpetuate single story stands that have less structural diversity.

4.15.3.3 Current Forest with Very Large Trees

Throughout the 179 watersheds addressed in this analysis, forest with very large trees is the least common of the three forest condition classes. Only three watersheds have more than 30 percent of their forested area in forest with very large trees (Table 4.15-7). Nearly two-thirds (118) have less than 5 percent forest with very large trees. Fifty-five of these have less than 1 percent of forest with very large trees. This type of forest does not constitute a majority of the forested habitat in any of the watersheds, nor does it anywhere exceed the amount of either of the other two forest condition classes in any watershed.

Currently, forest with very large trees is not evenly distributed among the five Westside HCP Planning Units and the Olympic Experimental State Forest. Two HCP Planning Units (South Coast and South Puget) have no watersheds with more than 5 percent forest with very large trees (Table 4.15-7). This habitat type is particularly scarce in the South Coast HCP Planning Unit, where 22 of 24 watersheds have less than 1 percent forest with very large trees. In contrast, more than half (10 of 18) of the watersheds in the Straits HCP Planning Unit have at least 5 percent forest with very large trees. The North Puget HCP Planning Unit has the most watersheds with at least 10 percent forest with very large trees (20), while the Olympic Experimental State Forest has the highest percentage of forest with very large trees among all watersheds. In 15 of the top 20 forested trust lands, more

Table 4.15-7. Number of Watersheds[1/] Supporting Various Proportions of Forest with Very Large Trees among HCP Planning Units

Percent of Forest with Very Large Trees	Columbia	N. Puget	OESF	S. Coast	S. Puget	Straits	Total
<1%	14	15		22	4		55
1-5%	13	17	12	2	11	8	63
5-10%	8	9	6			7	30
10-20%	3	12	3			1	19
20-30%		6	1			2	9
>30%		2	1				3
Total	**38**	**61**	**23**	**24**	**15**	**18**	**179**
Average[2/]	*3.4%*	*7.9%*	*8.0%*	*0.4%*	*2.0%*	*7.1%*	*5.3%*

Data Source: Cumulative effects forest structure data
OESF = Olympic Experimental State Forest
1/ The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.
2/ Average = average percent of forested area with very large trees.

than 10 percent have been designated as Nesting, Roosting, and Foraging Management Areas for northern spotted owls. See Appendix E, Table E-19 for the percentage of the forested area with very large trees in all 179 watersheds, and the distribution of this habitat among different ownership categories. DNR designated northern spotted owl management areas (Nesting, Roosting, and Foraging Management Areas) account for more than 10 percent of forested trust lands in 37 of the 179 watersheds. In most of these, the majority of forest with very large trees falls on federal lands. The 13 watersheds summarized in Table 4.15-8 have less than half of the existing forest with very large trees occurring on federal lands, with the majority of the existing forest being on forested trust lands. In all Alternatives, the area of structurally complex forest on DNR-managed forested trust lands is projected to increase in designated Nesting, Roosting, and Foraging Management Areas (see Table 4.4.3).

Table 4.15-8. Summary of Watersheds[1/] in which at Least 10 Percent of Forested Trust Lands are Designated Northern Spotted Owl Nesting, Roosting, and Foraging Management Areas, and where less than 50 Percent of Existing Forest with Very Large Trees Falls on Federal Lands

HCP Planning Unit	Number of Watersheds	Average Percent of Forest with Very Large Trees	Average Percent of Forest with Very Large Trees in Different Ownerships			
			DNR	Federal	Private	Other
Columbia[2/]	2	4%	30%	14%	41%	15%
N. Puget	11	8%	45%	22%	31%	2%
Westside	***13***	***8%***	***43%***	***21%***	***32%***	***4%***

Data Source: Cumulative effects forest structure data.
1/ The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.
2/ In one of these watersheds (Hamilton Creek - 280106), 27 percent of the existing very large forest occurs in Beacon Rock State Park, and is thus not likely to be harvested

As noted above, in most of the watersheds with the highest proportion of forest with very large trees, the majority of that habitat occurs on federal lands. Table 4.15-9 summarizes the distribution of habitat among different ownerships in 11 watersheds where at least 10 percent of the forested area consists of forest with very large trees, and where at least 20 percent of that habitat is on forested trust lands. In the short term (i.e., before additional habitat can develop on federal or forested trust lands), relatively more intensive timber harvest on forested trust lands (as under Alternative 5) in these watersheds could substantially reduce the amount and quality of habitat in forest with very large trees in some areas where this type of forest is comparatively plentiful. If Alternative 5 where implemented, more in-depth planning and protection of existing forest stands with very large trees would be warranted.

Fifty-five westside watersheds support little or no forest with very large trees (less than 1 percent of the unit). Intensive harvest of lands in any ownership might carry the risk of effectively eliminating this habitat type—and the species that depend on it—from those watersheds in the foreseeable future (Appendix E, Table E-19), except in areas where such habitats occur on land protected for other policy reasons such as riparian habitat or slope stability. DNR’s process of evaluating such effects on the environment during the design of timber harvest projects with an extended State Individual Environmental Protection Act checklist provides an opportunity to redesign or modify the project and reduces the risk of the eliminating the very large tree habitat type. Modification or redesign of a timber harvest project would take into consideration the DNR’s policies and procedures, such as but not limited to, leave tree requirements, management for protection of slope stability, Riparian Management Zones, and adjacency of regeneration harvests (Forest Resource Plan Policy No. 32). Varying amounts of older age classes occur in riparian areas, where they routinely receive protection by the Forest Practices Rules and the HCP.

Over the long term, all Alternatives would maintain or increase the total area of structurally complex forests on western Washington forested state trust lands (see Figure 2.6-4 in Chapter 2). For the short term, Alternatives 5 and the Preferred Alternative

Table 4.15-9. Summary of Watersheds[1/] in which at Least 10 Percent of Forested Lands Supports Forest with Very Large Trees, and Where at Least 20 Percent of Existing Forest with Very Large Trees Occurs on Forested Trust Lands

Planning Unit	Number of Watersheds	Average Percent of Forest with Very Large Trees	Average Percent of Forest with Very Large Trees in Different Ownerships			
			DNR	Federal	Private	Other
Columbia	2	13%	38%	56%	7%	0%
N. Puget	7	15%	50%	38%	10%	2%
OESF	2	13%	64%	35%	0%	1%
Westside	***11***	***14%***	***50%***	***41%***	***8%***	***1%***

Data Source: Cumulative effects forest structure data
OESF = Olympic Experimental State Forest
[1/] The term “watershed” is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations

provide direction to the DNR to establish a target of 10 to15 percent of each Westside HCP Planning Unit area to be in older forest conditions, while Alternative 4 provides direction to protect from harvest all forest stands managed by DNR that are 150 years and older in 2004.

Current Wetlands

Interagency Vegetation Mapping Project data do not identify all wetland areas. Wetlands are identified in fewer than half of the 179 watersheds addressed in this analysis, and they account for no more than 1.2 percent of the area of any single watershed. These are the best available data for an analysis of this scale, and serve as a screening tool for identifying areas where wetlands may be of particular concern.

Table 4.15-10 assesses watersheds where wetlands may face a higher risk of disturbance from land management activities. Interagency Vegetation Mapping Project data indicate that at least 10 percent of the land area consists of agricultural and/or urban lands. Wetlands on agricultural and urban lands may have been filled-in or otherwise degraded, and wetlands that persist in these settings may face an elevated relative risk. Additional effort may be needed to ensure that management on trust lands in these watersheds does not contribute to potentially significant adverse cumulative effects on wetlands. DNR current policy (Forest Resource Plan No. 21), HCP, and current procedure (PR 14-004-110) specify that wetlands require significant protection, and stipulate no overall net loss of wetlands due to state land management. See Section 4.9 (Wetlands) for an assessment of the risks to wetlands from forest management activities.

4.15.3.4 Summary of Environmental Effects on Forest Conditions and Wildlife Habitat

The current conditions of the forests and wildlife habitats vary in the watersheds where DNR manages western Washington forested trust lands. The outstanding forest condition that lacks substantial acreage across all watersheds is forests with large/very trees. These forests are an indicator of structurally complex forests; forests that provide certain key

Table 4.15-10. Areas with an Elevated Potential for Development Where Wetlands Have Been Identified

HCP Planning Unit	Number of Watersheds[1/]	Average Area of Wetlands	Average Percentage of Land Area in Different Land Classes or Ownerships			
			Agriculture	Urban	DNR	Private
Columbia	9	0.04%	21%	5%	12%	83%
N. Puget	14	0.15%	16%	5%	19%	78%
S. Coast	9	0.18%	17%	3%	26%	72%
S. Puget	2	0.07%	3%	14%	23%	68%
Straits	1	0.01%	33%	2%	13%	62%
Westside	***35***	***0.12%***	***17%***	***5%***	***19%***	***77%***

Data Source: DNR MASK Geographic Information System layer.

[1/] The term “watershed” is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.

habitats for wildlife and plant species in western Washington. All the Alternatives project improvements in structurally complex forest on forested trust lands over time. The Preferred Alternative has the greatest potential to increase structurally complex forest through implementation of silvicultural systems that promote structural diversity in forest stands (biodiversity pathway management).

This increase in structurally complex forest on forest trust lands will have the greatest potential for a positive impact in watersheds where state trust ownership is greatest. For other watersheds, where the state trust ownership is small, the development of structurally complex forest will be dependent upon other landowners. Federal management of forestlands is currently assumed to be dominated by passive management pathways, with few acres receiving silvicultural treatment. Large private forest ownership is, in general, assumed to be focused on commercial timber production unless the ownership has an HCP with the Federal Services (this includes National Oceanic and Atmospheric Administration – Fisheries Service and U.S. Fish and Wildlife Service). Nonindustrial landownership consists of mixture of passive and commercial timber management and forest conversion activities. Based on the analysis of the Alternatives presented in this Final Environmental Impact Statement (see Section 4.2.2, Forest Structure and Vegetation) that examined a range of both passive and commercial timber management options, neither passive nor industrial management approaches are likely to offer substantial improvements in structural complex forest in the near or long term. Model outputs indicate that biodiversity pathways management proposed under the Preferred Alternative provides the best opportunity to accelerate the development of structural complex forest and provides the most fully functionally forest over the life of the HCP (see Table 4.2-8).

4.15.4 Fish

Several factors influence the potential for forest management to contribute to significant adverse cumulative effects to fish resources. These factors include the presence of fish or fish habitat, the existing condition of these resources, geomorphologic processes, and the frequency and intensity of management activities. The location of management activities also plays a role. Activities in the riparian area may influence the potential for adverse effects, as well as those in upslope areas with the potential to deliver significant amounts of sediment into the aquatic ecosystems. Activities in areas of unstable slopes (and an elevated risk of mass wasting) may increase the potential for sediment delivery, while those in significant rain-on-snow zones may alter the timing and magnitude of peak stream flows.

Areas that have more fish resources (as indicated by stream density per square mile or miles of stream per square mile of land) are considered to be potentially more at risk to cumulative effects. Similarly, areas that have higher levels of past disturbance (e.g., small riparian trees) or potential future disturbance (unstable slopes) are considered to be potentially at higher relative risk of showing adverse cumulative effects currently or in the future. Finally, management strategies on different ownerships can result in different levels of future activities. Higher levels of activity are considered to have a higher relative potential to contribute to significant adverse cumulative effects. Federal ownership is expected to result in few forest management activities under the Northwest Forest Plan, while private forest ownership, except in areas covered by private forestland HCPs, is expected to result in more intensive and frequent management as compared to western Washington forested trust lands. The level of forest management activities in riparian areas proposed on forested trust lands may be relatively low (Alternatives 1 and 4) or relatively high (Alternatives 5 and the Preferred Alternative) depending on the Alternative chosen.

In general, fish resources and their habitat would be expected to improve in the long term because of the Northwest Forest Plan, improved Forest Practices Rules, and various habitat conservation plans being developed and implemented in the region. Each of these landscape-level plans has a goal of protecting and restoring fish resources in the Pacific Northwest. Nevertheless, forest management activities are expected to continue in the region. The risk of adverse cumulative effects needs to be evaluated in light of these activities, current conditions, and the previously identified legal, contractual, and policy constraints.

The cumulative effects analysis for fish resources uses the watershed as the spatial scale for analysis, and the planning unit as the scale for summarizing them.

The cumulative effects analysis for fish resources integrates a number of measures for each watershed. These include the following:

- Percent of forested trust lands ownership in the total watershed area (Appendix E, Table E-20);
- Percent of riparian area with small trees (a quadratic mean diameter of less than 10 inches) (Appendix E, Table E-21)
- Anadromous fish stream length and stream density (stream miles per square mile) (Appendix E, Table E-22);
- Total stream length and stream density (stream miles per square mile) (Appendix E, Table E-23);
- Resident fish stream density (Types 1 to 3 stream miles per square mile) (Appendix E, Table E-24);
- Bull trout stream density (bull trout stream miles per square mile) (Appendix E, Table E-25);
- Percent of watershed area with urban or agricultural land use (Appendix E, Table E-26);
- Percent of rain-on-snow area with hydrologically immature forest (see Section 4.7, Hydrology) (Appendix E, Table E-22);
- Miles of stream on the 303(d) list for temperature (see Section 4.8, Water Quality) (Appendix E, Table E-13);
- Miles of stream on the 303(d) list for dissolved oxygen (see Section 4.8, Water Quality) (Appendix E, Table E-14);
- Miles of stream on the 303(d) list for fine sediment (see Section 4.8, Water Quality) (Appendix E, Table E-15); and
- Percent of watershed area assessed as having a high rating for shallow rapid landslides (see Section 4.6, Geomorphology, Soils, and Sediment) (Appendix E, Table E-29)

The available information (summarized in Table 14.5-15) indicates that the highest average proportion of watersheds that may be experiencing cumulative effects (i.e., the watershed is present in the upper quartile for the resource measures described listed above) was in the North Puget HCP Planning Unit (an average of about 33 percent of watersheds in the upper quartile), followed by the Olympic Experimental State Forest (about 17 percent), Columbia (about 16 percent), South Coast (about 14 percent), South Puget (about 6 percent), and Straits (about 6 percent) HCP Planning Units.

If each HCP Planning Unit is examined individually, then the Olympic Experimental State Forest has the highest number of watersheds (about 33 percent) that have resource areas that may be experiencing cumulative effects (i.e., the watershed is present in the upper quartile for the resource measures described listed above). The Olympic Experimental State Forest is followed by South Coast (about 26 percent), North Puget (about 24 percent), Columbia (about 19 percent), South Puget (about 17 percent), and Straits (about 14 percent). Based upon this summary information, the relative potential for existing adverse cumulative effects to fish resources is highest for the North Puget and Olympic Experimental State Forest HCP Planning Units, moderate for the Columbia and South Coast HCP Planning Units, and relatively low for the South Puget and Straits HCP Planning Units. Individual watersheds may have a higher or lower potential for existing adverse cumulative effects to fish resources than these planning unit averages.

The relative potential of future adverse cumulative effects is related to a large number of factors that include conditions in the marine environment and fisheries management (for anadromous fish), current conditions, and the intensity and type of future forest management activities in riparian areas. The focus of this analysis will be on the last two factors. Upslope activities on unstable areas that result in large mass movements may affect fish resources by contributing sediment to streams. Slope stability cumulative effects are addressed in Section 4.15.5.6. Consequently, the relative potential for future cumulative effects from activities on western Washington forested state trust lands may be highest under Alternative 5 and the Preferred Alternative compared to other Alternatives. However, thinning dense stands of small and medium trees (trees under 20 inches in diameter) in combination with other habitat enhancement activities as proposed in the Preferred Alternative would be expected to improve riparian conditions over time. The forest management activities associated with the riparian restoration activities in the Preferred Alternative are based on biodiversity pathways management and are likely to enhance the development of fully functional riparian forests for a larger area in an earlier timeframe. Therefore, the near-term relative risks of some adverse cumulative effects from tree removal and ground disturbance may be higher under the Preferred Alternative compared to Alternatives 1 through 4, which have relatively low levels of management activities in riparian areas. On the other hand, the current levels of potential adverse cumulative effects that result from having less-than-fully functional riparian areas are expected to decline more rapidly from active management under the Preferred Alternative compared to other Alternatives.

4.15.4.1 Evaluation of Potential Cumulative Effects to Fish

Under all of the Alternatives, riparian management activity on forested state trust lands is designed to achieve stand development stages at and beyond understory initiation (see Table 4.2-4). Most of the riparian management activities would occur concurrent with adjacent upland forest management activities.

Based upon the current best reasonably available information, the relative potential for existing adverse cumulative effects to fish resources from the proposed Alternatives is highest for the North Puget Habitat Conservation Plan (HCP) Planning Unit, followed by the Olympic Experimental State Forest, and then the Columbia, South Coast, South Puget, and Straits HCP Planning Units. The relative potential of future contributions to adverse cumulative effects is assumed to be related to current conditions and the intensity and type of future forest management activities in riparian areas. Consequently, the relative potential for future cumulative effects from activities on forested trust lands may be highest under Alternative 5 and the Preferred Alternative compared to other Alternatives. Under the Preferred Alternative riparian stands in the competitive exclusion stage will have a high priority for thinning activity. The forest management activities associated with these riparian harvests in all HCP Planning Units in the Preferred Alternative are generally based on biodiversity pathway management and are likely to enhance and accelerate the development of fully functioning riparian forests for a larger area in an earlier time frame. The relative risks of some adverse cumulative effects from tree removal and ground disturbance may be higher under the Preferred Alternative, as compared to Alternatives 1 through 4, which have relatively low levels of management activities in riparian areas. On the other hand, the current levels of adverse cumulative effects that result from having less-than-fully functioning riparian areas are expected to decline more rapidly under active management.

4.15.5 Water Resources

4.15.5.1 Hydrology

Hydrologically mature forest is defined as a conifer-dominated forest having a relative density of at least 25 on Curtis' relative density index scale and a stand age of 25 years or older. Hydrologic immaturity is therefore defined as any forested area that is younger than 25 years old, or that has a relative density of less than 25 (HCP, page IV 68). The significant rain-on-snow zone varies with location, but typically is found between elevations of approximately 1,000 and 3,000 feet above sea level. Of the 179 watersheds in which forested trust lands make up at least 5 percent of the total ownership, 159 of these also have areas of hydrologically immature forest in the rain-on-snow zones. These areas are summarized by ownership in Appendix E, Table E-27.

As discussed in the Forest Practices Rules Final Environmental Impact Statement (2001), Section 3.3, pages 3-27 and 3-28, three primary processes affect the hydrologic functions of forested watersheds: 1) precipitation and water flow regimes (i.e., flow with respect to time) largely controlled by climate; 2) the role of vegetation in intercepting precipitation and controlling the amount of water, including snow:rain ratio, that reaches the forest floor; and 3) the role of surface and subsurface pathways that deliver surface runoff and subsurface water to streams. Forest management can affect the hydrology of forested watersheds by affecting annual water yield, low flows, and peak flows. Of these effects, the rate and types of harvest under certain circumstances can significantly affect peak flows. Changes in peak flows may lead to slope failure or increased incision and erosion of stream channels depending on local geomorphologic processes. Increasing the forest canopy within the watershed can lessen these effects. Maintaining or increasing hydrologic maturity within the significant rain-on-snow zones can particularly lessen the effects.

4.15.5.2 Evaluation of Potential Cumulative Effects to Hydrology

None of the Alternatives would alter the existing policies and procedures related to management of significant rain-on-snow zones. In all of the Alternatives, the percentage of mature forest on forested trust lands within the "significant" rain-on-snow zones (the rain on snow and snow-dominated zones) of watersheds would not drop below 66 percent, as defined in the Habitat Conservation Plan (HCP) (page IV. 68) and procedure 14-004-060. As shown in Appendix E, Table E-27 and discussed in Appendix E, the Olympic Experimental State Forest has the largest percent of immature forest in the significant rain-on-snow zones under DNR ownership, meaning that this is the HCP Planning Unit in which DNR carries the greatest relative risk for increasing peak flows relative to other ownerships. Management intensity at the watershed level (indicated by number watersheds having a 20 percent of more of forested trust land regenerated during the first decade) in the Olympic Experimental State Forest is presented by Alternative in Table 4.15-11. Alternatives 1, 3, and 4 would appear to present the least intensive management for the Olympic Experimental State Forest in the first decade. Alternative 5 would present the greatest risk to increasing peak flows in potentially eight watersheds, while Alternative 2 and Preferred Alternative demonstrate intermediate positions. This ranking of Alternatives is similar for the other planning units, with Alternative 5 presenting the most watersheds with relatively high regeneration harvest levels and the Preferred Alternative an intermediate rank.

4.15.5.3 Water Quality

Water quality was evaluated in terms of the miles of stream listed under 303(d) for temperature, fine sediment, and dissolved oxygen in each of the 179 watersheds with greater than 5 percent DNR ownership. There were no 303(d) listings in these watersheds for phosphorous or other nutrients. The purpose of the analysis was to determine which planning units and watersheds would be at risk for decreased water quality due to proposed changes in harvest levels on forested trust lands. See Appendix E and Appendix E, Tables E-12, E-14, and E-15.

Table 4.15-11. Number of Watersheds by HCP Planning Unit and Alternative with a Modeled Regeneration Harvest Area of 20 Percent or Greater of Forested Trust Lands in Watersheds Where Forest Trust Lands Amount to 22 Percent or More of the Watershed Area

	HCP Planning Unit					
Alternatives	**Columbia**	**North Puget**	**South Coast**	**South Puget**	**Straits**	**OESF**
1	2	3	1	0	2	0
2	1	2	5	1	1	2
3	4	1	6	1	4	0
4	6	6	9	1	1	0
5	8	3	9	8	6	8
PA	8	4	5	3	1	2

PA = Preferred Alternative
OESF = Olympic Experimental State Forest

4.15.5.4 Evaluation of Potential Cumulative Effects to Water Quality

As discussed in Section 4.8, Alternatives 2 through 5 and the Preferred Alternative would include increased harvest in riparian areas, meaning that there would be a relative risk of reduced shade and increased sedimentation in the short term with these Alternatives. While no harvest is proposed for the inner Riparian Management Zones in any of the Alternatives, the Preferred Alternative does model patch cuts of greater than 1 acre as part of its biodiversity pathway approach to Riparian Management Zones. These patches could increase the risk of blowdown and slightly increasing relative risk of fine sediment input to streams. Harvest intensity could affect the amount of road traffic, increasing the risk of fine sediment input to streams. Additionally, of the Alternatives proposed, only Alternative 5 and the Preferred Alternative would increase fertilizer use. These two Alternatives, with higher harvest rates and some use of fertilizers, have the highest relative risk for decreasing dissolved oxygen levels on listed streams. While the long-term and landscape-level risks are low for water quality under implementation of any of the Alternatives, the 303(d) stream listings may be used as an allocation tool for planning resources to assess water quality and forest management interactions.

4.15.5.5 Slope Stability and Soils

Slope stability and soil productivity are critical variables in protecting the environment and maintaining harvest levels, as discussed in the Forest Practices Rules Final Environmental Impact Statement (2001, pp. 3-5 through 3-8) and this document (Section 4.6). Both parameters are analyzed here based on slope stability, soil characteristics, and ownership data, and are discussed below.

4.15.5.6 Slope Stability

None of the Alternatives change DNR's policies and procedures in the management of slope stability. Slope stability has been modeled for all watersheds in the study area using the Shaw-Johnson model for slope stability (Shaw and Johnson 1995). Appendix E, Table E-29 contains data for areas classified as "high" for potential slope instability. Appendix E, Table E-30 contains data for areas classified as "moderate" for potential slope instability. Evaluation using the Shaw-Johnson model is one of the methods used to initially identify areas of potential slope instability for DNR procedure 14-004-050, Assessing Slope Stability. If this method is used to determine slope stability, the areas identified using the Shaw-Johnson model must then be field-verified by qualified staff. Management operations, including timber harvest, are then determined. The current process for prevention of slope failure is a function both of identification of potentially unstable areas and careful planning of operations in those areas.

Slope stability rankings, as determined by the Shaw-Johnson model, vary regionally with topographic relief. The average percent area by watershed that is classified as high for potential slope instability is shown for each planning unit in Table 4.15-12.

DNR ownership of these areas does not vary significantly among planning units from the average for western Washington forested state trust lands. The North Puget HCP Planning Unit and the Olympic Experimental State Forest have the highest percent areas classified, as a result of modeling, as high for potential slope instability. Additionally, of 45 watersheds ranked in the top quartile for percent area classified as high for potential slope instability, nine have majority DNR ownership of these lands. These nine watersheds are in either the North Puget or Olympic Experimental State Forest HCP Planning Units, as shown in Appendix E, Table E-29.

Existing DNR policies and procedures and Forest Practices Rules require specialist resources to identify any potentially unstable areas on which management is proposed. As

Table 4.15-12. Average Percent Area Classified as High for Potential Slope Instability by HCP Planning Unit and Ownership

HCP Planning Unit	Number of Watersheds[1/] Analyzed	Average Percent of Watershed Acreage Classified as High	Percent of Area Classified as High for Potential Slope Instability by Ownership			
			DNR	Federal	Private	Other
Columbia	38	7.5%	21%	13%	64%	1%
North Puget	61	17.1%	27%	36%	34%	2%
OESF	23	16.2%	39%	29%	28%	4%
South Coast	24	11.3%	27%	0%	70%	3%
South Puget	15	10.0%	38%	18%	39%	5%
Straits	18	13.5%	25%	50%	24%	1%
Average		**12.6%**	**30%**	**27%**	**40%**	**3%**

Data Source: DNR MASK Geographic Information System layer.
OESF = Olympic Experimental State Forest
[1/] The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.

the Shaw-Johnson model has not been calibrated for all areas on state trust forests in western Washington, the potential relative risks for proposed Alternatives is discussed qualitatively.

Landslide risk is a function of physical conditions, policy, and management activities. Given current conditions across the landbase and no changes in the proposed policies related to landslides under any of the alternatives, relative risk can be evaluated in terms of the proposed harvest levels and resources required to prevent or mitigate landslide hazards. Alternatives that propose higher levels of harvest in the North Puget HCP Planning Unit and Olympic Experimental State Forest HCP Planning Units, and increased harvest intensity in general, would pose a slightly higher risk in terms of the necessity for additional resources devoted to assessment and planning for management activities on potentially unstable slopes.Therefore, Alternatives are ranked from lowest to highest for the relative need to evaluate forest management activities on potentially unstable slopes by the amount of regeneration harvest area (expressed as greater than 20 percent of the forest trust land ownership in a watershed) during the first decade. Table 4.15-13 presents the number of watersheds with regeneration harvests from the upper quartile group identified with high potential slope instability. North Puget HCP Planning Unit and the Olympic Experimental State Forest have the greatest number of watersheds with regeneration activities. Alternatives 1 and 4 demonstrate the least number of watersheds during the first decade with regeneration areas greater than 20 percent of the state trust ownership in the watershed, while Alternative 5 presents the most in this category.

Under all Alternatives and in all HCP Planning Units, but especially in the North Puget and Olympic Experimental State Forest, DNR will continue to plan and design regeneration harvest activities that minimize the risk of slope failure by following its current policy and procedures.

Table 4.15-13. Number of Watersheds from the Upper Quartile Rank with High Potential Slope Instability with Regeneration Harvests in the First Decade

	Colombia		North Puget		OESF		South Coast		South Puget		Straits	
	Percent of Forested Trust Lands Area Generated during the First Decade											
Alternatives	**0-20%**	**>20%**	**0-20%**	**>20%**	**0-20%**	**>20%**	**0-20%**	**>20%**	**0-20%**	**>20%**	**0-20%**	**>20%**
1	4	1	19		8		2		1		4	
2	5		18	3	7	1	2		1		3	1
3	5		21		8		2		1		1	3
4	3	2	20	3	8		1	1	1		2	2
5	4	1	19	4	6	2	2		1			4
PA	4	1	21	1	7	1	2		1		4	

PA = Preferred Alternative
OESF = Olympic Experimental State Forest

4.15.5.7 Soil Compaction

Soil compaction can reduce site productivity by reducing the permeability and porosity of soil, making it more difficult for roots and water to penetrate the soil. Soil compaction can also influence hydrology by reducing the ability of soil to hold water. Soil compaction potential is a determination of the potential for moist soils to be compacted. Compaction of moist soils can occur during harvest. Harvest practices vary in the amount of compaction resulting in susceptible soils. Ground-based logging practices generally compact and disturb more soil area than practices using partial or full suspension of logs. Policies and procedures in use by DNR to protect soil from compaction are discussed in Appendix C. Compaction effects from timber harvest may be short-lived, especially in coastal Washington, where reduced height of Douglas-fir in skid trail areas compared to nonskid trail areas was found to last only 2 years (Heninger et al. 2002).

Compaction potential varies regionally, with climate and soil type, but sensitivity of soils to compaction is a characteristic common to all of the 179 watersheds considered here for cumulative effects. Both “high” and “moderate” rated moist soil compaction potential data were analyzed, but only high compaction potential soil areas are discussed here. See Appendix E, Tables E-31 and E-32 for the analysis of all 179 watersheds.

Table 4.15-14 shows the percent area of planning units that have soils classified as high for potential for moist soil compaction. Four of the six HCP Planning Units, and therefore a majority of the total area under DNR management, are dominated by soils classified as high for moist soil compaction.

Of the 45 watersheds in the top quartile for percent area classified with a high potential for moist soil compaction, all have at least 83 percent of their area classified as high for this parameter. Therefore, it can safely be assumed that in those 45 watersheds, there is a high probability that any planned harvest would occur on soils that could be considered at risk for compaction during moist soil conditions, regardless of ownership.

Table 4.15-14. Average Percent Acreage Classified as High for Moist Soil Compaction Potential

HCP Planning Unit	Average Percent Acreage Classified as High	Percent of Area Classified as High for Potential for Soil Compaction by Ownership			
		DNR	Federal	Private	Other
Columbia	64%	20%	1%	77%	2%
North Puget	57%	32%	3%	62%	3%
OESF	62%	39%	3%	55%	4%
South Coast	89%	31%	0%	64%	5%
South Puget	27%	38%	1%	49%	11%
Straits	18%	37%	4%	57%	2%

Data Source: DNR MASK Geographic Information System layer.
OESF = Olympic Experimental State Forest

A total of 107 of the 179 watersheds evaluated have greater than 50 percent of the soils rated as having high moist soil compaction potential. Of the 107 watersheds, DNR owns 50 percent or more of the watershed area identified as having high moist soil compaction potential in 17 watersheds. Of these 17, six watersheds rank in the top quartile for percent area classified as high for moist soil compaction potential, as shown in Table 4.15-12. These six watersheds would be the watersheds in which DNR's activities would have the most relative influence in terms of maintaining soil productivity and function in the watershed under the proposed Alternatives.

DNR policies and procedures described in Chapter 2 and Appendix C give general guidance for the timing and type of harvest operations to prevent unnecessary compaction as a result of harvest. As a result of this guidance, the relative risk of increased soil compaction is generally low, regardless of Alternative. The majority of the watersheds in which DNR manages more than 5 percent of the land area are dominated by soils classified as high for potential moist soil compaction. In addition, more intensive harvests would likely result in a greater amount of compaction. Therefore, the relative risk of compaction under each Alternative would be a function of two main factors: 1) total acreage disturbed by higher volume removal harvest activities (greater than 20 thousand board feet per acre) on moist soils, and 2) total acreage disturbed by all harvest activities. The Alternatives can be ranked from least to greatest risk for potential soil compaction as follows: Alternatives 1 and 4 would be essentially the same, followed by the Preferred Alternative and Alternatives 2, 3, and 5.

4.15.6 Potential Impacts of Future Harvests

4.15.6.1 Summary of Current Conditions

Of the 179 watersheds in which DNR manages western Washington forested state trust lands, 83 have a forested trust land ownership level of 22 percent or greater of the total watershed area (these watersheds are referred to hereafter as the "83-group"). The threshold of 22 percent, although appearing arbitrary, represents the upper quartile rank of the forested trust land ownership as a percent ownership in all watersheds that DNR manages lands in western Washington (see Section 4.2.4.2, Forest Structure and Vegetation and Appendix E for more details). Thus, the 83-group represents the watersheds where DNR has the greatest potential to influence current and future cumulative effects, because these are the watersheds where the DNR manages most land.

Use of the "quartile" and "upper quartile" in this analysis is principally used as a screening tool for identifying the potentially "worst-case scenario.". The majority of the resource areas that this environmental analysis examines do not have sufficient reasonably available data to make precise descriptions about the current conditions that exist in a watershed. In addition, making a resource assessment of current or future conditions based upon these best available data would likely result in somewhat arbitrary judgments about whether the conditions are "good" or "poor.". Therefore, the use of statistics (in this case quartiles) provides an alternative method to highlight the most extreme conditions and events (disturbances causes by regeneration harvests) in relative terms of all the conditions that DNR manages in western Washington. As the upper quartile rank of conditions and events represents the potentially “worst-case” situations that may occur, these are analyzed and considered for potential cumulative effects.

Table 4.15-15 summarizes the spatial distribution of the upper quartile rank of 10 resources areas across the five HCP Westside Planning Units and the Olympic Experimental State Forest. Only 9 watersheds out of the 83-group were found to have no occurrences of any of the 10 resource areas represented in the upper quartile (see Table 4.15-16). In other words, the majority of the 83-group of watersheds in which DNR manages 22 percent or more of the land may have existing and/or may be sensitive to future impact of cumulative effects. The majority of the 83-group of watersheds has at least 1 and potentially multiple occurrences of indices ranked in the upper quartile. Therefore, forest management activities, such as harvesting timber, could have potential cumulative effects on these 10 key resources, the 74 remaining watersheds where DNR management has the greatest ownership.

Table 4.15-17 characterizes the resource areas that appear most frequently in the 83-group of watersheds. From the data presented in the Table 4.15-17, the most common resource areas listed are the amount of small diameter, open forests (see Section 4.15.3.1 for a definition), potential slope instability, and resource areas related to riparian and fish resources within these watersheds. These resource areas have been identified from the Geographic Information System data. Other resources areas such as cultural, scenic, and recreational resources also may be important. In part, these resources (not readily captured in Geographic Information System data) may be associated with the amount of small diameter, open forests and are discussed in Sections 4.12, 4.13, and 4.14.

Table 4.15.15. Number of Watersheds in the Upper Quartile, Percent of Upper Quartile, and Percent of Watersheds in a Planning Unit with at Least 5 Percent Forested Trust Lands Ownership

	Columbia			South Coast			Olympic Experimental State Forest			Straits			North Puget			South Puget			
Measure	Number	% of Upper Quartile	% of Planning Unit watersheds	Number	% of Upper Quartile	% of Planning Unit watersheds	Number	% of Upper Quartile	% of Planning Unit watersheds	Number	% of Upper Quartile	% of Planning Unit watersheds	Number	% of Upper Quartile	% of Planning Unit watersheds	Number	% of Upper Quartile	% of Planning Unit watersheds	Total Number of watersheds in Upper Quartile
Small Trees	11	24.4%	28.9%	9	20.0%	37.5%	6	13.3%	26.1%	5	11.1%	27.8%	6	13.3%	9.8%	8	17.8%	53.3%	45
Bull Trout Stream Density	3	6.7%	7.9%	2	4.4%	8.3%	5	11.1%	21.7%	1	2.2%	5.6%	33	73.3%	54.1%	1	2.2%	6.7%	45
Anadromous Fish Stream Density	2	4.4%	5.3%	7	15.6%	29.2%	16	35.6%	69.6%	0	0.0%	0.0%	18	40.0%	29.5%	2	4.4%	13.3%	45
Resident Fish Stream Density	3	6.7%	7.9%	11	24.4%	45.8%	12	26.7%	52.2%	1	2.2%	5.6%	16	35.6%	26.2%	2	4.4%	13.3%	45
Stream Density	19	42.2%	50.0%	15	33.3%	62.5%	6	13.3%	26.1%	0	0.0%	0.0%	1	2.2%	1.6%	4	8.9%	26.7%	45
Hydrologic Maturity in Significant Rain-on-Snow Zones	20	44.4%	52.6%	0	0.0%	0.0%	5	11.1%	21.7%	4	8.9%	22.2%	11	24.4%	18.0%	5	11.1%	33.3%	45
303(d) list for temperature	4	8.9%	10.5%	4	8.9%	16.7%	13	28.9%	56.5%	5	11.1%	27.8%	16	35.6%	26.2%	3	6.7%	20.0%	45
303(d) list for fine sediment	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%	2	4.4%	3.3%	0	0.0%	0.0%	45
Shallow rapid landslides	1	2.2%	2.6%	1	2.2%	4.2%	8	17.8%	34.8%	5	11.1%	27.8%	29	64.4%	47.5%	1	2.2%	6.7%	45
Urban and Agricultural Land Use	10	22.2%	26.3%	9	20.0%	37.5%	1	2.2%	4.3%	6	13.3%	33.3%	17	37.8%	27.9%	2	4.4%	13.3%	45
Average	7.2	16.0%	18.9%	6.2	13.8%	25.8%	7.5	16.7%	32.6%	2.6	5.8%	14.4%	14.6	33.1%	23.9%	2.6	5.8%	17.3%	
Number of watersheds with at least 5% DNR ownership		38			24			23			18			61			15		179

Table 4.15-16. Distribution of Watersheds with Multiple Resource Areas Represented in the Upper Quartile from Watersheds That Have at Least 22 Percent State Trust Land ownership

Frequency of occurrences (upper quartile for the 10 resource areas)	HCP Planning Unit						
	Columbia	**South Coast**	**OESF**	**Straits**	**North Puget**	**South Puget**	**Total**
0	1	1	2	2	3		**9**
1	5	5	3	2	6	5	**26**
2	3	1	2	1	11	2	**20**
3	2	3	3	2	4	1	**15**
4	1		3			1	**5**
5		1	2		1	1	**5**
6		1			1		**2**
7			1				**1**
Total	**12**	**12**	**16**	**7**	**26**	**10**	**83**

Table Notes:
Values in the table represent number of watersheds.
The 10 select resource areas are listed in Table 4.15-15. The frequency of occurrences represents multiple resources areas.
OESF = Olympic Experimental State Forest

Table 4.15-17. Occurrences of the 10 Listed Resources from Table 14.15-15 in the 83-group of Watersheds

Resource Acres	Tally of Occurrences That an Upper Quartile Resource Areas is Present in a Watershed							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Overall**
Small diameter, open forests	6	8	4	3	2	0	0	23
Anadromous streams	1	1	8	5	5	2	1	23
Bull trout streams	3	7	6	1	2	2	1	22
Stream density and length	3	0	7	4	4	1	1	20
Resident fish streams	0	1	6	4	4	2	1	18
Agricultural area	3	6	4	0	2	2	0	17
High potential slope instability	4	6	3	0	2	0	1	16
Hydrologically immature forests in the rain-on-snow zone	3	6	2	1	2	0	1	15
Urban area	3	4	4	0	1	1	0	13
303(d)streams listed for temperature	0	1	0	2	1	2	1	7
303(d) streams listed for fine sediment	0	0	1	0	0	0	0	1

Table notes:
Values in the table represent number of times the resource occurs.
Sample is the 83-group of watersheds with a resource area represented in the upper quartile and forest trust ownership is greater than 22 percent of the watershed area.

The analysis of open forests, potential slope instability, and resource areas related to riparian and fish resources, would suggest that future DNR management would require site-specific assessment of the actual current conditions. This assessment may lead to the development of landscape and/or site-specific strategies to ensure adequate protection of the specific resources.

4.15.6.2 Rates of Harvest

Table 4.15-18 identifies watersheds by Alternative from the "83-group" that may have relatively higher levels of regeneration harvest. Table 4.15-18 identifies watersheds where the Alternative's modeling outputs indicate regeneration harvest levels of greater than 20 percent of the forest trust ownership within a watershed over 7 decades. It is important to remember that the model was developed to help inform policy and not to set watershed specific harvest schedules. However, the Table 4.15-18 may be useful in distinguishing and ranking the Alternatives.

From the harvest report presented in Table 4.15-18, a pattern of three groups distinguishes the Alternatives from one another. Alternatives 1, 2, and 3 have a relatively low number of watersheds with a total regeneration harvest over 20 percent per decade. The Preferred Alternative and Alternative 4 illustrate an intermediate number of watersheds. Alternative 5 presents the highest range.

Beyond the first decade, the Preferred Alternative and Alternative 1 project a similar pattern of a small number of watersheds from the "83-group" that have modeled total decadal regeneration harvest over 20 percent.

Table 4.15-18. Number of the 83-Group Watersheds That Have a Modeled Decade Levels of Regeneration Harvest Greater than 20 Percent[1/] of the Forested Trust Land in the Watershed by Alternative and Decade

Decade[2/]	Alternatives					
	1	2	3	4	5	PA
1	11	14	16	25	42	24
2	10	18	27	24	53	4
3	5	8	6	19	53	2
4	6	10	10	6	57	7
5	6	12	30	17	27	7
6	7	14	24	14	34	8
7	0	0	0	0	0	0

[1/] The total harvest is calculated separately for each decade and watershed. The percentage is of the forested trust lands ownership in a watershed.
[2/] Only 4 years of harvests are during the last decade (2064-2067), which is not enough for any watersheds to cross the threshold under any of the alternatives necessary to be listed in this table.
PA = Preferred Alternative

The Preferred Alternative's reduction after the first decade is largely due to the following factors:

- higher regeneration acres in the first decade in stands not suitable for long-rotation heavy thinning biodiversity pathway management (see Section 4.2.4, Forest Structure and Vegetation), and a
- greater proportion in subsequent decades' landscapes managed with thinnings and partial harvests, thereby reducing the area of regeneration harvests.

4.15.6.3 Policy Context

All Alternatives implement the DNR Habitat Conservation Plan (HCP) strategies. The HCP riparian management strategy is a core component used to achieve many of its major conservation objectives. The combination of the riparian conservation strategy and the supportive silvicultural activities designed to restore conditions has been described in detail in Chapter 2. Implementation of restoration activities under the Preferred Alternative is likely to increase the probability of improving riparian conditions within the foreseeable future as opposed to other Alternatives, such as 1 and 4, which restrict active riparian restoration activities (see Section 4.3). Alternatives with less management in the riparian, including Alternatives 1 and 4, will rely on natural disturbances and forest succession to develop structurally complex forests and improve riparian conditions. While succession and natural disturbances will happen, the changes could take a long time (Franklin et al. 2002).

None of the Alternatives propose changes to DNR management of potential slope instability. Management direction for potentially unstable slopes conditions is found in the current HCP, DNR's procedure, and Forest Practices Rules (see Section 4.6 for more details).

The Alternatives differ in their procedural approach to small diameter, open forests. The only current procedural direction that addresses the amount of small diameter, open or "young" forests (at the watershed scale) is found in a portion of Task 14-001-010 – Maintenance of Mature Forest Components. Under this task, DNR forest managers are directed to maintain at least 50 percent of forested trust lands within a watershed in a condition of 25 years or older. This rule, commonly known as the"50-25 rule," is applied to all watersheds where forested trust lands ownership is at least 5 percent of the watershed area or greater.

The "50-25 rule" was introduced in 1999, and related to circumstances surrounding the HCP's adoption. Even before the HHCP was signed in 1997, litigation was filed that attempted to block its implementation. A fundamental concept in any HCP is that it must provide adequate mitigation for any incidental "taking" of the species covered by the plan. Thus, the litigation carried with it a risk that if an adverse court ruling invalidated DNR's agreement to the HCP, DNR would *still* need to provide mitigation for any "taking" that occurred while it operated under the plan. To reduce this risk, DNR temporarily deferred timber harvests within Status-1-Reproductive and Southwest Washington owl circles. Simultaneously, DNR also deferred harvest activities under in 56 of the 66 critical northern spotted owl circles described in HCP Memorandum #1 (Section 4.4). DNR's temporary deferral of harvests within all Status-1-Reproductive and Southwest Washington northern spotted owl circles was not anticipated in the HCP or the 1996 sustainable harvest calculation.

The implications of the previously identified risk management strategies raised some questions. In particular, a large area (approximately 314,000 acres in 115 northern spotted owl circles) had been placed "off-base" to timber harvest, if only temporarily, without any adjustment in the statewide harvest level. The result was a likely increase in timber harvesting in other non-deferred or on-base areas. DNR foresaw that if the "temporary" harvest restrictions continued for some time, harvest rates in watersheds with fewer constraints might climb. Without the benefit of thorough landscape level analysis to reveal the potential of the concern, DNR introduced the "50-25 rule" in an attempt to prevent "over-harvesting" in less constrained watersheds (Task 14-001-010, 1999). The rule borrows from the concepts used in DNR's HCP strategies for management of the "significant rain-on-snow" areas based on the hydrologic principles contained in the 1991 emergency state Forest Practices Rules on rain-on-snow (HCP, IV.75).

Alternative 1 is the only Alternative to maintain the "50-25 rule" portion of the task, while Alternatives 2, 3, 4, 5, and the Preferred Alternative replace this portion of the task with the recognition that DNR forest managers use the State Lands Timber Sale expanded State Environmental Policy Act checklist to assess for cumulative effects of timber harvest activities.

The modeling of the Alternatives provides an opportunity to examine the impacts of the proposed changes in the Task. Table 4.15-19 presents the number of watersheds for the 83-group that are estimated to have less than 50 percent of their area in forest of an age 25 years or older. For details on the all watersheds, please refer to Appendix E.

Table 4.15-19. Estimated Number of Watersheds from the "83-group" Having Less Than 50 Percent of Their Forested Trust Lands Area in Forest 25 Years or Older

Alternative	2004	2013	2031	2067
1	1	0	0	0
2	1	0	0	0
3	1	0	1	0
4	1	0	0	0
5	1	0	0	0
PA	1	0	0	0

PA = Preferred Alternative

If all watersheds where DNR manages at least 5 percent of the watershed are considered, then there are also only small differences between the Alternatives (Table 4.15-20) in terms of the number of watersheds that do have more than 50 percent of their area at 25 years or older.

The "50-25 rule" is proposed to be replaced by targeted analyses addressing site-specific considerations. DNR has developed a specially expanded version of the State Environmental Policy Act Environmental Checklist. Beyond completing all legally required analyses within Department of Ecology's (standard) Environmental Checklist, DNR has integrated over 100 additional questions into the (expanded) Environmental Checklist. These additions are designed to more fully explore the environmental implications, including cumulative effects, of proposed sustainable forestry actions.

4.15.6.4 Summary of Potential Impacts of Future Harvests

For the watersheds where DNR management is most likely to have a potential impact on multiple resource areas (i.e. from the 83-group of watersheds), the "50-25 rule" appears to have no meaningful effect on the condition of the watershed when measured by the age threshold. If other DNR management strategies and mitigation are considered such as Riparian Management Zones, potential slope instability management, visual area management, adjacency of regeneration harvest, leave trees, etc., then on average, a watershed will have approximately half of the forested trust lands ownership in either a riparian or an upland area with specific objectives (see Table 4.15-21 for a summary and Appendix E for list of details on individual watersheds). The combined effect of DNR's forest management policies and procedures appears to provide protection to the resources that might be at potential risk to cumulative effects of timber harvesting in these watersheds. DNR's forest management policies and procedures will assist in the reduction of overall levels of cumulative effects in the future. In addition, DNR's policies and procedures should act in combination with Forest Practices Rules and the Northwest Forest Plan to reduce cumulative effects.

Table 4.15-20. Estimated Number of Watersheds From the "179 Watersheds" Having Less Than 50 Percent of Their Forested Trust Lands Area in Forest 25 Years or Older

Alternative	2004	2013	2031	2067
1	5	0	0	0
2	5	1	0	1
3	5	1	4	3
4	5	0	0	2
5	6	3	1	1
PA	5	3	1	0

PA = Preferred Alternative

Table 4.15-21. Land Class Area (expressed as a Percentage of the Total Area by State Trust Ownership group) in each HCP Planning Unit

State Trust Ownership Group	HCP Planning Unit	Uplands with General Objectives	Uplands with Specific Objectives	Riparian and Wetlands
Less than 22 percent of the watershed	Columbia	40%	28%	32%
	North Puget	22%	55%	23%
	OESF	0%	63%	37%
	South Coast	43%	20%	37%
	South Puget	42%	38%	20%
	Straits	50%	33%	17%
	Overall	34%	39%	27%
More than 22 percent of the watershed	Columbia	23%	44%	33%
	North Puget	22%	53%	25%
	OESF	0%	56%	44%
	South Coast	52%	14%	34%
	South Puget	2%	71%	27%
	Straits	53%	27%	20%
	Overall	22%	45%	32%
	Total	26%	43%	31%

Coupled with regulatory and federal land management provisions, all of the Alternatives, and their associated policies and procedures, mitigate significant adverse cumulative effects.

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Chapter 5

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Chapter 6

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6. GLOSSARY

Anadromous fish – Those species of fish that mature in the ocean and migrate to freshwater streams to spawn; an example is salmon.

Archaeological object – An object that comprises the physical evidence of an indigenous and subsequent culture including material remains of past human life including monuments, symbols, tools, facilities, and technological by-products (from RCW 27.53.030).

Archaeological resources – All sites, objects, structures, artifacts, implements, and locations of prehistorical or archaeological interest, whether previously recorded or still unrecognized, including, but not limited to, those pertaining to prehistoric and historic American Indian or aboriginal burials, campsites, dwellings, and habitation sites, including rock shelters and caves, their artifacts and implements of culture such as projectile points, arrowheads, skeletal remains, grave goods, basketry, pestles, mauls and grinding stones, knives, scrapers, rock carvings and paintings, and other implements and artifacts of any material that are located in, on, or under the surface of any lands or waters owned by or under the possession, custody, or control of the state of Washington or any county, city, or political subdivision of the state (from RCW 27.53.040).

Archaeological site – A geographic locality in Washington, including, but not limited to, submerged and submersible lands and the bed of the sea within the state's jurisdiction, that contains archaeological objects (from RCW 27.53.030).

Basal area – The area in square feet of the cross-section of a tree bole measured at 4.5 feet above the ground.

Biological diversity – The relative degree of abundance of wildlife species, plant species, communities, habitats or habitat features in an area.

Blowdown – Trees felled by high winds.

Bog – A hydrologically isolated, low nutrient wetland that receives its water from precipitation only. Bogs typically have no inflow and rarely have outflows. Bogs have peat soils 16 or more inches in depth (except where over bedrock), and specifically adapted vegetation such as sphagnum moss, Labrador tea, bog laurel, sundews, and some sedges. Bogs may have an overstory of spruce, hemlock, cedar, or other tree species, and may be associated with open water.

Buffer – A forested strip left during timber harvest to conserve sensitive ecosystems or wildlife habitat, or potentially unstable slopes. Management activities may be allowed as long as they are consistent with the objectives for the buffer.

Canopy – The continuous cover of branches and foliage formed collectively by the crowns of adjacent trees and other woody growth. See also "understory canopy" and "overstory canopy."

Canopy closure – The degree to which the canopy (forest layers above one's head) blocks sunlight or obscures the sky. See also relative density.

Carbon sequestration – The uptake and storage of carbon. Trees and other plants, for example, absorb carbon dioxide, release the oxygen, and store the carbon.

Channel migration zone – For each of the types of streams described below, the area where the active channel of such stream is prone to move and where movement would result in a potential near-term loss of riparian forest adjacent to the stream. For purposes of this report, channel migration zones are associated with moderately confined streams, and unconfined avulsing streams.

Class IV-Special – A Washington forest practices class; forest practices that fall under SEPA (RCW 76.09.05), as they have been determined to have potential for a substantial impact on the environment, and so require an environmental checklist and additional review.

Clearcut – A harvest method in which all or almost all of the trees are removed in one cutting; an even-aged silvicultural system. Clearcutting establishes a stand without protection from an overstory canopy.

Climax – The culminating, highly stable stage in plant succession for a given environment; an ecosystem will stay at the climax stage until disturbance affects the ecosystem and the stages of ecological succession begin again.

Commercial thinning – The removal of generally merchantable trees from an even-aged stand, so that the remaining trees can develop faster and with less competition.

Competitive exclusion forest – Forested habitat characterized by a single, dense canopy layer dominated by trees between 10 and 30 inches in diameter at breast height. In younger stands, the high density and uniform size of relatively short trees allows only small amounts of sunlight to reach the forest floor, creating sparse understory conditions and low levels of biological diversity. Consists of the sapling exclusion, pole exclusion, large tree exclusion, and understory reinitiation stand development stages.

Cultural resources – Archaeological and historic sites and artifacts and traditional religious, ceremonial and social uses and activities of affected Indian tribes (from Washington Administrative Code 222-16-010).

Debris flow – A moving mass of rock, soil, debris, and mud (more than half the particles being larger than sand size) that can travel many miles down steep confined mountain channels; a form of debris torrent.

Debris slide – The very rapid and usually sudden sliding and flow of incoherent, unsorted mixtures of soil and weathered bedrock.

Debris torrent – Debris flow or dam-break flood. Rapid movement of a large quantity of materials, including wood and sediment, down a stream channel. Usually occurs in smaller streams during storms or floods, and scours the stream bed in steeper channels.

Deep-seated landslide – Landslides in which the zone of movement is mostly below the maximum rooting depth of forest trees, to depths of tens to hundreds of feet.

Diameter at breast height – The diameter of a tree, measured 4.5 feet above the ground on the uphill side of the tree.

Dispersal – The movement of juvenile, subadult, and adult animals from one sub-population to another. For juvenile spotted owls, dispersal is the process of leaving the natal territory to establish a new territory.

Dispersal habitat – Habitat used by juvenile spotted owls or by owls of any age to disperse or move from one area of nesting, roosting, foraging habitat to another. The DNR's Habitat Conservation Plan calls for dispersal habitat to be maintained on 50 percent of lands designated as dispersal management areas. DNR Procedure 14-004-120 specifies the following minimum requirements for dispersal habitat:

- a relative density of at least 50;
- a quadratic mean diameter of 11 inches on at least 100 trees; and
- at least 40 trees per acre that are at least 85 feet tall.

Dispersal Management Areas – Lands identified in the Habitat Conservation Plan that are managed to facilitate dispersal of spotted owls.

Ecosystem initiation forest – Forests representing the establishment of a new forest ecosystem following death or removal of overstory trees by wildfire, windstorm, insects, disease, or timber harvesting.

Edge – An abrupt change between adjacent plant communities, successional stages, or vegetative conditions.

Edge effects – The modified environmental conditions along the margins, or edges, of forest patches.

Endangered Species Act – The federal Endangered Species Act of 1973 (16 U.S.C. §1531 et. seq.), as amended, sets up processes by which plant and animal species can be designated as threatened or endangered. Two federal agencies, the U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration – Fisheries Service, administer the Act. Once species are listed, the Act also provides that these agencies develop recovery plans for these species, including conserving the ecosystems on which listed species depend.

Environmental impact statement – A document prepared under the Washington State Environmental Policy Act to assess the impacts that a particular action or program will have on the environment.

Erosion – The removal of soil or rock material from a soil surface or area to a position where it is deposited. Erosion may be caused by a variety of factors, including but not exclusive to changes in moisture conditions, flowing water, changes in subsurface conditions that lead to gravitational instability, or wind action.

Even-aged – A system of forest management in which stands are produced or maintained with relatively minor differences (generally less than 10 years) in age.

Evolutionarily significant units – A population that is substantially reproductively isolated from other population units of the same species, and represents an important component in the evolutionary legacy of the species.

Extirpation – The elimination of a species from a particular area.

Federally listed – Species formally listed as a threatened or endangered species under the federal Endangered Species Act; designations are made by the U.S. Fish and Wildlife Service or National Oceanic and Atmospheric Administration – Fisheries Service.

Fertilization – The act or process of applying natural and/or synthetic materials, including manure, nitrogen, phosphorous and potassium, applied to the soil to increase fertility.

Forest Practices Act – A Washington State statute (Chap. 76.09 RCW) establishing minimum standards for forest practices, and providing for necessary administrative procedures and rules applicable to activities conducted on or pertaining to forests, on both state managed and private lands.

Forest Practices Board – A Washington State agency created by the Forest Practices Act to adopt forest practices rules that protect public resources coincident with the maintenance of a viable forest products industry. These rules are administered and enforced by DNR.

Forest structure class – A way of classifying forested habitat types based on wildlife species' associations with structural characteristics such as tree size, canopy closure, and the presence and abundance of snags and down logs. Compare to stand development stages. Both are described in greater detail in Appendix B.

Geographic information system – A computer system that stores and manipulates spatial data, and can produce a variety of maps and analyses. DNR's Geographic Information System is able to: 1) assign information and attributes to polygons and lines, which represent relationships on the ground; and 2) update and retrieve inventory, mapping, and statistical information. DNR uses its Geographic Information System as one of several tools for setting landscape-level planning objectives.

Geomorphic processes – Landscape-modifying processes such as surface erosion, mass wasting, and streamflow.

Ground water – Water that is beneath the land surface. The source of seeps, springs and wells.

Growth and yield – Growth is the change in standing tree volume over time. Yield is the amount of timber harvested over time.

Habitat Conservation Plan – An implementable program for the long-term protection and benefit of a species in a defined area; required as part of a Section 10 incidental taking permit application under the federal Endangered Species Act. DNR has a Habitat Conservation Plan signed in 1996 in agreement with the U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration – Fisheries Service. The plan covers approximately 1.6 million acres of state trust lands managed by DNR within the range of the northern spotted owl.

Habitat preference – The choice of habitat(s) that an animal would make if all habitat types were available to it.

Harvest intensity types – A way of classifying management intensity at a particular site during a particular period, based partially on the volume of timber removed. For this analysis, harvest intensity is divided into three classes, as follows:

- **Low-volume removal harvests** (Harvest Type "A" – less than 11 thousand board feet per acre) – usually involve the removal of small diameter trees from the stand. These harvests are typically thinnings in small diameter closed stands, but may include other harvest treatment depending on the mixture of tree species, site potential and location of a stand.
- **Moderate-volume removal harvests** (Harvest Type "B" – between 11 and 20 thousand board feet per acre) – typically occur in stands of trees with large diameters. However, the category may include other harvest methods, for example variable density thinnings, patch-cutting, and clearcuts in hardwood stands. Stand regeneration may be associated with some of these harvest types.
- **High-volume removal harvests** (Harvest Type "C" – greater than 20 thousand board feet per acre) – represents the harvest design of a larger number of trees and high volume removed from the stand. Harvest methods within this category are typically associated with stand regeneration and heavy thinnings. Most common harvest methods are clearcuts, partial harvest, shelterwoods, and variable density thinnings. The precise harvest method depends on the mixture of tree species, site potential, location of the stand, and the management goals for the site.

Historic archaeological resources – Those properties which are listed in or eligible for listing in the Washington State Register of Historic Places (RCW 27.34.220) or the National Register of Historic Places as defined in the National Historic Preservation Act of 1966 (Title 1, Sec. 101, Public Law 89-665; 80 Stat. 915; 16 U.S.C. Sec. 470) as amended (from RCW 27.53.030).

Historic site – Sites, areas, and structures or other evidence of human activities illustrative of the origins, evolution and development of the nation, state or locality; or places associated with a personality important in history; or places where significant historical events are known to have occurred even though no physical evidence of the event remains (from Washington Administrative Code 222-16-010).

Hydrologic maturity – The degree to which hydrologic processes (e.g., interception, evapotranspiration, snow accumulation, snowmelt, infiltration, runoff) and outputs (e.g., water yield and peak discharge) in a particular forest stand approach those expected in a late seral stand under the same climatic and site conditions. In DNR's Habitat

Conservation Plan, a hydrologically mature forest, with respect to rain-on-snow runoff, is a well-stocked conifer stand 25 years or older.

Interior-core riparian buffer – Streamside buffer in the DNR's Habitat Conservation Plan riparian strategy for the Olympic Experimental State Forest; minimizes disturbance of unstable channel banks and adjacent hillslopes, and protects and aids natural restoration of riparian processes and functions. See also buffer.

Land classification – A system developed to represent DNR policy goals and management constraints. The system classifies all lands into one of three classes based upon specific management objectives and resource sensitivity. The three classes in order of decreasing resource sensitivity and resulting management specificity are:

- Riparian and Wetland Areas that have very specific management objectives;
- Upland Areas with Specific Management Objectives or resource sensitivities, including areas such as unstable slopes, rain-on-snow areas, and northern spotted owl nesting, roosting, foraging, and dispersal management areas; and
- Upland Areas with General Management Objectives, where DNR practices general ecological management, including practices such as "leave trees" and "green-up."

Landscape – Large regional units of lands that are viewed as a mosaic of communities, or a unit of land with separate plant communities or ecosystems forming ecological units with distinguishable structure, function, geomorphology, and disturbance regimes. In the DNR's Habitat Conservation Plan, a landscape is defined as a large area comprising various interacting patterns of stand structure and function going through alterations over time.

Landscape planning – The process of planning for a specified landscape by setting specific objectives for a given area, such as protection of wildlife and timber production.

Landscape-level planning – The process of planning across an area larger than individual stands or harvest areas.

Landslide – Any mass movement process characterized by downslope transport of soil and rock, under gravitational stress, by sliding over a discrete failure surface or the resultant landform. In forested watersheds, landsliding typically occurs when local changes in the pore-water pressure increase to a degree that the friction between particles is inadequate to hold the mass on the slope.

Large woody debris – Large pieces of wood in stream channels or on the ground, includes logs, pieces of logs, and large chunks of wood; provides streambed stability and/or habitat complexity. Also called coarse woody debris or down woody debris. Large organic debris is large woody debris, but may contain additional non-woody debris, such as animal carcasses.

Legacy tree – A tree that is retained for more than one rotation in an area actively managed for timber production.

Long-term deferrals – Areas deferred from timber harvest for an indefinite period of time.

Low-order streams – Small streams with very few tributaries; often are headwaters. Type 4 and 5 waters are low order streams.

Mass wasting – Dislodgment and downslope transport of soil and rock under the direct application of gravitational stress.

Mycorrhizal fungi – Fungi that form a symbiotic relationship with the roots of certain plants, receiving energy and nutrients from the plant and, in some cases at least, providing the plant with improved access to water and some nutrients.

National Oceanic and Atmospheric Administration - Fisheries – The federal agency that is the listing authority for marine mammals, anadromous fish and other marine species under the federal Endangered Species Act.

Nesting, roosting, and foraging habitat – Habitat with the forest structure, sufficient area, and adequate food source to meet the needs of a nesting pair of spotted owls. In implementing the Habitat Conservation Plan conservation strategy for spotted owls, DNR Procedure 14-004-120 specifies the following minimum requirements for nesting, roosting, and foraging habitat:

- at least 50 percent of the total basal area in conifer trees greater than 3.5 inches diameter at breast height;
- a relative density of at least 50;
- no more than 280 trees per acre;
- at least 40 trees per acre that are at least 85 feet tall;
- at least 3 snags or cavity trees per acre that are at least 20 inches diameter at breast height and at least 16 feet tall; and
- 2,400 cubic feet per acre of down woody debris.

Nesting, Roosting, and Foraging Management Areas – Lands identified in the Habitat Conservation Plan that are managed to: 1) provide demographic support, and 2) contribute to maintaining species distribution for the northern spotted owl.

Off-base – A DNR classification for lands and timber resources not available for timber harvest.

Old-growth forest – A forested stand characterized by a complex community of living plants as well as abundant coarse woody debris, cavity trees, litter, and soil organic matter, supporting diverse and interconnected communities of vertebrates, invertebrates, fungi, and plants. Stands with these characteristics, a stand age greater than 250 years, and no history of silvicultural management are called "old natural forests."

Old forest – As used in this document, areas that meet the criteria of the fully functional or old natural forest stand development stages.

Perennial stream – Defined in the Washington Forest Practices Board emergency rules, effective March 20, 2000, Type 4 waters as follows: all segments of natural waters within the bankfull width of defined channels that are not Type 1, 2 or 3 waters and which are perennial waters of non-fish-bearing streams. Perennial waters means waters downstream from a perennial initiation point.

Periphyton – Organisms that grow on underwater surfaces; periphyton include algae, bacteria, fungi, protozoa, and other organisms.

Physiographic province – A region having similar geologic structure and climate, and which had a consistent geomorphic history; a region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

Pre-commercial thinning – Cutting trees at an immature age to allow for better growth of the remaining trees; may include removal of excess and/or diseased trees 10 to 35 years old.

Rain-on-snow zone – Area, generally defined as an elevation zone, where it is common for snowpacks to be partially or completely melted during rainstorms.

Recovery plan – A plan developed by a government agency, that if implemented will result in the recovery of a threatened or endangered species to the extent that the species can be removed from threatened or endangered status.

Regeneration harvest with green-tree and legacy tree retention – A harvest method in which live trees are left within regeneration harvest units to provide habitat after harvest.

Relative density – A ratio based on a sampling of tree measurements that represents the amount of growing space occupied by trees within a forest stand.

Revised Code of Washington (RCW) – A revised, consolidated, and codified form and arrangement of all the laws of the state of a general and permanent nature.

Riparian area – Areas of land directly influenced by water or that influence water. Riparian areas usually have visible vegetative or physical characteristics reflecting the influence of water. Riversides and lake shores are typical riparian areas.

Riparian buffer – As defined for the Habitat Conservation Plan's westside planning units, the inner buffer of the riparian management zone that serves to protect salmonid habitat. See also Riparian Management Zone.

Riparian ecosystem – In DNR's Habitat Conservation Plan, the area of direct interaction between terrestrial and aquatic environments.

Riparian Management Zone – Riparian Management Zone is a specified area around streams of Type 1 - 4 where specific measures are taken to protect the stream and its functions. The Riparian Management Zone consists of the stream, the adjacent riparian buffer and, where appropriate, a wind buffer to protect the integrity of the managed riparian butter. The riparian buffer has been designed to maintain/restore riparian processes that influence the quality of salmonid habitat and to contribute to the conservation of other aquatic and riparian obligate species. Consideration was given to water temperature, stream bank integrity, sediment load, detrital nutrient load, and large woody debris. The buffers vary according to stream type, location of the flood plain, windthow, and stream width. Riparian Management Zone buffers are described in DNR Procedures 14-004-150 and 14-004-160.

Riparian Management Zone core zone – For western Washington, the 50-foot buffer measured horizontally outside of the bankfull width or the channel migration zone, whichever is greater, of a Type 1, 2 or 3 water (see Washington Administrative Code 222-30-021).

Riparian Management Zone inner zone – For western Washington, the area measured horizontally from the outside boundary of the core zone of a Type 1, 2, or 3 water to the outer limit of the inner zone. The outer limit of the inner zone is determined based on the width of the affected water, site class, and the management action chosen for timber harvest within the inner zone (see Washington Administrative Code 222-30-021).

Riparian Management Zone outer zone – The area measured horizontally between the outer extent of the inner zone and the Riparian Management Zone width as specified in the Riparian Management Zone definition above. Width is measured from the bankfull width or the channel migration zone, whichever is greater (see Washington Administrative Code 222-30-021 and 22-30-022).

Riparian zone – A narrow band of moist soils and distinctive vegetation along the banks of lakes and streams; in the Habitat Conservation Plan, the portion of the riparian ecosystem between the aquatic zone and the direct influence zone (uplands).

Runoff – The amount of rain water directly leaving an area in surface drainage, as opposed to the amount that seeps out as groundwater.

Salmonid – Fish species belonging to the family Salmonidae, including trout, salmon, char, and whitefish species.

Scoping – Determining the range of proposed actions, alternatives, and impacts to be discussed in an Environmental Impact Statement (Washington Administrative Code 197-11-793).

Sensitive species – A state designation. State sensitive species are species native to Washington that are vulnerable or declining, and are likely to become endangered or threatened in a significant portion of their ranges within the state without cooperative management or the removal of threats.

Short-term deferrals – Areas deferred from timber harvest during a portion of the next decade.

Silviculture – The theory and practice of controlling the establishment, composition, growth, and quality of forest stands in order to achieve management objectives.

Site class – A grouping of site indices that are used to determine the 100-year site class. The site index from the state soil survey, corresponding site class.

For Western Washington:

Site class	50-year site index range (state soil survey)
I	137+
II	119-136
III	97-118
IV	76-96
V	≤75

Site index – A measure of forest productivity, expressed as the height of the dominant trees in a stand at an index age.

Site potential tree height – The height represented by the approximate mid-point of one of five site classes projected to a stand age of 100 years, as in the following table:

Region	Site Class	Site Potential Tree Height
Westside	I	200
	II	170
	III	140
	IV	110
	V	90

Site potential tree height numbers in this table were derived from Douglas-fir stands.

Skid trail – A path along which logs are dragged over the land surface to a landing.

Snag – A dead tree that is still standing.

Stand – A group of trees that possess sufficient uniformity in composition, structure, age, spatial arrangement, or condition to distinguish them from adjacent groups.

Stand development stage – A representation of the structural conditions and developmental processes occurring within a forest stand. These development stages are based on the Washington Forest Landscape Management Project by Carey et al. (1996). That project employed a generalized classification that focuses on the ecological processes underlying the stages of forest development. Physical characteristics associated with stand development stages serve as indicators of these processes at work. Compare to forest structure classes. Both are described in greater detail in Appendix B.

The following table provides a summary of the stand development stages used in this Draft Environmental Impact Statement.

Stand Development Stage	Description
Ecosystem Initiation	Establishment of a new forest ecosystem following death or removal of overstory trees by wildfire, windstorm, insects, disease, or timber harvesting. Varying rates of retention of biological legacies (e.g., understory trees, large snags and down wood, soil microbes and invertebrates, fungi and non-vascular plants, etc.) influence the rate at which the stand develops into a fully functional forest in the future.
Sapling Exclusion	Trees fully occupy the site (canopy cover exceeds 70 percent) and start to compete with one another for light, water, nutrients, and space. Most other vegetation is precluded and many trees become suppressed and die.
Pole Exclusion	The high density and uniform size of relatively short trees creates dark understory conditions and low levels of biological diversity. Suppression mortality of smaller trees leads to the creation of small snags.
Large Tree Exclusion	Continued suppression mortality reduces tree density and creates small openings where scattered pockets of ground vegetation become established. Small snags created during the Pole Exclusion stage fall, creating small down logs.
Understory Reinitiation	Achievement of dominance by some trees (and death of others) leads to the development of canopy gaps where understory plants become established. Stands that arrive at this condition through natural development typically have greater than 70 percent canopy coverage overall; thinning produces stands with 10-70 percent canopy cover.
Developed Understory	Understory of herbs, ferns, shrubs, and trees develops after death or removal of some dominant trees; time has been insufficient for full diversification of the plant community.
Botanically Diverse	Organization and structure of the living plant community becomes complex with time, but lack of coarse woody debris and other biological legacies precludes a full, complex biotic community.
Niche Diversification	The biotic community becomes complex as coarse woody debris, cavity trees, litter, soil organic matter, and biological diversity increase; diverse trophic pathways develop; wildlife foraging needs are met.
Fully Functional	Additional development provides habitat elements of large size and interactions that provide for the life requirements of diverse vertebrates, invertebrates, fungi, and plants.
Old Natural Forests	Structural characteristics are the same as those of fully functional forest, but age (greater than 250 years), natural origin, and lack of management history may contribute attributes and organisms that do not exist in younger stands that developed through other processes (e.g., silvicultural management).

State Environmental Policy Act – This law (Chapter 43.21C RCW) is the basic state statute for protection of the environment. The State Environmental Policy Act requires all state agencies to consider and analyze all significant environmental impacts of any action proposed by those agencies; to inform and involve the public in the agencies' decision-making processes; and to consider the environmental impacts in the agencies' decision-making processes.

Structurally complex forest – Forests containing a large tree component (generally 30 inches or greater), multiple canopies, and varying degrees of biological legacies such as coarse woody debris, cavity trees, litter, and soil organic matter. Consists of the developed understory, botanically diverse, niche diversification, fully functional, and old natural forest stand development stages.

Succession – A series of changes by which one group of organisms succeeds another group in an ecosystem; a series of developmental stages in a community.

Suppression mortality – Competition between trees for limited sunlight, nutrients, water, and space, leading to the death of some trees within a stand.

Talus – A deposit of rock rubble, ranging in size from 1 inch to 6.5 feet; derived from and lying at the base of a cliff or very steep, rocky slope.

Threatened and endangered species – Formal classifications of species. Federal designations are made by the U.S. Fish and Wildlife Service or National Oceanic and Atmospheric Administration – Fisheries Service; state of Washington designations are made by the Washington Fish and Wildlife Commission (RCW 77.08.010).

Trust land – Lands held in trust and managed by the DNR for the benefit of a trust beneficiary.

Turbidity – The relative lack of clarity of water, which may be affected by material in suspension.

Uncommon habitat – A category of forested and nonforested habitats including cliffs, caves, talus slopes, oak woodlands, and very large, old trees. A habitat description for DNR-managed lands.

Understory canopy – Forest undergrowth; the lowest canopy layer of trees and woody species. See also canopy and overstory canopy.

United States Fish and Wildlife Service – The U.S. Fish and Wildlife Service, which is the federal agency that is the listing authority for species other than marine mammals and anadromous fish under the federal Endangered Species Act.

Washington Administrative Code – The compilation of all current, permanent rules of state agencies.

Water quality classification – Washington State Department of Ecology water quality standards; specifications are given in Washington Administrative Code 173-201-045. Class AA water is “extraordinary,” Class A water is “excellent,” Class B water is “good,” and so on.

Water typing system – A simplified explanation of Washington’s classifications of water types appears here. (For the complete classification system, see Washington Administrative Code 222-16-030.)

Type 1: All waters, within their ordinary high-water mark, as inventoried as shorelines of the state under the Shoreline Management Act.

Type 2: Segments of natural waters that are not Type 1 and have a high use and are important from a water quality standpoint for domestic water supplies; public recreation; fish spawning, rearing, or migration or wildlife use; are highly significant to protect water quality.

Type 3: Segments of natural waters that are not Type 1 or 2 and are moderately important from a water quality standpoint for: domestic use; public recreation; fish spawning, rearing, or migration or wildlife uses; or have moderate value to protect water quality.

Type 4: Segments of natural waters that are not Type 1, 2, or 3, and for the purpose of protecting water quality downstream are classified as Type 4 Water upstream until the channel width becomes less than two feet in width between the ordinary high-water marks. These may be perennial or intermittent.

Type 5: Natural waters that are not Type 1, 2, 3, or 4; including streams with or without well-defined channels, areas of perennial or intermittent seepage, ponds, natural sinks and drainage ways having short periods of spring or storm runoff.

Type 9: Streams of unknown classification.

Watershed – The drainage basin contributing water, organic matter, dissolved nutrients, and sediments to a stream or lake. The term “watershed” is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.

Watershed Administrative Unit – In Washington, the hydrologic area unit used for watershed analysis. See Washington Administrative Code 222-22-020 for more information.

Watershed analysis – A systematic procedure for characterizing watershed and ecological processes to meet specific management objectives; provides a basis for resource management planning. In Washington, the assessment of a Washington Administrative Unit completed under forest practices rules (Chapter 222-22 Washington Administrative Code).

Western Washington – The geographic area of Washington west of the Cascade crest.

Wetland – An area that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support (and under normal circumstances does support) a prevalence of vegetation typically adapted for life in saturated soil conditions; includes swamps, bogs, fens, and similar areas.

Wetland Management Zone – A specified area around wetlands greater than 0.25 acres, where specific measures are taken to protect the wetland and its hydrologic, biogeochemical, and habitat functions. The Wetland Management Zone consists of the wetland and the adjacent buffer. The buffers, described in DNR Procedures 14-004-150 and 14-004-160, are:

Westside HCP Planning Units (not including Olympic Experimental State Forest)

- Wetlands 0.25 to 1 acre: 100 feet
- Wetlands greater than 1 acre: The larger of 100 feet or greater than or equal to site potential tree height

Olympic Experimental State Forest

- Wetlands 0.25 to 5 acres: two-thirds of the site potential tree height
- Wetlands larger than 5 acres: site potential tree height

Wetland typing system – A simplified explanation of Washington's classifications of wetland types appears here. For the complete classification system, see Washington Administrative Code 222-16-035.

Non-forested wetland – Any wetland or portion thereof that has (or if the trees were mature would have) a crown closure of less than 30 percent. There are two types of nonforested wetlands. A Type A wetland is: (1) greater than 0.5 acre in size; (2) associated with at least 0.5 acre of ponded or standing open water; or (3) are bogs and fens greater than 0.25 acre. All other non-forested wetlands greater than 0.25 acre are Type B wetlands.

Forested wetland – Any wetland or portion thereof that has (or if the trees were mature would have) a crown closure of 30 percent or more.

Wind buffer – As defined for the Habitat Conservation Plan's Westside HCP Planning Units, the outer buffer of the riparian management zone that maintains the ecological integrity of the riparian buffer by reducing windthrow.

Windthrow– Trees blown down by wind; also called blowdown.

Yarding – Transporting logs from the point of felling to a collecting point or landing.

Yarding corridor – A narrow, linear path through a stand (especially with a riparian management zone) to allow suspended cables necessary to support cable yarding methods, and suspended or partially suspended logs to be transported through these areas by cable yarding methods.

Appendix A
Scoping Summary and Responses to Public Scoping Comments

WASHINGTON STATE DEPARTMENT OF
Natural Resources

2003 Calculation of the Sustainable Harvest for DNR-managed Forests[1] in Western Washington

Environmental Impact Statement Scoping Summary and Responses to Public Comments received during the Scoping Process

August 1, 2002

Table of Contents

NOTE TO READERS

This document contains many references to state laws and codes.
The laws are contained in the Revised Code of Washington (RCW), and Washington Administrative Code (WAC), which can be found in libraries throughout the state, and on the state of Washington website at www.wa.gov

The State Environmental Policy Act (SEPA) and details about DNR's SEPA office and Environmental Impact Statements (EIS) process can be found at www.wa.gov/dnr, which also is linked to the State Department of Ecology website.

[1] DNR-managed Forests include: Federally Granted Lands, Forest Board Purchase Lands, Forest Board Transfer Lands, Natural Area Preserves (NAPs) and Natural Resource Conservation Areas (NRCAs).

I. Overview

The Washington State Department of Natural Resources (DNR) has unique obligations in managing lands for the State of Washington. With the State as the trustee, the Legislature has designated DNR as manager of federally granted state trust lands, and other trust lands acquired by the state. The State acquired the granted trust lands under the Enabling Act and State Constitution when Washington became a state in 1889. State Forest Board trust lands were formerly private lands that were mostly logged, abandoned and tax delinquent, foreclosed by the counties, then transferred to the state, mostly in the 1930s; and some Forest Board lands were purchased by the state. There is also a recently established trust set up by the legislature to support construction of community and technical colleges statewide.

DNR manages approximately 1.4 million acres of the forest land in western Washington. DNR has a duty to produce long-term income for the trust beneficiaries — public schools and universities, various state institutions, and many counties. DNR uses best forest management principles in its stewardship of these lands.

State law (RCW 76.68) directs DNR to apply "sustained yield" management of state trust forestlands. The law requires DNR to periodically adjust acreages designated for inclusion in the sustained yield management program, and re-calculate a 10-year sustainable timber harvest level. To accomplish this, DNR recalculates timber harvest with the goal of producing sustainable even-flow harvest volumes over time, to make sure that harvests can be sustained into the future with fairness to today's beneficiaries as well as all future generations of trust beneficiaries.

The current sustainable harvest project includes the use of a new computer spatial model to recalculate a 10-year sustainable harvest level for DNR-managed forests in western Washington. The result is a more robust analysis of forest landscapes, growing and harvesting scenarios, fish and wildlife habitat and other information to assist policy decisions made by the Board of Natural Resources (Board), which sets major policies for the state lands managed by DNR.

The purposes of the re-calculation proposal are:

1. To incorporate new information into a new model to recalculate the decadal sustainable timber harvest level under current existing DNR policy, federal and state laws.
2. To permit the Board to evaluate any policy changes after a number of policy alternatives have been modeled and analyzed through an Environment Impact Statement.

The Sustainable Harvest Environmental Impact Statement (EIS)

DNR will be developing an EIS for the 2003 sustainable harvest calculation for DNR-managed forests in western Washington. The State Environmental Policy Act (SEPA) process was formally initiated with the scoping notice released on February 22, 2002 and with a series of public meetings that were held around the state in the following locations on the following dates.

March 6 – Seattle (Seattle Vocational Institute)

March 11 – Sedro Woolley (Three Rivers Inn Restaurant)

March 13 – Ellensburg (Central Washington University)

March 19 – Port Angeles (Peninsula College)

March 20 – Longview/Kelso (Lower Columbia College)

March 21 – Olympia/Lacey (Lacey Community Center)

There were also ten informal meetings with stakeholder groups seeking a better understanding of the model and overall harvest calculation process.

II. EIS Scoping Summary

Scoping is the first formal step in preparing an Environmental Impact Statement (EIS). The EIS is intended to initiate public involvement in the process, and is conducted to fulfill a three-fold purpose, to:

1. Narrow the focus of the EIS to significant environmental issues,
2. Eliminate issues that would have insignificant impacts, or that are not directly related to the proposal, and
3. Identify alternatives to be analyzed in the EIS.

This summary highlights a wide range of issues that commenters have identified as potentially important and related to the proposed sustainable harvest calculation. It is important to note that under SEPA, only issues related to *probable significant environmental impacts* will be addressed in the EIS.

This comment response document includes summaries of comments by 330 public meeting participants, and more than 410 written letters submitted to DNR. Also included are comments given by 26 organizations represented at ten stakeholder meetings, and other written comments received to date. In all, about 2,000 individual comments have been received regarding the sustainable harvest calculation EIS for westside state DNR-managed forests.

The 2,000 comments capture diverse issues, ideas, and opinions proposed by the public and stakeholders to be included in the scope of the EIS. Comments have been summarized by subject, and have been examined to determine:

1. If the issues are germane to the sustainable harvest calculation for state DNR-managed forests, and
2. How comments about those issues will be addressed.

In summary, the comments received have led DNR to develop four questions that highlight the broad policy issues for the Board of Natural Resources (Board):

1. How should DNR manage for biological conservation?
2. How intensively should DNR manage DNR forests?
3. How should harvest levels be organized? (For instance, as a whole, by trust, by ownership group, as defined in the Forest Resources Plan, etc.)
4. How much older forest is desirable on DNR-managed forests?

III. Summary of Comments Received and Responses to them

A. ISSUES TO BE CONSIDERED BY THE BOARD OF NATURAL RESOURCES IN DETERMINING A SUSTAINABLE TIMBER HARVEST LEVEL FOR STATE DNR-MANAGED FORESTS

GENERAL PROCESS

EIS Process. Many public comments included a concern about the EIS process. Commenters want all meetings to be open and democratic, and for outside contractors to develop the Environmental Impact Statement (EIS). There is considerable interest in what kind of impacts should be evaluated in the EIS. Others commented on specific additions that should be included in the computer modeling assumptions used, so that a broader array of alternatives would be analyzed during the SEPA process.

> ***Response:*** The EIS process enables government agencies and interested citizens to review and comment on proposed government actions. This process is intended to assist the agencies and applicants to improve their plans and decisions, and to encourage the resolution of potential concerns or problems prior to issuing a final EIS. Agency officials, like the Board, use the process to make decisions.
>
> For a detailed description of the process involved in the development of a *non-project EIS* under the State Environmental Policy Act, see WAC 197-11-443.
>
> As stated since the initiation of this SEPA process, DNR is committed to conducting an open and transparent process that will integrate public comments into the EIS. To this end, DNR is including extended public comment periods at appropriate stages in the process. The Board will be briefed of public comments collected during the formal scoping period, and will integrate the scope of issues as laid out by the public and DNR into their decision for a range of reasonable alternatives to be evaluated in the EIS.
>
> An independent contractor will be retained to complete the EIS, which will evaluate potential environmental impacts as required by SEPA.

Modeling. Commenters are interested in geographic and timing aspects of the sustainable harvest calculation – where, how and when DNR is to harvest. Commenters ask DNR to run the calculation in different geographic units. Commenters want the Department to run the model to measure many conditions, including historic land management, selected sensitivity analyses and selected financial and economic impacts (market conditions, discount rate, etc.). There is concern about the computer modeling scenarios to be chosen, and the type and quality of model outputs. Additionally, there is concern about the interpretation of DNR's sustainable even-flow harvest policy.

> ***Response:*** The purpose of the project is two-fold:
>
> 1. To incorporate new information into a new model to recalculate the decadal sustainable timber harvest level under current existing DNR policy, federal and state laws.

2. To permit the Board to evaluate any policy changes after a number of reasonable policy alternatives have been modeled and analyzed through an Environment Impact Statement (EIS).

The need for this harvest level recalculation is defined in RCW 79.68. This state law requires DNR to periodically adjust the acreages designated for inclusion in the sustained yield management program, and recalculates a sustainable harvest level. This requirement, however, allows for substantial fluctuations in the amount of timber offered for sale between decades, as long as there is no prolonged curtailment or cessation. The sustainable even-flow policy in the Department's 1992 Forest Resource Plan allows DNR to harvest approximately the same amount of timber in future years. It prevents major fluctuations between decade levels, and prevents DNR from favoring one generation of beneficiary over the other.

The model will recalculate a sustainable harvest level for all DNR-managed forests west of the Cascade Crest. Calculations will be completed for the westside lands using 24 ownership groups, and at the Board's request, may be developed separately by region or by other ownership groupings.

A computer model is programmed with conditions and variables, and run with alternative scenarios projecting the conditions 200 years into the future to find a sustainable level, before the decadal level is determined.

The SEPA process will assess cumulative impacts of present and future decisions, but the model will not be run retroactively. Sensitivity analyses will be completed on some variables to determine their influence in model results. An analysis of selected financial and economic impacts will be completed.

The reasonable alternatives have not been selected, but will reflect public comments. Modeling assumptions, methodology, and results have been and will be rigorously reviewed by a technical review committee comprised of academic, public agency, and industry experts.

Science versus Emotion. The Board of Natural Resources should use the best available science in making decisions.

Response: The sustainable harvest calculation is based on informed science, a weighing of public values, and DNR's legal trust responsibilities. The Board will base their decisions on these factors. The consultant developing the EIS also will base their analysis of the alternatives on informed science. This is an estimate of the harvest level, which is based on assumptions and sample data. The results are reliable within a confidence interval.

Data Information and interpretation of modeled results. Commenters want independent review of the EIS with some support for the concept of an advisory group (comprised of tribal representatives, DNR staff, GIS experts, etc.). There are concerns about the uncertainties associated with data, modeling assumptions, and interpretation of results. Some commenters suggest using other models [University of Washington's Landscape Model System (LMS)] for predicting harvest levels.

> ***Response:*** DNR has convened a technical review committee comprised of academic, public agency, and industry experts in the fields of forest science and management. The committee's role is to assist in evaluating the modeling process, and provide recommendations to the Board and DNR to create a scientifically supportable sustainable harvest calculation. In addition, DNR has and will continue to solicit input from the public and stakeholder groups as the process progresses.
>
> A private contractor will develop the environmental analysis and write the EIS. A request for proposals was initiated in April, and DNR has selected an "Apparent Successful Contractor."
>
> DNR is currently also contracted with D.R. Systems, which is assisting DNR in the development and customization of the model. The D.R. Systems model OPTIONS® utilizes input data supplied by DNR. Environmental impact analysis will be performed using data created by the model and other available data.

Consideration of Comments. All viewpoints need to be considered. Tribal comments should be recognized differently than other comments (on a government to government basis). Some commenters want the Commissioner of Public Lands alone to determine the balance. Overall, commenters requested a fair process. Some question the methodology of the survey handed out at the public meetings.

> ***Response:*** DNR will give serious consideration to all comments received. DNR is committed to a respectful government-to-government relationship working with tribal governments.
>
> On any given issue associated with the sustainable harvest calculation, public values are frequently deeply divided. The Board will take all the information available to it and make a decision that meets its responsibilities to the trust beneficiaries and laws, while accommodating the broadest band of public desires within that context.

THE TRUST MANDATE AND OTHER POLICY CONSIDERATIONS

Clear Statement of Mandate. Commenters want a clear statement of the trust mandate and DNR's mission. Some think that the constraints used to determine a harvest level should be weighed against the trust mandate. Many believe the trust mandate means balancing economic, environmental and social concerns (i.e., existing laws, contractual agreements, social obligations). There are also concerns with protecting the body of the trusts by sustaining healthy forests.

> ***Response:*** According to the 1992 Forest Resource Plan, a trust is a relationship in which one entity, the trustee, holds title to property, which it must keep or use for the benefit of another. The relationship between the trustee and the beneficiary is a fiduciary relationship, and it requires the trustee to act solely in the best interests of the beneficiary. As a trust manager, DNR is required to follow the common law duties of a trustee, which include: administering the trust in accordance with the provisions that created it, maintaining undivided loyalty to each of the trusts, managing trust assets prudently, producing long-term income from the trust properties for the beneficiaries while recognizing the perpetual nature of the trusts, dealing impartially with beneficiaries, and reducing the risk of loss to the trusts.
>
> DNR has a legal duty to produce long-term income for the trust beneficiaries, one of the principles commonly called the "trust mandate." In 1984, the Washington State Supreme Court specifically addressed the state trust relationship in <u>County of Skamania v. State of Washington</u>. This case addressed two of a trustee's duties. It found that a trustee must act with undivided loyalty to the trust beneficiaries, to the exclusion of all other interests, and manage trust assets prudently. The Court also cited a series of cases in which private trust principles were applied to land grant trusts.
>
> It is the Board of Natural Resources legal and fiduciary responsibility to make all decisions within the confines of the trust mandate and all existing legal/contractual mandates. In addition, they will address issues of sustainability in examining the balance of social, environmental, financial, and economic impacts associated with setting a sustainable harvest level. The Board will serve the long-term interest of the trusts by sustaining healthy forest lands.

DNR-Managed Forests. Commenters want to know for whom the lands are managed.

> ***Response:*** State DNR-managed forests are held in trust for various beneficiaries, in perpetuity — that is, forever. By law, the Commissioner of Public Lands administers the state trust lands. The legislature has designated DNR as manager of all of the state trust lands.
>
> There are three types of state trust lands: Federally Granted trusts, Forest Board trusts, and Community College Forest Reserve. In preparation for Washington's statehood, the U.S. Congress set aside sections of land across the state. Known as Federal Grant lands, they were to provide funding to support eight specific state trusts. The largest is the Common School trust (originally, two sections of each township of the state – 2 of every 36 square miles) to support construction of Kindergarten through 12th grade public

schools statewide; others include the Agricultural School trust and Scientific School trust (support the Washington State University), Charitable, Educational, Penal and Reformatory Institutions trust (supports those state institutions), University Original trust (supports the University of Washington), University Transfer trust (originally part of the charitable trust but was transferred by the legislature to provide additional support to the University of Washington), Normal school trust (supports what were originally teachers colleges, now the three regional Universities: Western Washington University, Central Washington University, and Eastern Washington University), and Capitol building trust (supports construction of state buildings on the capitol campus in Olympia).

Forest Board lands fall into two categories, Forest Board Transfer and Forest Board Purchase lands. Forest Board Transfer lands were generally logged over tax-delinquent lands deeded to the state to manage pursuant to RCW 76.12.020 and 76.12.030. Forest Board Purchase lands were logged or burned-over lands purchased by the state pursuant to RCW 76.12. They support the counties and their junior taxing districts in which they are located and the state general fund. The Community College Forest Reserve revenues go into a special fund for operating expenses or capital improvements on community college campuses.

Intergenerational Equity. Commenters wanted the Board of Natural Resources (Board), as trust managers, to remember inter-generational equity – that this generation is responsible to both future generations of trust beneficiaries and the current generation. One generation cannot receive more than its fair share. Some feel this could be accomplished through longer forest harvest rotations. Still other commenters question the benefit to future generations of even-age plantations.

Response: Common law requires that a trustee make trust property productive without unduly favoring present beneficiaries over future beneficiaries. The Board takes very seriously the responsibility of managing for intergenerational equity, as well as the other three trust principles discussed earlier. The Board is interested in looking at a range of alternatives in the EIS, all of which meet the trust management principles. Alternatives chosen will represent a range of forest management strategies. One of the concepts of sustainability is to foster inter-generational equity. This can be achieved by preventing major harvest fluctuations between decade levels.

Maximizing Income. Commenters want management based on DNR’s fiduciary responsibility, even if current policies or laws must be modified to do so. Other comments call for allowing export logging, and using contract logging as a way to maximize income for timber from DNR-managed lands. Commenters expressed an interest that harvest rotation age be determined solely using financial criteria and not biological. Other commenters want DNR to manage for both ecological values and revenue to maintain trust viability for long-term benefits.

Response: The Board has directed the DNR to develop a recalculation of the sustainable harvest level that meets: 1) all Federal and State Statutes; 2) the Trust Mandate; 3) the 1997 Habitat Conservation Plan objectives; and 4) the 1992 Forest Resource Plan policies. In addition, the current Forest Resource Plan policy #4 states that “the Department will manage state forests lands to produce a sustainable, even-flow harvest of timber, subject to economic, environmental and regulatory considerations.”

Desired modifications in DNR's marketing and timber harvesting practices that require changes in state law are beyond the scope of this proposal and DNR and Board authority. Such requests should be directed to the state legislature. While decisions about forest management strategies (rotation age, for example) are within DNR's purview, the restriction on the export of logs coming from state lands is a decision of the U.S. Congress.

Beneficiaries. Commenters want the school trusts, counties, and small communities to have predictable and reliable revenue. Some comments suggested that local school district boundaries be part of an economic impact analysis. Some comments indicated that the calculation should be based on long-term sustainability rather than maximizing today's revenues to schools. Other comments suggested that: DNR should consider current and future budget shortages in analysis and reminded the DNR that it is one of the biggest 'beneficiaries' of trust revenues; some commenters called for DNR to renegotiate the HCP in order to maximize revenue to beneficiaries.

Response: The requirement of undivided loyalty to trust beneficiaries is fundamental to all policies and activities regarding trust lands. This principle requires that trust land and its assets not be diverted to benefit others at the expense of the trust beneficiaries without compensation. Integral to the concepts of both sustained yield (79.68 RCW) and sustainability is stability of benefits to trust beneficiaries. As trust managers, the DNR intends to provide revenue to the trust beneficiaries through providing a sustainable even-flow of timber from state DNR-managed forests, both today and in the future.

To provide stability and predictability for trust land forest management, DNR and federal agencies signed a 70-100 year Habitat Conservation Plan (HCP) agreement in January of 1997. The HCP covers 1.6 million acres of DNR-managed forests affected by the federal listing of the northern spotted owl as threatened. DNR's multi-species HCP agreement establishes habitat commitments that need to be met over the life of the contract. The agreement allows DNR flexibility to meet conservation benefits, revenue production, and public use goals for state trust lands. DNR's HCP protects habitat for all upland endangered species, and provides riparian protection along waters and wetlands on DNR-managed western Washington forests and other state lands in its care. It provides protection of all current and future listed aquatic species.

As long as DNR meets its commitments defined in the plan, the federal government agrees not to add restrictions or disrupt long-term timber harvest plans based on its Endangered Species Act (ESA) enforcement authority. Nor will they seek penalties for an incidental harming of a listed species or accidental removal of some habitat (see HCP Implementation Agreement).

DNR will perform a financial and economic analysis of alternatives and their impacts on trust revenues, though not by school districts. DNR will not base the sustainable harvest level on current or future budgetary needs. It is not the function of the sustainable harvest calculation to predict future budgetary conditions.

The HCP commitments, along with current Board policies, are being modeled in a scenario (Tier 3). The sustainable harvest process may examine other management strategies to meet HCP goals. Re-negotiating the HCP is beyond the scope of this project.

Foreclosing Future Options. Some commenters suggested that given future environmental uncertainties, DNR should minimize all resulting negative impacts to the environment or analyze the full environmental and economic costs of any negative impacts. Others suggested that the DNR should consider in its analysis future population growth and its possible affect on foreclosed future options. Meanwhile, other commenters suggested that DNR should make forest management changes necessary to become Forest Stewardship Council certified in an effort to not foreclose future options.

Response: DNR believes it is prudent to manage trust assets so that future income is not foregone by actions taken today. This includes future income from revenue-generating activities undertaken today, those expected to be undertaken in the future (like timber harvest), and those unforeseeable at the present time.

At the same time as meeting DNR's goals, minimizing negative environmental impacts is a crucial component of trust asset management. There will likely be a greater demand for most trust land resources given population projections for Washington State. The management of DNR forests under a certification system will be considered independently from the sustainable harvest calculation process.

Prudent Person Doctrine. Commenters express that the prudent person language is key to long-term public support of trust land management activities.

Response: Trust managers are legally required to manage a trust as a 'prudent person,' exercising such care and skill as a person of ordinary prudence would exercise in dealing with his or her own property. In DNR's view, this means, among other things, avoiding undue risk.

Forest Resource Plan (FRP). There is concern about how the 1992 Forest Resources Plan (FRP) is being interpreted and whether changes in the plan should be examined. Particular interest surrounds the interpretation of issues relating to sustained yield and the DNR's policy on sustainable even flow of timber harvest. Confusion exists about whether the sustainable harvest calculation represents a ceiling or an obligation. Commenters want a clear explanation of FRP policies, their interpretation and implementation. Some want DNR to renew the expired FRP in conjunction with sustainable harvest calculation.

Response: The sustainable, even-flow timber harvest policy (FRP policy #4) directs DNR to harvest approximately the same amount of timber every year, prevent major fluctuations between decadal levels, and avoid favoring one generation over another. This policy is implemented by setting a harvest level for the coming decade and then, by dividing that number by ten, an average annual harvest volume is calculated. The decadal volume becomes DNR's obligation.

The FRP policy #4 provides the ability for the DNR to fluctuate the annual harvest volume up to 25 percent (plus or minus) from the decade average. This annual flexibility gives DNR some latitude to capitalize on timber market changes. DNR has and will continue to look at ways to increase trust revenue through the control, timing, and type of products entering the market. Under the present lump-sum system of selling timber, DNR has control over timing of sales at timber auction, but has less control over exact time of harvest. Purchasers have the option to harvest any time during their contract, which usually has a term of 2 to 3 years.

The Board will continue to make policy decisions and interpretation of those policies in a way that is transparent to the public. The 1992 Forest Resource Plan was extended for an additional three years, ending June 30, 2005 and is projected to undergo a thorough review over the next three years.

Forest Board Ownership Groups. There was disagreement by commenters on how Forest Board lands should be managed, i.e. whether revenue from them should be pooled – and shared proportionately with ownerships – or remain un-pooled; how to provide stable funding to counties and their junior taxing districts, and if counties can 'opt out' if they are unsatisfied with trust management.

Response: The Forest Resource Plan (FRP) addresses how DNR structures revenue within the different ownership groups in Policy #6 (Western Washington Ownership Groups). The Board will base decisions on the 1992 Forest Resource Plan and may examine alternative policy positions in the reasonable alternatives assessed in the EIS.

The Board may amend FRP policies relating to or affecting the sustainable harvest calculation during the completion of the EIS, however other FRP policies will be reviewed within three years in a separate process. Changes in state law are beyond the scope of this proposal. Desires to change authorities of DNR and the Board should be directed to the state legislature.

Sustainability and Sustainable Harvest. There is significant concern about how "sustainability" is defined and measured, and that a long-term view be considered. Opinions differ as to how to balance environmental, social, and economic considerations. Some concern was expressed that a balance would not or could not be struck. Interest was expressed that any definition of sustainability includes specific factors. There is interest in keeping the sustainability issue properly confined to the appropriate legal context of "sustained yield" rather than "sustainability" (79.68 RCW). Commenters want sustainability of DNR-managed state lands judged in the context of other public and private lands, and for this sustainable harvest level to be a real number, not an inflated one.

Response: In the state Public Lands Act, Chapter 79.68 RCW, the legislature directs DNR to manage those state-owned lands under its jurisdiction capable of growing forest crops on a sustained yield basis when compatible with other legislative directives. The statute also requires DNR to periodically adjust acreages designed for inclusion in the sustainable harvest calculation. "Sustained yield," as defined by statute, means forest management to provide continuing harvest without prolonged curtailment or cessation.

There are issues associated with the concept of "sustainability" that are not included in the definition of "sustained yield plans" (RCW 79.68.030), components of which are addressed in other policies and mandates implemented by DNR. The Board and DNR have been discussing the goals of sustainable forest management as a policy direction, and how it will be implemented. These discussions are likely to be ongoing as the Board examines Forest Resource Plan policy implementation in the sustainable harvest calculation process, and the review of the Forest Resource Plan in the coming years.

Habitat Conservation Plan (HCP) Review. Commenters are unclear about the relationship between the HCP, the federal Endangered Species Act (ESA) and trust land management obligations. Some commenters felt the HCP should be renegotiated or cancelled because of high costs to beneficiaries relative to ecological benefits.

Response: Periodic reviews of the HCP are scheduled to evaluate the plan's effectiveness at achieving its goals. Comprehensive reviews are scheduled to occur within one month of the first, fifth, and tenth, anniversaries of the effective date and every tenth anniversary thereafter for the full term of the agreement. Upon mutual agreement of all the parties, additional reviews may be scheduled at any time. DNR (with approval by the Board of Natural Resources) reserves the right to terminate the HCP agreement with thirty days written notice to the federal 'Services' (US Fish and Wildlife Service, and National Marine Fisheries Service).

The HCP is a key factor in determining the sustainable harvest level. The HCP, a contractual agreement with the Services, was developed to protect DNR from potential "take" violations under the ESA by agreeing to a set of habitat management objectives and strategies. Without assurances provided in the HCP, all forest management activities on DNR-managed forest lands would be subject to different provisions of the ESA and the uncertainty associated with protecting habitat for species listed in the future. DNR remains committed to the intent of the HCP as outlined in the plan's objectives. However effective, strategies to achieve those objectives may be examined as part of the sustainable harvest calculation modeling and SEPA environmental impact analysis; the HCP implementation Agreement provides for both minor and major amendments requested by the signatory parties.

HCP Plan Implementation. Commenters expressed interest in examining the implementation of the HCP and the protections it provides for (ESA listed) managed species. Comments supported and opposed the length of the HCP plan, the science employed, and its effectiveness.

Response: The HCP is the primary tool for implementing policy #23 of the Forest Resource Plan (FRP), which provides for protection of endangered, threatened, and sensitive species on DNR-managed forest lands. The HCP also sets wildlife management objectives. A monitoring program for plan implementation is outlined in the HCP.

As stated above (in section on *HCP Review*), DNR is committed to the objectives in the HCP, and the Board is interested in having staff model various strategies for accomplishing habitat commitments. It is important for strategies employed by DNR to meet the objectives of the HCP as currently adopted, or modified in the future. The sustainable harvest modeling process provides an excellent opportunity to examine the effectiveness and efficiency of different habitat management strategies in meeting HCP objectives.

Asset Stewardship Plan. Commenters want DNR to revisit this plan.

Response: DNR develops long-term plans for managing the lands and resources in its care. In general, plans outline the obligations, goals and objectives for the particular assets addressed. The Asset Stewardship Plan provides the consistent, overarching connection tying together DNR's asset and land planning efforts. The Board of Natural Resources adopted the Final Asset Stewardship Plan in January 1998. Revision of the plan would be a Board decision.

Multiple Use Concept. Commenters want DNR to follow the "Multiple Use Concept" (Public Lands Act) and examine the impacts of public use on the sustainable harvest level or management decisions.

Response: "Multiple use," as defined in RCW 79.68, is the management and administration of state-owned lands under the jurisdiction of DNR to provide for several uses simultaneously on a single tract, or the planned rotation of one or more uses on and between specific portions of the total ownership consistent with the provisions of RCW 79.68.010. The law allows public use of DNR-managed forests when compatible with management activities and when it does not damage resources or interfere with trust management responsibilities.

Federal Legislation. Commenters want DNR to comply with all federal laws.

Response: Complying with all federal laws is DNR's legal obligation. The policies and plans developed and implemented on state trust and other lands managed by DNR must be compatible with applicable federal and state laws.

MODELING SCENARIOS, AND OPTIONS WITHIN SCENARIOS

Baseline. There is some confusion about why DNR is using tier levels – three scenarios for use during in the calculation process. There is support both for and against using the tier approach, and different ideas about what the baseline should be and include.

> ***Response:*** DNR has selected a tier approach resulting in three scenarios that allow the Board of Natural Resources to gain a better understanding of (a) the modeling process, and (b) the impacts of regulatory responses and policy decisions on harvest levels as it evaluates scenarios for a sustainable harvest calculation.

☒ **Tier 1.** Most comments centered on what should be included in Tier 1. Most comments suggested dissatisfaction that Tier 1 was presenting a scheme entirely unfettered by rules and regulations. Others believed Tier 1 is not inclusive enough without including all DNR-managed lands (including Natural Area Preserves and Natural Resource Conservation Areas) or modeling full growth capacity. There was also some concern about the appropriateness of the Stand Projection System, the growth model used in the modeling process.

> ***Response:*** Tier 1 reflects the baseline 'biological capacity' — the (tree) growth-and-yield of the current trust forestland base using DNR's current silvicultural practices, but without any environmental or social management strategies. Natural Area Preserves and Natural Resource Conservation Areas are included in the scenario but are not available for harvest due to special ecological concerns or features. If implemented, the scenario Tier 1 would not meet current federal and state laws, and is **not** intended as a reasonable EIS alternative or harvest level. It is a baseline scenario for the Board to compare the results of their policy decisions and laws on harvest levels, habitat and public use commitments reflected in the other tiers and future proposed harvest scenarios.

☒ **Tier 2.** Though there were no specific comments about Tier 2, an explanation may be helpful as context for the other tiers. Tier 2 models all current laws and policies, without DNR's HCP. Tier 2 models state Forest Practices Rules as they are written to date and includes assumptions about the federal Endangered Species Act and its restrictions in the absence of DNR's HCP.

> ***Response*:** The Tier 2 scenario represents (tree) growth-and-yield of trust forest land management under federal laws (including the Endangered Species Act) and state Forest Practices Rules. This scenario models how DNR would manage timber harvest while avoiding "take" of a listed species under the Endangered Species Act. The Habitat Conservation Plan is not considered under Tier 2.

☒ **Tier 3.** Many commenters were concerned with how the HCP is modeled in Tier 3, and specifically how northern spotted owl habitat is modeled. Issues included whether habitat needs will be met according to the HCP, how nesting, roosting, and foraging (NRF) habitat will be measured, and whether or how owl circles will be modeled. There was also concern over the management of marbled murrelets, and other elements potentially missing in Tier 3 assumptions. Other comments related to how DNR will address issues of data quality and policy interpretation. Lastly, there were comments that questioned the validity of Tier 3 as a "no action" alternative, e.g. whether it truly represents the full suite of current policies and procedures.

> ***Response:*** Tier 3 models DNR-managed forests under Board adopted and approved policies and strategies plus any current regulatory requirements. These policies and strategies include those in DNR's 1997 Habitat Conservation Plan.

Scoping Scenarios. Comments focused on the range and substance of reasonable scenarios chosen for the EIS. There is interest in seeing EIS scenarios reflect a wide variety of strategies and management regimes. Concern over the scoping scenarios offered by DNR was expressed. There is concern that alternatives meet SEPA and HCP requirements, and that details of alternatives be compared with ecological, economic and social analyses. Commenters offered reference for a variety of specific alternatives.

> ***Response*:** Four very preliminary straw proposals (put forward as 'Initial Sustainable Harvest Modeling Scenarios' and labeled here as scoping scenarios lettered A through D) were posted on DNR's website and offered at the public scoping meetings. These proposals were designed to:
>
> - Stimulate dialog during the scoping phase by providing real examples of many elements that would be included in the more refined modeling, and
> - Illustrate examples of how policy changes affect the modeling process.
>
> Substantial improvements to the framework for developing scenarios have been made as a result of guidance from the Technical Review Committee. Comments received during the scoping period relating to the modeling of scenarios (and summarized in this section) are instrumental to DNR and the Board in understanding the scope of issues of concern to the public. They will help build alternatives. Therefore, the alternatives chosen to be evaluated in the EIS will look different from the scoping scenarios.
>
> All those issues will be considered during the Board's selection of alternatives. The selection of alternatives is a Board policy decision. The specific range of modeled scenarios chosen by the Board will reflect an array of concerns.
>
> A reasonable alternative, as defined by SEPA (WAC 197-11-786), is an *action that could feasibly attain or approximate a proposal's objectives, but at a lower environmental cost or decreased level of environmental degradation.* The alternatives assessed in the EIS will be varied solutions to accomplish DNR's goal to meet the requirements of the trust mandate. As the trust lands manager, DNR's responsibility is to provide a continuous stream of revenue for the beneficiaries, while providing ecological and social benefits.

Silvicultural Regimes

☒ **Harvest Type/Level.** Some commenters recommended harvest be regulated not only by volume, but also by area. Commenters also want DNR to equate harvest volume with types of proposed harvest (thinning, clear-cutting, etc.), define harvest by both volume and revenue, and increase harvest levels. Harvest options suggested by commenters include:

- No/minimal harvest option
- Variable density thinning
- Harvest 2nd growth forest only
- Selective harvest, no clear-cuts
- Clear-cut harvest (both for and against)
- Support whatever management regimes re-establishes a multi-storied forest over time
- Harvest "old growth"

> ***Response:*** Forest Resource Plan policy #5 directs the DNR to develop its sustainable harvest calculations based on volume rather than acreage or other considerations.
>
> The modeling results will show harvest by type. In addition, harvest volume by type will be a key factor in the financial and economic impact analysis. Suggestions by commenters of harvest type will be considered by the Board in the development of reasonable alternatives for the EIS.
>
> Analysis of current and potential management regimes is a key component of the sustainable harvest recalculation. This analysis will be included in the development of reasonable alternatives for the EIS. (Please refer also to *Average Rotation Harvest Age*, below.)

☒ **Average Rotation Harvest Age.** Average rotation harvest ages from 40 to 140 years were suggested. Shorter rotations (40-60 years) were proposed to meet a number of social and economic goals. Other commenters suggest longer rotations (60-140 years) to meet a number of ecological, social and economic goals. Some comments propose varied rotation regimes to create a diversity of habitat across the landscape.

> ***Response*:** The rotation harvest age is one of many variables which, when combined with others, will determine the sustainable harvest level. Generally, DNR refers to an "average rotation harvest age;" rotation age applies to even-aged management regimes. Depending on the location of and goals for a particular stand, different harvest ages may be applied.
>
> Under current policy in western Washington, DNR's current average rotation age is modeled at 60 years. This means that, as a general rule, trees younger than 55 years of age will not be harvested. However, some exceptions occur as a result of specified objectives, such as biological diversity or remoteness. DNR may cut some stands as early as 45 years and other stands only when trees reach 100 years.
>
> Some Forest Resource Plan (FRP) policies relating to or affecting the sustainable harvest calculation may be amended by the Board during the sustainable harvest calculation EIS

project. However, DNR will be reviewing the FRP and its policies in detail within two to three years in a separate process, which will include public involvement.

Alternatives to current management regimes may be considered by the Board, either separately or combined with other variables, and integrated into the reasonable alternatives to be examined in the EIS.

☒ **Management Intensity.** Comments ranged from recommending use of all modern intensive silvicultural techniques to more passive management with minimal use of herbicides, pesticides, fertilizers, reforestation, and pre-commercial thinnings. Other comments requested that DNR explore the possibility of managing fewer acres intensively versus many acres passively.

Response: In selecting silvicultural activities, DNR ensures that its actions are consistent with its responsibilities as a trust manager.

DNR will integrate timber harvest with watershed and wildlife protection objectives as well as social objectives such as recreation and education. DNR and the Board are exploring a range of management intensities, including use of pre-commercial thinning and other variables to meet different landscape-level objectives.

Currently, the state trust forest landscapes are not managed or harvested with a one-size-fits-all solution. One of the reasons that DNR is conducting the sustainable harvest calculation is to investigate different ways of carrying out its various responsibilities. Alternatives to current forest management regimes may be considered by the Board, either separately or combined with other variables, and integrated into the reasonable alternatives to be examined in the EIS.

☒ **Reforestation and Green-up.** Comments predominantly centered on the timing and composition of reforestation. Several comments propose multi-species and multi-aged regeneration; there is concern about monoculture plantations and the genetic stock of trees planted. Commenters expressed interest in knowing how the 'green-up' policy is handled in the model.

Response: Reforestation is required by Forest Practices rules (WAC 222-34). Reforestation is a prudent forest management practice designed into every timber harvest, and is key to forest productivity and health. DNR foresters apply site-specific silvicultural prescriptions with specific objectives for all timber sales. Reforestation treatments include on-the-ground site preparation methods, selection and planting of seedlings, natural regeneration, control of competing vegetation while seedlings are young, and proper tree spacing.

In the sustainable harvest model, reforestation treatments are based upon current DNR forest management practices. All harvested stands in the model are assumed to regenerate through planting. Natural regeneration is also a current practice on DNR forestlands.

DNR's forest inventory demonstrates that the majority of forest stands are actually multiple species and multiple aged. However, for modeling purposes, the forest inventory is simplified and classified. The result is that the forest inventory is classified into single species forest types and into single age classes; such as 30-year old Douglas fir dominated, 30-year old Western hemlock dominated, 30-year Western red cedar dominated, 30-year old hardwood dominated etc.

In developing the sustainable harvest calculation, green-up and adjacency rules are operational constraints that affect the development of site-specific harvest planning. The sustainable harvest model evaluates the strategic impacts from policy decisions and therefore not all operation considerations are modeled explicitly. In the current modeling effort, the impact of green-up and adjacency rules are mitigated for through a set of assumptions for explicitly deferred areas, wildlife management areas, riparian management zones and green tree retention. This assumption, along with other modeling assumptions will be tested and verified by DNR field staff.

☒ **Sustainable Harvest Calculation Implementation.** It was commented that implementation is just as important as the calculation itself. Commenters also requested that DNR: allow for local input into timber harvesting decisions once a harvest level is implemented, utilize alternative harvest systems (such as horse logging), utilize salvage timber (fire, pest damaged) and non-merchantable wood, and consider whether to include these timber sources in calculation.

Response: The DNR continues to consider alternative timber harvest methods as a normal business practice. Maintaining the health and productivity of DNR-managed forests is essential to DNR in its responsibilities as trust manager. Prediction of the amount of salvage timber that will result from fire and pest damage is a variable not currently used in the model in determining the harvest calculation. Alternatives to current management regimes may be considered by the Board, either separately or combined with other variables, and integrated into the reasonable alternatives to be examined in the EIS.

DNR field staff will be consulted on the implementation issues associated with all the selected reasonable alternatives examined in the EIS. The DNR modeling team will work with DNR regional staff to assure that implementation is achievable. This verification will be integrated into the process of establishing a sustainable harvest level, and will continue after the EIS is completed.

☒ **Old Growth.** Commenters advocate protection of all remaining old growth (150+ year old) forest. Comments questioned the DNR classification and location of old growth. A wide range of values was expressed as reason to preserve old growth forest. Still other comments revolved around how to manage old growth, requesting a clear statement by DNR about how it would be managed under each proposed alternative. Some commenters advocate harvest of old growth trust forests.

Response: The HCP, Forest Practices Rules and Forest Resource Plan policies advocate older forest protections as habitat and for forest biodiversity.

DNR's current policy for wildlife habitat helps support native wildlife populations or communities. The policy directs the agency to find a balanced solution when trust objectives and wildlife habitat are in conflict. Through implementation of the HCP, the

Department has identified many balanced solutions that address both listed and other species. Under the HCP, within 200 years the trees in riparian buffers will increase in age to more than 160 years old. Other HCP strategies involve the management of forest lands for northern spotted owls, which includes structural components of older forests through silvicultural prescriptions. No formal DNR policy currently exists for dealing with 150+ year older forests. The definition of old growth in the DNR's HCP is based on both age and structure (1997 HCP Appendix).

Alternatives to current management regimes may be considered by the Board, either separately or combined with other variables, and integrated into the reasonable alternatives to be examined in the EIS.

Landscape Level Issues

☒ **Habitat Complexity.** Commenters supported management for increased habitat complexity, both to the level specified in the HCP and in excess of the plan. There is interest in meeting a number of goals related to habitat complexity, including managing for biodiversity, forest structure, and landscape-level parameters.

Response: DNR has a number of HCP strategies in place to manage for habitat complexity. Maintained or restored under the HCP are northern spotted owl habitat, marbled murrelet habitat sites, riparian management zones and wetlands, and in western Washington, additional cave, talus field, cliff, bald, oak woodland, large structurally unique tree, snag and mineral spring habitat. The HCP strategies are designed to support the forested landscapes through active forest management practices that will produce a diverse living mosaic of forest types across landscapes.

Alternatives to current management regimes may be considered by the Board, either separately or combined with other variables, and integrated into the reasonable alternatives to be examined in the EIS.

☒ **Stewardship.** Comments requested the consideration of a mix of active and passive stewardship in one alternative.

Response: Various ways of applying active and passive stewardship strategies are being considered in the modeling process. Ultimately, they will be considered by the Board, either separately or in a combined fashion with other variables, and integrated into the reasonable alternatives to be examined in the EIS.

☒ **Set-asides.** Concerns were expressed about what forestland is in set-asides and how that affects the sustainable harvest level.

Response: The state Natural Area Preserve (NAP) system presently includes 26,400 acres in 47 sites distributed throughout the state. Preserves are established to protect rare native ecosystems and the at-risk plant and animal species within them. Western Washington preserves include five large coastal preserves supporting high quality wetlands, salt marshes, and forested buffers. Other preserve habitats include mounded prairies, sphagnum bogs, natural forest remnants, and grassland balds. Statewide, preserves range from 8 acres to 3,500 acres in size.

Forested NAPs and Natural Resource Conservation Areas (NRCAs) are included in the sustainable harvest model forest inventory database, although these areas are deferred from timber harvest. These areas are included to provide a board assessment of the conservation benefits of the DNR management on forested landscapes. In addition to the NAPs and NRCAs providing various habitats, the HCP also protects critical habitats for threatened and endangered species. For further discussion, see the above section on *Old Growth*.

A "zoned" habitat approach designates areas of the forest landscape for particular goals (such as reserves or 'set-asides' to achieve habitat), whereas, an "unzoned" approach provides areas that meet objectives across the landscape over time, but not always in the same place. DNR currently utilizes a zoned approach for the implementation of the HCP riparian strategies, northern spotted owl nest patches and interim owl circle protections and for potential and occupied marbled murrelet habitat. In accordance with the HCP, the Olympic Experimental State Forest (OESF) is designed to integrate production and conservation across the landscape, using what is commonly known as an unzoned forest approach. Management strategies using both zoned forest and unzoned forest strategies may be considered among options for reasonable modeling scenarios.

☒ **Biodiversity and Wildlife.** Commenters request that the model consider management for biological diversity, ecological processes, wildlife and wildlife corridors, and endangered species. An analysis of biodiversity pathway management is requested. Comments related to the management of particular species, with specific concerns about the northern spotted owl, marbled murrelet, salmon species, and their habitats.

Response: Management for wildlife and biological diversity is a priority for DNR. DNR has made clear that the calculation model will incorporate obligations pertaining to trust mandate, state and federal laws, and 1997 Habitat Conservation Plan including multi-species habitat protection for northern spotted owls, marbled murrelet and salmonids, among other native species. As such, the sustainable harvest calculation model will help DNR fulfill those mandates. As part of the modeling, DNR will examine different ways to achieve habitat objectives for these species. For further discussion on habitat, see the above sections on *Habitat Complexity* and *Old Growth*.

Alternatives to current management strategies may be considered by the Board, either separately or combined with other variables, and integrated into the reasonable alternatives to be examined in the EIS.

☒ **Riparian Areas.** Comments addressed the treatment of riparian areas (the buffers of trees and other vegetation that protect streams, lakes, and other water bodies), including the level of management inside buffers. There is also concern about data quality of the GIS stream layer, and whether HCP goals are modeled.

Response: Both the state Forest Practices Rules and DNR's HCP provide rules and guidance for protecting surface waters and stream flow. The HCP resulted in greater protections for riparian areas in western Washington by allowing some deciduous and all young conifer forests within riparian areas to be managed to develop into older forests. The width of the riparian buffers along Type 1, 2, and 3 streams is based on the potential height of mature conifer trees in a stand at that particular site. In addition, under the HCP, a 100-foot-wide riparian buffer is applied to both sides of Type 4 waters, which are less protected under the state Forest Practices Rules.

The level of management activities inside riparian buffers, as well as mapping concerns regarding unmapped type 4 and 5 waters, are both being addressed in the modeling process. These issues, along with a number of other riparian-related issues (habitat, wildlife, water quality, etc.) may be considered by the Board, either separately or combined with other variables, and integrated into the reasonable alternatives to be examined in the EIS.

☒ **Wetland Areas.** Commenters address the treatment of wetland areas and the ecological impact of harvest and road construction in and adjacent to wetland areas. There is concern that wetland areas be protected for tribal resources. There is also concern about wetland data quality and accuracy.

Response: Under DNR's HCP, there is to be no overall net loss of wetlands or their function. Important wetland functions that are protected under the HCP include, but are not limited to, the augmentation or addition of water into streams during low-flow seasons, and the capture and absorption of overflow water during peak storm flows.

Special consideration is given to the historical and cultural concerns of the tribes. DNR recognizes that Native American tribes have a special interest in state DNR-managed forests (Appendix F, Forest Resource Plan). DNR has an existing plan to address tribal and archeological resources, and will continue to work with the tribes to improve that process. The model does not map unidentified tribal resources, but DNR will rely on existing policies when tribal resources are discovered. Impacts to tribal and archeological resources will be assessed in the EIS.

The level of management activities inside wetland buffers and concerns about unmapped wetlands are both being addressed in the modeling process. Alternative approaches to these issues, along with a number of other wetland-related issues (habitat, wildlife, water quality, etc.) may be considered by the Board, either separately or combined with other variables, and integrated into the reasonable alternatives to be examined in the EIS.

☒ **Municipal Watersheds.** Commenters requested that DNR use special management prescriptions for municipal watersheds where DNR manages five percent or more of the watershed.

Response: State Forest Practices rules require DNR to analyze the risks to public resources (which include water, wildlife, etc.). In many respects, DNR's existing policies — for example, its HCP requirements — are already significantly more protective of water quality than the Forest Practices rules. Additionally, DNR uses a variety of tools to evaluate environmental impacts from its management activities. The sustainable harvest model incorporates a number of current strategies including riparian areas and unstable slopes that address water quality issues.

These are trusts lands (that help build public schools, or help fund county services in many counties). As such, assets cannot be taken from them without compensation to the trusts. Municipalities may request DNR to adjust how it manages trust lands in a watershed, as long as they are willing to fully compensate for increased costs, deceased land values and lost revenue to the trusts. Within the scoping comment period, no municipality has requested that DNR apply special management within their watershed. At this time, such specific requests have not been made, but would require separate environmental and financial analysis. See RCW 79.01.128(1).

☒ **Unstable slopes.** There is concern over activities within both deep-seated and shallow/rapid unstable slopes, and their treatment within the model.

Response: Provisions in both the Forest Practices Rules and the 1997 Habitat Conservation Plan guide DNR in special treatments to protect unstable slopes. Those requirements are modeled in the sustainable harvest calculations. Alternatives to current management regimes may be considered by the Board, either separately or combined with other variables, and integrated into the reasonable alternatives to be examined in the EIS.

☒ **Cultural resources.** Commenters requested that DNR consider protection of cultural resources, both registered and unregistered, including cultural and archeological sites, wetland and riparian areas, plant resources, and protection within tribal watersheds.

Response: Special consideration is given to the historical and cultural concerns of the tribes. DNR recognizes that Native American tribes have a special interest in state DNR-managed forests (Appendix F, Forest Resource Plan). DNR has an existing plan to address tribal and archeological resources, and will continue to work with the tribes to improve that process. The model does not map unidentified tribal resources, but DNR will rely on existing policies to respond to their discovery. Impacts to tribal and archeological resources will be assessed in the EIS. (See also section *Wetland Areas*, above)

☒ **Roads.** Concern exists about roads to be built, maintained, or abandoned. How DNR will maintain existing culverts was another issue. Additional concern was expressed about how DNR will estimate acreage for roads in the model.

Response: Road maintenance plans are a requirement under WAC 222-24, the state Forest Practices Rules that govern forestry roads. DNR continues to develop and implement its road maintenance and abandonment plans for state DNR-managed forests.

Improvements to meet fish passage standards in existing roads do not change the acreage involved in the calculation. The model uses the existing land base without additional restrictions associated with roads and road construction, maintenance, or abandonment. Because DNR does not know exactly where and how new roads will be built to reach currently un-roaded future timber harvest sites, new roads are not modeled in the sustainable harvest calculation. Road construction, however, will be assessed for potential environmental impacts in the EIS.

☒ **Recreation.** Commenters asked that DNR consider managing for recreation and multiple-use. One suggestion proposed the establishment of a trail corridor around DNR-managed lands abutting the Pacific Crest Trail.

Response: In 1974, the state legislature directed DNR to use the concept of multiple-use management where it is in the best interests and general welfare of the state and its citizens, is consistent with trust provisions of the lands involved, and is compatible with activities that fulfill the financial obligations of trust management (RCW 79.68.010).

Dispersed recreation – hiking, biking, etc. – is not directly modeled in the sustainable harvest calculation, however the impacts on forest management activities are accounted for in the model through GIS data and "fall-down" factors related to operational constraints. For example, areas around trails may retain more trees per acre at final harvest than under normal harvesting rules. In the EIS, potential impacts to recreation will be assessed.

Arrearage. Some commenters asserted that arrearage should be discussed as part of the sustainable harvest calculation. They want DNR to provide analysis of arrearage over the past decade and bring the arrearage forward without rolling it into 2003 calculation. Some want the arrearage examined by trust and by county.

Response: The arrearage question is related to, but separate from the calculation of the sustainable harvest level. RCW 79.68.045 directs DNR to conduct analysis of alternatives to determine a course of action regarding arrearage to provide the greatest return to the trusts based on economic conditions then existing or forecast, as well as the impacts on the environment of harvesting the additional timber.

Simply stated, the concept of arrearage is that if some trust land timber sales are not sold — or purchasers default on sales — it results in the sustainable harvest level not being met. If there is an arrearage, DNR will conduct an analysis and may add arrearage sales on top of the sustainable level during the next decade.

Arrearage analysis would need to be performed after the sustainable harvest calculation has been set for the next decade because, until the updated sustainable harvest volume is established, it is unknown if there is any arrearage volume available that meets the statutory tests. After the sustainable harvest calculation is completed, DNR will review management options related to any arrearage.

Assessing the environmental impacts associated with any arrearage is beyond the scope of the SEPA analysis for calculating the sustainable harvest level for the coming decade.

Ownership Groups. Commenters are concerned as to how ownership groups (individual trusts or groups of trusts) will be handled – whether trusts will be considered individually or grouped. Interest was expressed both in examining the Forest Board Transfer forest lands individually by county and in exploring benefits of combining them in some way.

Response: DNR's current direction is established in Policy #6 (Western Washington Ownership Groups) of the 1992 Forest Resource Plan. It directs DNR to establish a sustainable even-flow harvest level for: Forest Board Transfer Lands by individual counties, Federal Grant Lands and Forest Board Purchase lands by DNR administrative regions, the Capitol State Forest, and the Olympic Experimental Forest.

The Board has expressed a clear interest in examining the current ownership groups and having a trust-by-trust analysis of the financial and other impacts of each reasonable alternative. Harvest calculations will likely be modeled at several levels from which trust by trust impacts will be derived. An analysis of selected ecological, financial and economic impacts to each trust may also be completed for each alternative.

Certification. Commenters requested that DNR model a Forest Stewardship Council scenario or another green certification option. Others suggested that DNR should not pursue green certification.

Response: DNR stated that it will not consider certification of DNR-managed forests as part of the sustainable harvest calculation process. Certification will be considered in a parallel process. If DNR and the Board pursue certification at a later date, it will evaluate its impact to harvest levels at that time. It is likely, however, that some or most of the management activities that would meet the requirements for Forest Stewardship Council or other certification processes will be included in the sensitivity analysis of Tier 3 and may be reflected in the chosen reasonable alternatives.

This approach will not foreclose the Board's option to pursue certification in the future.

ENVIRONMENTAL IMPACT ANALYSIS SUGGESTIONS

General. There was concern expressed over what would be included in the EIS, and the timeframe which the analysis will consider. Specific concern was expressed that the SEPA rules (as laid out in the Washington Administrative Code – WAC) should be interpreted broadly. There were requests that DNR evaluate the current management regime and (tree) age-class distribution on trust land forests, and analyze impacts for the entire 200-year modeling period.

> ***Response:*** The Environmental Impact Statement (EIS) for DNR's sustainable harvest calculation will be written according to the State Environmental Policy Act (SEPA) rules. It will evaluate impacts — direct, indirect, and cumulative — to the natural and built elements of the environment (WAC 197-11-444). As required by SEPA, reasonable alternatives and a "no action" alternative (representing current management policies) will be evaluated in the EIS. The contractor writing the EIS will evaluate potential significant impacts to the environment over the 10-year timeframe of the proposed action.

Water quality. DNR is asked to consider the potential environmental impacts on water quality due to forest management, including chemical fertilization; also address impacts to shade in riparian areas, stormwater and its management, drinking water, and municipal watersheds. There was concern that DNR use "good science," and protection for physical, chemical and biological components of water quality.

> ***Response:*** Potential impacts to water quality will be examined in the EIS [WAC 197-11-444(1)(c)]. Potential impacts of forest management strategies on riparian and wetland areas, stormwater management, and public water supplies will be evaluated. The Department of Ecology co-adopts a number of Forest Practices Rules to meet Clean Water Act requirements; all DNR operations meet or exceed Forest Practices Rules. DNR and the contractor writing the EIS will use informed science in evaluating potential water quality impacts.

Soil quality. DNR was encouraged to evaluate the causes of soil degradation and impacts to long-term soil productivity.

> ***Response:*** Soils and other physical components of the natural environment will be examined in the EIS [WAC 197-11-444(1)(a)]. Soils will likely be addressed in several sections, including earth resources (including erosion) and fish and wildlife habitat. Possible impacts on soil degradation and long-term soil productivity will be assessed.

Air quality. DNR was encouraged to evaluate the potential impacts of reduced carbon sequestration on air quality, and the burning of slash.

> ***Response:*** Potential impacts to air quality will be examined in the EIS [WAC 197-11-444(1)(b)].

Riparian Areas. DNR was encouraged to evaluate the potential impacts of logging, road building, and other forest management activities on riparian structure and function. Include impacts to all elements of habitat of native aquatic and terrestrial species.

> ***Response:*** Potential impacts to riparian areas will be examined in the EIS [WAC 197-11-444(1)(d)]. Forest management activities will be evaluated for impacts to riparian and upland habitat structure and function.

Sensitive Areas. Commenters asked DNR to examine potential impacts to unstable slopes and other sensitive areas and the benefits of no-cut buffers and wind buffers on unstable slopes.

> ***Response:*** Potential impacts to unstable slopes and other sensitive areas will be examined in the EIS [WAC 197-11-444(1)(a)]. Sensitive areas to be assessed for potential impacts include unstable slopes, riparian and wetland areas. Mitigation of adverse impacts to sensitive areas will be assessed.

Biodiversity, Wildlife Habitat and Species. DNR is asked to examine potential impacts to biodiversity, habitat (fragmentation), plant species, endangered species (including marbled murrelet), non-listed species (Roosevelt elk, black bear, bobcat, etc.), and fish habitat. Particular comments related to meeting the goals of the 1997 HCP and use of the best credible science in determining impacts.

> ***Response:*** Potential impacts to native plants, fish and wildlife, and their habitat will be examined in the EIS [WAC 197-11-444(1)(d)] for known sites. Additionally, conservation benefits will be assessed for the various alternatives in a separate process. Separate from the formal EIS process, DNR staff will analyze and provide the Board with information on how (according to the model) the alternatives will meet the objectives of the 1997 HCP. The assessment will help DNR evaluate the effectiveness of proposed HCP strategies for each alternative.

Cultural and Archeological Resources. DNR is asked to protect cultural and archeological resources from potential impacts of timber harvest activities, and classify such areas as "off base."

> ***Response:*** Potential impacts to cultural and archeological resources will be examined in the EIS [WAC 197-11-444(2)(b)]. Policy #24 (Identifying Historic Sites) in the Forest Resource Plan addresses DNR policy on the identification and preservation of cultural and archeological resources. In particular, DNR remains committed to working with tribal governments and continuing to develop and maintain effective programs for protecting areas of cultural significance.
>
> See also section on *Wetland Areas* (above).

Roads. DNR is asked to address the impacts of new roads, maintenance of old roads, and road decommissioning.

> ***Response:*** During the EIS process, potential impacts on a number of components of the natural and built environments resulting from road building, maintenance, and abandonment – or decommissioning – will be examined [WAC 197-11-444(1) and (2)].

Population. Commenters asked that DNR address the potential impacts due to population growth and conversion or development of DNR-managed lands, or those adjacent to DNR-managed lands.

> ***Response:*** The setting of sustainable harvest level will not have a significant impact on population growth; however, DNR anticipates that timber harvesting activities in close proximity to growing population centers could conflict with other land uses.

Cumulative impacts. DNR is asked to consider cumulative impacts across the landscape and within a watershed due to timber harvest practices, both past and present. There is an interest in DNR analyzing large-scale forest health on DNR-managed lands.

> ***Response:*** Potential cumulative impacts will be assessed in the EIS, consistent with the requirements of SEPA [WAC 197-11-060(4)(e)]. Large-scale forest health issues are included for examination of cumulative impacts. DNR recognizes the importance of examining potential cumulative impacts, and the complexity of assessing cumulative impacts across an area as sizable and diverse as western Washington, which obviously includes many landowners. DNR will be working with the EIS contractors to develop some strategies to assess how the differing EIS reasonable alternatives lead to different levels and types of impacts, including cumulative impacts.

Recreation. DNR is asked to examine the potential impacts to recreation, including integration with forest management, location of harvests relative to recreation areas, and differentiation between harmful and benign recreation uses. There is specific interest in adding hiking trails and maintaining their use in relation to harvest areas.

> ***Response:*** Potential impacts of proposed harvest level alternatives to the recreational use of state DNR-managed forests will be assessed in the EIS [WAC 197-11-444(2)(b)(v)]. However, recreation planning is outside the scope of this EIS, and will not be assessed.

Fire hazard. Requests were made for DNR to examine the impacts of the timber harvest level on fire management and fire danger reduction. Using science, commenters want DNR to address restoring fire to ecosystem, and communicate this information to the public.

> ***Response:*** Potential impacts of proposed alternatives on fire management and fire danger reduction will be assessed in the EIS [WAC 197-11-444(2)(d)]. Though the sustainable harvest calculation for western Washington will not include the use of fire to promote ecosystem health, the EIS will evaluate the extent to which management strategies in alternatives may impact catastrophic wildfires in DNR-managed forests.

Aesthetics. Some commenters asked that DNR consider impacts to scenic values, including size and shape of clear-cuts and their location relative to highways. Others did not want viewsheds to be considered.

> ***Response:*** Potential scenic and aesthetic impacts of proposed alternatives will be assessed in the EIS [WAC 197-11-444(1)(e)(v) and (2)(b)(iv)]. The sustainable harvest calculation will not include site-specific harvest plans that can be evaluated for their scenic impacts. Alternatives may, however, include different patterns of harvest at a landscape level, and such potential impacts will be assessed.

ANALYSIS OF SELECTED FINANCIAL AND ECONOMIC IMPACTS

Wood Products Market. Commenters want a predictable, dependable amount of raw material for mills, perhaps taking into account private timber and its impact on local mills. Some commenters believe that changes in harvest levels have an impact on customer base and that DNR should consider wood product markets for Forest Stewardship Council certified wood products, hardwoods, and exports. Still others believe that continued population growth is not a good indicator of consumption patterns.

> ***Response:*** The wood products market and DNR's role in the market will be studied to some degree. Alternatives will be examined to assess likely marketable products. A market analysis will be presented to the Board as part of the information they are given to help choose a preferred alternative.

Log Size Market. Considerable disagreement exists about the market for larger diameter logs, both now and in the future. Some express concerns that DNR reflect an inventory in the computer model of the current log market of less than 25-inch diameter trees, while others foresee DNR helping to retain a large diameter log market, effectively cornering the market, while lowering operation costs (associated with thinning).

> ***Response:*** As the manager of the state trust lands, it is DNR's responsibility is to protect the trusts, and to provide options for current and future trust revenue production. DNR cannot predict with confidence what will happen to log markets or the future ability of mills to process large-diameter logs. However, DNR has an interest in future markets.
>
> DNR will consider the range of alternatives run through the EIS process with respect to the products market, as it exists today, with some basic assumptions about future markets. The Board will receive this analysis as part of the information they are given to choose a preferred alternative.

Analysis of Financial Return to the Trusts. Commenters suggest that DNR analyze the economic, social, and ecological health impacts to forests to determine the impacts (present and future) from the different scenarios. Commenters want a clear discussion in the EIS of analytical assumptions, costs and benefits of scenarios in dollars, including discount rates (positive and negative proposed) used within net present value (NPV) calculations and opportunity costs of various constraints (including sensitivities to shadow costs). Commenters suggest using the Washington Investment Board's recommended discount rate and prepare alternative price scenarios for review by policy makers; in comparing rotational ages, evaluate short and long term financial impacts, including management costs; suggest using biodiversity pathways to compare increases in habitat and rotation age on timber returns; examine overhead costs of operations.

> ***Response:*** As stated above, analyses of financial and economic impacts will include an examination of forest and tree harvest policy alternatives and their potential impacts on returns to the trusts. A range of discount rates may be given to the Board as part of NPV calculations. The Board will receive this analysis as part of the information they are given to help choose a preferred alternative.

Social, Financial and Economic Consequences
General. Commenters want an analysis to consider social benefits along with short and long-term benefits and include indirect and external costs, using best available science.
Costs of Harvest. Commenters are concerned with the regional differences in harvest levels. Commenters want DNR to consider economic impacts of timber harvest on recreation, local economy, adjacent property values, and rural communities generally. Others want DNR to recognize the total costs of harvest (such as recovery of sediment-damaged streams), the costs of restoration and flood control, and the economic value of non-timber resources. There are others who are concerned that DNR will not have enough money to manage within the current state budget.

> ***Response:*** DNR is interested in looking at the social, financial and economic consequences of different harvest levels. Analysis will be restricted, however, to an assessment of primary impacts (i.e. financial returns to the trusts from land management). Analysis of secondary and other indirect effects, such as those to rural communities and impacts to services provided by trust beneficiaries (the counties or schools, for instance) will be discussed in terms of their potential environmental impact in the EIS [WAC 197-11-444(2)(d)].

Social and Economic Consequences – Costs of Endangered Species Recovery. DNR is asked to analyze the costs of protecting watersheds and the recovery of threatened and endangered species and its impact on rural communities that are now suffering economic hardship.

> ***Response:*** DNR is interested in the environmental, social, financial and economic consequences of harvest on endangered species recovery. The HCP was created to provide habitat to assist in the recovery of Endangered Species Act listed species (e.g., the northern spotted owl and marbled murrelet), and to minimize risks to the trusts associated with ESA compliance.
>
> However, analysis of costs associated with the recovery of threatened and endangered species and impacts on rural communities is outside the scope of the EIS.

Alternative Sources of Trust Revenue.
General. Some commenters want DNR to consider non-harvest forest products, while others don't want DNR to set aside land to be unavailable for timber harvest in the future. Others would pay higher taxes to replace timber revenue rather than see forests managed unsustainably.
Recreation. Commenters want DNR to consider and clearly understand tradeoffs between managing the forest for recreational revenues vs. managing to maximize timber harvest revenue. Some suggest user fees for recreational use, while others oppose more fees for recreation. Others are concerned that recreational fees will not generate enough money for trust beneficiaries to replace timber harvest.
Carbon Sequestration. Some suggest that carbon sequestration should be analyzed because it could be a significant revenue producer. Analyze carbon sequestration from a young forests vs. old forests standpoint, as young forests sequester more carbon.
Certification. Consider forest certification as a way to increase revenue.
Other Sources. Commenters want DNR to consider other funding sources, including creative leasing, no-interest bonds, industrial hemp farming, development of wind power, biomass conversion and co-generation, and having schools raise their own funding. Others would like a

discussion of the economic impacts of expanded special forest products and small wood utilization.

> ***Response:*** DNR will examine alternative sources of trust revenue as part of its analysis. Also considered for examination are some "opportunity costs" associated with timber harvest – forgone revenue from alternative potential forest revenue sources. Revenue from sources including recreation (fees), the carbon credit market, and any premium for certified wood may be examined as alternatives sources of income to compare against timber harvest.
>
> Impacts outside DNR's purview (school construction, tax structure, and agriculture) will not be considered. DNR will use net present value analysis to evaluate alternative sources of trust revenue. Any decision to pursue alternative sources of trust revenue is at the discretion of the Board or state legislature.

B. ISSUES AND CONCERNS WITHIN BOARD OF NATURAL RESOURCES AND DNR'S PURVIEW, BUT OUTSIDE THIS SUSTAINABLE HARVEST CALCULATION ACTION

Forest Certification. Commenters want the Washington State Department of Natural Resources to be a national leader and to pursue forestry certification through Forest Stewardship Council, Sustainable Forestry Initiative, or development of a DNR self-certification process.

> ***Response:*** DNR is committed to managing the state's trust lands with high environmental and business standards. The Board has indicated that, in a process separate from the determination of a sustainable harvest level, it will address certification. Proceeding in this manner will not foreclose on the Board's option to pursue certification in the future.

Recreation Planning. Commenters would like to see the forests used for recreation through better planning that identifies economic benefits and cost of recreation use.
Commenters would like to have buffered trails. Some are concerned with the environmental costs of off road vehicle (ORV) use, while others want more ORV trails and campgrounds. Still other commenters suggest that DNR-managed lands be opened up to privately maintained ORV areas.

> ***Response:*** Forest Resource Plan policy #29 addresses the issue of recreation on state DNR-managed forests, which historically are open to the public through state law and long-standing DNR policy. DNR carries out recreation planning using funding from a grant program through the Inter-Agency Committee for Outdoor Recreation. (For example, Capitol State Forest recreation planning currently underway has a volunteer citizen advisory group that represents many different recreational interests)
>
> In addition, several initiatives are underway to address recreation and public access issues. A task force — comprised of leaders from state agencies (state Parks and Recreation Department, state Department of Fish and Wildlife, and DNR) and state legislators — has been created to seek a better balance of public and commercial (trust) uses of DNR-managed lands. In addition, the Commissioner of Public Lands has proposed the creation of a new land trust to fund public access on state lands. Lastly, DNR strategic planning is examining ways to implement public trails on DNR-managed lands.

Public Access. Some commenters want public access closures to be considered, because of the negative environmental impacts, while others want more access and limited access on roads.

> ***Response:*** Forest Resource Plan policy #25 allows public access for multiple uses on state forest lands. In certain circumstances, DNR will control vehicular or other access, but only where necessary to accomplish specific management objectives. Public access may be limited to protect public safety, to prevent theft, vandalism and garbage dumping, to protect soils, water quality, plants and animals, or to meet other objectives identified in the Forest Resource Plan.

The "multiple use concept" (RCW 79.68.010) allows public use of DNR-managed forests when compatible with management activities and when it does not damage resources or interfere with trust management responsibilities.

Community Involvement. Commenters are concerned about the impact of recreational users on adjacent private property owners. They say that recreational use should be compatible with adjacent landowner concerns and there should be a policy to address this issue.

Response: DNR is also concerned with the potential impact to adjacent landowners from recreational activities on DNR-managed lands. DNR incorporates community involvement when planning for recreational use on DNR-managed state lands. The DNR has a 'stewardship' philosophy. As stewards of the land, DNR safeguards the natural and scenic value of the trust lands, including protecting against the impacts of land use activities on adjacent property owners. Planning activities are the responsibility of the DNR regions; specific concerns should be addressed to specific DNR regions.

Public Education. Commenters believe that the general public needs to be educated on the constraints used to determine timber harvest levels.

Response: DNR staff is aware that many levels of understanding exist regarding forest management activities in state DNR-managed forests. A greater public understanding of the process and DNR's responsibilities will likely be one of the outcomes of the extensive public involvement processes that is part of the sustainable harvest calculation. In addition, DNR will continue to work with the public through various forms of public outreach.

Research. Commenters are concerned with the lack of DNR biologists and geologists, and suggest hiring more. Still others suggest that state DNR-managed forests should foster forestry research on management practices, Cooperative Monitoring Evaluation and Research (CMER), and related data collection. A commenter also suggests DNR examine the role of DNR-managed state land in providing corridors of low elevation forest creating a link from saltwater up to old-growth forests on federal lands.

Response: DNR has a diverse staff representing a broad range of technical expertise, including biologists and geologists. In addition, DNR is committed to working closely with specialists in other organizations and agencies such as the Washington Department of Fish and Wildlife. The Department's objective is to make forest management decisions based on sound science and currently available information. According to the Multiple Use Concept, state forest lands are maintained and managed for a variety of uses, including research. However, DNR does not have the resources or the legal mandate to research all issues common to land management, independent of ownership.

Asset Stewardship. There are a number of commenters who want DNR to maintain the state land base intact (without further sale or exchange of lands). Others thought the state should sell or trade state-owned environmentally sensitive lands to the highest bidder. Commenters are interested in DNR terminating grazing leases in eastern Washington.

Response: As provided by law and trust mandate, DNR uses a variety of tools to create trust revenue. The Trust Land Transfer allows DNR to transfer to other owners assets with unique ecological or public value. Trust lands with low productivity (due, for example, to poor soils or site class), or high management may be exchanged or sold. If transferred or sold, replacement properties of higher long-term value to the trusts are purchased. Repositioning also occurs via land exchange or land sales. These are Board-approved activities, and are dealt with in separate processes from the sustainable harvest calculation.

Site Specific Concerns. Commenters had concerns about site-specific DNR-managed trust lands, including Lake Whatcom, Loomis, Burnt Hill, Blanchard Mountain and the Upper Hoh River.

> ***Response:*** The sustainable harvest calculation currently being undertaken includes the 1.4 million-acre landscape of DNR-managed forests west of the Cascade Crest. Specific and localized management decisions will not be addressed as part of the sustainable harvest calculation EIS. It should be emphasized that the sustainable harvest calculation is not a harvest schedule planning process – it is not a tactical planner that identifies individual timber sales. The calculation is a policy simulation tool that is used to assess policy implications of various alternatives. Once approved by the BNR, the results set the broad landscape-scale harvest level for the next decade. It will include no site-specific plans for the areas mentioned, or any other land blocks. DNR regional staff addresses planning for the aforementioned state forest blocks in separate planning processes.

Timber harvest calculation for Eastern Washington DNR-managed forests. Commenters want the eastside calculation done as soon as possible and to consider forest health issues to determine the sustainable yield level.

> ***Response:*** DNR plans to develop the sustainable harvest calculation for eastern Washington DNR-managed forests after the completion of the western Washington calculation. Once DNR has compiled the data necessary for the eastside calculation, work on it will begin. As with the current westside effort, forest health issues will be addressed in the determination of a sustainable harvest level.

Forest Resource Plan – Tribal Policy. Commenters asked for tribal government-to-government relationship to implement the Forest Resource Plan policies

> ***Response:*** DNR is committed to a respectful government-to-government relationship when working with tribal governments. DNR works with tribes to implement goals identified in the Forest Resource Plan, including the sustainable harvest calculation.

Other Issues. Commenters want timber sales auction prices to be inclusive of all costs; find alternative funding to pay for the protection of drinking water resources on DNR-managed state lands; reintroduce fire in ecosystems; consider grazing in Natural Resources Conservation Areas; start another experimental forest (such as the Olympic Experimental State Forest) based on stakeholder management; and stop hunting in certain areas of the forest.

> ***Response:*** A number of DNR programs work to address the above issues within their responsibilities. DNR remains committed to working with the public and stakeholders to create innovative programs to better manage our state lands while fulfilling DNR's legal responsibilities.

DNR is interested in comments on the management of the forests in its care. However, these issues are not within the scope of the sustainable harvest calculation.

C. ISSUES AND CONCERNS THAT FALL OUTSIDE BOARD OF NATURAL RESOURCES AND DNR PURVIEW

Rural community economics. Consider timber harvest levels on DNR-managed state trust lands and their secondary and indirect impacts on rural communities. In particular, examine impacts from changes to harvest levels on employment, community stability etc. Commenters want the model to incorporate impacts on rural communities, such as non-extractive forest uses.

> ***Response:*** DNR and the Board's duty is the long-term interests of the trusts, which benefit the local communities in many ways. However, the secondary impacts of harvest levels are outside of the purview of the sustainable harvest calculation process. DNR and the Board will assess primary financial and economic impacts of DNR actions relating to setting a sustainable harvest level.

Greater Washington State economy. Commenters want DNR's role examined in the context of stability of the state economy and school funding. Commenters also expressed a concern about positive impacts on growing economy as a result of a healthy environment (company relocation, tourism), and encouraged making decisions that meet the needs of citizens, not corporations.

> ***Response:*** The DNR has limited statutory or constitutional authorities that are largely focused on management for the specific and direct benefit to the trust beneficiaries. DNR manages trust lands with that responsibility as its guiding principle.

National and global context. Examine the impacts of the sustainable harvest level for DNR-managed forests on the global economy, global wood products market, global impacts of using alternatives to wood products (particularly as it relates to the use of fossil fuels). Also look at global environmental impacts, such as the impact of timber harvested unsustainably in other countries.

> ***Response:*** DNR is not able to assess effects of DNR actions on global markets, impacts, or trends, nor can it guide its actions based on those factors. Since harvest on DNR-managed lands is small relative to domestic and global wood consumption, recalculation of the sustainable harvest level is unlikely to have a discernable effect on the global economy or global wood products market.

State and Federal Legislative. Some commenters said DNR should eliminate the export ban or support the export ban, remove the tie between school construction funding and trust land timber harvest and identify other sources to replace that funding, create a law to protect old growth, and educate the public about relationship between harvest level and higher taxes.

> ***Response:*** The export ban is federal legislation. DNR is not in the position of determining state or federal legislative actions. DNR has provided significant protection of older forests through carrying out objectives of the Forest Resource Plan, and using the Trust Land Transfer program.

Other Issues. There is interest in DNR's role in county and municipal planning, recreation outside of trust lands, assessing impacts on all lands, education of the public on behalf of the forest industry, public school design and administration, the Growth Management Act, and climate change.

Response: These issues are beyond the scope of the EIS and the sustainable harvest calculation.

Appendix B
Modeling Process and Results

Appendix B

B. MODELING PROCESS AND RESULTS

TABLES

FIGURES

Appendix B

B.1 MODELING RESULTS

This section provides sustainable forest management modeling results for western Washington forested state trust lands managed by the Washington State Department of Natural Resources (DNR).

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Appendix B

DRAFT Reference Materials for July 6, 2004

Amended July 7, 2004

Sustainable Forest Management Modeling Results

For the
Board of Natural Resources

July 6, 2004
Washington Department of Natural Resources
1111 Washington St. SE
PO Box 47016
Olympia WA 98504-7016

Contents: Comparison of Alternatives

[1] County-specific data for the Forest Board Trust will be completed shortly

Changes in Forest Structure

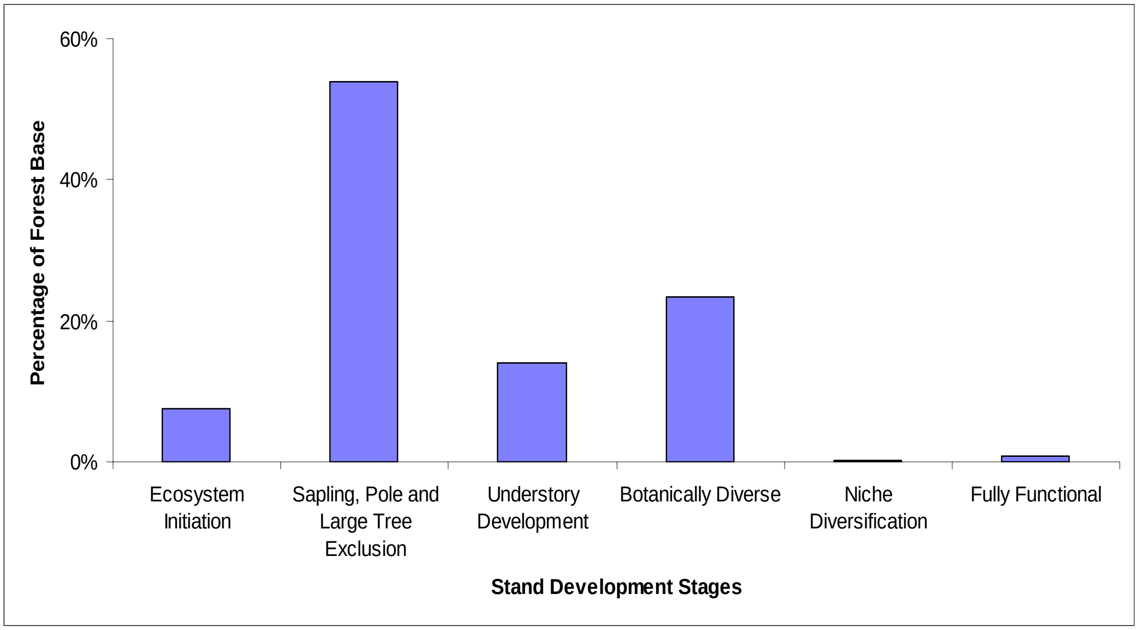


Figure B.1-1. Estimated Forest Structure in 2004

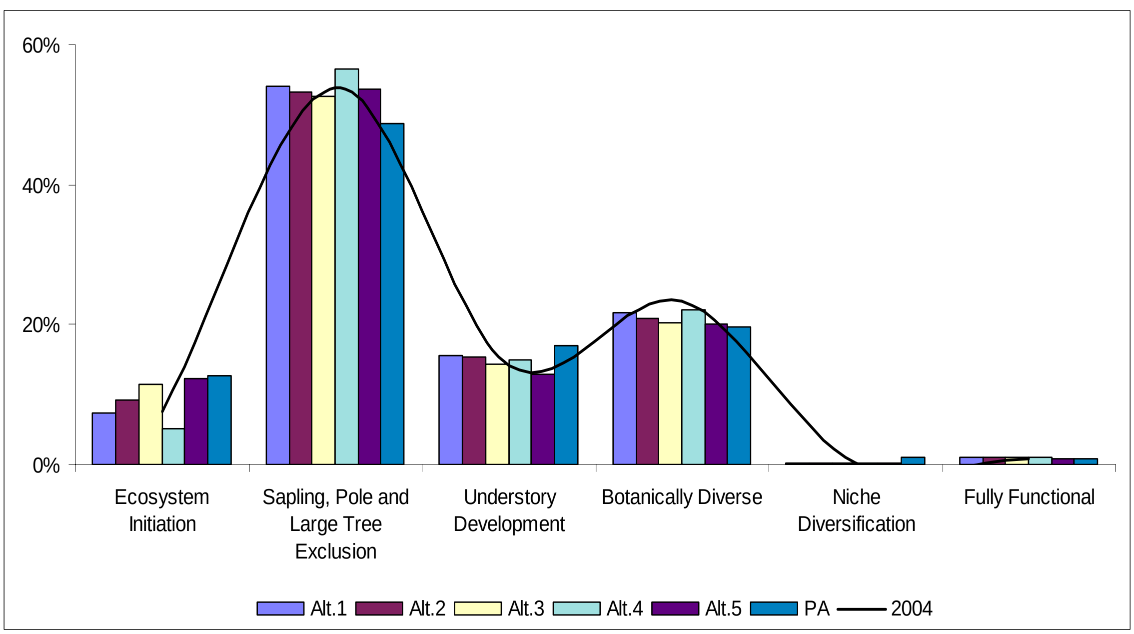


Figure B.1-2. Estimated Forest Structure in 2013

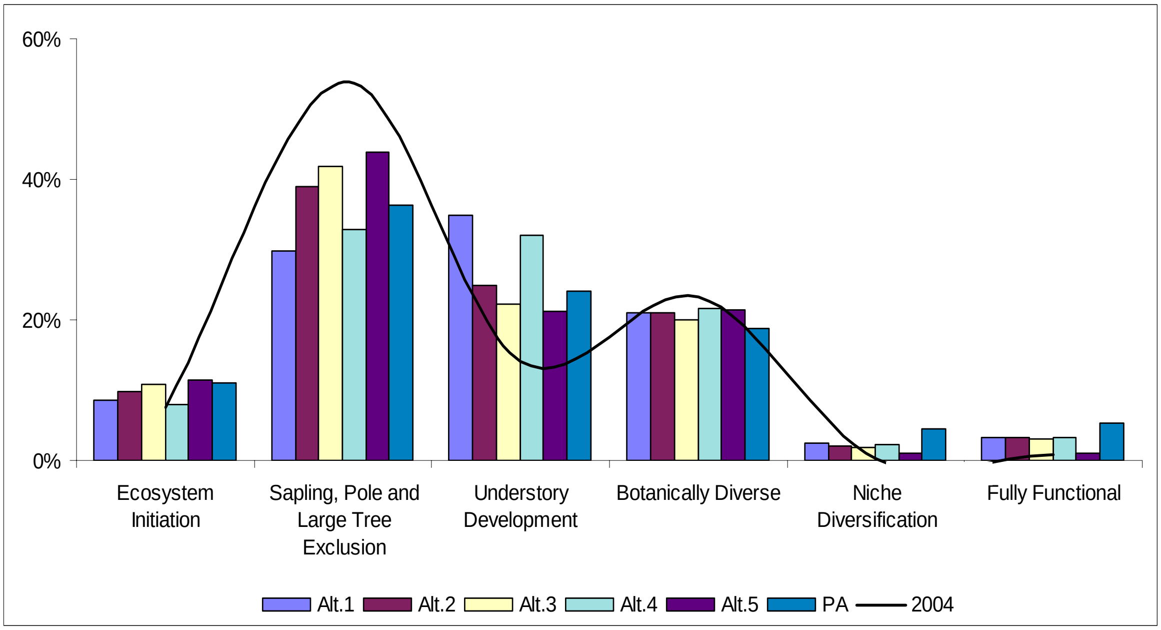


Figure B.1-3. Estimated Forest Structure in 2067

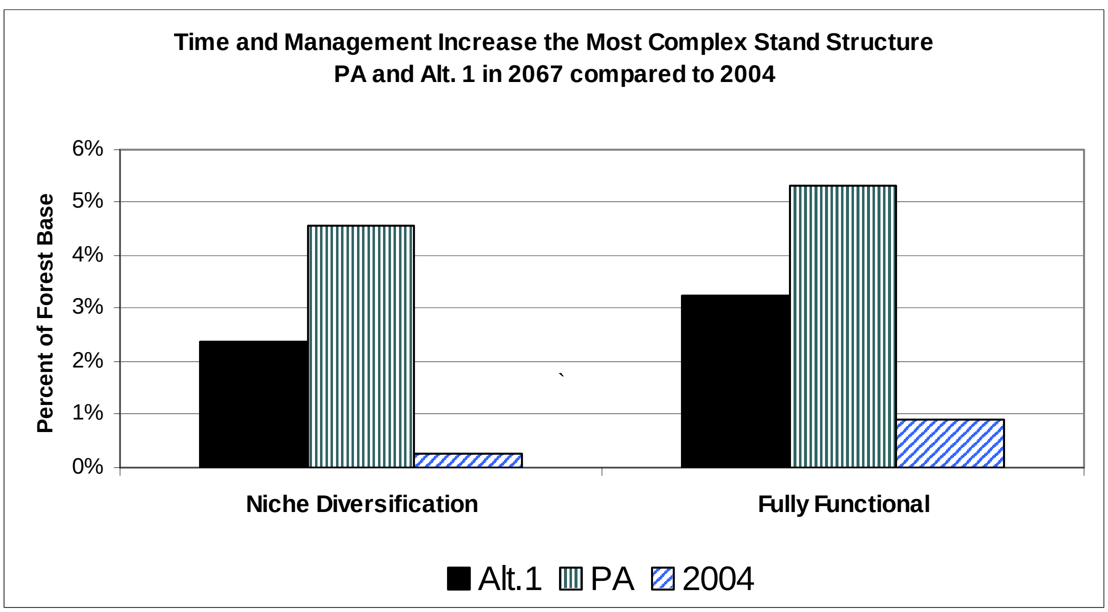


Figure B.1-4. Most Complex Stand Structure Comparison (2067 versus 2004)

Appendix B

Changes in Inventory

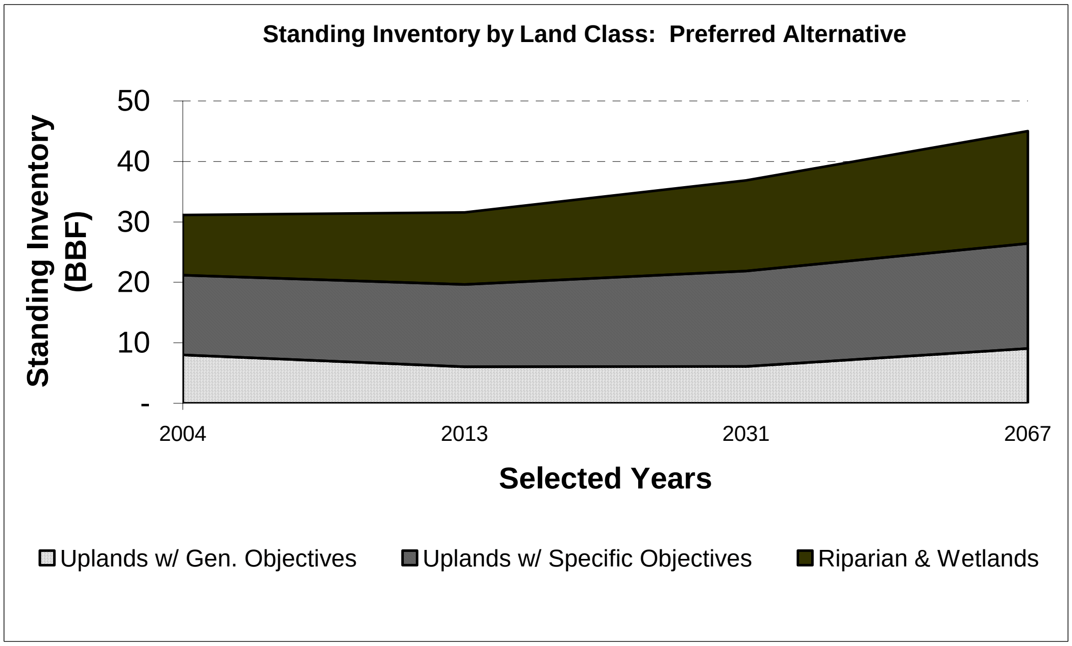


Figure B.1-5. Standing Inventory by Land Class for the Preferred Alternative

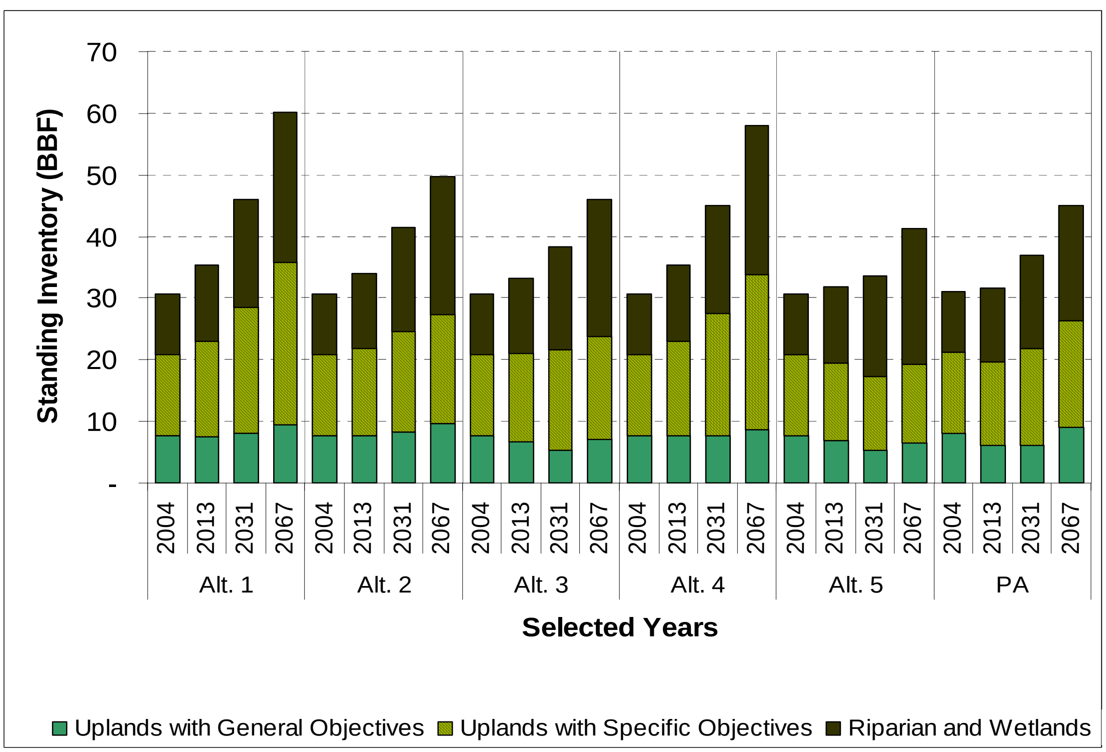


Figure B.1-6. Changes in Standing Volume by Alternative

Table B.1-1. On and Off-base Acres

				On-Base					
Year	**Alternative**	**Off-base**		**Riparian and Wetland area**		**Uplands with Specific Objectives**		**Uplands with General Objectives**	
		acres	%	acres	%	acres	%	acres	%
2004	Alt.1	763,000	55%		0%	322,500	23%	305,200	22%
	Alt.2	489,300	35%	214,800	15%	343,100	25%	343,500	25%
	Alt.3	514,400	37%	238,600	17%	328,100	24%	309,600	22%
	Alt.4	755,500	54%		0%	326,400	23%	308,800	22%
	Alt.5	513,400	37%	238,700	17%	329,600	24%	309,000	22%
	PA	515,500	37%	237,800	17%	327,800	24%	309,600	22%
2013	Alt.1	736,600	53%		0%	348,400	25%	305,700	22%
	Alt.2	281,100	20%	278,100	20%	477,200	34%	354,200	25%
	Alt.3	213,000	15%	346,200	25%	477,200	34%	354,200	25%
	Alt.4	573,400	41%		0%	463,500	33%	353,800	25%
	Alt.5	213,000	15%	346,200	25%	477,200	34%	354,200	25%
	PA	232,100	17%	329,000	24%	475,400	34%	354,200	25%

Harvest and Financial Data

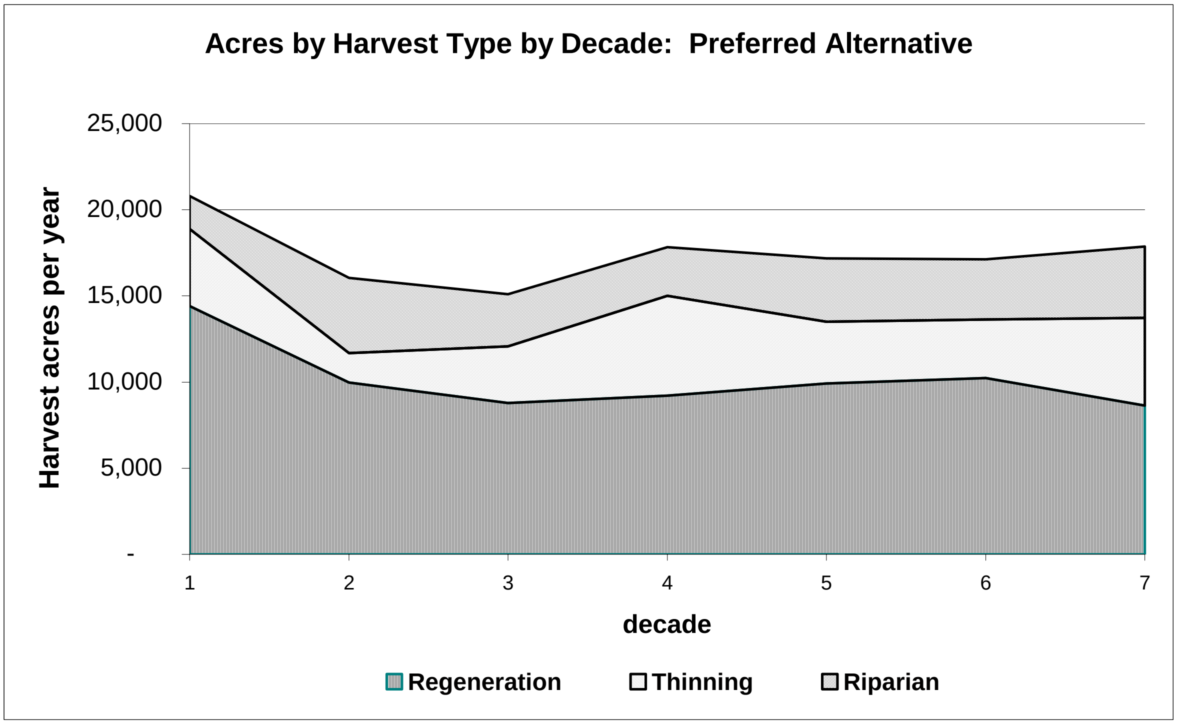


Figure B.1-7. Acres by Harvest Type for the Preferred Alternative

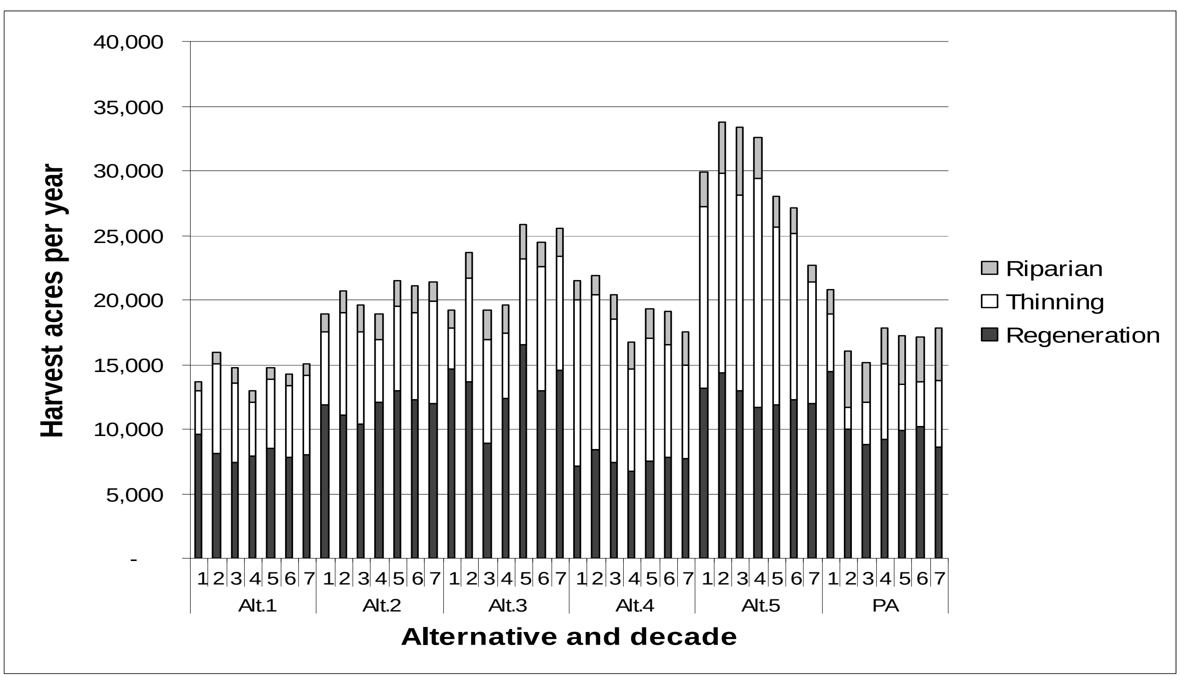


Figure B.1-8. Harvests by Type by Alternative for 7 Decades

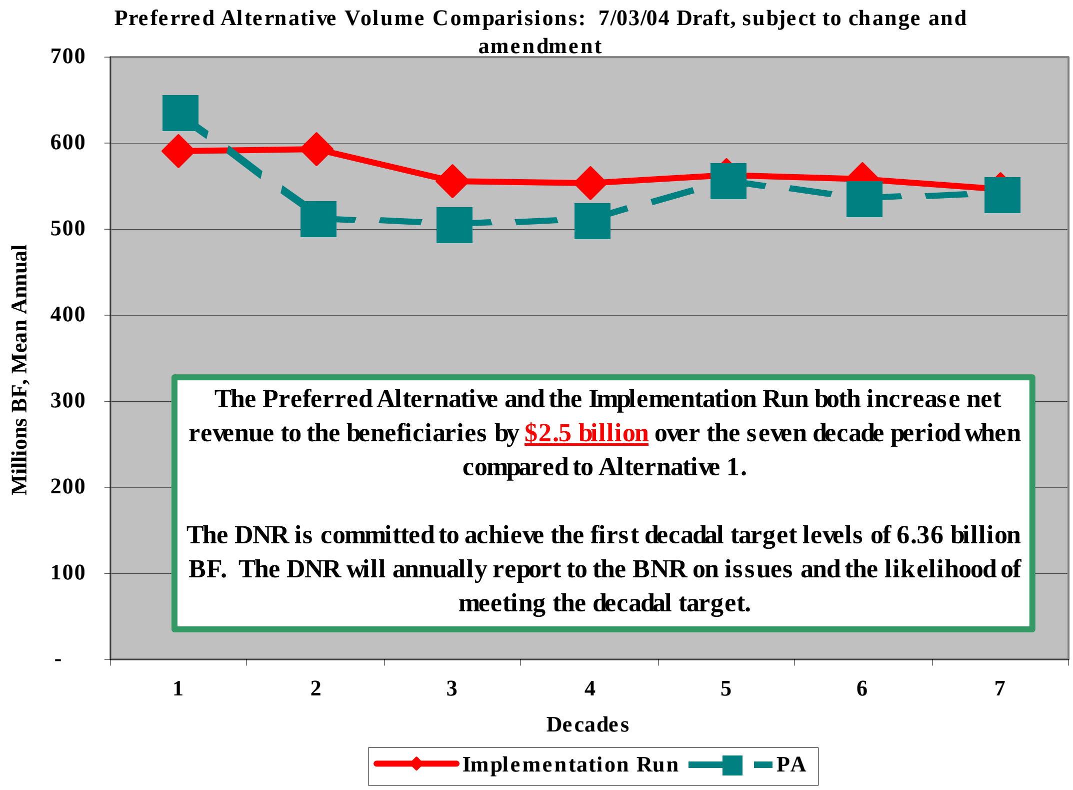
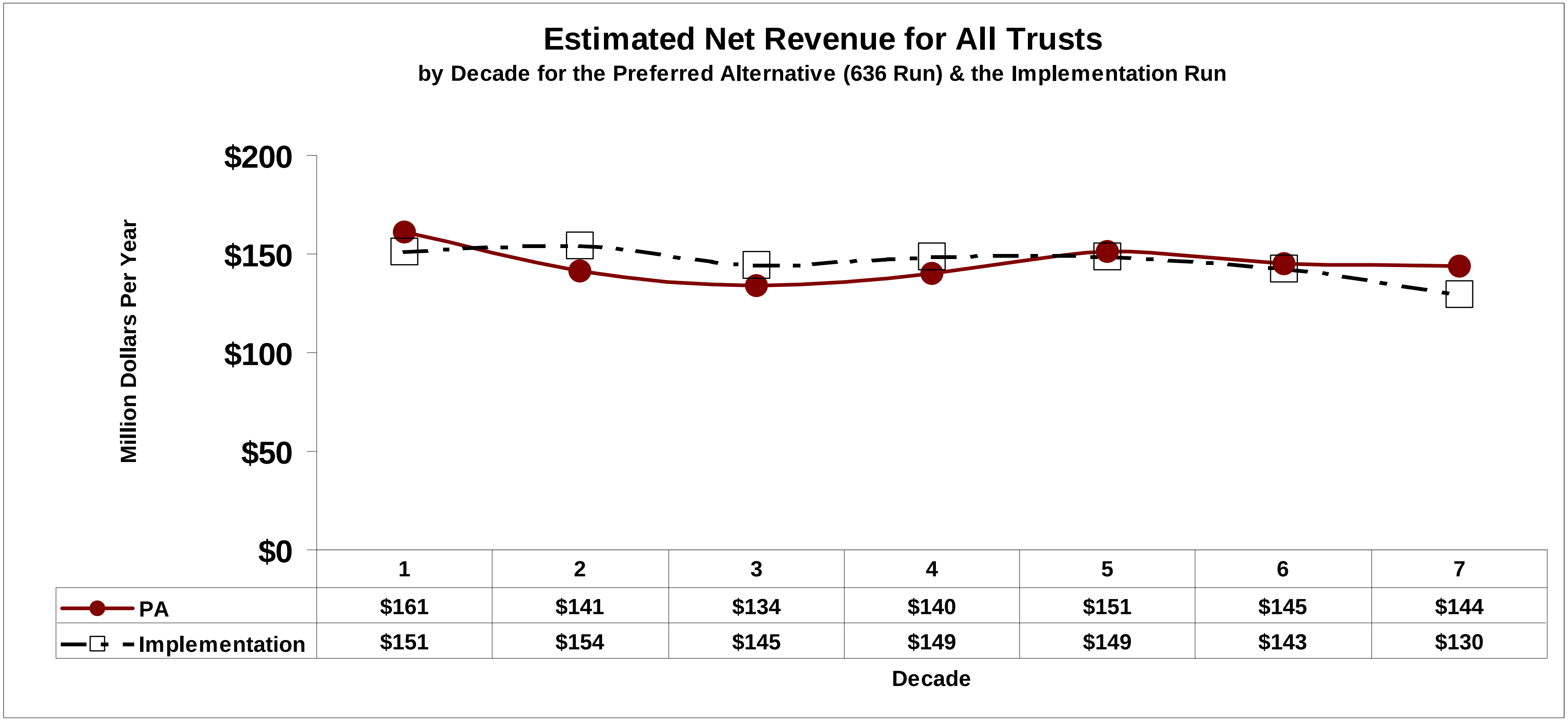


Figure B.1-9. Preferred Alternative Volume Comparisons

Table B.1-2. Net Returns to the Beneficiaries, a Comparison of the Preferred Alternative to Alternative 1

Net Revenue to Beneficiaries: Preferred Alternative and Alternative 1 All dollars in millions					
	Comparison of Annual Differences			Cumulative Decadal Difference	
Time Period	**Alt. 1**	**Preferred Alternative (PA)**	**Implementation Run**	**PA – Alt. 1**	**Implementation – Alt. 1**
1st Decade	$121.2	$161.0	$151.4	$397	$302
7 Decade Average	$109.7	$145.2	$145.7	$355	$360
Increase in net revenue to the beneficiaries over a 7 decade period				**$2,481**	**$2,520**



	1	2	3	4	5	6	7
PA	$161	$141	$134	$140	$151	$145	$144
Implementation	$151	$154	$145	$149	$149	$143	$130

Figure B.1-10. Preferred Alternative Net Revenue Comparisons

Table B.1-3. Gross and Net Revenue Comparison over 7 Decades: All Trusts for Selected Alternatives

All Trusts: All Values in Millions: PA = Preferred Alternative

Gross Revenue	**Alternative**			**Decadal Differences**	**Decadal Differences**
Decadecut	**Alt. 1**	**PA**	**Implementation**	**PA- Alt. 1**	**Implementation - Alt. 1**
1	$166	$219	$208	$529	$412
2	$158	$194	$209	$352	$504
3	$152	$183	$196	$310	$432
4	$154	$191	$201	$375	$472
5	$149	$205	$202	$559	$536
6	$147	$199	$197	$516	$495
7	$146	$196	$181	$501	$352
7 Dec. Avg.	$153	$198	$199		

Net Revenue	**Alternative**			**Decadal Differences**	***Decadal Differences***
Decadecut	**Alt. 1**	**PA**	**Implementation**	**PA- Alt. 1**	**Implementation - Alt. 1**
1	$121	$161	$151	$397	$302
2	$114	$141	$154	$270	$398
3	$109	$134	$145	$245	$353
4	$110	$140	$149	$297	$383
5	$106	$151	$149	$451	$431
6	$104	$145	$143	$410	$383
7	$103	$144	$130	$410	$271
7 Dec. Avg.	$110	$145	$146		

7 Decade Cumulative Increase in Net Revenue to Beneficiaries

PA- Alt. 1	**Implementation - Alt. 1**
$2,481	**$2,521**

Table B.1-4. Net Revenue to Beneficiaries: A Summary Comparison for All Trusts

Trust ***All Values in Millions of Net Dollars to the Beneficiaries***

Trust	Net Revenue	Annual Values by Alternative			Decadal Differences	
	Decadecut	**Alt. 1**	**PA**	**Implementation**	**PA- Alt. 1**	**Imple. - Alt. 1**
Total for	1	$121.2	$161.0	$151.4	$397.3	$301.7
	2	$114.3	$141.3	$154.1	$270.0	$397.9
	3	$109.2	$133.8	$144.6	$245.3	$353.3
	4	$110.5	$140.2	$148.8	$297.0	$382.8
	5	$106.0	$151.0	$149.1	$450.8	$431.1
	6	$104.3	$145.3	$142.6	$410.4	$383.1
	7	$102.7	$143.7	$129.7	$410.3	$270.7
All Trusts	7 Decade Avg.	$109.7	$145.2	$145.7	$354.4	$360.1

7 Decade Cumulative Increase in Net Revenue to Beneficiaries

PA- Alt. 1	***Imple. - Alt. 1***
$2,481.1	***$2,520.6***

The Preferred Alternative substantially increases net revenue to the beneficiaries.
Compared to Alternative 1, the Preferred Alternative will increase net revenue by about $2.5 billion over the seven decade period.
This number reflects all projected costs assumed in the model. All alternatives have costs greater than 25%.

Table B.1-5. Net Revenue to Beneficiaries: A Summary Comparison for Individual Trusts

All Values in Millions of Net Dollars to the Beneficiaries

Trust	Net Revenue	Annual Values by Alternative			Decadal Differences	
	Decadecut	Alt. 1	PA	Implementation	PA- Alt. 1	Imple. - Alt. 1
Agricultural School	1	$2.7	$3.8	$3.7	$11.0	$9.4
	2	$2.4	$4.2	$3.9	$17.9	$15.0
	3	$1.8	$3.1	$3.8	$13.1	$19.8
	4	$2.0	$3.5	$3.3	$14.7	$12.6
	5	$1.7	$2.6	$2.7	$9.6	$10.4
	6	$2.0	$3.6	$3.5	$15.6	$15.2
	7	$1.6	$2.7	$2.7	$10.8	$11.0
	7 Decade Avg.	$2.0	$3.4	$3.4	$13.3	$13.4

7 Decade Cumulative Increase in Net Revenue to Beneficiaries

PA- Alt. 1	Imple. - Alt. 1
$92.8	$93.5

All Values in Millions of Net Dollars to the Beneficiaries

Trust	Net Revenue	Annual Values by Alternative			Decadal Differences	
	Decadecut	ALT1	PA	Implementation	PA- Alt. 1	Imple. - Alt. 1
Capitol Grant	1	$8.7	$12.3	$11.9	$36.3	$32.3
	2	$6.7	$8.7	$9.0	$19.8	$23.4
	3	$5.5	$7.6	$7.9	$21.1	$24.1
	4	$5.4	$7.8	$8.0	$23.8	$25.1
	5	$5.0	$7.7	$6.9	$26.3	$19.1
	6	$4.7	$10.1	$10.8	$54.1	$61.2
	7	$4.9	$8.8	$7.7	$39.0	$27.4
	7 Decade Avg.	$5.9	$9.0	$8.9	$31.5	$30.4

7 Decade Cumulative Increase in Net Revenue to Beneficiaries

PA- Alt. 1	Imple. - Alt. 1

Table B.1-5. Net Revenue to Beneficiaries: A Summary Comparison for Individual Trusts (continued)

All Values in Millions of Net Dollars to the Beneficiaries

Trust	Net Revenue	Annual Values by Alternative			Decadal Differences	
	Decadecut	Alt. 1	PA	Implementation	PA- Alt. 1	Imple. - Alt. 1
CEP & RI	1	$5.0	$5.9	$5.8	$9.0	$7.6
	2	$4.0	$4.7	$4.9	$7.4	$9.5
	3	$3.4	$3.9	$4.1	$5.2	$7.5
	4	$3.9	$4.0	$4.1	$0.7	$1.9
	5	$3.2	$4.2	$3.8	$10.3	$6.3
	6	$3.4	$5.2	$5.4	$18.0	$20.0
	7	$3.0	$4.5	$4.5	$15.5	$15.9
	7 Decade Avg.	$3.7	$4.6	$4.7	$9.4	$9.8

7 Decade Cumulative Increase in Net Revenue to Beneficiaries

PA- Alt. 1	Imple. - Alt. 1
$66.0	$68.7

Table B.1-5. Net Revenue to Beneficiaries: A Summary Comparison for Individual Trusts (continued)

All Values in Millions of Net Dollars to the Beneficiaries

Trust	Net Revenue	Annual Values by Alternative			Decadal Differences	
	Decadecut	ALT1	PA	Implementation	PA- Alt. 1	Imple. - Alt. 1
Comn Schl & Indem	1	$50.2	$65.2	$63.0	$150.1	$127.8
	2	$48.8	$63.9	$67.7	$150.3	$189.0
	3	$48.8	$62.4	$63.8	$136.6	$150.3
	4	$49.6	$66.0	$67.9	$164.0	$183.3
	5	$49.4	$74.2	$73.1	$247.9	$237.5
	6	$46.8	$63.5	$62.3	$167.0	$155.2
	7	$48.0	$64.9	$59.1	$168.8	$110.8
	7 Decade Avg.	$48.8	$65.7	$65.3	$169.2	$164.9
					7 Decade Cumulative Increase in Net Revenue to Beneficiaries	
					PA- Alt. 1	Imple. - Alt. 1
					$1,184.7	$1,154.0

All Values in Millions of Net Dollars to the Beneficiaries

Trust	Net Revenue	Annual Values by Alternative			Decadal Differences	
	Decadecut	ALT1	PA	Implementation	PA- Alt. 1	Imple. - Alt. 1
Community College	1	$0.3	$0.2	$0.1	-$1.1	-$1.7
	2	$0.6	$0.8	$0.7	$1.7	$1.6
	3	$0.1	$0.5	$0.7	$4.4	$5.5
	4	$0.6	$0.7	$0.7	$0.6	$0.8
	5	$0.3	$0.2	$0.1	-$1.1	-$1.4
	6	$0.2	$0.2	$0.2	$0.4	$0.3
	7	$0.8	$0.7	$0.7	-$0.8	-$1.1
	7 Decade Avg.	$0.4	$0.5	$0.5	$0.6	$0.6
					7 Decade Cumulative Increase in Net Revenue to Beneficiaries	
					PA- Alt. 1	Imple. - Alt. 1
					$4.1	$4.0

Table B.1-5. Net Revenue to Beneficiaries: A Summary Comparison for Individual Trusts (continued)

Trust ***All Values in Millions of Net Dollars to the Beneficiaries***

Trust	Net Revenue	Annual Values by Alternative			Decadal Differences	
	Decadecut	ALT1	PA	Implementation	PA- Alt. 1	Imple. - Alt. 1
Escheat	1	$0.4	$0.3	$0.3	-$0.8	-$0.9
	2	$0.2	$0.3	$0.3	$1.4	$1.5
	3	$0.3	$0.3	$0.3	$0.5	$0.4
	4	$0.1	$0.5	$0.5	$3.5	$3.7
	5	$0.3	$0.5	$0.5	$1.2	$1.2
	6	$0.2	$0.2	$0.3	$0.7	$1.6
	7	$0.3	$0.2	$0.1	-$1.8	-$2.5
	7 Decade Avg.	$0.3	$0.3	$0.3	$0.7	$0.7

7 Decade Cumulative Increase in Net Revenue to Beneficiaries

PA- Alt. 1	Imple. - Alt. 1
$4.6	$5.0

Table B.1-5. Net Revenue to Beneficiaries: A Summary Comparison for Individual Trusts (continued)

Trust ***All Values in Millions of Net Dollars to the Beneficiaries***

Trust	Net Revenue	Annual Values by Alternative			Decadal Differences	
	Decadecut	ALT1	PA	Implementation	PA- Alt. 1	Imple. - Alt. 1
Normal School	1	$1.8	$2.3	$2.2	$5.0	$4.0
	2	$1.3	$2.2	$2.6	$8.7	$12.5
	3	$2.1	$2.9	$2.9	$8.8	$8.3
	4	$1.9	$2.5	$2.6	$5.6	$6.5
	5	$1.6	$3.6	$3.7	$19.3	$20.8
	6	$1.8	$3.1	$2.9	$12.9	$10.8
	7	$1.5	$4.3	$2.2	$28.3	$7.5
	7 Decade Avg.	$1.7	$3.0	$2.7	$12.6	$10.1

7 Decade Cumulative Increase in Net Revenue to Beneficiaries

PA- Alt. 1	Imple. - Alt. 1
$88.5	$70.5

Trust ***All Values in Millions of Net Dollars to the Beneficiaries***

Trust	Net Revenue	Annual Values by Alternative			Decadal Differences	
	Decadecut	ALT1	PA	Implementation	PA- Alt. 1	Imple. - Alt. 1
Scientific School	1	$6.3	$7.6	$7.5	$12.8	$11.8
	2	$6.7	$8.7	$9.2	$20.1	$25.0
	3	$5.0	$6.0	$6.1	$9.9	$10.3
	4	$5.1	$5.7	$5.2	$6.7	$1.0
	5	$3.9	$8.2	$7.8	$42.9	$39.0
	6	$4.0	$6.6	$6.6	$25.7	$25.9
	7	$3.4	$9.6	$8.0	$61.5	$45.5
	7 Decade Avg.	$4.9	$7.5	$7.2	$25.7	$22.7

7 Decade Cumulative Increase in Net Revenue to Beneficiaries

PA- Alt. 1	Imple. - Alt. 1
$179.6	$158.6

Table B.1-5. Net Revenue to Beneficiaries: A Summary Comparison for Individual Trusts (continued)

Trust — ***All Values in Millions of Net Dollars to the Beneficiaries***

Trust	Net Revenue	Annual Values by Alternative			Decadal Differences	
	Decadecut	ALT1	PA	Implementation	PA- Alt. 1	Imple. - Alt. 1
St Forest Bd Purch	1	$5.7	$6.4	$6.4	$7.1	$6.8
	2	$4.6	$6.9	$6.1	$23.2	$15.1
	3	$4.9	$4.1	$4.5	-$8.2	-$3.6
	4	$4.8	$4.9	$4.3	$0.8	-$5.2
	5	$3.6	$4.9	$4.6	$13.6	$10.7
	6	$4.7	$5.7	$5.7	$9.4	$9.6
	7	$5.3	$4.4	$4.0	-$9.6	-$12.9
	7 Decade Avg.	$4.8	$5.3	$5.1	$5.2	$2.9

7 Decade Cumulative Increase in Net Revenue to Beneficiaries

PA- Alt. 1	Imple. - Alt. 1
$36.2	$20.5

Trust — ***All Values in Millions of Net Dollars to the Beneficiaries***

Trust	Net Revenue	Annual Values by Alternative			Decadal Differences	
	Decadecut	ALT1	PA	Implementation	PA- Alt. 1	Imple. - Alt. 1
St Forest Bd Transf	1	$39.3	$54.3	$48.7	$149.7	$93.4
	2	$37.0	$38.7	$46.7	$17.0	$96.4
	3	$34.4	$38.4	$46.0	$39.1	$115.1
	4	$35.3	$41.3	$48.9	$60.3	$135.7
	5	$34.0	$43.1	$43.6	$91.7	$96.7
	6	$33.6	$43.2	$40.9	$95.7	$73.1
	7	$31.3	$41.1	$37.5	$97.8	$61.3
	7 Decade Avg.	$35.0	$42.9	$44.6	$78.8	$96.0

7 Decade Cumulative Increase in Net Revenue to Beneficiaries

PA- Alt. 1	Imple. - Alt. 1
$551.4	$671.7

Table B.1-5. Net Revenue to Beneficiaries: A Summary Comparison for Individual Trusts (continued)

Trust — ***All Values in Millions of Net Dollars to the Beneficiaries***

University - Original

Net Revenue	Annual Values by Alternative			Decadal Differences	
Decadecut	ALT1	PA	Implementation	PA- Alt. 1	Imple. - Alt. 1
1	$0.3	$0.2	$0.2	-$0.7	-$1.2
2	$0.2	$0.2	$0.2	$0.6	$0.6
3	$0.2	$0.4	$0.4	$2.1	$1.9
4	$0.2	$0.2	$0.3	-$0.1	$0.1
5	$0.2	$0.4	$0.5	$2.1	$3.0
6	$0.3	$0.3	$0.3	-$0.2	-$0.5
7	$0.3	$0.2	$0.2	-$1.4	-$1.4
7 Decade Avg.	$0.2	$0.3	$0.3	$0.3	$0.4

7 Decade Cumulative Increase in Net Revenue to Beneficiaries

PA- Alt. 1	Imple. - Alt. 1
$2.4	$2.6

Trust — ***All Values in Millions of Net Dollars to the Beneficiaries***

University – Transf

Net Revenue	Annual Values by Alternative			Decadal Differences	
Decadecut	ALT1	PA	Implementation	PA- Alt. 1	Imple. - Alt. 1
1	$0.4	$2.3	$1.7	$19.1	$12.4
2	$1.9	$2.1	$2.7	$1.9	$8.1
3	$2.8	$4.1	$4.1	$12.8	$13.4
4	$1.4	$3.1	$3.2	$16.4	$17.3
5	$2.8	$1.6	$1.6	-$13.0	-$12.3
6	$2.5	$3.6	$3.5	$11.1	$10.5
7	$2.1	$2.3	$3.0	$2.1	$9.3
7 Decade Avg.	$2.0	$2.7	$2.8	$7.2	$8.4

7 Decade Cumulative Increase in Net Revenue to Beneficiaries

PA- Alt. 1	Imple. - Alt. 1
$50.5	$58.8

Table B.1-6. Estimated Cumulative Present Net Value

NPV*	Alternative						
Decade	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Preferred Alternative	Implementation
1	$113	$143	$189	$104	$146	$151	$142
2	$220	$283	$375	$216	$307	$283	$286
3	$322	$427	$499	$322	$458	$408	$421
4	$425	$581	$673	$426	$595	$539	$560
5	$524	$726	$888	$540	$736	$680	$700
6	$621	$872	$1,045	$661	$886	$816	$833
7	$717	$1,012	$1,223	$782	$1,036	$950	$954

* Net Present Value in Million Dollars Per Year; Discount Rate = 5% Per Year

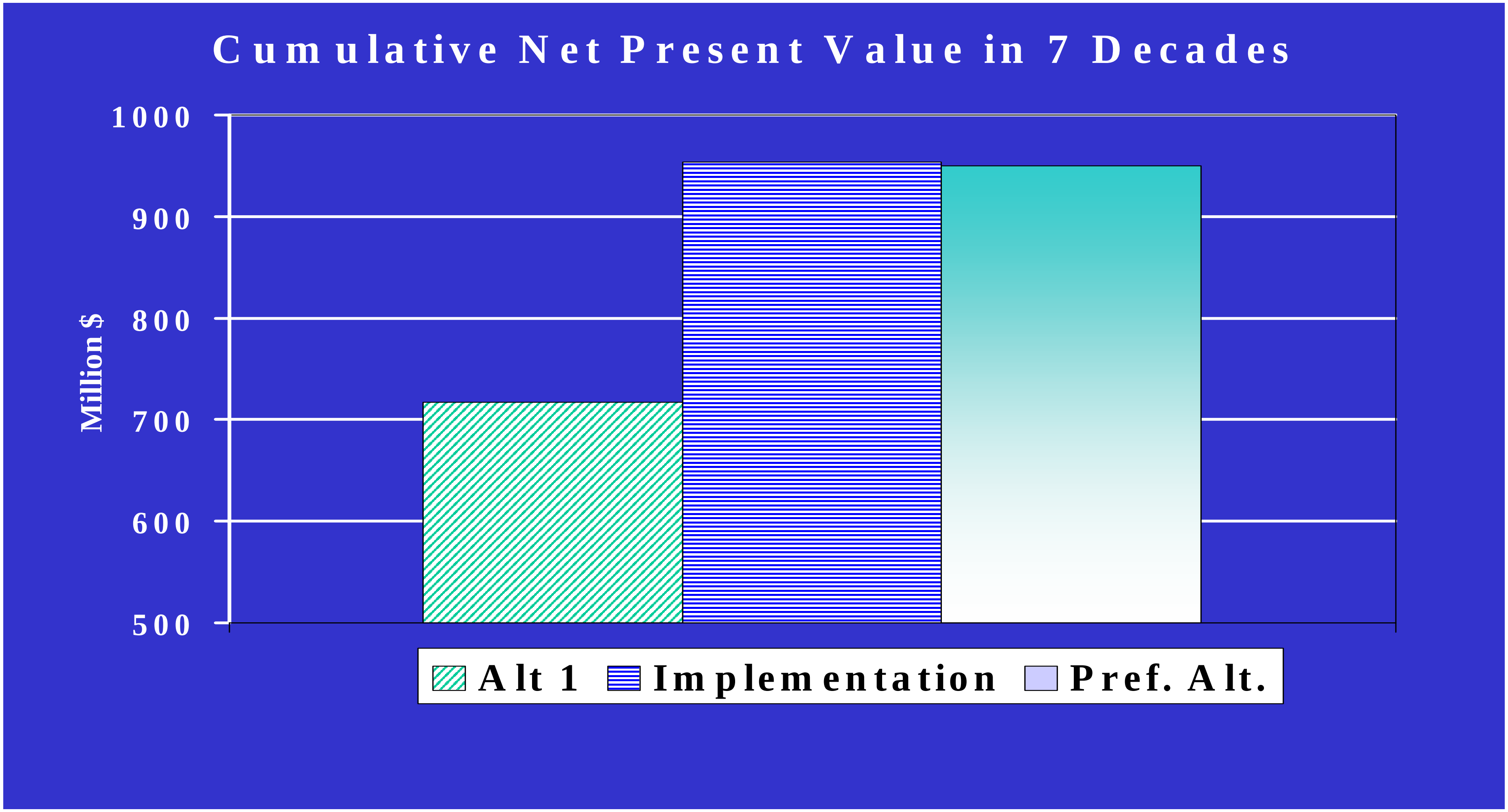


Figure B.1-11. Cumulative Net Present Value in 7 Decades for two Alternatives

B.2 MODELING INPUT AND PROCESS

B.2.1 Technical Note No. 1: Description of Growth and Yield Modeling Updates for the 2004 Sustainable Harvest Calculation

Attached is a technical paper describing growth and yield modeling improvements for the sustainable harvest calculation prepared by DNR.

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Technical Note No. 1

Description of growth and yield modeling updates for the 2004 sustainable harvest calculation

W. Jaross, B. Lu, A. Brodie, and D. Riemer

The growth and yield methods supporting the stand development stages and value-based Alternatives (DNR 2003) were identified as having potential flaws. The initial yield tables accelerated stand development and inflated volumes for the value-based calculations (Alternatives 5 and the Preferred Alternative). The volume-based calculations (Alternative 1 through 4) were not identified as a concern as a result of these issues. Specifically, three comments were received supporting the growth and yield updates (DNR, March 8, 2004).

- "The projections of increased structurally complex forest using either passive management or standard commercial thinning are overestimates".
- "The economic analysis presented to date appears to be solely based on timber prices times log volume and is so inferior that one can make no judgments on what treatments are economic"
- "Volume estimates, too high?" (South Puget Sound Region Office, January 9, 2004)

To improve the stand development stages and value-based calculations (Alternatives 5 and the Preferred Alternative), the 2004 Sustainable Harvest calculation needed to reflect more site-specific values, densities, and stocking levels. Three corrections were considered.

- More inventory variables were passed to the OPTIONS V™ model (Table B.2.1-1).
- Yields tables were reviewed and revised to match the density and stocking levels observed in the Department's forest inventory (Reimer, February 26th, 2004)
- Stumpage and volume were estimated for forest inventory stands (Equations 1 & 2).

Table B.2.1-1. Estimated Forest Inventory Stand Variables Passed to the OPTIONS V™ Model (Lu, April 26, 2003)

Stand Level Variable	Initial Runs	Updated Runs
Inventory Classification (Species, Age, Site Class)	Species class defined by trees per acre.	Species class defined by basal area per acre.
Stocking	Not imported	Imported All trees >2" diameter at breast height (dbh)
Basal Area	Not imported	Imported All trees >2" dbh
Diameter	Not Imported	Imported All trees >2" dbh
Volume (value)	Imported cubic feet per acre (Alts 1-4)	Imported $/acre (Alts 5 & PA)
Height	Not imported	Not imported

Equation 1. Converting inventory cubic feet to stumpage value.

$$\textit{Value}_{\text{model (\$/acre)}} = \textit{Cubic Feet}_{\text{merch inventory (cft/acre)}} * \frac{Value_{yield\ (species,\ site,\ age)}}{Cubic\ Feet_{yield\ (species,\ site,\ age)}}$$

Equation 1 estimated a stumpage value using a conversion ratio (Bowering and Lu, circa 2002) specific to species composition (Lu, January 27th, 2003), origin (planted or naturally regenerated), site class (WAC-222), and 10-year age class of the revised yield tables built using SPS (Arney 2002). Value output from the OPTIONS V™ model was converted to Scribner volume (board feet) and gross revenue specific to species composition, height and quadratic mean diameter (qmd). Equation 2 applied ratios derived from the yield analysis and a correction for timber utilization.

Equation 2. Converting OPTIONS V™ model value to Scribner board feet.

$$\textit{Board Feet}_{\text{merch (bf/acre)}} = \textit{Value}_{\text{model (\$/acre)}} * \frac{Board\ Feet_{yield\ (species,\ site,\ age)}}{Value_{yield\ (species,\ site,\ age)}} * \left(\frac{qmd_{\text{model}}}{height_{\text{model}}}\right)^{0.125}$$

The timber utilization exponent of 0.125 in Equation 2 was arrived at through trial and error. This exponent adjusted the Scribner board foot estimates to more closely reflect the Department's advertised sales volumes. Utilization adjustments were the same for stands with the similar height and diameter ratios. It was assumed that leaving an average of eight trees per acre resulted in 6% yield reductions. Further reductions are assumed to result from hard-to-reach locations within harvest units. In total, the model values, corrected for timber utilization, were adjusted by 10.8% (6% for leaving trees and 4.8% operability). The gross revenues and DNR timber sale costs were calculated from the Scribner board foot estimates using the cost estimates and stumpage prices presented in Tables B.2.1-2 and B.2.1-3.

Table B.2.1-2. Summary of Timber Sale Cost Assumptions ($ / thousand board feet)

REGION	Regular Sale	Thinning Sale	Partial Cut Sale
Northwest	18	36	24
South Puget Sound	18	36	24
Southwest	15	30	20
Central	18	36	24
Olympic	21	42	28
Olympic Experimental State Forest	21	42	28

Table B.2.1-3. Summary of Stumpage Rate Assumptions Applied to Scribner Volume Estimates (Bowering and Lu, circa 2002) ($ / thousand board feet)

Forest Type	Regular Sale	Thinning Sale	Partial Cut Sale
Douglas fir	376	183	287
Douglas fir – non-Commercial	200	73	117
Douglas fir – hardwood	321	111	160
Douglas fir – red cedar	478	166	278
Douglas fir – western hemlock	332	132	233
Non-commercial	114	44	60
Non-commercial – conifer mix	170	62	99
Non-commercial – hardwood mix	175	68	92
Hardwood	296	108	173
Hardwood – Douglas fir	296	108	173
Hardwood – western hemlock	372	136	217
Red cedar	440	161	193
Red cedar – Douglas fir	448	164	197
Red cedar – hardwood	432	158	190
Red cedar – western hemlock	415	161	219
Silver fir	212	77	123
Western hemlock	250	102	139
Western hemlock – Douglas fir	286	106	174
Western hemlock – hardwood	175	68	92
Western hemlock – red cedar	415	161	219
Western hemlock – silver fir	212	82	88

Conclusions

The Department reviewed and revised the growth and yield methods for the 2004 Sustainable Harvest calculation of forested state trust lands in Western Washington managed by the state Department of Natural Resources.

The improvements “slowed” stand development and provided more realistic volumes from the value-based calculations (Alternatives 5 and the Preferred Alternative). This was accomplished by passing more inventory variables to the OPTIONS V™ model, matching the density and stocking levels observed in the Department’s forest inventory, and estimating stumpage for each forest inventory stand.

The revised growth and yield forecasts more closely matched the experience of forest stand structures and stumpage revenues. The review also demonstrated that the original volume-based yields were acceptable. Therefore, the volumes calculated for Alternatives 1 through 4 were not a concern. As a result, the Department updated the value-based calculations (Alternatives 5 and the Preferred Alternative) and redesigned the stand development stages for all the Alternatives.

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B.2.2 Technical Note No. 2: Modeling Forest Stand Development Stages for Strategic Modeling of Forested State Trust Lands in Western Washington

Attached is a technical paper describing the stand development stage model developed by DNR.

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Technical Note No. 2

Modeling forest stand development stages for strategic modeling of forested state trust lands in western Washington

A.W. Brodie, W. Jaross, B. Lu and D. Lindley

This paper describes the stand development stage model developed by the Washington State Department of Natural Resources (Department). A brief introduction describing the purpose of stand structure and the management objectives of the Department's Habitat Conservation Plan will be included. Also, the Department's initial and current classification schemes will be discussed and illustrated with examples. More detailed information on the programming code changes will be provided in the appendices.

Introduction

As part of the 2004 Sustainable Harvest calculation of forested state trust lands in Western Washington managed by the state Department of Natural Resources (Department), the Department developed a stand structural classification model called Stand Development Stages (SDS). For the calculation, the SDS model illustrates the effects of forest management on the developmental stages of forest structure over time.

The Department reviewed the SDS model during further analysis between the Sustainable Forest Management Draft Environmental Impact Statement (EIS) and Final EIS. The model was restructured so that new information could be considered in the Board of Natural Resources (Board) decision to adopt a suite of policy changes and a new Sustainable Harvest level.

The revisions to SDS modeling for the Final EIS "slow" the development of the forest structure over time, similar to Forest Vegetation Simulator (FVS) simulation runs under a no management scenario. The results of the revisions reflect the expectations of forestry expert reviews.

The purpose of a stand development stage model

During the latter half of the 1990s the Department developed and agreed to a Habitat Conservation Plan (HCP) with the US Federal Agencies responsible for threaten and endangered species and their habitat (USFW and NMFS) (WADNR, 1997). Under the HCP the Department has management strategies to meet various habitat objectives on state trust lands for northern spotted owls, marbled murrelets, salmonid and riparian obligate species, and unlisted species of concern, within the range of the northern spotted owl. The HCP objectives call for conservation of populations through provision of habitat conditions that are anticipated to contribute to demographic support, dispersal, and maintenance of geographic distribution of northern spotted owls across the landscape.

The Department's Habitat Conservation Plan uses a combination of landscape and stand-scale strategies for the management of forest conditions to meet specific and general habitat requirements. The stand-scale strategies are described as a set of forest conditions in terms of forest structure: for example, number and size of live and dead trees (snags) and dead wood debris of various sizes and conditions. An assumption is made that if the forest contains the identified structural conditions across the specific landscapes, the species' habitat requirements will be met. During the development of the Habitat Conservation Plan, a stand development stage model based on improved inventory was envisioned (WADNR 1997, pages HCP IV 180-181).

Arriving at a common understanding of forest structural development requires some means of describing the attributes that concern the purposes of forest management. Structural attributes embody the elements of change necessary to achieve management objectives related to biodiversity conservation and habitat management. Structure is a more readily measured surrogate for functions (e.g. productivity or as habitat for organisms) that are difficult to measure directly. Structure has direct value as a product (e.g. wood) or in providing a service (e.g. in sequestering carbon or influencing hydrologic responses (absorbing heavy rainfall, etc)(Franklin et al, 2002).

For commercial even-age silviculture, the features of stand development – primarily age and tree sizes – have proven useful to foresters. As the Department's objectives have evolved to include biodiversity and habitat conservation, those familiar metrics alone become ineffective depictions of the new management objectives. Objectives such as maintaining and sustaining biodiversity and productivity require forest managers to relate to the ecological principles of stand development. Structural classifications present a vocabulary that describes more than just the productive importance of stand development.

The Department's Stand Development Classification System

The Department's stand development stage model describes the forest in terms of stand structure and forest development and draws from recent works by Franklin et al. (2002), Johnson and O'Neil (2001) and Carey et al. (1996) and Habitat Conservation Plan (WADNR, 1997). The Department built upon the nomenclature and descriptions of stand development stages from Carey et al. (1996). Carey's stand development classification was selected because it focused on the relationship of ecological process and stand development. For the purposes of this modeling exercise, no explicit linkages are made to any specific wildlife habitat suitability models.

Authors in the forest ecology and forestry literature (Franklin et al. 2002; Carey et al. 1996; O'Hara, et al. 1996; Spies and Franklin, 1996, Oliver and Larson, 1990) also have developed classifications describing stand development. However, most of these classifications are conceptual in nature or are built from a specific set of stand data, and must be applied to similar datasets to support repeatable conclusions.

Several information sources were considered during the development of the stand development stage model. These consisted of:

- Diameter class and stand-level information from the Department's Forest Resource Inventory System (FRIS). FRIS 1 is sample-year data, while FRIS 2 is projected ("grown") and updated for management activities to current-year (November, 2002, 2003);
- Simulated FRIS 1 under a "no management" scenario using the USDA Forest Service Forest Vegetation System (FVS). This provided information of number of canopy layers per stand and the likely development of future canopy layers under no

management over a 100-year period. Default keyword parameters were used for "StrClass"[1] and related FVS variables (Crookston and Stage, 1999)

- Decay rates for snags and coarse woody debris from coarse woody debris dynamics simulator (Marcot et al., 2002).

There were two iterations of the SDS model. The results of the initial stand development stage model were published in the Draft EIS (WADNR, November 2003). A reviewer (Paula Swedeen, Department of Fish and Wildlife) thought the Draft EIS SDS projections overestimated the amount of change from a competitive exclusion stage to more structurally complex stage. Also, the Department own reviews of the Draft EIS Sustainable Harvest calculations indicated that revisions to the SDS model were necessary.

Figures 4.4-1 of the Draft EIS illustrated Alternatives 1 and 4 (the more passive management alternatives) simulated more structurally complex forested habitat types (botanically diverse, and greater) than the other management Alternatives, (WADNR, 2003). Even Alternative 6, which promoted specific strategies and activities (biodiversity thinning) aimed at creating more structurally complex forested habitat types, developed less. This result was neither intuitive nor expected.

Concurrently, the Department observed few changes in structural complexity from a100-year no-management simulation produced with the USDA Forest Service Forest Vegetation System (FVS). These FVS results were consistent with both the Department's and the reviewer's opinions that the Draft EIS SDS overestimated the rate of change. .

In addition, the Department updated the yield valuations for Alternatives 5 and the Preferred Alternative (Jaross et al., 2004). The yield revisions reflected stocking of all trees, not just the commercial cohort and therefore the initial stand development stage assumptions were no longer appropriate. The details of the initial and revised approaches are discussed herein.

Initial Approach to the Department's stand development stage model

The Department's initial stand development stage (SDS) model approach was developed around a set of growth and yield assumptions based primarily upon a commercial even-aged cohort (Jaross et al., 2004).

The main determinate for the initial stand development stage model was average stand diameter (quadratic mean diameter or QMD) development. Trees per acre (TPA), Curtis's relative density (Curtis, 1982), and management occurrences (thinning) were included. Stand age also played a role. For further details see Table B.2.2-1.

A relative density (RD) threshold condition of 44.6 (Oliver et al, 1995), was assumed to distinguish an open stand condition from a closed one, as well as distinguishing a single story stand from stands with multiple canopy layers. Management activities, such as thinning were assumed to affect canopy layers and closure. Figure B.2.2-1 illustrates the distribution in 2004 and expected changes in stand development changes as presented in the Draft EIS.

[1] Use of the keywords and post processes was made without any attempt at changing the default values.

Table B.2.2-1 presents the variables and logic for the initial stand development stage model. Notice that diameter and age are distinguishing the stages. Programming code is provided in the attachments.

Table B.2.2-1. Initial SDS Classification - Coded Variables

Forest Structure Class (FSC) adapted from Johnson and O'Neil (2001)	Stand Development Stage (SDS) adapted from Carey et al (1996)		Logic	Stand-level Variable and Associated Shreshold Value					
				QMD	RD	TPA	Management Activity		Stand Age
							Thin Age	Frequency	
Grass_Forb	EIS	Ecosystem Initiation		<1					
ShrubSap			or	>=1 & <5	<=44.6	<=328			
ShrubSap_closed	SES	Ecosystem Initiation		>=1 & <5	>44.6				
ShrubSap_closed			or	>=1 & <5		>328			
Pole_multi	URS	Understory reinitiation		>=5 & <10	<=44.6		>25	>=1	
Pole_multi			or	>=5 & <10	<=44.6			<0	>=40
Pole_multi_closed	PES	Pole exclusion		>=5 & <10	>44.6		>25	>=1	
Pole_multi_closed			or	>=5 & <10	>44.6			<0	>=40
Pole_single_closed			or	>=5 & <10	>44.6				
Pole_single	URS	Understory reinitiation		>=5 & <10	<=44.6				
Large_multi_closed			or	>=10 & <19	>44.6		>45	>=1	
Large_multi_closed			or	>=10 & <19	>44.6			<0	>=160
Large_multi_closed			or	>=10 & <=14	>44.6				
Large_single			or	>=10 & <19	<=44.6				
Large_single			or	>=10 & <19		<=150			
Large_single_closed	LTS	Large tree exclusion		>=10 & <19	>44.6	>150			
Large_multi	DUS	Developed understory		>=10 & <19	<=44.6		>45	>=1	
Large_multi			or	>=10 & <19	<=44.6			<0	>=160
Large_multi			or	>14 & <19	<=44.6				
Giant_multi	BDS	Botanically diverse		>=19 & <=23		<130		<2	
Giant_multi			or	>=19 & <=23			>55	>=2	
Giant_multi + HE_ND	NDS	Niche diversification		>=19 & <=23		>=130			
Giant_multi + HE_ND			or	>=19 & <=23				>=2	
Giant_multi + HE_FF	FFS	Fully functional (mgd)		>23		>=95			
Giant_multi + HE_FF			or	>23				>=1	
Giant_multi + HE_FF			or	>23			>85	>=2	
Giant_multi + HE_FF			or	>23		<95		<1	<250
Old Natural Forests	ONF	Old Natural Forests		>23		<95		<1	>=250

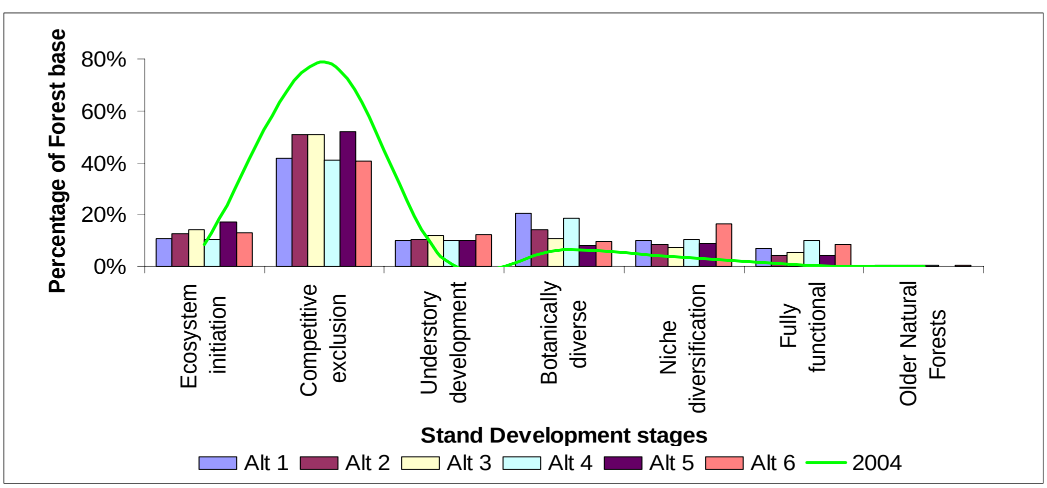

Figure B.2.2-1. Percent of Total Forest Base in DEIS SDS stages for the Alternatives 2067 (HCP planning horizon)

The Department's Revised Stand Development Stage model for the Final EIS

The SDS model was re-designed to address the shortcomings observed in the initial modeling logic, as well as to incorporate new information. The initial stand development stage model distinguished development stages mostly by diameter and age. The Department changed the principle determinates to reflect a process of multiple canopy development, closure, and decadence. The role of thinning was included in the revised classification logic.

The stand development stage in year 2004 was modeled using new information. As Figure B.2.2-2 illustrates, an FVS simulation provided an indication of canopy layers for each stand.

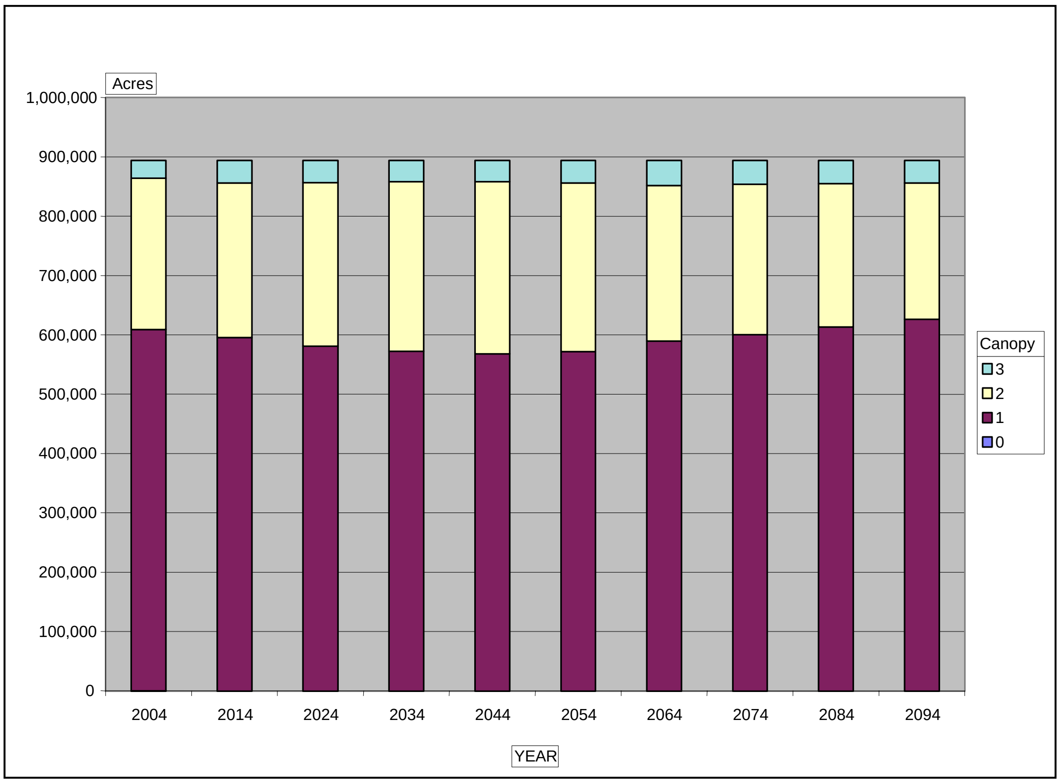

Figure B.2.2-2. A No Management Scenario Using FVS Illustrates Little Change in the Acre Distribution of Canopy Layers over a 100-year Simulation

Consistent with the findings illustrated in Figure B.2.2-2, the Department assumed that without management, the possibility of increased complexity for forest stands was conditional upon competition induced mortality. The Department assumed that stands passing maximum relative density would develop decadence and an understory through natural processes. This transition period was labeled *understory development stage* (UDS). After a period of time, a stand would develop into a botanically diverse or niche diverse state. Decadence played a role in distinguishing between the *botanically diverse stage* (i.e. multiple canopy layers and species) and a stage that has structural complexity and snags and course woody debris. These time periods were adjusted through trial and error, until the modeling results were consistent with the model validations and forestry expert reviews.

Thinning could either perpetuate or change a stand development stage. For example, a removal of less than 50 percent of the standing basal area in a thinning from below was expected to perpetuate the competitive exclusion state (or current stage).[2] It was assumed that increased removals, creating gaps, and recruiting snags and coarse woody debris from the dominant canopy, increased the likelihood that stands would transition from a competitive exclusion stage. However, thinning did not automatically introduce structural complexity. The Department assumed that some time was necessary for decadence and the planted and naturally regenerated understory to establish. These time periods were adjusted through trial and error, until the modeling results were consistent with the new information. Figure B.2.2-3 illustrates the Department's revised stand development stage model.

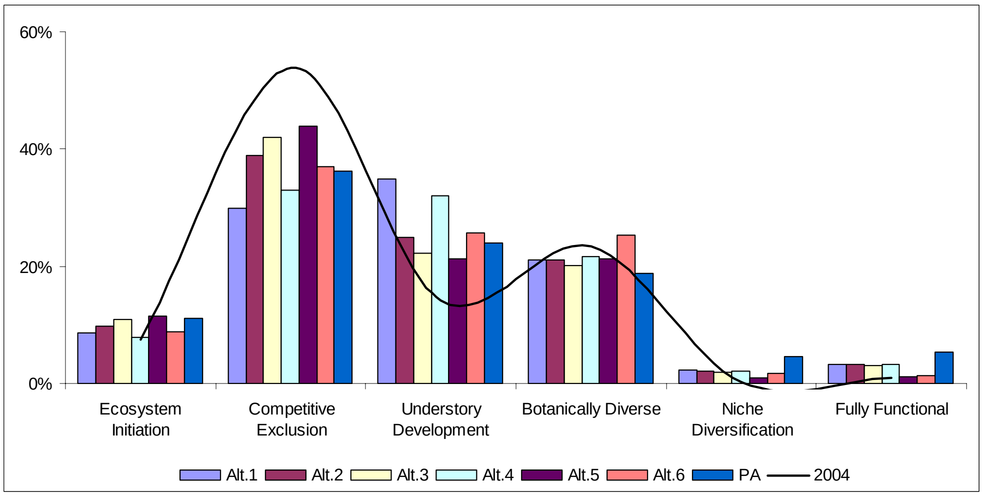

Figure B.2.2-3. Percent of Total Forest Base in FEIS SDS Stages for the Alternatives in Year 2067 (HCP planning horizon)

Table B.2.2-2 presents the variables and logic for the Department's revised stand development stage model. Programming code is provided in the attachments. Note that stand age is used differently in the revised approach. For the sake of simplifying the algorithms, yield table ages corresponding with maximum relative density signaled the passing of peak relative density, and the onset of understory development and the more structurally complex stages.

[2] The 50 percent breakpoint was imprecise and arbitrary, however, the basic concepts of how thinning intensities can affect the dominant tree cohort have been demonstrated through DNR's thinning and partial cutting timber sales.

Table B.2.2-2. Final EIS SDS Classification - Coded Variables

Stages			Stand-level Variable and Associated Threshold Value									
							Management Activity					
Summarized	Detailed		QMD	Canopy Layer	RD	Stand Age	BioThin Age	Years Since BioThin	Thin Age	Years Since Thin	Snag Ratio1	CWD
Ecosystem Initiation	Ecosystem Initiation		<2									
Competitive Exclusion	Sapling Exclusion		>=2									
	Pole Exclusion		>5									
		or							>0	>=0		
	Large Tree Exclusion		>11									
		or	>11						>0	>=0		
	Understory Development		>=2	>1								
		or	>=2		>=MaxRD							
		or	>=2			>MaxRD Age						
		or	>=2				>0	>=0				
Structually Complex	Botanically Diverse		>=2	>1								
		or	>=2	>1		>=MaxRD Age+60						
		or	>=2	>1			>0	>=0				
		or	>=2	>1	>=MaxRD							
		or	>=2		>=MaxRD	>=MaxRD Age+60						
		or	>=2		>=MaxRD		>0	>=0				
		or	>=2			>=MaxRD Age+60	>0	>=0				
		or	>=2				>0	>5				
		or	>=2	>1		>MaxRD Age						
		or	>=2			>=MaxRD Age+60						
		or	>=2			>MaxRD Age	>0	>5				
	Niche Diveris-ification		>=2	>1		>=MaxRD Age+80					>0.07	>2400
		or	>=2	>1		>=MaxRD Age+80	>0	>0				
		or	>=2	>1			>0	>5				
		or	>=2		>=MaxRD	>=MaxRD Age+80					>0.07	>2400
		or	>=2		>=MaxRD	>=MaxRD Age+80	>0	>0				
		or	>=2		>=MaxRD		>0	>5				
		or	>=2			>=MaxRD Age+80					>0.07	>2400
		or	>=2			>=MaxRD Age+80	>0	>0				
		or	>=2			>MaxRD Age	>0	>5				
		or	>=2			>=MaxRD Age+80	>0	>=0			>0.07	>2400
		or	>=2			>=MaxRD Age+80	>0	>0				
		or	>=2				>0	>5			>0.07	>2400
	Fully Functional		>=2	>1		>=MaxRD Age+160					>0.07	>2400
		or	>=2	>1		>=MaxRD Age+160	>0	>0				
		or	>=2	>1			>0	>40				
		or	>=2		>=MaxRD	>=MaxRD Age+160					>0.07	>2400
		or	>=2		>=MaxRD	>=MaxRD Age+160	>0	>0				
		or	>=2		>=MaxRD		>0	>40				
		or	>=2			>=MaxRD Age+160					>0.07	>2400
		or	>=2			>=MaxRD Age+160	>0	>0				
		or	>=2			>MaxRD Age	>0	>40				
		or	>=2			>=MaxRD Age+160	>0	>=0			>0.07	>2400
		or	>=2			>=MaxRD Age+160	>0	>0				
		or	>=2				>0	>40			>0.07	>2400

Two stages or classes were dropped from the initial classification: "*developing understory*" and "*old natural forests*." The initial grouping of the classifications into ecosystem initiation stage (EIS), *competitive exclusion stage* (CES) and *structurally complex forests* (SCF) was also changed to reflect the logic changes in the classification system.

Understory initiation and developing understory were summarized into one stage as "*understory development*." The available data was insufficient to make a distinction between these stages. The "*old natural forest*" stage in the Draft EIS, was dropped from the classification. The available data was insufficient to distinguish these stands from fully functional, niche diverse stands or even botanically diverse stands.[3]

In summarizing the stages for presentation purposes, the new understory development stage was grouped with the competitive exclusion stages. The Department assumed that while the processes of *competitive exclusion* and *understory development* were different, the structural characteristics of *understory development* were more similar to competitive exclusion than structurally complex stages.

Conclusions

This paper described the forest stand structure classification developed by the Department for the current Sustainable Harvest calculation. A brief introduction described the stand structure management objectives of the Department's Habitat Conservation Plan. Also, the revisions of the Department's classification scheme were discussed and illustrated with examples. More detailed information on the code changes will be provided in the appendices.

Results of the revisions to modeling for the Final EIS demonstrated a "slowing" down of the development of the forest over time. This appeared to be similar to the FVS simulation runs under a no management scenario. The results of the revisions reflected the expectations of expert reviews and model validation.

[3] A review of the stand development stage model uncovered a number of false positives; i.e. stands with low basal areas and small average stand diameters (QMD) s that were identified as old growth naturals.

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Attachment: DEIS SDS Programming Code

Initial SDS Code

```
Function SDSClass2(Age As Variant, QMD As Variant, RD As Variant, TPA AS _
  Variant, AAge As Variant, AFreq As Variant, Optional K As Variant) As RecSDS
  Dim S As RecSDS, N As Integer
  N = IIf(IsMissing(K), VolC(QMD), QMDC(QMD))
  Select Case N
    Case 1
      S.Code = "1.1"
      S.SDS = "Grass_Forb"
      S.LMP = "EIS"
      S.HCP = "Open"
    Case 2
      S.Code = IIf(RD <= 44.6 And TPA <= 328, "1.2", "1.2.0.1")
      S.SDS = IIf(RD <= 44.6 And TPA <= 328, "ShrubSap", "ShrubSap_closed")
      S.LMP = IIf(RD <= 44.6 And TPA <= 328, "EIS", "SES")
      S.HCP = "Regeneration"
    Case 3
      S.Code = IIf(RD <= 44.6, "1.3.2", "1.3.2.1")
      S.SDS = IIf(RD <= 44.6, "Pole_single", "Pole_single_closed")
      S.LMP = IIf(RD <= 44.6, "URS", "PES")
      If (AAge > 25# And AFreq >= 1) Or (Age >= 40# And AFreq < 0) Then
        S.Code = IIf(RD <= 44.6, "1.3.1", "1.3.1.1")
        S.SDS = IIf(RD <= 44.6, "Pole_multi", "Pole_multi_closed")
        S.LMP = IIf(RD <= 44.6, "URS", "PES")
      End If
      S.HCP = "Pole"
```

Initial SDS Code (Continued)

```
 Case 4
    S.Code = IIf(RD <= 44.6 Or TPA <= 150, "1.4.2", "1.4.2.1")
    S.SDS = IIf(RD <= 44.6 Or TPA <= 150, "Large_single", "Large_single_closed")
    S.LMP = IIf(RD <= 44.6, "URS", "LTS")
    S.HCP = "Closed"
    If (AAge > 45# And AFreq >= 1) Or (Age >= 160# And AFreq < 0) Or _
      (RD <= 44.6 And QMD > 14#) Then
      S.Code = IIf(RD <= 44.6, "1.4.1", "1.4.1.1")
      S.SDS = IIf(RD <= 44.6, "Large_multi", "Large_multi_closed")
      S.LMP = IIf(RD <= 44.6, "DUS", "URS")
      S.HCP = "Complex"
    End If
Case 5
    S.Code = IIf(AFreq < 2 And TPA < 130, "1.5.1", "1.5.1.0.1")
    S.SDS = IIf(AFreq < 2 And TPA < 130, "Giant_multi", "Giant_multi + HE_ND")
    S.LMP = IIf(AFreq < 2 And TPA < 130, "BDS", "NDS")
    S.HCP = IIf(AFreq < 2 And TPA < 130, "Complex", "Fully Functional")
    If AAge > 85# And AFreq >= 2 Then
      S.Code = "1.5.1.0.1"
      S.SDS = "Giant_multi + HE_ND"
      S.LMP = "NDS"
      S.HCP = "Fully Functional"
    ElseIf AAge > 55# And AFreq >= 2 Then
      S.Code = "1.5.1"
      S.SDS = "Giant_multi"
      S.LMP = "BDS"
      S.HCP = "Complex"
    End If
```

Initial SDS Code (Continued)

```
   Case 6
     S.Code = IIf(AFreq < 1 And TPA < 95, "1.6", "1.5.1.0.2")
     S.SDS = IIf(AFreq < 1 And TPA < 95, "OldGrowth_natural", "Giant_multi + HE_FF")
     S.LMP = IIf(AFreq < 1 And TPA < 95, "ONF", "FFS")
     If (AAge > 85# And AFreq >= 2) Or (S.Code = "1.6" And Age < 250#) Then
       S.Code = "1.5.1.0.2"
       S.SDS = "Giant_multi + HE_FF"
       S.LMP = "FFS"
     End If
     S.HCP = "Fully Functional"
    Case Else
     S.Code = "D" & Format(QMD, "0.0") & "/A" & Age & "/AA" & AAge
     S.SDS = "Not defined"
     S.LMP = "Not defined"
     S.HCP = "Not defined"
    End Select
  SDSClass2 = S
End Function
Function QMDC(QMD As Variant) As Integer
  Dim N As Integer
  Select Case Nz(QMD, 0)
    Case Is < 1#
      N = 1
    Case Is < 5#
      N = 2
    Case Is < 10#
      N = 3
    Case Is < 19#
      N = 4
    Case Is <= 23#
      N = 5
    Case Else
      N = 6
  End Select
  QMDC = N
End Function
```

Attachment: FEIS SDS Programming Code

```
Function SDSClass(Age As Integer, YrSOF As Integer, QMD As Double, Layer As Integer, _
    SnagR As Double, CWD As Double, RD As Double, MaxRD As Double, AgeMaxRD As Integer, _
    YrT As Integer, AgeT As Integer, YrBT As Integer, AgeBT As Integer, Optional Spp As _
    String = "WHSF") As RecSDS
  Dim S As RecSDS, N As Long
  If QMD < 2 Then
    S.DNR4 = "EIS"
    S.DNR9 = "EIS"
  Else
    S.DNR4 = "CES"
    S.DNR9 = "SES"
    If QMD > 5 Or (AgeT > 0 And YrSOF >= YrT) Then S.DNR9 = "PES"
    If QMD > 11 Then
      S.DNR9 = "LTS"
      If S.DNR9 = "PES" And (AgeT > 0 And YrSOF >= YrT) Then S.DNR9 = "LTS"
    End If
    If Layer > 1 Or RD >= MaxRD Or Age > AgeMaxRD Or (AgeBT > 0 And YrSOF >= YrBT) Then
      S.DNR4 = "BDS"
      S.DNR9 = "UDS"
      If Layer > 1 Or Age - AgeMaxRD >= 60 Or (AgeBT > 0 And YrSOF - YrBT > 5) Then S.DNR9 =
"BDS"
      If (SnagR > 0.07 And CWD > 2400) Or (AgeBT > 0 And YrSOF > YrBT) Then
        If Age - AgeMaxRD >= 80 Then
          S.DNR4 = "SCF"
          S.DNR9 = "NDS"
          If Age - AgeMaxRD > 160 Then S.DNR9 = "FFS"
        End If
        If AgeBT > 0 Then
          If YrSOF - YrBT > 5 Then S.DNR9 = "NDS"
          If YrSOF - YrBT > 40 Then S.DNR9 = "FFS"
        End If
      End If
    End If
  End If
  SDSClass = S
```

```
End Function

Function Snag(TPA As Double, AFreq As Integer, ID As Integer) As Double
  Dim Standing As Double
  Standing = IIf(AFreq = -1, 0.7, 0.22)
  Snag = TPA * IIf(ID = 0, Standing, 1 - Standing)
End Function

Function CDWD(Yr As Integer, YRORG As Integer, CV As Double, DBH As Double) As Double
  Dim kf As Double
  If CV = 0 Then
    CDWD = 0
  Else
    kf = IIf(DBH >= 15, 0.008, 0.01)
    CDWD = CV * IIf(DBH >= 6, Exp(-kf * (Yr - YRORG)), 1)
  End If
End Function
```

B.2.3 Photographic Examples of Stand Development Stages and Silvicultural Harvest Treatments - This page is intentionally left blank.

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Photographic examples of stand development stages and silvicultural harvest treatments

Washington Department of Natural Resources (DNR) developed a forest classification system to illustrate ecological development of forest stand structures. DNR is working to help create more acres of structurally complex forest from the less complex "competitive exclusion" phases throughout the western Washington forest landscape. DNR manages forested trust lands to earn revenue and provide habitat for many native wildlife species.

The stand development stages used in this analysis are adapted from three principal sources: Brown (1985), Carey et al. (1996), and Johnson and O'Neil (2001) (Chapter 4.2). DNR's classification system summarizes forest stand structures using three major categories with eight more detailed stand development stages. This provides a systematic comparison of forest management Alternatives. The following chart, descriptions, and photos illustrate the stand development stages.

SUMMARIZED STAND DEVELOPMENT STAGES UNDER CURRENT CONDITIONS

Less Complex Forest ↑ / ↓ More Complex Forest

Summarized Stand Development Stage	Stand Development Stage	Acres	Percent of Westside Forested Trust lands
Ecosystem Initiation	Ecosystem Initiation	105,240	8
Competitive Exclusion	Sapling Exclusion	234,979	17
	Pole Exclusion	286,880	21
	Large Tree Exclusion	226,347	16
	Understory Development	196,417	14
Structurally Complex	Botanically Diverse	324,725	23
	Niche Diversification	3,681	0
	Fully Functional	12,435	1
Total		**1,390,704**	**100**

Data source: Model output data - stand development stages

Regeneration harvesting follows the Habitat Conservation Plan guidelines and state Forest Practice Rules. Legacy and leave trees remain clumped and scattered. Some trees continue standing, while others are left on the ground. Riparian (streamside) and other habitat protections are part of this activity. In addition, adjacent stands are not harvested in similar ways until the newly regenerated trees on this stand are well established.

DESCRIPTION OF CLASSES (ADOPTED FROM CAREY ET AL. 1996)

Natural disturbances, tree growth, and harvest can change forest structures.

ECOSYSTEM INITIATION STAGE

Death or removal of mature forest overstory trees by wildfire, windstorm, insects, disease, or timber harvest leads to establishment of a young forest ecosystem. The absence of overstory trees leads to the re-establishment of a young forest ecosystem. This open canopy forest is dominated by herbs, forbs, and small trees.

COMPETITIVE EXCLUSION STAGE

Trees fully occupy the site and compete for light, water, nutrients and space. Most other vegetation and many trees become suppressed and trees die. This class has four subcategories. The first three—**Sapling Exclusion, Pole Exclusion and Large Tree Exclusion**—are determined by the tree size, and the last—**Understory Development**—is determined by reduced tree competition**.**

Sapling Exclusion

The pioneer of competitive exclusion is the sapling exclusion stage. It has a dense canopy from the ground up. Shrubs and branches of regenerated trees begin to intertwine.

Pole Exclusion

Closed canopies feature taller, intermediate-sized trees. Understory forest floor plants are absent. Mortality of suppressed trees is evident.

Large Tree Exclusion

Even larger, closely spaced trees of similar heights compete, perpetuating mortality and suppression of forest floor plants. There are not enough large openings to allow light for forest floor plants to grow. Mortality of larger trees is evident.

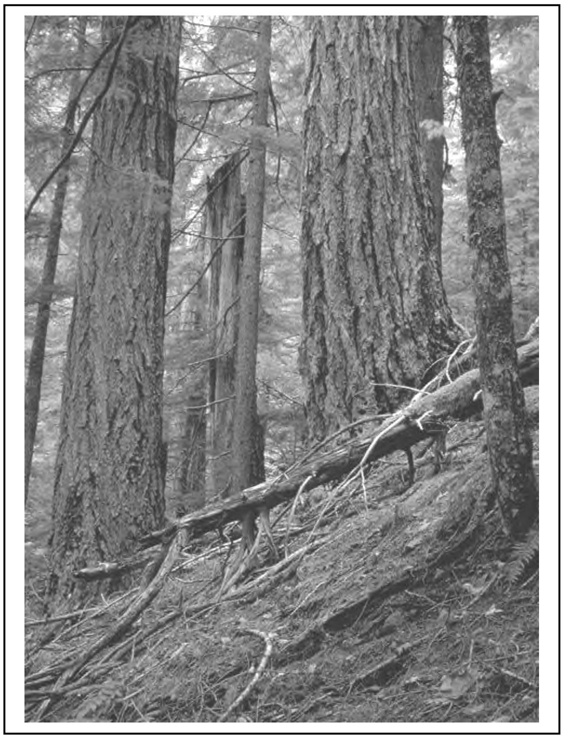
Understory Development

As overstory trees die, fall down, or are harvested, the competetive exclusion of overstory trees fades and canopy gaps become larger. Light penetrates the canopy gaps and an understory of trees, forbs, ferns, and shrubs develops. There is little diversification of plant communities.

STRUCTURALLY COMPLEX

Structurally complex stands are described by three stages: the Botanically Diverse, Niche Diversification, and Fully Functional.

Botanically Diverse



Multiple canopies of trees and communities of forest floor plants are evident. Large and small trees have a variety of diameters and heights. Decayed and fallen trees are lacking abundance.

Niche Diversification

Coarse woody debris, cavity trees, tree litter, soil organic matter, and diversity of forest floor plant communities are evident, as well as the wildlife that use this type of habitat. Multiple canopies of trees are present. Large and small trees have a variety of diameters and heights.

Fully Functional

The most complex of the forest structures, the Fully Functional forest has large-scale habitat elements such as rotting fallen trees or “nurse logs,” onto which trees and other vegetation grow. The added complexity enables the increased interactions that provide for the life requirements of diverse vertebrates, invertebrates, fungi, and plants.

Other examples of forested trust lands timber harvests

Thinning generates revenues for trusts by harvesting some trees. Thinning reduces overstory tree competition. If enough overstory trees are harvested, light reaches the forest floor through canopy openings, encouraging the understory growth of trees, bushes, forbs, lichen, and other plants that provide habitat and soil stability.

One example of a DNR thinning

Forest before thinning.

Forest after thinning. Note that more sky is visible through the tree tops than in the photograph above.

Another example of a DNR thinning

Forest in competitive exclusion before thinning. Insufficient light through treetops and no forest floor plants.

Two years after thinning, showing substantial growth of vegetation on the forest floor.

An understory of trees may not develop as the overstory canopy closes.

Examples of other silvicultural options

Photo by J. Alan Wagar   Two-age unit immediately after harvest – aeriel oblique

Photo by J. Alan Wagar - Patch cut unit immediately after harvest –aerial oblique
(From Curtis, Robert O.; Marshall, David D.; DeBell, Dean S., eds. 2004 Silvicultural options for young-growth Douglas-fir forests: the Capitol Forest study—establishment and first results. Gen. Tech. Rep. PNW-GTR-598. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 110 p.)

REFERENCES

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Carey, A., C. Elliot, B.R. Lippke, J. Sessions, C. J. Chambers, C.D. Oliver, J.F. Franklin and M. G Raphael 1996 Washington Forest Landscape Management Project – A pragmatic, ecological approach to small-landscape management. USDA Forest Service, Washington State Department of Fish and Wildlife and Washington State Department of Natural Resources

Johnson, D.H. and T. A. O'Neil (managing directors) 2001. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press p.685, plus Appendices and CD-ROM

B.2.4 Differences Between Alternative 6 and the Preferred Alternative

This section contains Table B.2.4-1, Summary of Policy, Procedural, and Modeling Differences Between Alternative 6 and the Preferred Alternative.

Table B.2.4-1. Summary of Policy, Procedural, and Modeling Differences Between Alternative 6 and the Preferred Alternative

Management Issue	Policy, Procedure, Task Reference	Alternative 6	Preferred Alternative	Modeling Differences
Ownership groups	Policy No. 6	Change policy (20 groups)	Change policy (20 groups)	Same
Even-flow of harvest	Policy No. 4 PR 14-001-010 TK 14-001-020	+/- 25% flow Change procedure, task	+/- 25% flow Change procedure, task	Same Same
Harvest regulation	Policy No. 5	Value	Value	Same
Maturity criteria and silviculture	Policies No. 4, 11, 30, 31 PR 14-005-020	Change policy By Value Regimes designed to max NPV subject to objectives Update policy discussion (Nos. 4, 11) Change procedure	Change policy By Value Regimes designed to max NPV subject to objectives Update policy discussion (Nos. 4, 11) Change procedure	Very light thinning excluded from Preferred Alternative modeling, thought to be un-economical Same
Northern spotted owl conservation	Nesting, roosting, foraging, and dispersal PR 14-004-120	As HCP envisioned Change procedure	As HCP envisioned Change procedure	Both alternatives' model design was to demonstrate biodiversity pathways. Alternative 6 resulted in modeling without regeneration harvest for approximately the first 70 year of the model. The Preferred Alternative used a combination of heavy and light thinnings and regeneration harvest to demonstrate biodiversity pathways.
Old forest components	Owl circles PR 14-004-120 Policy No. 14 (Old Growth Research Areas)	Deferred until 2007 Change procedure	Deferred until 2007 except in the OESF where Admin. circles release 2004 Change procedure	Same approach, except OESF Admin. circles not deferred in model
		10-15% of HCP unit targeted Change/new policy	10-15% of HCP unit targeted Change/new policy	Same
	Task 14-001-010 (Maintaining Mature Forest Components)	New procedure/task	New procedure/task	Same
	Task 14-001-010 (Maintaining Mature Forest Components)	50/25 replaced with SEPA checklist Change Task	50/25 replaced with SEPA checklist Change Task	Same
	PR 14-006-090 (Legacy and Leave Tree Levels)	7% to min. 8 trees Change procedure	7% to min. 8 trees Change procedure	Same
Riparian and wetland areas	PR1 14-004-150	Biodiversity thinnings for restoration under HCP Change procedure (Requires Services' agreement)	Biodiversity thinnings for restoration under HCP Change procedure (Requires Services' agreement). Board wished to see less area of activities in riparian areas	Riparian modeling strategy in Preferred Alternative updated from an extensive strategy to an intensive strategy (see note below)
Marbled murrelets	No procedure or policy change	No procedure or policy change	No procedure or policy change	Occupied sites and occupied reclassified habitat model as deferred from harvest in Preferred Alternative. In Alternative 6, these areas were released in 2007.

HCP = Habitat Conservation Plan
OESF = Olympic Experimental State Forest
SEPA = State Environmental Policy Act

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B.2.5 Definition of Harvest Types

Washington Department of Natural Resources (DNR) carries out many types of silvicultural activities that result in the harvest of trees on western Washington forested state trust lands. Some of these—such as pre-commercial thinnings and cutting of competing vegetation—do not result in merchantable timber, and are not included in this discussion on harvest types.

The two basic reporting categories used for silvicultural activities resulting in merchantable timber are thinnings and clear-cuts. DNR typically designs thinnings for dense, closed stands with both small- and large-diameter trees.

Thinning does not typically result in significant regeneration – that is, growth of new groups or a ‘cohort’ of trees within the stand. Clear cuts result in significant regeneration. In the forest structure-oriented silviculture of today, regeneration harvests can include shelterwoods, partial harvests, variable density thinning, patch cuts, and other harvest design options.

To simplify the reporting of the harvest types that make up the sustainable harvest, three reporting categories are presented:

- Low-volume removal harvest (Harvest Type “A”) – less than 11 thousand board feet per acre (11 mbf/acre) removed
- Medium-volume removal harvest (Harvest Type “B”) – between 11 and 20 mbf/acre removed
- High-volume removal harvest (Harvest Type “C”) – greater than 20 mbf/acre removed

Harvest type “A” is usually the removal of small-diameter trees from the stand. These harvests are typically thinnings in small-diameter closed stands, but may include other harvest treatment depending on the mixture of tree species, site potential, and location of a stand.

Harvest type “B” is typically a thinning in large-tree diameter stands. However, the category may include other harvest methods, for example variable density thinnings, patch-cutting, and clear cuts in hardwood stands. Stand regeneration may be associated with some of these harvest types.

Harvest type “C” represents the harvest design of a larger number of trees and high volume removed from the stand. Harvest methods within this category are typically associated with stand regeneration. Most common harvest methods are clear cuts, partial harvest, shelterwoods, and variable density thinnings. The precise harvest method depends on the mixture of tree species, site potential and location of the stand, and, of course, the management goals for the site.

B.2.5.1 DNR Definitions for Specific Timber Harvest Types

Smallwood Thinning (typically harvest Type A): A partial-cut timber harvest in young stands, typically occurring before maturity criteria have been met (see discussion of maturity criteria in Chapter 2 page 2-11). Smallwood thinning maintains or enhances the growth potential and quality of the trees left in the stand.

Shelterwood Removal Cut (typically harvest Type A): The second or final harvest in a series conducted as part of the even-aged shelterwood system. The purpose is to remove overstory trees that create shade levels that are too high for the new understory trees to thrive.

Seed Tree Removal Cut (typically harvest Type A): The second or final harvest in a series conducted as part of the even-aged seed tree silvicultural system. The purpose is to remove overstory trees that create shade levels that are too high for the new understory trees to thrive.

Selective Product Logging (typically harvest Type A): A timber harvest that removes only certain high-value species above a certain size. This is typically a pole/cabin log sale or an individual high-value tree removal.

Temporary Retention Removal Cut (typically harvest Type A): The second or third harvest in a series conducted as part of the even-aged temporary retention silvicutural method. Some overstory trees are removed to reduce shade levels that are too high for the new understory to thrive. Several removal harvests may be necessary to establish a second stand under an overstory of scattered retention trees.

Late Rotation Thinning (Older Stand Thinning) (typically harvest Type B): A partial-cut timber harvest that extends the stand beyond its maturity criteria to achieve a silvicultural objective (e.g., habitat, visual, protection of sensitivity resource) that requires a stand of large trees. Stands eligible for late rotation thinning are typically at or beyond their maturity criteria.

Phased Patch Regeneration Cut (typically harvest Type B): An even-aged timber harvest method using small patch cuts (1 to 5 acres in size) to progressively harvest and regenerate a single stand over a period (typically 10 to 15 years). Several separate patches are harvested at a single point in time within a forest management unit. After an adequate green-up period (5 to 10 years) of new trees in the cut areas, additional patches are harvested and the process is repeated until the forest unit is entirely harvested.

Variable Density Thinning (typically harvest Type B or C): Thinning to create a mosaic of different stand densities on a scale of approximately 1/4 to 1 acre. The thinning prescription objective is to accelerate structural diversity development in areas where owl habitat is needed or to meet other objectives. Snag, down wood, and underplanting treatments are also typically included in these thinnings.

Salvage (typically harvest Type C): Logging of trees that are dead, dying, or deteriorating due to fire, insect damage, wind, and disease injuries.

Clear Cut (typically harvest Type C): A timber harvest that removes the entire stand of trees except for reserve trees designated for habitat. Reserve trees may be clumped at densities exceeding 8 trees per acre. Reserve trees may be clumped or dispersed throughout portions of the stand at densities less than 10 trees per acre.

Shelterwood Intermediate Cut (typically harvest Type C): The first timber harvest in a series conducted as part of the even-aged shelterwood system. The purpose is to provide shelter (typically shade) and possibly a seed source for the seedlings that are regenerating at the site. Up to 20 trees per acre may be left following this harvest.

Seed Tree Intermediate Cut (typically harvest Type C): The first timber harvest in a series conducted as part of the even-aged seed tree silvicultural system. The purpose is to provide a desirable seed source to establish seedlings. Up to 10 trees per acre may be left following this harvest.

Temporary Retention First Cut (typically harvest Type C): A partial-cut timber harvest in which selected overstory trees are left for a portion of the next rotation. Shelterwood and seed tree harvests are traditional examples with relatively short retention periods (for those trees left after harvest). Habitat objectives increase the length of retention periods up to the time of precommercial or smallwood thinnings. The purpose of this harvest method is to retain overstory trees without slowing the establishment of a new stand. Two-age stands can be an outcome when some level of overstory is left through the entire rotation.

Two Age Management – Westside (typically harvest Type C): An even-aged harvest method that is essentially the same as a temporary retention except that the overstory trees are not planned for removal until the time of the planned rotation for the younger component of the stand. Both will be cut at the same time.

B.2.6 Harvest Deferrals

Table B.2.6-1. Summary of Major Long-Term and Short-Term Deferrals

	Alternatives					
Description	**1**	**2**	**3**	**4**	**5**	**PA**
0.25-mile buffer around location of eagle nests	Indef	-	-	-	-	-
Older forests equal to or greater than 150 years	-	-	-	Indef	-	-
Marbled murrelet occupied sites	Indef	2007	2007	2007	2007	9999
Marbled murrelet reclassified habitat (occupied)	Indef	2007	2007	2007	2007	9999
Marbled murrelet reclassified habitat (non-occupied)	Indef	2007	2007	2007	2007	2007
Additional murrelet reclassified habitat for North Puget and South Puget	Indef	2007	2007	2007	2007	9999
Buffer around Nesting, Roosting, and Foraging Management nest core areas	Indef	2052	2052	2052	2052	2052
300-acre nest patch core areas	Indef	2052	2052	2052	2052	2052
Admin Stat. 1R spotted owl circles (within OESF)	Indef	-	-	-	-	-
Admin Stat. 1R spotted owl circles (outside OESF)	Indef	-	2007	2007	2007	2007
Admin SW spotted owl circles	Indef	-	2006	2006	2006	2006
Memo 1 spotted owl circles	2007	2007	2007	2007	2007	2007
0.25-mile buffer around location of peregrines	Indef	-	-	-	-	-

Note:
When deferred areas are released, the land within the deferred area is classified according to one of three land classes: riparian and wetlands, uplands with specific management objectives or uplands with general management objectives.
Indef = Harvest is suspended for the indefinite future. DNR may reconsider this deferral at some time in the future.
OESF = Olympic Experimental State Forest

Table B.2.6-2. Acres of Land Deferred from Timber Harvest and Acres by Land Classification for Each Alternative

		Acres Deferred from Timber Harvest		Land Classification		
Year	**Alts.**	**Long-term Deferrals**	**Short-term Deferrals**	**Riparian and Wetlands**	**Uplands with Specific Objectives**	**Uplands with General Objectives**
2004	1	486,000	40,000	237,000[1/]	323,000	305,000
	2	281,000	208,000	215,000	343,000	343,000
	3	213,000	301,000	239,000	328,000	310,000
	4	238,000	280,000	238,000[1/]	326,000	309,000
	5	213,000	300,000	239,000	329,000	309,000
	PA	213,000	302,000	238,000	328,000	310,000
2013	1	486,000		251,000[1/]	348,000	306,000
	2	281,000		278,000	477,000	354,000
	3	213,000		346,000[1/]	477,000	354,000
	4	238,000		336,000	464,000	354,000
	5	213,000		346,000	477,000	354,000
	PA	232,000		329,000	475,000	354,000

Data Source: Model output data (State of the Forest)

[1] The majority of the area in riparian and wetlands in these Alternatives is effectively in long-term deferral.

B.2.7 Silvicultural Implementation Strategies

Table B.2.7-1. Summary of the Range of Implementation Strategies Modeled in the Alternatives

Silvicultural Elements		Alternatives 1	2	3	4	5	PA
Thinning – stand level	Removed volume limit[1/]	Up to 35%	Up to 35%	Up to 35%	Up to 35%	Up to 35%	Up to 70% for biodiversity pathways
	Pre-thin stand RD	55	None	55	55	55	55
	d/D[2/]	0.9	0.9	0.9	0.9	0.9	0.8
Thinning harvest – forest level	Priority	Second	Second	Second	First	Third	Second
	Target[3/]	17%	20%	17%	32%	22%	25%
fertilization		Not applied	Not applied	Not applied	Not applied	Applied [4/]	Applied
Reforestation methods		Planted using improved stock	Planted using improved stock	Planted using improved stock	Natural Regeneration	Planted using improved stock	Planted using improved stock
Assessment of sensitive resources [5/]		30%	50%	50%	30%	50%	50%

[1/] The percent is of the pre-thin stand volume.

[2/] The d/D ratio is the average diameter of trees removed (d) vs. trees of the original stand (D). A uniform thinning from below is typically between 0.8 and 1.0; overstory removal is 1.0 and greater.

[3/] The thinning target is expressed as the average percentage of the total harvest target used in modeling the Alternative.

[4/] Applied to Douglas-fir stands on better sites (site class I, II and III).

[5/] The percent represents the area of “uplands with specific management objectives” available for regeneration-type harvests.

B.2.8 Modeling Process: Participants and Acknowledgements

Steering Committee

- The Lands Steward, Bruce Mackey
- The Upland Region Operations Coordinator, Jack Hulsey
- The Policy Director, Rick Cooper, and then Craig Partridge
- Land Management Division Manager, Julie Sandberg, John Baarspul, and then Gretchen Nicholas
- Region Participation, various participants.

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- Dr. Andrew Carey (USDA Forest Service),
- William Hamilton (American Forest Resources),
- Dr. Jim Hotvedt (DNR),
- Dr. Valerie LeMay (UBC),
- Bruce Lippke (UW),
- Roger Lord (Boise Cascade.),
- Dr. Fred Martin (DNR),
- Mike Mossmen (Port Blakely Tree Farms, L.P.),
- Steven McConnell (Northwest Indian Fisheries Commission)
- Pam Overhulser (Oregon Department of Forestry)
- Dr. Don Reimer (DRS Inc.).
- Dr. John Sessions(OSU)

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- Joanne Snarski (to June 2000)
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With assistance from D.R. Systems

- Don Reimer
- Michael Bowering
- Trina Sunderland
- Kristine Allen
- Mark Perdue

B.3 MODELED HARVEST LEVELS

Tables B.3-1 and B.3-2 provide westside sustainable forestry harvest levels by Alternative.

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Table B.3-1. Westside Sustainable Forestry Harvest Levels in Million Board Feet per Year, by Ownership Group, for Period 2004-2067

Trust Group	Ownership Group	Alternative 1							Alternative 2						
		1[1/]	2	3	4	5	6	7	1	2	3	4	5	6	7
Federal Granted Trusts	DNR Central Region	42	41	42	42	43	44	38	66	65	70	71	68	76	75
	DNR Northwest Region	44	41	23	34	32	38	47	56	57	41	60	59	59	53
	DNR Olympic Region	7	8	7	8	7	7	8	17	15	16	13	14	14	13
	DNR South Puget Sound Region	41	40	41	30	27	24	25	34	34	36	35	34	36	36
	DNR Southwest Region	56	55	55	44	43	44	45	65	61	54	66	64	55	56
	Federal Grants as one group														
	Capitol State Forest	39	38	39	39	35	39	37	42	46	47	51	43	43	33
	OESF[2/]	18	20	28	29	29	29	30	63	55	93	89	91	89	97
Forest Board Transfer	Clallam County	7	7	7	6	7	7	6	15	27	16	17	17	19	16
	Clark County	12	12	12	12	11	11	7	13	16	10	13	12	13	6
	Cowlitz County	5	5	5	5	5	5	4	6	6	5	5	5	4	4
	Grays Harbor Co.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson County	5	5	4	4	3	3	4	6	6	7	5	5	5	5
	King County	9	10	10	8	9	5	4	8	8	8	8	8	8	8
	Kitsap County	3	2	2	2	2	1	2	3	4	2	3	3	3	3
	Lewis County	15	15	14	14	14	14	14	21	21	19	20	19	17	20
	Mason County	8	8	7	6	4	3	3	9	9	8	10	9	10	8
	Pacific County	4	4	5	5	5	5	5	8	8	8	9	8	8	8
	Pierce County	4	4	4	4	4	4	4	4	4	4	5	4	6	4
	Skagit County	30	28	20	27	29	30	32	35	37	31	39	38	41	38
	Skamania Co.	5	7	7	7	7	7	7	14	11	15	10	13	15	7
	Snohomish Co.	23	23	23	24	21	23	24	28	30	30	30	29	31	29
	Thurston County	3	3	3	3	3	3	3	6	2	6	2	5	1	2
	Wahkiakum Co.	4	4	4	4	4	4	3	5	5	5	5	5	6	6
	Whatcom County	11	11	11	10	10	10	11	14	16	15	16	16	14	15
All trusts as one Westside group															
Westside harvest level		396	391	374	364	352	360	364	537	541	546	582	568	572	541

Trust Group	Ownership Group	Alternative 3							Alternative 4						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
Federal Granted Trusts	DNR Central Region								62	69	68	56	64	72	54
	DNR Northwest Region								48	49	49	38	50	51	51
	DNR Olympic Region								14	14	13	14	12	14	14
	DNR South Puget Sound Region								24	25	25	25	26	26	26
	DNR Southwest Region								56	58	58	51	58	56	61
	Federal Grants as one group														
	Capitol State Forest								39	38	39	32	38	41	36
	OESF[2/]								10	8	7	9	12	13	12
Forest Board Transfer	Clallam County								17	17	17	17	17	17	17
	Clark County								10	10	10	10	10	10	10
	Cowlitz County								5	5	5	5	5	5	5
	Grays Harbor Co.								0	0	0	0	0	0	0
	Jefferson County								3	3	4	3	4	4	4
	King County								6	6	6	6	6	6	6
	Kitsap County								2	2	2	2	2	3	2
	Lewis County								18	19	17	18	18	19	19
	Mason County								7	7	6	7	7	7	5
	Pacific County								7	7	7	7	7	7	7
	Pierce County								1	1	1	1	1	1	1
	Skagit County								32	32	18	34	33	35	35
	Skamania Co.								3	4	5	4	5	5	5
	Snohomish Co.								27	27	28	27	27	27	21
	Thurston County								3	3	3	3	3	3	3
	Wahkiakum Co.								6	6	6	6	6	6	6
	Whatcom County								13	13	13	13	13	13	13
All trusts as one Westside group		663	737	479	655	883	626	738							
Westside harvest level		663	737	479	655	883	626	738	411	422	406	389	424	437	414

Trust Group	Ownership Group	Alternative 5							Preferred Alternative						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
Federal Granted Trusts	DNR Central Region														
	DNR Northwest Region														
	DNR Olympic Region														
	DNR South Puget Sound Region														
	DNR Southwest Region														
	Federal Grants as one group	260	334	295	254	243	254	265	307	245	214	211	261	244	265
	Capitol State Forest	41	52	44	46	47	46	49	37	48	31	45	30	33	30
	OESF[2/]	136	109	113	112	103	91	47	77	58	105	94	95	91	80
Forest Board Transfer	Clallam County	23	24	23	19	23	23	21	20	19	16	17	14	16	15
	Clark County	13	12	13	12	11	12	15	10	14	7	13	8	9	6
	Cowlitz County	6	6	5	5	6	6	4	5	6	3	4	4	4	2
	Grays Harbor Co.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson County	7	6	6	6	7	7	6	6	7	5	5	5	4	4
	King County	11	12	10	8	10	9	10	10	5	3	7	10	8	10
	Kitsap County	3	3	2	3	4	3	3	2	2	2	2	2	2	2
	Lewis County	22	18	20	19	21	19	21	18	17	18	15	16	13	12
	Mason County	9	8	7	9	10	10	10	5	8	5	4	4	9	3
	Pacific County	9	13	9	7	7	10	6	10	8	8	7	7	7	9
	Pierce County	5	6	5	5	3	5	4	7	3	4	4	4	3	2
	Skagit County	36	50	32	38	38	36	37	49	18	33	34	36	36	32
	Skamania Co.	15	14	15	14	12	18	17	21	13	10	9	19	12	12
	Snohomish Co.	27	40	31	32	29	28	32	27	23	22	22	23	24	24
	Thurston County	4	4	4	4	4	4	5	5	3	4	3	3	4	3
	Wahkiakum Co.	7	9	8	8	6	7	8	6	5	5	5	5	4	5
	Whatcom County	13	18	19	13	16	14	15	14	11	11	11	13	13	13
All trusts as one Westside group															
Westside harvest level		648	738	663	613	598	601	575	636	514	506	511	559	537	528

1/ Numbers represent average annual harvest for each decade period (1= 2004 to 2013, 2 = 2014 to 2023, etc.) except 7, which represents four years (2064 to 2067)

2/ OESF = Olympic Experimental State Forest

Table B.3-2 Westside Sustainable Forestry Harvest Levels in Million Board Feet per Year by State Trust, by Alternative, for Period 2004-2067

	Alternative 1							Alternative 2							Alternative 3							Alternative 4							Alternative 5							Preferred Alternative						
TRUSTS	1[5]	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Agricultural School	9	10	6	7	5	8	6	9	13	13	12	10	12	11	8	20	16	12	23	15	13	12	11	9	6	10	11	12	11	19	18	15	14	9	11	17	15	13	13	10	14	10
Capitol Grant	34	27	22	20	19	19	20	40	32	37	35	29	28	32	47	45	32	38	69	49	50	29	28	25	22	25	23	16	58	50	42	39	34	40	38	58	36	34	31	31	42	39
Charitable/Educational/Penal & Reformatory Instit.	14	10	9	10	7	8	6	15	14	10	9	10	11	11	17	19	8	12	17	11	12	12	12	12	11	9	11	10	16	18	14	12	11	15	16	19	13	11	11	11	15	12
Common School and Indemnity	113	118	118	114	118	113	124	174	162	183	203	203	208	200	180	202	184	241	322	207	339	119	129	128	114	133	148	150	202	242	252	216	209	195	177	197	173	180	184	225	183	185
Community College Forest Reserve	1	3	1	3	2	1	3	1	3	1	3	2	1	3	0	4	1	3	2	1	2	1	1	1	1	4	2	2	0	5	3	3	1	1	4	1	3	2	3	1	1	3
Escheat	2	1	1	0	1	1	1	2	1	1	1	2	1	2	2	1	1	2	2	1	4	1	1	2	1	1	1	3	1	3	2	2	2	1	2	1	1	1	2	2	1	1
Normal School	6	5	8	7	6	8	6	12	9	8	15	11	15	9	11	11	12	16	14	16	13	7	5	7	6	8	10	7	13	12	15	16	16	15	7	9	8	13	10	15	12	17
Scientific School	23	24	18	18	12	14	11	22	27	22	25	27	19	19	28	49	22	23	31	23	24	23	25	23	24	23	17	16	27	43	27	20	28	28	29	32	30	22	20	30	26	37
State Forest Board Purchase	33	28	29	27	21	29	33	37	45	37	46	32	35	31	60	52	21	46	43	41	42	36	33	31	27	31	31	27	45	50	33	40	38	42	50	42	45	27	34	31	34	28
State Forest Board Transfer	159	155	146	149	146	146	140	212	220	214	216	213	219	209	299	308	159	244	328	242	231	167	168	154	172	174	175	166	260	268	235	224	228	242	234	248	178	179	186	193	192	186
University - Original	1	0	1	1	0	1	1	0	3	1	2	1	1	2	1	2	1	1	2	1	1	1	1	1	0	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	1	0
University - Transferred	1	10	16	7	15	13	12	12	12	20	16	28	21	12	9	24	21	17	32	20	7	3	8	15	5	4	7	4	13	28	21	25	16	12	6	12	11	22	17	8	16	10
Grand Total	396	391	374	364	352	360	364	537	541	546	582	568	572	541	663	737	479	655	883	626	738	411	422	406	389	424	437	414	648	738	663	613	598	601	575	636	514	506	511	559	537	528

[5] Numbers represent a decade periods (1= 2004 to 2013, 2 = 2014 to 2023, etc..) except 7 which represents four years (2064 to 2067)

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Appendix C
Overview of Policies and Procedures

Appendix C

C. OVERVIEW OF POLICIES, HABITAT CONSERVATION PLAN STRATEGIES, AND DNR FORESTRY HANDBOOK PROCEDURES THAT APPLY TO RESOURCES ADDRESSED IN THIS ENVIRONMENTAL IMPACT STATEMENT

Appendix C

TABLES

FIGURES

Appendix C

C.1 THREATENED, ENDANGERED, AND SENSITIVE PLANT SPECIES

The federal Endangered Species Act was passed in 1973 to "conserve the ecosystems on which endangered and threatened species depend" and to conserve and recover the listed species. Species may be listed federally as either "endangered" or "threatened." Endangered means the species is in danger of extinction throughout all or a significant portion of its range. Threatened means a species is likely to become endangered within the foreseeable future. Species can also be designated as a species of concern, an unofficial status indicating that the species may be in jeopardy.

The "take" provisions of the Endangered Species Act limit conduct that could harm, wound, kill, or collect listed plant species. The "take" provisions do not apply to listed plant species on forested trust lands, unless the land is part of a project that involves either federal funding or requires a permit issued by a federal agency.

Washington does not have a state endangered species act. However, the Washington Natural Heritage Program, part of Washington DNR, was created in 1981 to collect data about existing native ecosystems and plant species and to provide an objective, scientific basis from which to determine protection needs. The Program classifies rare plants within the state as endangered, threatened, or sensitive and maintains a database of known occurrences. The Program does not have regulatory authority but encourages land managers to conserve rare plants in their natural condition. Transplanting or reintroducing rare plants has met uncertain success and is not a preferred method of recovery or mitigation.

The Washington State Forest Practices Rules do not include specific regulations regarding threatened, endangered, and sensitive plants. However, the State Environmental Policy Act process must be followed for timber harvest activities. The State Environmental Policy Act provides a way to identify possible effects to environmental assets including rare plants. The review process includes disclosure of any known occurrences of listed threatened and endangered plants. Although there are no required actions, this information could be used to reduce likely impacts.

DNR management activities on all forested trust lands follow DNR Forest Resource Plan Policy No. 23, Endangered, Threatened, and Sensitive Species. It states that,

> "The Department will meet the requirements of federal and state laws and other legal requirements that protect endangered, threatened and sensitive species and their habitats. In addition, the Department will voluntarily participate in efforts to recover and restore endangered and threatened species to the extent that such participation is consistent with trust obligations."

C.2 RIPARIAN AREAS

The DNR Forest Resource Plan policy relevant to riparian areas is Policy No. 20, Riparian Management Zones. This policy requires the establishment of Riparian Management Zones along Types 1 through 4 waters and where necessary along Type 5 streams. Within these zones, DNR is required to focus its efforts on protecting non-timber resources such as water quality, fish, wildlife habitat, and sensitive plant species. This policy is realized today through the implementation of DNR's Habitat Conservation Plan.

Under the Habitat Conservation Plan (DNR 1997), riparian zones are protected through the Riparian Conservation Strategy and the implementation of Riparian Management Zones along each side of a stream. The width of a Riparian Management Zone along Types 1 through 3 streams within the Westside HCP Planning Units –excluding the Olympic Experimental State Forest– is equal to the average height of an adjoining conifer stand at a 100-year site index or 100 feet, whichever is greater. For Type 4 streams, zones are 100 feet wide. Riparian Management Zones start at the outer edge of the 100-year floodplain. In addition, 50-foot (for Type 3 streams greater than 5 feet wide) or 100-foot (for Types 1 and 2 streams) "windthrow buffers" are required on the windward side of streams that have at least a moderate risk of blowdown. Under the Habitat Conservation Plan, the first 25 feet of a Riparian Management Zone is a no-harvest zone where only ecosystem restoration activities are permissible. The next 75 feet is a minimal-harvest zone where ecosystem restoration and single-tree selection are permitted. The remaining portion of the Riparian Management Zone is a low-harvest zone where ecosystem restoration, single-tree selection, group selection, thinning, and salvage harvest are permitted. Yarding corridors, and road-stream crossings are allowed throughout a Riparian Management Zone. See the Habitat Conservation Plan (DNR 1997, pages IV.49 to IV.62) for additional details.

The riparian conservation strategy for the Olympic Experimental State Forest is different from the other five Westside HCP Planning Units, because of the unique physical and ecological features of the western Olympic Peninsula. These differences are primarily related to the high potential for mass wasting and windthrow (DNR 1997, page IV.106). Within the Olympic Experimental State Forest, streams receive protection through interior-core buffers and exterior buffers. Prescriptions are more flexible than the other five Westside HCP Planning Units in order to be consistent with the experimental nature of management in the Olympic Experimental State Forest. Interior-core buffer widths are developed on a site-specific basis and vary depending upon channel size, valley confinement, and landform characteristics. Exterior buffers are designed to protect the integrity of interior-core buffers from damaging winds and maintain riparian functions. Widths average 150 feet for Types 1, 2, and 3 streams, and 50 feet for Types 4 and 5 streams.

Procedures 14-004-150 (five Westside HCP Planning Units, excluding the Olympic Experimental State Forest) and 14-004-160 (Olympic Experimental State Forest) for Identifying and Protecting Riparian and Wetland Management Zones have been developed to implement the Forest Resource Plan policy and Habitat Conservation Plan conservation strategy. Currently, the riparian conservation strategy for the Habitat Conservation Plan has not been completely implemented. Procedure 14-004-150 is interim until the permanent procedure is developed and approved by the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration – Fisheries Service. Under the current interim procedure, timber harvest is not allowed within Riparian Management Zones except for road and bridge building. Other forest management activities are permissible with specific approval by the State Lands Assistant in each DNR Region.

Riparian forest management activities that could be implemented in riparian areas of the six Westside HCP Planning Units include road building and stream crossings, yarding corridors, restoration, invasive and competing plant control, fertilization, and varying levels of timber harvest (minimal and low). Development of permanent roads removes trees along the road corridor, disturbs stream banks, and may provide a pathway for the transport of water and sediment from the roadway to a stream. Yarding corridors also remove trees, but may contribute to soil disturbance or compaction along yarding corridors if full suspension of the logs is not achieved. Yarding corridors are generally used when cross-stream yarding is more economical and less damaging to the environment than building a road.

The Habitat Conservation Plan allows forest management activities that maintain or restore the quality of salmonid habitat within the Riparian Management Zone, including timber harvest in some sub-zones of Riparian Management Zones (DNR 1997, pp IV.59 and IV.60). Within five of the six westside planning units (i.e., excluding the Olympic Experimental State Forest), "silvicultural practices that might be appropriate for Riparian Management Zones may include precommercial thinning, commercial thinning, partial cuts, single tree selection harvesting, and stand conversion" (DNR 1997, p. IV.208). Consequently, regeneration harvests are not allowed within Riparian Management Zones under the Habitat Conservation Plan (but were conducted prior to this plan under the Forest Practices rules in place at the time of harvest). Restoration activities can include conversion of hardwood-dominated stands to conifer and pre-commercial or commercial thinning to accelerate the growth of riparian trees (DNR 1997, p. IV.208). Thinning reduces stocking levels and competition while increasing growth rates for remaining trees (Carey et al. 1996, Thysell and Carey 2000).

The Habitat Conservation Plan strategies envisioned partial cuts and single tree harvest in Riparian Management Zones to increase wind-firmness and develop older forest conditions or for other reasons (DNR 1997, pp IV.60, IV.209). In the no-harvest zone, only road construction, yarding corridors, and restoration activities are permitted. In the minimal-harvest zone, single tree selection is permitted in addition to roads, yarding, corridors, and restoration activities. The remaining sub-zone of the Riparian Management Zone (low-harvest zone) and any associated wind buffer may include the activities of the other sub-zones plus partial harvests.

Within the Olympic Experimental State Forest, there are no programmatic restrictions on harvest activities within the interior-core and external riparian buffer zones. However, a 12-step process (DNR Procedure 14-004-160) is followed for conducting environmental assessments, designing buffer widths, and developing silvicultural and road development prescriptions plus monitoring, documentation, and review requirements.

C.3 WILDLIFE SPECIES AND HABITATS

This section describes the policies and procedures that govern DNR's management of wildlife resources on western Washington forested state trust lands, as well as those that indirectly influence wildlife species by directing DNR's management of the habitats upon which wildlife depend.

Forest management activities on forested trust lands are governed principally by the policies in the Forest Resource Plan. The Habitat Conservation Plan provides strategies to achieve specific conservation objectives for identified species and habitats within the range of the northern spotted owl. These and other strategies are implemented by procedures in the Forestry Handbook. Collectively, policies in the Forest Resource Plan, and the procedures outlined in the Forestry Handbook to implement the Habitat Conservation Plan conservation strategies, influence the quality and distribution of wildlife habitat on the western Washington forested state trust lands.

Two Forest Resource Plan policies specifically govern management of wildlife on forested trust lands:

- Forest Resource Plan Policy No. 22 directs DNR to provide wildlife habitat conditions that have the capacity to sustain native wildlife populations or communities. Where wildlife habitat management objectives appear to conflict with trust management obligations, DNR is to seek balanced solutions.
- Forest Resource Plan Policy No. 23 makes explicit DNR's commitment to meeting the requirements of federal and state laws and other legal requirements that protect endangered, threatened, and sensitive species of wildlife and plants and their habitats (see Section C.1 [Threatened, Endangered, and Sensitive Plants] for a summary of the Endangered Species Act as it applies to DNR actions). The policy further directs DNR to participate in efforts to recover and restore these species, to the extent that such participation is consistent with trust obligations.

The Habitat Conservation Plan is a plan for forested trust lands that allows timber harvesting and other management activities to continue while providing for species conservation as described in the Endangered Species Act. To this end, the Habitat Conservation Plan identifies conservation goals and strategies for the conservation of northern spotted owls, marbled murrelets, other federally listed species, and certain unlisted species of concern, as well as habitat for riparian-associate species. The intended aggregate effect of these conservation strategies is the creation of landscapes containing interconnected patches of late-successional forest, along with early and mid-seral stage forest habitat in other managed forestlands.

More than 20 DNR procedures have been developed to implement the Forest Resource Plan policies and Habitat Conservation Plan conservation strategies designed to manage wildlife and their habitat on western Washington forested state trust lands. Procedures that apply to species and habitats addressed in this Environmental Impact Statement are identified in the appropriate discussions below. Only one procedure specific to wildlife (Procedure 14-004-120, Management Activities Within Spotted Owl Nest Patches, Circles, Designated Nesting, Roosting, and Foraging and Dispersal Management Areas) is under consideration for revision under the proposed Alternatives. Current implementation of this procedure for the northern spotted owl, as well as discussion on recent population trends and status, is described in the research report provided in Section C.3.2. In addition, the conservation strategy for the marbled murrelet under DNR's Habitat Conservation Plan is attached.

Procedures for management of forest, riparian areas, and wetlands influence wildlife habitat conditions. See Section 4.2 (Forest Structure and Vegetation) of the Final Environmental Impact Statement for a discussion of the policies, procedures, and tasks that relate to the management of forest structure classes, old forest, and legacy trees, as well as forest management within riparian and wetland zones. Sections C.2 (Riparian Areas) and C.7 (Wetlands) provide additional information about the management direction for these habitat types.

C.3.1 Uncommon and Non-Forested Habitats

The following DNR procedures address unique and uncommon habitats; none of these is under consideration for revision under any of the Alternatives addressed in this Environmental Impact Statement:

- 14-004-170 Protecting Talus Fields,
- 14-004-180 Protecting Caves,
- 14-004-190 Protecting Cliffs,
- 14-004-200 Protecting Oak Woodlands,
- 14-004-220 Protecting Balds (i.e., grass- or moss-dominated forest openings), and
- 14-004-230 Protecting Mineral Springs.

C.3.2 Northern Spotted Owl

DNR's report summarizing the analyses in the Habitat Conservation Plan's Draft Environmental Impact Statement regarding northern spotted owl population performance and level of take on forested trust lands is attached.

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Research Report

COMPARISON BETWEEN THE HCP DEIS ANALYSES AND PROJECTIONS OF NORTHERN SPOTTED OWL POPULATION PERFORMANCE AND THE CURRENT POPULATION DATA FOR WASHINGTON STATE

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June 2004

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This report summarizes the analyses in the Habitat Conservation Plan's Draft Environmental Impact Statement (DNR, 1996) regarding northern spotted owl population performance and level of take on DNR-managed land and compares the projections on the species demography trend made in 1996 with the recent data on spotted owl occupancy and population status in Washington. This comparison is intended to help DNR decide to which extent the agency can rely on the HCP DEIS analyses from 1996 to assess the effects of the proposed sustainable harvest alternatives on spotted owl population.

The first part of the report describes the methods used to evaluate the impacts of the current HCP on spotted owl population on DNR-managed lands and the projected outcomes within 100 years of HCP implementation.

The second part of the report summarizes the results from the range wide owl demography studies since the HCP DEIS was published as well as the results from the DNR's monitoring on spotted owl occupancy and reproduction in the Eastside Planning Units and Olympic Experimental State Forest in the recent years. No monitoring data are available for the Westside Planning Units.

1. ANALYSES AND PROJECTIONS OF THE HCP IMPACT ON NORTERN SPOTTED OWL ON DNR-MANAGED LANDS

1.1. Westside and Eastside Planning Units

At the time the HCP was proposed, the considered reasonable management alternatives were:
A – No Action (continue current management intensity with avoidance-of-take approach)
B – Current HCP
C – Current HCP with increased level of conservation

The impacts of the three alternatives were analyzed for six criteria:
1. Change in amount and distribution of NRF habitat
2. Impacts to current and future spotted owl activity centers
3. A qualitative comparison of provision of dispersal habitat
4. Qualitative comparisons of demographic support
5. Maintenance of species distribution
6. Forest health and risk of catastrophic disturbance (Eastside Planning Units only)

1.1.1. METHODS

Criterion 1: Change in amount and distribution of Nesting, Roosting, and Foraging (NRF) habitat

The amount and distribution of suitable owl habitat that would be provided under each alternative was the most influential factor in determining the impacts.

Methods for estimation of the amount of suitable owl habitat

"Suitable habitat" was defined as a mix of habitat qualities that provide for some or all of the life needs of the spotted owl. This definition did not include habitat that only meets dispersal function.

Two main methods for estimation of suitable owl habitat were used for the westside planning units:

1. Age class method
   The age class of the primary tree species in a stand was used. The 70-200 year old forest was considered submature habitat that provides for roosting, foraging, and some nesting. 200 years and older forest was considered high quality nesting habitat.
2. Multiple data source method
   Data from several sources (DNR field verification, USFWS habitat mapping, DNR age class data, satellite data, etc.) were compared and combined using GIS technology.

For the Eastside planning units the first method was not used because many of the forests were in uneven-aged stands and it was not possible to use the age-class distribution as a surrogate for habitat growth.

The distribution and conservation of the spotted owl habitat on federal land was considered in the impact assessment. The final Draft Recovery Plan for the Northern Spotted Owl (USDI, 1992) determined that the entire critical habitat in WA was on federal lands. A system of Late Successional Reserves was established within the range of the northern spotted owl under the Northwest Forest Plan (USDA and USDI, 1994): 66% of the suitable NRF habitat and 61% of known spotted owl site centers on federal lands within reserve areas were protected. Overall the FSEIS for the Northwest Forest Plan (USDA, USDI, 1994) determined that there was 83% likelihood of providing habitat that is of sufficient quality, distribution, and abundance to allow the species population to stabilize.

The HCP followed the principles propounded by the Northern Spotted Owl Recovery Team (USDI, 1992) that nonfederal lands will support spotted owls that reside on federal lands. The distribution of suitable owl habitat was estimated within 2 miles of federal reserves in Westside and 1.8 miles in Eastside planning units. 2-4 mile distance was used for the remainder of the habitat likely to be used by spotted owls with activity centers between federal reserves and DNR-managed lands on the Olympic Peninsula. These areas were designated as NRF management areas (NRF MA).

Criterion 2: Impacts to current and future spotted owl activity centers

Methods for assessing Incidental Take outside NRF management areas

Owl circles drawn around known territorial spotted owl site centers and approximating the median home range of the subspecies were used in the analyses. The circles had 1.8-mile radius in the Westside, 2.0-mile radius in the Eastside and 2.7-mile in Western Washington Lowland Province. The total amount of suitable habitat within each circle (for all ownerships) was estimated using the multiple source data method (see above).

The amount of habitat on DNR-managed land was estimated using "70-year old stands" method and was substituted for the acreage derived from multiple source method. The resulted acreage was calculated as a percentage of the total amount of suitable habitat within the circle. It was assumed that the entire habitat that currently exists on DNR-managed lands within known owl circles outside the NRF management areas would be harvested over the term of the HCP. Spotted owls were deemed at a risk of incidental take (USDI, 1990) when (1) harvest of habitat on DNR-managed lands within a circle reduces the level of habitat from above the 40% threshold to below the 40% threshold; and (2) harvest of habitat on DNR-managed lands occur within owl circles that are already below a 40% habitat level.

Methods for projecting the number of affected owl site centers inside NRF management areas

Near-term impacts

The following simplified assumptions were made – the site center location would remain static; the harvest would only occur in WAUs in which sufficient amount of habitat is available based on assessment of conditions in 1996. The target level of 50% suitable habitat per Watershed Administrative Unit (WAU) in NRF management areas was established and harvest was allowed if the habitat was in excess of this level. The estimation of the incidental take was based on the criterion whether the harvest in the WAUs where excess habitat is available would decrease amount of habitat in individual owl circle below the 40% threshold.

Long-term impacts

The number of future spotted owl sites that could be negatively affected in the long term was estimated as dependent on 1) current population trends, 2) how quickly habitat conditions improve on federal reserves to the point that the population stabilizes, and 3) where the new sites are established relative to NRF management areas and federal reserves. Estimating the potential incidental take in the long term based on these factors was admitted to be a speculative process.

The first step was to project the number of known sites that would be at risk for incidental take of resident spotted owls if all NRF management areas were at their target habitat condition. The second step was to construct a model to predict how the number of owls would change over time given what was known from demographic modeling, probable changes on federal reserves and nonfederal lands, and population dynamics in general. A lot of information needed for truly accurate assessment was missing due to insufficient knowledge.

Three simplified assumptions were made – (1) after the first decade the owl habitat on DNR-managed lands outside NRF management areas will be insufficient to support spotted owls; (2) source-sink population dynamics concept was adopted and it was anticipated that federal reserves will support a source sub-population and the DNR-managed land will support a sink sub-population; (3) the annual rate of population change (λ) was approximated to the results presented in demography report of Burnham et al. (1994) in the FSEIS for the Northwest Forest Plan.

There were two long-term demographic study areas used in the federal monitoring program for the northern spotted owl that applied to Washington spotted owl provinces in 1996 – the Olympic Peninsula study area and the Cle Elum study area. Olympic Peninsula study area included some of the DNR owl sites in the Olympic Experimental State Forest adjacent to Forest Service lands. DNR used the demography data from these two study areas to analyze the potential take. The value of λ from Cle Elum study area was used to define the owl population status in the eastside planning units. The point estimate was 0.924 - a negative 7.6% annual rate of change; the 95% confidence intervals of λ were 0.8610 and 0.987. For the westside planning units the value of λ was averaged for the two study areas to give a rate of population change of 0.9356 - an annual rate of decline of 6.4%. The 95% confidence intervals for the westside were 0.8789 and 0.9922. As discussed in the FSEIS for the Northwest Forest Plan (USDA and USDI, 1994) such rapid rates of decline seemed inconsistent with the observations from population density studies at that time. The upper limits of the confidence intervals were considered to be closer to the reality than the midpoint. They equaled to annual rate of decline of 0.8% for the westside and 1.3% for the eastside. DNR used these upper limits in their analysis.

A model was developed to predict the change in the number of owl activity centers over time. In the model, the number of activity centers was multiplied by λ each year. This yielded the number of activity centers expected in the next year. The value of λ started at 0.992 for the westside and at 0.987 for the eastside and increased over time as habitat develops on federal lands. Five scenarios were developed to relate λ to owl population changes on federal habitat. Each scenario specified a set of conditions which determined the point in time when the population should be stable, i.e. $\lambda = 1.0$. Beyond this point in time λ continued to increase at the same rate until federal lands reach their maximum habitat capability. The initial number of spotted owl sites for this model was 74 for the westside (66 known sites + 30 projected sites – 22 sites that were considered lost to incidental take during the first decade); for the eastside the initial number of owl sites was 31.

Criterion 3: Provision of dispersal habitat

Dispersal habitat provides for successful movement of juvenile spotted owls among clusters, or subpopulations and is a separate category from NRF. This habitat category describes forest types that provide adequate cover and forage for dispersing juveniles, but does not contain the structural characteristics that are required for suitable NRF habitat.

Methods for delineation of dispersal habitat

Distribution and the amount of the Dispersal management areas on DNR-managed lands were determined using the recommendations described in the Final Draft Recovery Plan for Northern Spotted Owl (USDI, 1992) and the recommendations of the Washington Forest Practices Spotted Owl Science Advisory Group (Hanson et al., 1993). Most of the dispersal habitat on DNR-managed lands was delineated within areas listed as “of main concern for connectivity between Designated Conservation Areas” (USDI, 1992).

Given the state of knowledge in 1996 it was not possible to use the amount of spotted owl dispersal habitat for comparison among proposed alternatives.

Criterion 4: Demographic support to the population
Demographic support refers to the contribution of individual spotted owl territories or cluster of territories to the maintenance of the overall spotted owl population. Nonfederal lands were recognized as important for the demographic support because of (1) the risks to the populations on federal lands given the existing management plans and (2) in some portions of the northern spotted owl's range federal lands alone are not sufficient for the recovery of the population (USDI, 1992).

The contribution of NRF habitat on DNR-managed lands was analyzed in the context of metapopulations and source and sink dynamics. In general, areas with larger continuous habitat patches that support clusters of 20 or more spotted owls were considered to have a likelihood of being self-sustaining (Thomas et al., 1990). A plausible assumption was made that many of the owl habitats on federal reserves would act as source areas. DNR-managed lands within 4 miles of the federal reserves that provide habitat for spotted owls were expected to act more often like sink areas because the small amount of DNR-managed lands in suitable habitat and because of its fragmentation. They were anticipated to provide demographic support to the population at least occasionally. Recommendations of the Spotted Owl Recovery Team (USDI, 1992) and Spotted Owl Advisory Group (Hanson et al., 1993) for nonfederal lands with respect to demographic support were taken into consideration during the designation of NRF management areas.

Criterion 5: Maintenance of species distribution
Maintaining distribution of the spotted owl population throughout the range of ecological conditions and geographic locations in which the owl has historically resided is important to conservation of the species because it reduces the risk of widespread extirpation (USDI, 1992). The Recovery Team identified several areas that are of key distributional concern to the spotted owl population (USDI, 1992). Nonfederal lands played a role in all these areas. These recommendations as well as the analyses of the Washington Forest Practices Spotted Owl Science Advisory Group (Hanson et al., 1993) and federal Reanalysis Team (Holthausen et al., 1995) were taken into consideration for NRF and dispersal habitat designation.

Criterion 6: Forest health and risk of catastrophic disturbance
Historically, wildfires have played a central role in the landscape dynamics of the eastern Washington Cascades. Forest fire suppression and silvicultural techniques in the last decades have altered the natural patterns of community succession and made forests susceptible to wildfire, insect attack, disease and wind throw (FEMAT, 1993).

Natural disturbance, caused preliminary by wildfires, was thought to be one of the most severe threats to the continued existence of spotted owls in the eastside (USDI, 1992). An active management was considered necessary to reduce the risk. The Recovery Team recommended different strategies, some of which would protect future suitable owl habitat by initially degrading owl habitat, i.e. underburning, thinning, etc.

1.1.2. CONSEQUENCES

Criterion 1: Change in amount and distribution of NRF habitat

Westside Planning Units

A total of 186,000 acres of potentially suitable owl habitat was estimated on DNR-managed land in the westside planning units using the age class method. Approximately 366,000 acres were estimated to be suitable habitat using the multiple source data method. The second method was considered a less accurate value.A total of 163,000 acres of DNR-managed land in the Westside was designated to be managed as NRF management areas under the HCP.

Of that amount, 68,487 acres were classified as suitable spotted owl habitat at the time HCP was written

This left a total of 117,513 acres of suitable habitat outside NRF MA that were available for immediate harvest after the HCP was approved.

A threshold target of 50% of the designated acres were supposed to meet NRF habitat criteria at any one time. This 50% target totaled 81,500 acres.

The net acres remaining to be developed in order to meet the HCP spotted owl conservation strategy goal of 81,500 acres were estimated to be 13,013 acres.

At the time the HCP was developed, there were 35 WAUs in which NRF MAs contained less than the required 50% habitat threshold . There were 13 WAUs in which NRF MAs were above the 50% habitat threshold, and adjacent federal reserves were above this threshold as well. In 16 WAUs, the NRF MAs had more than the required 50% habitat threshold and the adjacent federal reserves had less than 50% suitable owl habitat.

DNR growth models in 1996 predicted that over the next 100 years all WAUs that include NRF MAs should reach the 50% habitat threshold. Overall net change in habitat was estimated to be negative 63-77%.

Eastside Planning Units

A total of 67,400 acres of forest were classified as owl habitat in the eastside planning units.

A total of 39,200 acres of DNR-managed land were designated to be managed as NRF MA.

Of that amount, 19,400 acres were classified as owl habitat at the time the HCP was written.

This left 48,000 acres of suitable spotted owl habitat outside NRF MAs available for immediate harvest after the HCP was approved.

A threshold target of 50% of the designated NRF MAs were supposed to meet the NRF habitat criteria at any one time, this equaled 19,600 acres.

The net acres that needed to be developed in order to meet the HCP spotted owl conservation strategy goal of 19, 600 acres were estimated to be 200 acres.

At the time HCP was written 5 WAUs, out of 35 WAUs that included NRF MAs, were above the 50% habitat threshold. This resulted in 2,100 acres available for harvest. Adding that amount to the 48,000 acres of habitat outside NRF MAs, which was available for immediate harvest, resulted in 51,500 acres of suitable spotted owl habitat at risk for harvest in short term - a negative 74% change.

The amount of suitable habitat in 1996 was estimated to be 99% of the threshold amount of 19, 600 acres. The short-term harvest was projected to reduce this percentage to 88%. DNR growth models in 1996 predicted that over the next 100 years all WAUs that include NRF MAs should reach the 50% suitable NRF habitat threshold at which time the overall net change in habitat will be a negative 71%.

Criterion 2: Impacts to current and future spotted owl activity centers

Westside Planning Units

At the time HCP was written there were 145 known territorial spotted owl site centers (WDFW Status 1, 2 or 3) that influenced DNR-managed lands in the five westside planning units (i.e., these sites occurred either on or within a median home range radius of DNR-managed lands). A total of 79 of these site centers had owl circles outside of the proposed NRF MAs; 66 were located inside NRF MAs.

There were 42 additional sites projected to exist that were potentially influenced by DNR-managed land.

A total of 51-55 sites of the known 79 sites located outside of NRF MAs were determined to be at risk of take in the near term (within the first decade of the HCP implementation). 36 sites of known 66 sites within NRF MAs were located within WAUs that exceeded the 50% threshold values for suitable habitat. Only in 15 of these 36 would the harvest on DNR-managed land reduce the amount of habitat within the individual owl circle below the 40% habitat threshold. For this reason only 15 owl circles were counted as being at risk of take in near term. An additional 15 of the projected 42 unknown owl circles were classified as being at risk of take.

Table C.3.2-1. Projected impact on spotted owl site centers in the Westside Planning Units

Owl sites	Known in 1996	Predicted to be affected by Incidental Take		Projected unknown sites
		In near term (first decade)	In long term (no modeling)	
Within NRF management areas	66	15	7 – 16*	30
Outside NRF management areas	79	51-55*	0	12
Total	145	66-70*	7-16*	42

* this difference comes from the two different methods for estimating suitable owl habitat –age class method and multiple data source method.

These calculations resulted in 81-85 of 187 known and projected resident owl site centers to be put at risk for incidental take. A total of 66-70 owl site centers (45-48%) were put at risk for take in near term. The harvest in these owl sites would likely take place in the first 10-20 years. Most of the sites that would be lost or impaired are located farther than 4 miles from federal reserves. Thus, it was assumed that the HCP would result in a rapid decrease of the number of spotted owls contributing to the overall population in areas distant from the boundaries of federal lands in the Western Cascades. Support to the population in the northeastern portion of the Olympic Peninsula (Straits Planning Unit) would also decrease, though many of these owl sites were located in close proximity of suitable habitat on federal land, so the overall impact to the population was not intended to be as high as it would be in areas with little federal land and little prospect or the development of suitable habitat in the future.

The long-term impacts in owl site centers were analyzed in two steps. During the first step of analysis (assuming that all WAUs will be at the 50% habitat threshold) 7 to 16 owl circles (depending on the method used) were determined to be at risk of take (Table C.3.2-1).

During the second step, the results from the model with 5 scenarios for population change on federal lands were considered. These scenarios indicated that the population could continue to decline for anywhere from 5-50 years. One of the five modeled scenarios for population change showed that the number of territorial owls that were within the NRF MAs would never exceed the number of current sites. In the other four scenarios the present number of territorial owls would be exceeded by years 15, 24, 38, and 70 respectively. The worst-case scenario in which the population was not supposed to stabilize for 50 years defined the low end of DNR’s estimate: the number of spotted owls sites in NRF MAs would decrease to 60 by the end of the fifth decade and then increase to 73 by the end of the analysis period (100 years). Under this scenario 8-18 sites would be at risk for take. The maximum number of spotted owl home ranges that could overlap NRF MAs given a rapid recovery of the population (e.g. the population growth rate exceeds 1 within 10 years) delimited the high end of an estimate. Under the two most optimistic scenarios, the number of owl sites influencing NRF MAs would reach 150 at year 36 or 54. Under these scenarios, between 17 and 36 owl sites could be at risk for harm.

It was estimated that under the current HCP the NRF MAs would likely be in adequate condition to contribute individuals to the metapopulation over the course of 100 years (the span of the HCP).

<u>Eastside Planning Units</u>
At the time the HCP was written there were 78 known owl circles (WDFW Status 1, 2 and 3) that included DNR-managed lands. A total of 18 of these circles had their site centers located on DNR-managed lands.
A total of 23 unknown site centers were projected to exist within the median home range radius of DNR-managed lands.

A total of 33 of the known 78 site centers did not have circles that overlapped NRF MAs. Incidental take was expected for 20 of these site centers, and 10 site centers had a potential for incidental take.

Exactly 45 of the known owl circles overlapped the boundary of the NRF MAs. For 12 of these owl circles, incidental take was expected, and 8 owl circles had the potential for incidental take. The majority of the incidental take was expected to occur through the harvest of habitat outside of NRF MAs.

A total of 10 of the projected 23 unknown site centers could be at risk of take, and an additional 6 had the potential risk of take.

These calculations resulted in 42 known and projected site centers to be taken in near term and additional 24 site centers had the potential to be taken in long-term (Table C.3.2-2).

Table C.3.2-2. Projected impact on spotted owl site centers in the Eastside Planning Units

Owl sites	Known in 1996	Known sites predicted to be affected by Incidental Take		Projected unknown	Unknown sites predicted t be affected by Incidental Take	
		In near term (first decade)	In near term - potential take		Incidental Take	Potential Incidental Take
Within NRF management areas	45	12	8	11	3	2
Outside NRF management areas	33	20	10	12	7	4
Total	78	32	18	23	10	6

The long-term impacts in owl site centers were modeled again by relating λ with 5 scenarios for development of the owl habitat on federal reserves. The first scenario projected that the owl habitat would continue to decline for up to 50 years, so under this scenario $\lambda = 1$ at year 50. The other four scenarios differed in the forest age and amount of habitat necessary to support stable owl populations and projected a stable owl population in 20 to 58 years. The results for the impacts on owl site centers were wide ranging. The decline of the owl numbers in NRF MAs could continue for 20-50 years. The number of site centers in year 50 could range from 24 to 40. Based on the average of the 5 scenarios, the number of current site centers might not return to the 1996 level until year 100.

Criterion 3: Provision of dispersal habitat

Westside Planning Units

A total of 115,851 acres of Dispersal management areas were provided on DNR-managed lands under the HCP. Exactly 50% of these lands within each WAU were to be maintained in stand conditions that meet the definition for dispersal habitat. That resulted in 57,925 acres of dispersal habitat to be provided at any one time. The distribution of the dispersal management areas on DNR-managed lands matched, and in some cases exceeded, the recommendations described in the Final Draft Recovery Plan for Northern Spotted Owl (USDI, 1992).

Eastside Planning Units

A total of 85,000 acres were designated to be managed specifically for dispersal habitat under the HCP. A threshold target of 50% of these areas, measured by quarter township, were to be maintained as dispersal habitat at any one time. Nearly all DNR-managed lands in Dispersal management areas are located in the areas that the recovery team (USDI, 1992) and the Spotted Owl Advisory Group (Hanson et al., 1993) recommended for maintenance of dispersal habitat.

Criterion 4: Demographic support to the population

Westside Planning Units

The majority of NRF MAs were designated within 2 miles of federal reserves, some occurred within 4 miles, and a small percentage fell within the 4-6 mile distance band. There were no NRF MAs designated in the Straits and South Coast planning Units.

NRF MAs on DNR-managed lands in the five westside planning units were designated in all of the areas identified by the recovery team (USDI, 1992) as important for demographic support with the exception of SW Washington, which had no NRF MAs designated.

Under the current HCP, the amount of habitat on DNR-managed lands located within 2 miles of federal reserves was estimated to decrease from between 27 and 34% to 24.7%. Habitat within 4 miles of federal reserves was estimated to decrease from between 24 and 35% to 18.7%. The decrease in the total amount of habitat from the current condition was caused mainly by the lack of NRF MAs in the Straits planning unit.

Neither of the alternatives discussed in the HCP DEIS (including the current HCP) were likely to significantly improve DNR-managed land as potential source areas for spotted owls that would interact with the federal population.

Eastside Planning Units

DNR-managed lands within 2 miles of federal reserves were designated as NRF MAs in the landscapes considered by the Spotted Owl Scientific Advisory Group to be important for demographic support. In Chelan and Yakima planning units, DNR established NRF MAs in the two areas where the Recovery Team directed the nonfederal land to provide demographic support. Additional NRF MAs were established in Klickitat planning unit. At least 50% of these lands in each WAU would be maintained as NRF habitat at any one time.

Criterion 5: Maintenance of species distribution

Westside Planning Units

The HCP spotted owl conservation strategy intended to manage DNR lands to contribute to the maintenance of the species distribution by (1) providing a steady amount of spotted owl habitat near federal reserves in the North Puget, South Puget and Columbia planning units; (2) providing lower elevation NRF MAs compared to federal reserves and thus providing a wider elevation gradient of suitable owl habitat; (3) providing NRF MAs in areas with no federal reserves; (4) designating dispersal Management areas between and among federal reserves to facilitate the movement of juvenile spotted owls.

By not designating NRF MAs in the South Coast planning unit or in the western portion of the Columbia planning unit, the HCP left a significant gap in the potential DNR contribution to the maintenance of species distribution in Washington State. The HCP alternative was expected to lead to the most rapid loss of sites and thus contribute the most to increasing the risk of extirpation of the population from the western WA Lowland Province.

Eastside Planning Units
NRF MAs in the eastside planning units contribute mainly toward the maintenance of the species current range.

Criterion 6: Forest health and risk of catastrophic disturbance
In WAUs where natural or human caused disturbances reduce suitable habitat below the 50% minimum threshold, spotted owl habitat would be redeveloped.

1.2. Olympic Experimental State Forest

The considered reasonable management alternatives were:
A – No Action (continue current management intensity with avoidance-of-take approach)
B – Zoned Forest (special management areas set aside for habitat protection)
C – Unzoned Forest (current HCP)

The impacts of the three alternatives were analyzed for three criteria:

1. Abundance and distribution of habitat
2. Population trends
3. Estimates of the risk for incidental take of spotted owl sites

1.2.1. METHODS

Technique 1: General evaluation of habitat capability
An estimate of the current amount and distribution of forest stands of young and old-forest habitat in the OESF has been derived from analysis of Landsat Thematic Mapper satellite imagery (WDFW, 1994). Projections of the future amount and distribution of these stand-types under the proposed alternatives were made for 100 years ahead and analyses were conducted at the state of pair ranges, approximated by a circle of 2.7 miles radius.

Technique 2: Computer simulations of the spotted owl histories
The alternatives for spotted owl management in the OESF were analyzed with the model developed by Schumaker (1995) that incorporated both spatial and temporal effects on the spotted owl population. The simulation model was designed for use with raster GIS data that represented land cover and consisted of three separate modules that conducted habitat analysis, movement simulation, and demographic simulation.

A key feature of the demography module was its ability to link certain life history parameters (survivorship, fecundity, and site fidelity) to habitat quality. The parameters for minimum and maximum adult survivorship were chosen to approximate that of Burnham et al. (1994) for the Olympic Peninsula. They estimated the annual rate of population change $\lambda = 0.9472$ which corresponds to 5.3% decline per year.
By 1996 there were several published estimates of the number of spotted owl pairs on the Olympic Peninsula: the estimate of Thomas et al. (1990) was of 172-200 pairs; a later estimate by the Recovery Team (USDI, 1992) was 200±25 pairs and; Holthausen et al.

(1995) estimated 280-320 nesting spotted owl pairs on the Olympic Peninsula (all ownerships). DNR did not use the number of spotted owl pairs in its analyses – the number suitable owl sites estimated by the simulation model was used instead (see below).

Technique 3: Estimation of the risk for incidental take of spotted owls
The evaluation criteria of the USFWS to estimate the risk of incidental take (USDI, 1990) were used for this analysis Their criteria are based on maintaining a threshold proportion of suitable habitat in home range-sized circles around known owl sites – harvest of potential owl habitat within 2.7 mile radius circles around owl site centers in which habitat comprises of 40% or less land cover.

1.2.2. CONSEQUENCES

Criterion 1: Abundance and distribution of habitat
Evaluations based on habitat capability estimates showed that 48,900 acres out of 270,000 DNR-managed acres within the OESF had at least 40% potential habitat at the scale of pair ranges. That suggested that 18% of DNR-managed land was capable of supporting owl pairs in 1996. That percentage was used as a base line against which to evaluate the conservation benefits of the HCP. Projections of the Unzoned Forest alternative 100 years into the future resulted in 153,600 acres of DNR-managed land in the OESF that had at least 40% potential habitat. This alternative provided the greatest long term increases in habitat capability.

Evaluations based on the simulation model classified 435 owl sites on the Olympic Peninsula (all ownerships) as suitable. A suitable site is one in which the quantity and quality of the habitat within it and its adjacent areas is capable to support a nesting pair of spotted owls. The HCP's Unzoned Forest alternative was predicted to increase the number of suitable sites on the Olympic Peninsula (all ownerships) to 505.

Criterion 2: Population trends
It was emphasized that the strengths of the Schumaker (1995) model predictions were in the relative differences among predicted outcomes rather than in the absolute numbers and locations of spotted owls predicted in the model.

Numbers of spotted owl pairs on the Olympic Peninsula were predicted to decrease for 60 years based on model assumptions and current habitat conditions. After year 60, the population would start increasing. The abrupt change at year 60 was a result of simulated population responses to current landscape characteristics and assumptions about forest succession. The population trends were primarily due to habitat development on federal lands.

Criterion 3: Estimates of the risk for incidental take of spotted owl sites
There were 69 known owl sites within 2.7 miles of DNR-managed land in the OESF in year 1996 (WDFW, 1995). Based on the nature of the recorded observations, WDFW classified 45 of the known sites as pair sites, 2 as sites occupied by two owls, 13 territorial single sites, and 9 with an unknown status. The simplest estimate was that 31

spotted owl sites were at risk of take. The number dropped to 24 if considering that 7 of these sites had not been occupied for a number of years.

The exact number of the unknown sites that would be at risk for take was not estimated but it was suggested that the risk is relatively even among the alternatives.

2. RECENT DATA ON NORTERN SPOTTED OWL POPULATION PERFORMANCE

2.1. Demography reports on spotted owl population status and trends

There is a cooperative effort by the federal, state, tribal, and private landowners to monitor northern spotted owl demography across its geographic range. The demographic studies started in late 1980's on federal land and currently are conducted in 14 long-term study areas on federal, state, tribal and private land. The results of these studies are analyzed every 5 years at demography workshops. The HCP DEIS used the data from the 1993 workshop (Burnham et al., 1994). Since then three demography workshops took place and the results are reported in Burnham et al., 1996; Franklin et al., 1999; and Anthony et al., 2004 (draft).

The results from the last draft report released in May 2004 (Anthony et al., 2004) demonstrated that over the entire geographic range, northern spotted owl populations appear to be doing poorer than they were five years ago. Based on the 2004 estimates of annual population change (λ_{RJS}), the owl populations in many of the study areas have lower demographic rates compared to the rates in 1998. Populations were doing poorest in Washington where apparent survival rates and populations were declining on all the four study areas (Table C.3.2-3). The mean λ_{RJS} = 0.925 on the four study areas in Washington which suggests that these populations were declining by average of 7.5% per year.

According to the estimates of the realized population change (the trend in numbers over the entire period of study) the populations on the Cle Elum, Wenatchee and Mt. Rainier study areas declined substantially over the last decade - population sizes were only 40-60% of the initial populations. Declines on the Olympic Peninsula were not as great but are noteworthy - the population in 2002 was approximately 70-80% of the initial population.

Table C.3.2-3. Summary of the trends in demographic parameters from 4 study areas in Washington over the entire period of study (late 1980s – 2003)

Study area	*Land ownership*	*Fecundity*	*Apparent survival*	*Rate of population change λ_{RJS}*
Cle Elum	USFS	Declining	Declining	0.938 - Declining
Olympic Peninsula	USFS & NPS	Stable	Declining	0.956 - Declining
Wenatchee	Private	Stable	Declining	0.917 - Declining
Rainier	USFS	Stable	Declining	0.896 - Declining

The authors did not provide analyses on the causes for the accelerated decline. However, the possible reasons for the dramatic decline in Washington study areas included: 1) the high density of barred owls, 2) the loss of habitat due to wildfire 3) the logging of spotted owl habitat on state and private lands, 4) forest defoliation caused by insect infestations and 5) advancing forest succession toward climax for (*Abies spp*.) communities in the absence of wildfires.

2.2. DNR monitoring of spotted owl occupancy and reproduction in the Eastside Planning Units

In 2001, DNR contracted the National Council for Air and Stream Improvement (NCASI) to monitor northern spotted owl occupancy and reproduction in the three eastside planning units. NCASI has been conducting monitoring of spotted owls in eastern slopes of Cascades for more than 16 years with about 34 sites (located on federal, state, and private ownerships) monitored annually. 18 of these sites are on DNR-managed land. The number slightly varies through the years because the owls are found in slightly different areas each year, sometimes across ownership lines.

Results of NCASI surveys on DNR-managed land are presented on Table C.3.2-4 and Figure C.3.2-1.

Table C.3.2-4. Spotted owl occupancy in the Eastside Planning Units

Year	Surveyed spotted owl sites	Spotted owl detections			No detection
		Reproductive pair or nest	Nonreproductive pair	Single male or female	
1991	7	4	2	1	0
1992	8	6	2	0	0
1993	10	4	3	1	2
1994	18	13	2	1	2
1995	19	7	3	5	5
1996	17	8	3	3	3
1997	18	5	2	1	10
1998	18	8	1	2	7
1999	18	4	4	4	6
2000	18	3	7	3	7
2001	18	3	4	1	10
2002	17	1	3	3	10
2003	18	2	0	4	12

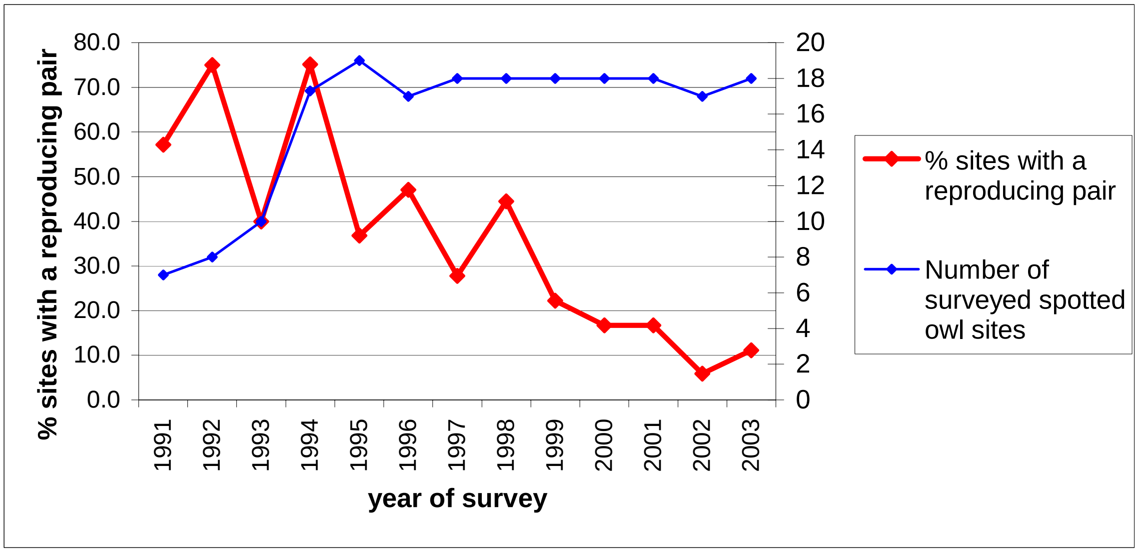

Figure C.3.2-1. Dynamics of spotted owl sites occupied by reproducing pairs in the Eastside Planning Units

2.3. DNR monitoring of spotted owl occupancy and reproduction in the OESF

DNR's monitoring program in the OESF was developed in 1995 to provide baseline data about the abundance, distribution, survival, reproduction, and movements of spotted owls in the OESF area. The monitoring results will help to evaluate the success of DNR management techniques in integrating species conservation with commodity production. In addition,, DNR monitoring in the OESF complimented the ongoing effectiveness monitoring in the Olympic Peninsula demography study area conducted by the Forest Service Pacific Northwest Research Station (PNWRS).

The initial number of surveyed areas in 1995 was 25. Three of the areas were located on Olympic National Park lands. Four of the areas maintained multiple spotted owl sites. The number of surveyed sites (and areas) varied through the years based on prioritization system developed by the survey team – the highest priority sites were either occupied by banded spotted owls or were important to the conservation strategy but without a history of thorough surveys. The highest number of sites (32) was surveyed in 1996. The number of surveyed sites in years 2001, 2002, and 2003 dropped significantly because of the staffing shortage and because most of the sites were found not occupied for several consecutive years. Summarized data of the spotted owl monitoring in the OESF (Wiedemeier and Clark, 1995; Wiedemeier and Horton, 1996; Wiedemeier, Horton, Alling, and Spaulding, 1997; Wiedemeier and Horton, 1998; Wiedemeier, 1999; Wiedemeier, 2000; Horton, 2004) are presented on Table C.3.2-5 and Figure C.3.2-2.

Table C.3.2-5. Results from the DNR's monitoring of northern spotted owl in the Olympic Experimental State Forest

Year	Spotted Owl Sites		Spotted Owl detections				Barred owl detections
	Surveyed	Occupied	Total	Individuals	Pair	Single	
1995	30	11	43	15	3	8	5
1996	31	8	44	17	4	4	7
1997	32	7	43	12	3	2	5
1998	22	5	15	8	3	2	8
1999	19	7	8	6	0	6	7
2000	19	3	9	3	1	2	2*
2001	10	2	7	3	1	1	6

* The small number is due in large part to not surveying the Queets Corridor, where numerous barred owls had been detected in the previous years (Wiedemeier, 2000).

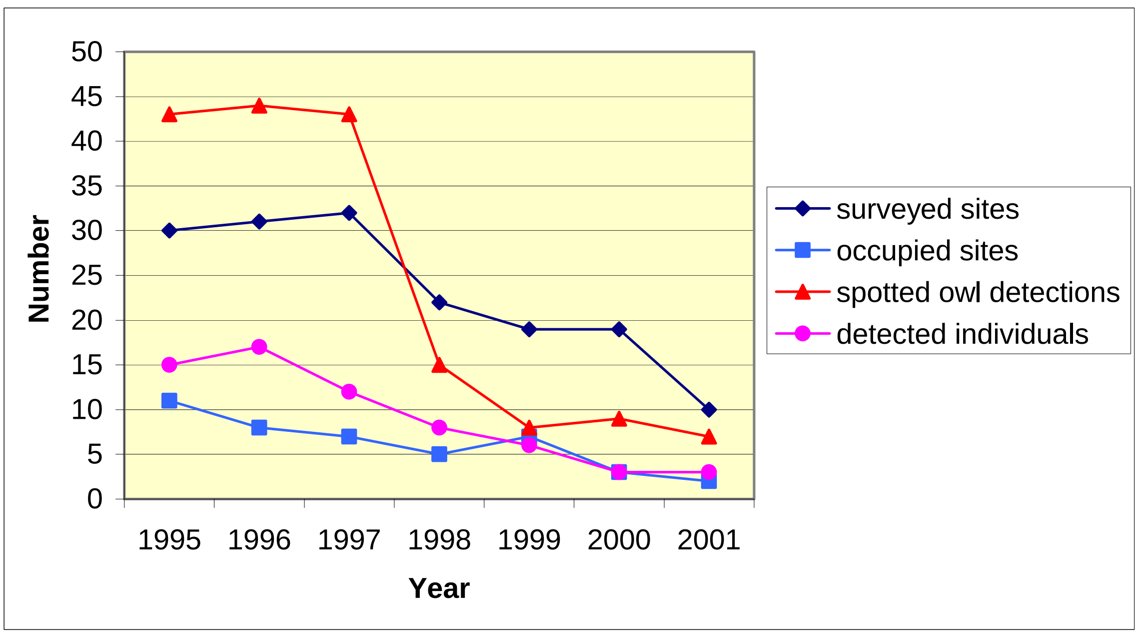

Figure C.3.2-2. Dynamics of spotted owl occupancy in the Olympic Experimental State Forest (OESF).

3. DISCUSSION

As already mentioned at the beginning of this report, a comparison between the analyses of spotted owl occupation, population dynamics and level of take provided in the HCP DEIS in 1996 and the current data on spotted owl population performance in Washington will help DNR to decide how extensively to use the HCP DEIS analyses to assess the effect of the proposed sustainable harvest alternatives on spotted owl population. In areas where the new data differ substantially from the projected in 1996 or where the methods of the analyses changed over the last decade a new approach should be considered.

There are several differences in the methods, study areas and sample size between the demography report used in the HCP DEIS (Burnham et al., 1994) and the last demography report (Anthony et al., 2004).

1. The annual rate of population change (λ) is calculated differently. The previous demography reports (Burnham et al., 1994; Franklin et al, 1999) estimated λ using the Leslie projection matrix (λ_{PM}). The HCP DEIS analyses were based on this estimate. The last demography report (Anthony et al., 2004) estimated the population rate of change by the parameterized Jolly-Seber method (λ_{RJS}). The main difference between the two methods is that λ_{PM} was computed from projection matrices using age-specific survival and fecundity from juvenile, subadult, and adult owls, assuming a stable distribution while the estimate of λ_{RJS} refers to the population of territorial owls only and takes into account the combination of gains and losses to the population by direct estimation from the capture-recapture data. Anthony et al. (2004) considered the estimate λ_{PM} biased low and recommend using only λ_{RJS}.

2. Barred owl covariate was included in the 2004 analyses on survival and fecundity, because the authors predicted the presence of barred owls would have a negative effect on demographic rates of spotted owls. The covariate was the proportion of spotted owl territories that were occupied by barred owls each year.

3. The 1994 report analyzed data from two demography study areas in Washington State - Olympic Peninsula (established in 1987) and Cle Elum (established in 1990). Data from two additional demography study areas in Washington were included in the 2004 report - Wenatchee (established in 1989) and Mt. Rainier (established in 1992).

4. The Olympic Peninsula study area was slightly modified in 2004 analyses to exclude nonfederal lands. Demography data from part of the OESF were included in the 1994 demography report.

5. The longer period of study and the larger number of study areas provided a considerably larger sample size for the 2004 analyses, which allowed estimating the annual rate of population change with greater statistical power.

Table C.3.2-6. Major findings of the demography studies for the period 1985-2003

Period of study	*Report*	*Number study areas*	*Study areas in WA*	*Annual rate of population of change for the entire geographic range*
1985-1991	Anderson and Burhnam, 1992	5	OLY	Population of the territorial females had declined an average of 7.5 % per year
1987-1993	Burhnam et al, 1994*	11	OLY CLE	Annual rate of population change λ_{PM} was significantly < 1.0 for 10 of the study areas 4.5% decline per year for the entire geographic range
1987-1998	Franklin et al., 1999	15	OLY CLE WEN RAI	The estimate of λ_{PM} = 0.961 and λ_{RJS} = 0.997 3.9 % decline per year for the entire geographic range
1987-2003	Anthony et al., 2004 (draft)	14	OLY CLE WEN RAI	Estimate of mean λ_{RJS} = 0.959 4.1% decline per year (7.5% in Washington, 2.8% in Oregon and 2.2% in California)

* DNR used this report for its projection and analyses of the spotted owl population trend
Acronyms of the study areas: OLY - Olympic Peninsula; CLE - Cle Elum; WEN – Wenatchee; RAI – Mt. Rainier

Table C.3.2-7. Comparison of the demography reports' estimates of the annual rates of population change from the two study areas used in the DNR's HCP DEIS.

Report	*Cle Elum*			*Olympic Peninsula*		
	*λ**	*95% confid. intervals*		*λ*	*95% confid. intervals*	
		lower	*upper*		*lower*	*upper*
Burhnam et al., 1994	0.924	0.861	0.987	0.9472	0.9217	0.9817
Franklin et al., 1999	0.941	0.8963	0.9848	0.8763	0.8449	0.9077
Anthony et al., 2004 (draft)	0.938	0.901	0.976	0.956	0.893	1.018

* λ_{PM} was used in 1994 and 1999 analyses and λ_{RJS} was used in 2004 analysis (see the text for explanation)

The HCP DEIS projected that owl populations on DNR land would continue to decline over the short term (first decade up to 50 years) at the same rate as the population on federal lands (HCP DEIS, 4-87). The initial expectation in the Northwest Forest Plan was that the owl population would decline in numbers during the initial decades of implementation of the Northwest Forest Plan , after which the population would eventually stabilize at a new equilibrium level as the habitat in owl conservation areas recovered. However, the magnitude of the decline in Washington, demonstrated in the 2004 report, was not expected.

The effect of the barred owl invasion on spotted owl populations in Washington State was not discussed in the HCP DEIS for the westside and eastside planning units. For the OESF it was stated that “the degree to which barred owls will continue to increase in abundance on the Olympic Peninsula is uncertain, as well as the degree to which they might interact with spotted owls” (HCP DEIS, 4-332). Recently, many biologists have detected rapid increases in barred owl numbers in Washington and suggested that barred owls have a negative effect on spotted owl populations throughout the Pacific Northwest (Dark et al., 1998; Levy, 1999; Forsman et al., 2003; Kelly et al. 2003; Pearson and Livezey (2003). All these studies are correlative and many of them rely on incidental data collection of barred owl presence, which do not allow estimating the mechanism and magnitude of the competition. Most of the above authors suspect that human caused loss of suitable habitat may reduce the ability of spotted owls to compete successfully with barred owls.

In addition to the barred owl invasion, several other threats were discussed during the public meetings organized between December 2003 and June 2004 as part of the 5-year status review for the northern spotted owl (details available at *http://www.sei.org/owl/meetings.htm*). The West Nile virus and the sudden oak death are considered new threats that were not present during the listing of the subspecies. They were also not discussed in the HCP DEIS. A scientific report, which evaluates the new scientific information about the northern spotted owl available since its listing, will be developed by a panel of experts assembled by the Sustainable Ecosystems Institute (SEI). The report will be provided to the USFS in July 2004. The USFS is expected to use this report to complete the 5-year status review of the northern spotted owl by the end of 2004.

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C.3.3 Marbled Murrelet

DNR's report is attached outlining the conservation planning efforts for the marbled murrelet in the context of the Habitat Conservation Plan.

DNR HCP Marbled Murrelet Conservation Strategy

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Overview

In January 1997, DNR entered into a Habitat Conservation Plan (HCP) in cooperation and agreement with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). The HCP authorizes DNR's forest management in 1.6 million acres of trust lands within the range of the northern spotted owl as compliant with the ESA if conducted according to terms of the HCP Implementation Agreement (DNR 1997, Appendix B).

The purpose of the HCP was to provide habitat at the landscape level to support long-term recovery efforts for species or species guilds. The purpose of this document is to outline the conservation planning efforts to date in the context of our legal and contractual responsibilities of the Habitat Conservation Plan (DNR 1997). The marbled murrelet long term conservation strategy was intended to help meet objectives of the federal Marbled Murrelet Recovery Plan (USFWS 1997), and to "…make a significant contribution to maintaining and protecting marbled murrelet populations in western Washington…" (DNR 1997, p IV.44).

Substantial expenditures have been made to answer several issues identified within the HCP. In particular, the five questions that follow:

1. How large and contiguous should habitat areas be to sufficiently conserve murrelet breeding areas?
2. In what developmental stages, and how much forest buffer is necessary?
3. How should new murrelet habitat be positioned and configured?
4. How should fragmentation be defined relevant to murrelet conservation?
5. How can the importance of individual murrelet sites be ranked?

The answers to these questions are the long-term framework to the conservation strategy for marbled murrelets. It is anticipated that by January 2005 all legal and administrative processes will be completed, including environmental analyses, external review, potential re-write of a biological opinion and new Incidental Take Permit for marbled murrelets issued.

Interim HCP Conservation Strategy for Marbled Murrelets

At the time DNR's Habitat Conservation Plan (HCP) was written, there was insufficient scientific information to develop a long-term marbled murrelet conservation strategy that had a high probability of successfully conserving murrelets. Therefore, DNR adopted an interim marbled murrelet conservation strategy that emphasized the acquisition of scientific information needed to develop long-term marbled murrelet conservation strategies for the six west-side HCP Planning Units. The following steps outline this interim strategy:

> Step 1: Habitat Deferral. Defer harvest on any part of a suitable habitat block, defined as at least 5 acres in size, containing an average of at least 2 potential nesting platforms per acre, and being within 50 miles from marine waters.
>
> Step 2: Habitat Relationships Studies. Conduct a two-year marbled murrelet forest habitat relationships study within each of the six HCP planning units within the murrelet's range to determine the relative importance of the various habitat types to murrelet occupancy of forest stands. Distance from marine waters and forest structure are two of the important factors of interest.
>
> Step 3: Habitat Reclassification. Based on analysis of data collected during the habitat

relationships studies, define and identify marginal, or lower-quality, habitat types expected to contain no more than 5% of the sites occupied by murrelets on DNR-managed lands within each planning unit. Make these habitat types available for timber harvest, pending other considerations.

Step 4: Surveys of Reclassified Habitat. Conduct murrelet surveys on all acreage constituting the higher-quality habitat types (expected to contain 95% of the occupied sites) in order to locate sites actually occupied by murrelets. Outside of Southwest Washington, release surveyed, unoccupied habitat for harvest if it is >0.5 miles from an occupied site *and* if, after harvest, 50% of the higher-quality murrelet habitat on DNR-managed lands in the Watershed Administrative Unit would remain.

Step 5: Long-term Conservation Planning. After Steps 1-4 are completed for each planning unit, using the information obtained from these and other research efforts, develop a long-term conservation strategy for marbled murrelet habitat on DNR-managed forest lands.

Until the long-term conservation strategies are implemented, DNR is protecting all sites known to be occupied by murrelets. DNR is also supporting cooperative, regional research efforts to the extent possible with available funding. These research projects are acquiring information needed for long-term habitat conservation planning (e.g., effects of timber harvest, forest fragmentation, and human activity on murrelet nesting success) and development of murrelet effectiveness and validation monitoring (e.g., distribution and abundance of murrelets in relation to marine habitat conditions).

Implementation

1. Prior to the completion of Step 3 of DNR's marbled murrelet interim conservation strategy, DNR defers from harvest marbled murrelet habitat that meets the definition of a *suitable habitat block* (HCP pages IV. 40-42). After the completion of Step 3, DNR defers from harvest higher-quality habitat, expected to contain a minimum of 95 percent of the occupied sites on DNR-managed lands within the planning unit. This habitat is termed "reclassified" habitat and is determined by application of the predictive model built from the habitat relationships studies. Lower-quality habitat, expected to contain a maximum of 5 percent of the occupied sites on DNR-managed lands within the planning unit, is termed "marginal" habitat and is released for harvest.

2. DNR defines marbled murrelet occupancy using the Pacific Seabird Group (PSG) definition " . . . where murrelets have been observed exhibiting **subcanopy behaviors**, which are behaviors that occur at or below the forest canopy . . ." (Methods for Surveying Marbled Murrelets in Forests: an Update to the Protocol for Land Management and Research [hereafter referred to as the PSG Protocol], available at http://www.pacificseabirdgroup.org/mamuforms.html; p. 4). For lands that are not managed by DNR, DNR relies primarily on the Washington Department of Fish and Wildlife (WDFW) Marbled Murrelet Detections Database. This database assigns occupancy to detections that include not only subcanopy behaviors but also circling behaviors up to a height of 2 canopies, as measured from the ground.

3. In accordance with Step 4 of DNR's marbled murrelet interim conservation strategy, the Department is deferring from harvest reclassified, or higher-quality, marbled murrelet habitat. Within this step, the Department goes above and beyond

recommendations in the PSG Protocol with 2 distinct protections. Step 4 states that . . . surveyed, unoccupied habitat will be released for harvest if it is not within 0.5 mile of an occupied site . . .Or, to state the inverse, all (reclassified) habitat will be deferred from harvest if it is within 0.5 mile of an occupied site. One aspect of protection in Step 4 that goes beyond recommendations in the PSG Protocol is that **non-contiguous**, reclassified habitat is included in the deferral. The PSG Protocol refers to potential habitat *that is contiguous with* the project area (p. 9). Another aspect of protection in Step 4 that goes beyond recommendations in the PSG Protocol is that all reclassified habitat within **0.5 mile** of an occupied site is included in the deferral. The PSG Protocol refers to potential habitat that is within **one-quarter mile** of the project area (p. 9).

4. In accordance with Step 4 of DNR's marbled murrelet interim conservation strategy, the Department is conducting surveys on all acreage constituting the reclassified, or higher-quality, marbled murrelet habitat in order to locate sites actually occupied by murrelets. The extent of these surveys is unprecedented, providing DNR with a high level of confidence that our interim timber management is not compromising areas important to murrelets.

5. DNR will not harvest nor propose for harvest any portion of an occupied site but may harvest non-habitat (non-reclassified habitat and non-suitable habitat block) on DNR-managed lands "adjacent to occupied marbled murrelet sites … without restriction" (page 90 Biological Opinion for department's HCP).

6. DNR considers forests on other ownerships that appear to contain suitable habitat but are not surveyed as unoccupied for purposes of implementing the HCP marbled murrelet interim conservation strategy.

7. DNR evaluates physical changes (blowdown or fire) or errors in the Department's forest inventory database or harvest activities database within reclassified habitat and considers not surveying part or the entire polygon. In general, DNR does not survey in areas where there are no trees.

8. DNR releases surveyed, unoccupied, reclassified habitat consistent with the conditions stated in Step 4 of DNR's HCP marbled murrelet interim conservation strategy when all surveys within the relevant Watershed Administrative Unit (WAU) are completed.

Predicting Stands Likely to be Occupied by Marbled Murrelets on DNR-managed Lands
Under the HCP, DNR agreed to conduct murrelet surveys in forest stands estimated to contain 95% of the occupied sites on DNR-managed lands within each Planning Unit. The abundance and distribution of these stands were estimated based on findings of a research program, called the Habitat Relationships Studies, conducted in each planning unit. In each planning unit, 54 commercially mature study sites were selected to evenly fill a 3 x 3 design with sites that were 1) near, 2) mid-, or 3) far from marine waters, and were: 1) young, structurally-simple; 2) young, structurally-complex; or 3) old, structurally-complex. This design was intended to assure an even distribution of study sites across factors presumed to influence murrelet occupancy and was not used in data analysis.

Fieldwork in all 4 Planning Units (1994-1996) measured forest stand and landscape characteristics, and murrelet occupancy (following Pacific Seabird Group Protocol). Multiple logistic regression techniques were used to model the probability that the study stands were occupied by murrelets. Analyses endeavored to develop the best fitting, most efficient, yet biologically reasonable logistic model, with predictive and classification abilities that were appropriate to the conservation objectives of the study (e.g., false negative classifications were deemed less acceptable than false positives). Two final models were developed by pooling studies from the 2 Olympic Peninsula Planning Units (Straits and OESF), and the 2 southwest Washington Planning Units (South Coast and Columbia). These models were then applied to all DNR-managed stands that met the structural threshold for inclusion in the Habitat Relationships Study within each planning unit to predict their probabilities of being occupied by murrelets.

The Olympic Peninsula model included a binary variable for whether or not the site was in the western vs. northern/eastern Olympic Peninsula; elevation above sea level in feet; stream network density within the stand, estimated from the state regulatory GIS database as linear feet of Types 1, 2, & 3 water per acre; and numbers of conifer trees >32" dbh per acre. The southwest Washington model relied more on forest structure and composition: distance from marine water; numbers of western hemlock trees >32" dbh per acre; numbers of western redcedar trees >22" dbh per acre; basal area per acre of Douglas-fir trees >7" dbh.

DNR assumed that a stand's size multiplied by its model-derived probability of occupancy estimated its "overall probability" of occupancy. Thus, stands were sorted, independently within each Planning Unit, in descending order based on their model-derived probabilities. Then the cumulative total of the overall probabilities were calculated from the top of the list for each Planning Unit. The stands at and above the level at which >95% of this total occurred were estimated to contain >95% of the "occupied sites" in each Planning Unit, and were designated as "Reclassified Habitat". This Reclassified Habitat was to be inventoried for murrelet occupancy according to the HCP Interim Strategy. Stands below this Planning Unit-specific probability threshold were designated "Marginal Habitat" and were made available for timber harvest, subject to other considerations, as agreed upon in the HCP.

Probability thresholds, and areas of Reclassified and Marginal Habitat are presented for each of the 4 Planning Units in the table below.

	Probability Threshold	**Reclassified Habitat (acres)**	**Marginal Habitat (acres)**
Straits	0.0512	15,600	3,200
OESF	0.3805	54,500	11,400
South Coast	0.0205	20,500	32,500
Columbia	0.0274	6,600	16,700

Summary of HCP-directed Marbled Murrelet Surveys in the OESF Planning Unit, 1996-2001

<u>Introduction</u>
DNR departed from its stepwise, linear process of developing an interim marbled murrelet conservation strategy in the Olympic Experimental State Forest (OESF) Planning Unit. The OESF contains the majority of DNR-managed older forests, and preliminary analyses of data collected for developing the marbled murrelet predictive model suggested that approximately

40,000 acres of structurally-complex, natural stands had a rather high probability of being used, i.e., occupied, by murrelets. DNR believed that there were other stands of potential murrelet habitat in addition to these structurally complex stands, and that the modeling process would identify them. Thus in 1995, DNR decided to begin an inventory of murrelet use in the OESF ahead of a statistical model predicting that use, because a very large area of clearly good potential habitat obviously needed to be surveyed and because DNR wished to move rapidly towards full implementation of the murrelet strategy. The inventory surveys were planned to be initiated over a three-year period beginning in 1996, with surveys initiated in approximately 1/3 of the 40,000 acres each year, reserving the stands of uncertain potential as habitat to be screened against the predictive model.

Methods - Survey Areas

In 1995, DNR's forest inventory did not contain sufficient resolution to estimate structural complexity from database searches. Thus, experienced staff used aerial photos to identify stands with deeply textured canopies and abundant trees with large-diameter crowns. From among these, stands that were at least 20 acres and with fairly compact shapes (e.g., excluding riparian leave areas) were designated for murrelet surveys. Almost invariably, these were older stands that originated after natural disturbances. Areas of the landscape that were disturbed by the hurricane-force, "21-Blow" windstorm now consist of a mosaic of fairly uniform-structured, naturally-regenerated 80 year-old stands and structurally complex stands with a variety of intergradations among those types. In these areas, only the more structurally complex portions of larger stands that may have been entirely potential habitat were designated for survey while awaiting the predictive model.

Methods - Murrelet Surveys

All surveys were conducted according to protocols developed and updated by the Pacific Seabird Group (PSG), Marbled Murrelet Technical Committee. Surveys were conducted for two years (usually 5 visits per year) or until murrelets were observed flying within the forest canopy (i.e., occupied behavior), whichever was sooner. DNR staff using aerial photography and GIS mapping techniques planned the layout of survey sites and stations. Field-location of survey stations, and the actual murrelet surveys were conducted by several private consulting firms (Resources Northwest, Inc.; Hamer Environmental; and Turnstone Environmental Consultants, Inc.) with substantial review by contractor and DNR staff.

Results

DNR delineated 600 survey sites comprising 39,286 acres. The survey project was quite expensive ($1.3 million in contract costs) and thus took longer to complete than anticipated, with the final year of surveys in 2001. Effort was distributed over the project as reported in the table below for surveys initiated in each of 5 years.

Start Year	1996	1997	1998	1999	2000
Sites (N)	235	192	63	31	79
Acres	13,826	13,304	4,142	2,151	5,864

DNR's contractors completed 4,584 murrelet surveys to PSG protocol standards, during which they recorded 6,909 murrelet detections on about one-third (1,561) of those surveys. Subcanopy (occupied) behavior was recorded on 601 occasions during fewer than 10% of surveys (333). No murrelet detections were recorded at fewer than 10% of the sites (51); murrelet presence was recorded at 237 sites; murrelet occupancy was recorded at the majority (312) of sites. Survey sites without murrelet detections comprised 3,017 acres, sites with presence totaled 14,686 acres, while most of the area surveyed (21,583 acres) was within occupied sites. The locations of these sites, their status and context are illustrated on Map 4.

Discussion

This report summarizes only a part of the DNR’s commitment to a murrelet inventory in the OESF, thus it is instructive to briefly discuss four related projects that will bring additional information to the conservation planning effort: 1) These surveys were only in old-growth forests selected by photo-interpretation, in advance of the statistical model that predicted stands estimated to contained 95% of the occupied sites in the planning unit. That model has since been developed and applied to the OESF landscape. 2) The HCP conservation strategy for spotted owls in the OESF made specific commitments for landscape-level retention and restoration of threshold amounts of old forest. These commitments are without regard to marbled murrelet survey findings. 3) Scott Horton, DNR’s Olympic Region wildlife biologist, is currently a Ph.D. candidate at University of Washington studying the landscape ecology of marbled murrelets with regard to their conservation in the OESF. 4) Marbled murrelet surveys were funded by the *Tenyo Maru* oil spill settlement and conducted by Washington Department of Fish and Wildlife (WDFW) at 22 sites in the OESF where DNR did not detect murrelet use.

The predictive model was developed for the DNR-managed lands on the entire Olympic Peninsula as described in the section *Predicting Stands Likely to be Occupied by Marbled Murrelets* of this information packet. The model includes a binary variable for whether or not the site was in the western vs. northern/eastern Olympic Peninsula; elevation above sea level in feet; stream network density within the stand; and numbers of conifer trees. 32” dbh per acre. Applying the logistic transformation to model output for stands in DNR’s inventory gives the predicted the probability of occupancy for each stand. Following the process described in the *Predicting Stands Likely to be Occupied by Marbled Murrelets* section, DNR estimated the stands predicted to contain 95% of the occupied sites in the OESF Planning Unit were those at or above the probability threshold of 0.3805, i.e., stands with a predicted probability of occupancy by murrelets of 38.05%. These stands in total comprise 54,452 acres, which after the old-growth surveys reported above leave (nominally) 15,166 acres of unsurveyed, reclassified habitat. DNR predicts lower rates of murrelet activity and use in these areas that lack the stature and structural complexity that characterized the stands surveyed in advance of the model.

DNR agreed upon an “unzoned” approach to spotted owl conservation in the OESF. This strategy is implemented at the scale of “Landscape Planning Units” (LPU), mid-scale (15,000 - 50,000 acre) areas of DNR-managed lands that are organized around watershed boundaries. DNR committed to maintain or restore at least 20% of each LPU to “old forest spotted owl habitat” and at least an additional 20% to “young forest habitat”. DNR’s landscape planning efforts to date have shown that old forest habitat and the “old-growth” murrelet survey areas

discussed in this report are almost entirely coincident. No LPUs currently have a “harvestable surplus” of old forest owl habitat, and forest growth modeling suggests that restoration of these LPUs to supra-threshold levels will not occur until after the HCP agreement has run its course (70-100 years). Thus DNR is committed to conserving and adding to its inventory of old-growth forests that can serve murrelet conservation, merely through implementing its spotted owl conservation strategy. This provides an opportunity to achieve a synergistic effect for conservation of old forest ecosystem functions through the upland (owl and murrelet) as well as the riparian conservation strategies of the HCP.

Scott Horton, Olympic Region wildlife biologist, is currently engaged in a program of research using the murrelet survey results summarized above to: 1) develop a better understanding of murrelet inland activity patterns; 2) discover associations between mid-scale (appropriate to management of the OESF) landscape patterns and murrelet activity, in order to index the "attractiveness" of particular landscapes to potentially nesting murrelets; 3) integrate this index with the model developed through research funded in part by DNR that relates predation rates at murrelet nests to landscape characteristics (e.g., Raphael et al. 2002. Studies in Avian Biology 25:221-235), in order to model the "productive capacity" of particular landscapes for murrelets; and 4) explore the efficacy of a variety of forest management scenarios in providing for outcomes in achieving HCP conservation and other land management objectives. This research will probably not be complete for at least one year, thus it may not be able to fully inform the conservation planning process. This exemplifies a greater challenge in developing the long-term conservation strategy, i.e., constructing a strategy that is adaptable to new knowledge in a way that enables effective murrelet conservation and efficient forest management for DNR's other objectives.

In summary, DNR is generally encouraged by the apparent situation in the OESF. The relatively abundant potential murrelet habitat, and the apparently high rates of murrelet use of that habitat should increase the numbers of options for murrelet conservation, land management, and research in the OESF.

Summary of HCP-directed Marbled Murrelet Surveys in the South Coast and Columbia Planning Units, 1998-2002

Introduction

Reclassified marbled murrelet habitat was identified using the same statistical model in the South Coast and Columbia Planning Units. Surveys were conducted in both planning units simultaneously between 1998 and 2002. Unlike in the Straits planning unit (reported later in this section), survey site boundaries were established without regards for model-derived predicted probabilities of occupancy.

Methods

All surveys were conducted according to protocols developed and updated by the Pacific Seabird Group (PSG), Marbled Murrelet Technical Committee. Surveys were conducted until murrelets were observed flying within the forest canopy (i.e., occupied behavior) or until the correct number of protocol surveys were achieved.

DNR and contract staff using aerial photography and GIS mapping techniques shared the layout of survey sites and stations. DNR or contract staff located field-location of survey stations. Two private consulting firms, Hamer Environmental L.P. and Turnstone Environmental Consultants, Inc. conducted the actual murrelet surveys with substantial contractor and DNR review.

Results

DNR and its contractors delineated 450 survey sites comprising 23,861 acres. Effort was distributed over the project as reported in the table below for surveys initiated in each of 4 years.

Start Year	1998	1999	2000	2001
Sites (N)	166	55	98	131
Acres	8,159	3,245	5,239	7,218

DNR's contractors completed 3,332 murrelet surveys to PSG protocol standards, during which they recorded 1,124 murrelet detections during 6% (213) of those surveys. Subcanopy (occupied) behavior was recorded at 20% (89) of sites, presence was recorded at 10% (45), while no marbled murrelet detections were recorded at 70% (316) of sites. Survey sites with occupied detections comprised 5,406 acres, sites with presence totaled 1,871 acres, while most of the area surveyed (16,583 acres) was without murrelet detections.

Marbled Murrelet Long-term Conservation Strategy

The marbled murrelet long term conservation strategy was intended to help meet objectives of the federal Marbled Murrelet Recovery Plan (USFWS 1997), and to "...make a significant contribution to maintaining and protecting marbled murrelet populations in western Washington…" (DNR 1997, p. IV.44).

The HCP provided a much looser discussion of the long-term strategy, including the "...general factors that would likely be considered... [and] ..an idea of the kinds of approaches expected...". Three forest-related factors were thought to be primary negative influences on murrelet populations:

1) Loss of nesting habitat mainly due to timber harvest;
2) The speculation that predation at nest sites is a major impact to recruitment of young birds into the population and to adult survival rates; and
3) The suspicion that logging-related disturbance of nesting birds significantly reduces nest success.

DNR then presented a series of considerations that were thought to be important to developing a conservation strategy in the context of those primary factors and assumptions that marbled murrelets had limited dispersal abilities and may be unable to colonize new breeding habitat. Those considerations generally belonged in one of the following categories: 1) stand-level issues at murrelet breeding areas; 2) landscape-level issues; and 3) issues of conservation biogeography.

Nine Planning Units comprise the DNR-managed lands under the HCP; marbled murrelets inhabit all 6 west-side planning units. Information-gathering and marginal habitat release (Steps 2-4 described above) are in progress in the North and South Puget Planning Units, and have been substantially completed in the Olympic Peninsula (Straits and OESF Planning Units) and southwest Washington (South Coast and Columbia Planning Units). As agreed upon in the HCP (DNR 1997, p. IV.40), DNR and USFWS are initiating the process of developing the long-term marbled murrelet conservation strategy for these 4 Planning Units, which encompass part of Conservation Zone 1 and all of Zone 2 designated in the Recovery Plan (USFWS 1997). Land ownership patterns, densities of marbled murrelets at sea, and DNR inland survey results vary dramatically among the Planning Units. The Olympic Peninsula is approximately 2.8 million acres, the majority of which (1.6 million acres) are federal lands in the Olympic National

Park (ONP) and Olympic National Forest (ONF). DNR-manages approximately 380,000 acres of land in this particular area. DNR-managed forests in the OESF Planning Unit (270,000 acres) are spread across a fairly broad (~20 miles) coastal plain and the foothills of the Olympic Mountains, in contrast to those in the Straits Planning Unit (112,000 acres) that are confined to a narrow band of non-federal land between the Olympics and the Pacific Ocean. The western portions of the Columbia and South Coast Planning Units are dominated by private lands (mostly commercial forest), with federal lands mostly peripheral to the marbled murrelets inland range. South of the Olympic Peninsula and within the range of the marbled murrelet, these two Planning Units comprise approximately 3.5 million acres, of which about 10% is managed by DNR.

Marbled murrelet activity recorded during DNR inland surveys was greatest in the OESF

Planning Unit, with 6,909 marbled murrelet detections recorded on 34% of 4,584 surveys, next in the Straits Planning Unit where 1,060 detections were recorded on 14% of 2,736 surveys, and least in the SW Washington Planning Units (Columbia and South Coast) where 1,124 detections were recorded on 6% of 3,332 surveys.

A Scientific Context for the Long-term Conservation Strategy

The intellectual model proposed by the British Trust For Ornithology, referred to as Integrated Population Monitoring (IPM, Cooke 1998), provides a logical framework for conservation planning: 1) determine the population trend, i.e., is there a decline and what is the rate?; 2) determine the demographic cause(s) for the decline - e.g., too few nesting attempts vs. nest success vs. adult mortality; 3) determine the mechanisms that link habitat conditions with population decline; and 4) determine how forest management interacts with those mechanisms, and how to adapt management to stabilize or increase populations.

Neither DNR or USFWS explicitly adopted this model, however, the IPM framework is used below to summarize the knowledge and assumptions employed in developing the HCP (DNR 1997) and Recovery Plan (USFWS 1997):

1. Murrelets were federally listed as threatened on September 28, 1992 in Washington, Oregon, and California because USFWS believed their populations were declining (Federal Register v. 57, pp. 45328-37). DNR adopted this assumption, and USFWS subsequently estimated that murrelets were declining at 4-7% per year in the 3-state area (USFWS 1997, Appendix B), based on projections using survival rates of similar alcids, and fecundity estimates derived from the ratio of juvenile to adult murrelets observed in at-sea studies. The fecundity estimate incorporates nesting rates as well as nest success. There was considerable uncertainty in both the survival and fecundity estimates however (USFWS 1997, Appendix B).
2. Both DNR and USFWS assumed that the principle demographic cause of the estimated decline is that fecundity is insufficient to maintain a stable murrelet population, based on the indirect assessment of fecundity described above and on observations of a low success rate at a small number of murrelet nests (9/32, Nelson and Hamer 1995).
3. USFWS described several mechanisms that could lead to diminished fecundity (Federal Register v. 57, pp. 45328-37); these assumptions were central to their approach in the Recovery Plan (USFWS 1997). DNR also based its thoughts on approaches to a long-term conservation strategy largely on these assumptions (DNR 1997). The proposed mechanisms, which are not mutually exclusive, are: 1) timber harvest has reduced the amount of nesting habitat in older forests, thus decreasing the proportion of the population that is able to find nest sites; 2) nests in old forests fragmented by logging are increasingly subject to deleterious edge effects, especially predation, that reduces their success rate; 3) the diminished availability of prime nesting habitat forces murrelets to nest in lower-quality habitat which diminishes nest success; and 4) nesting murrelets pack into the diminished amounts of habitat at higher densities, thus encouraging area-restricted searching by predators which further reduces nest success.
4. Based on the assumptions listed above, both USFWS and DNR proposed that forest management could be adapted to stabilize and possibly increase murrelet numbers and distribution through the following 5 approaches:
    1) Provide sufficient habitat area for individual breeding sites (DNR 1997), or maintain or restore nesting habitat in large, contiguous blocks (USFWS 1997);
    2) Provide forested buffers around breeding sites (DNR 1997, USFWS 1997);
    3) Develop new habitat to replace sites lost to disturbance and increase the amount and distribution of habitat (USFWS 1997);
    4) Reduce fragmentation of nesting habitat (DNR 1997, USFWS 1997); and

5) Understand the importance to conservation and management needs of individual breeding sites across broad landscapes (DNR 1997).

The 5 approaches to marbled murrelet conservation proposed by DNR and USFWS suggest complementary questions regarding their implementation in the Olympic Peninsula and southwest Washington Planning Units (and DNR-managed lands in general):

1. How large and contiguous should habitat areas be to sufficiently conserve murrelet breeding areas?
2. In what developmental stages, and how much forest buffer is necessary?
3. How should new murrelet habitat be positioned and configured?
4. How should fragmentation be defined relevant to murrelet conservation?
5. How can the importance of individual murrelet sites be ranked?

DNR suggests that answers to these questions will be central to developing a strategy that is effective for murrelet conservation, consistent with its HCP agreement, and is efficient for DNR to implement and integrate with its other land management responsibilities. DNR believes it is worth a substantial effort to have a scientifically-based marbled murrelet strategy, with measurable objectives, an empirical basis for predicting outcomes, and a credible approach to improve the strategy if necessary.

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C.3.4 Other Threatened, Endangered, and Sensitive Wildlife Species

Appendix Table D-8 lists the threatened, endangered, and sensitive species that are known or suspected to occur on western Washington forested state trust lands. It includes each species' state and federal listing status, and the habitats with which each species is associated.

The following DNR procedures provide specific direction for the management of habitat for species of interest, including threatened, endangered, and sensitive species:

- 14-004-240 Protecting Common Loon Nests
- 14-004-250 Protecting Harlequin Duck Nests;
- 14-004-260 Protecting Northern Goshawk Nests West of the Cascades;
- 14-004-270 Protecting California Wolverine Dens;
- 14-004-280 Protecting Pacific Fisher Dens;
- 14-004-300 Protecting Vaux's Swift Nests and Night Roosts;
- 14-004-310 Protecting Myotis Bat Communal Roosts and Maternal Colonies;
- 14-004-320 Protecting Marbled Murrelet Habitat;
- 14-004-330 Protecting Bald Eagle Nesting, Roosting, and Foraging Sites;
- 14-004-340 Protecting Peregrine Falcon Habitat;
- 14-004-350 Protecting Gray Wolf Habitat;
- 14-004-360 Protecting Grizzly Bear Habitat;
- 14-004-370 Protecting Oregon Silverspot Butterfly Habitat;
- 14-004-380 Protecting Columbia White-tailed Deer Habitat; and
- 14-004-390 Protecting Aleutian Canada Goose Habitat.

C.4 GEOMORPHOLOGY, SOILS, AND SEDIMENT

C.4.1 Current Policies and Procedures

In managing forested trust lands, essential timber harvest activities, by their very nature, create disturbances to the soil through existing and new roads, landings, skid trails, slash burns, etc. It has been demonstrated that logging activities generate sediment that is delivered to the aquatic ecosystem degrading habitat for fish and other species.

National concern for the quality of our surface waters led to the enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in1977, this law became commonly known as the Clean Water Act. Sediment runoff from forest operations is classified as "Non-Point Source of Pollution" and the Washington State Department of Ecology has been designated as the state agency for enforcing the provisions of the Clean Water Act. In 1973, the Endangered Species Act was passed by Congress and now includes threatened and endangered aquatic species in forest streams and rivers. The state of Washington responded by passing the Forest Practices Act in 1974. In response to the Endangered Species Act, in 1997, DNR implemented a Habitat Conservation Plan for 1.6 million acres of western Washington forested state trust lands. This Plan created the

Olympic Experimental State Forest and described provisions for effectiveness monitoring of the riparian systems for development of conservation strategies during harvest operations.

In order to resolve contentious forest practices problems, in February 1987, the Timber Fish Wildlife Agreement was negotiated between the tribes, the state, timber industry, and the environmental community. Although participants in this agreement continued to work cooperatively on policy at local and technical levels, native-run fish populations continued to decline. In 1999, the Timber Fish Wildlife caucuses came together to produce the Forest and Fish Agreement after salmonids and bull trout were added to the Endangered Species Act listings, and 660 streams in the state of Washington were identified with water quality problems and tabulated in section 303(d) of the Clean Water Act. A key strategy of the Forest and Fish Agreement, passed by the Legislature as House Bill 2091, is adaptive forest management based on effectiveness and validation monitoring.

In 2001, the state legislature passed Substitute Senate Bill 5637 requiring development of a state agency action plan that phases in full implementation of a monitoring strategy by June 30, 2007. Guidance for implementation has been published as “The Washington Comprehensive Monitoring Strategy and Action Plan for Watershed Health and Salmon Recovery” (Crawford et. al. 2002). In May 2001, the Forest Practices Board adopted permanent rules (Chapter 222 Washington Administrative Code) implementing the Forest and Fish Report to ensure compliance with the Clean Water Act, Endangered Species Act, and the Washington State Department of Ecology-established water quality standards for surface waters, as amended on July 1, 2003 (Chapter 173-201A). DNR’s obligations under the Habitat Conservation Plan are to conduct effectiveness monitoring for the riparian conservation strategy and determine how to harvest timber and meet conservation objectives by minimizing sediment runoff and preventing landslides that produce sediment that is adverse to fish populations. Because forest roads are a major source of sediment, Forest Practices has published Best Management Practices guidelines in Section 3 of the Forest Practices Board Manual outlining in detail Best Management Practices for road construction, maintenance, and abandonment.

On March 2, 2004, the Board of Natural Resources passed Resolution No. 1110, which authorized DNR to prepare the Final Environment Impact Statement for Sustainable Forest Management of State Trust Lands in Western Washington. Section 4 (L) of the resolution states: “The Department shall annually report to the Board of Natural Resources its assessment of the environmental and economic results of implementing the Preferred Alternative. The Department shall employ a structured monitoring and reporting program.”

C.4.1.1 Mass Wasting

There are no explicit policies for describing appropriate types of management activities on potentially unstable areas in the Forest Resource Plan. However, several policies such as Policy No. 16 (Landscape Planning), Policy No. 19 (Watershed Analysis), Policy No. 20 (Riparian Management Zones), Policy No. 30 (Silviculture Activities), and Policy No. 31 (Harvest and Reforestation Methods) describe objectives for the protection of soils, water quality, fish, wildlife, and other non-timber resources. In addition, Procedure 14-004-050 (Assessing Slope Stability) has the stated objective of protecting water quality, riparian ecosystem functions, and minimizing adverse impacts to salmonid habitat by restricting management activities on unstable slopes. These measures include the identification and avoidance of unstable slopes that would increase the frequency or severity of deep-seated or shallow-rapid landslides. Under this procedure, management activities other than required roads are prohibited on areas of instability or potential instability.

Under the Habitat Conservation Plan, conservation measures for the protection of unstable slopes are covered under the Riparian Conservation Strategy (DNR 1997, page II.62). Finally, if harvest is proposed in a potentially unstable area, a review of proposed forest practices and mitigations on potentially unstable slopes for effects on water quality and public safety is required under Washington Administrative Code 222-10-030 and Washington Administrative Code 222-16-050 1(d) in compliance with the State Environmental Policy Act guidelines.

C.4.1.2 Surface Erosion

Sediment input to streams is minimized during harvest felling and yarding by existing Forest Practices Rules, Washington Administrative Code 222-30 (Timber Harvesting). These rules prescribe the practices and limits for acceptable felling and yarding techniques, especially near streams.

C.4.1.3 Soil Productivity

Forest Resource Plan policies for the management of soil productivity include Policy No. 30 (Silviculture Activities), Policy No. 31 (Harvest and Reforestation Methods), Policy No. 34 (Fertilizing, Thinning, and Pruning), Policy No. 11 (Managing On-Base Lands), and Policy No. 9 (Forest Health). Each of these policies includes protection or enhancement of soils and/or biological productivity for growing trees. The Habitat Conservation Plan does not include conservation measures for protecting soil productivity other than through the retention of soils by minimizing and avoiding soil erosion and landslides. DNR Procedure 14-005-020 (Identifying and Prioritizing Stands for Regeneration Harvest) provides criteria for determining when a stand is ready for a regeneration harvest, which could affect soil productivity.

DNR Procedure 14-005-020 describes a method to determine the minimum age at which stands may be harvested. This procedure defines “rotation age” as the planned number of years between regeneration harvests and notes that rotation age is a result of the previous sustainable harvest process. This is the average minimum age at which a stand may be considered for regeneration harvest if the stand is not in an area with an acreage constraint, such as a nesting, roosting, foraging, or dispersal area. The average minimum regeneration harvest age varies by site class and species, but for areas on the west side of the Cascade crest without identified area-based landscape level conservation strategies, rotation ages are anticipated to average 60 years.

C.4.1.4 Harvest and Reforestation Methods

The methods used to harvest trees can affect soil health and productivity. Ground-based systems and cable systems without full suspension have the greatest relative potential to increase compaction or surface erosion, which can decrease soil productivity for some soils. Policy No. 31 (Harvest and Reforestation Methods) in the Forest Resource Plan states that DNR intends to examine every proposed harvest unit to select the harvest method that best satisfies the following criteria:

- Meets DNR responsibilities for generating current and long-term income;
- Meets biological constraints of the site condition;
- Maintains future stand productivity and health;
- Accomplishes DNR's objectives for protecting water quality and quantity and fish and wildlife habitat; and
- Minimizes impacts on special ecological features and wetlands.

Additionally, DNR Procedure 14-006-070 prescribes specifications for skidding and yarding to avoid or minimize soil compaction. Soil restrictions have been developed to minimize the potential for soil compaction or other disturbance to sensitive soils during timber harvest and road building activities. For example, restrictions limit skid trail widths and restrict ground-based logging to periods when soils are dry.

Intensity of Management/Fertilizer Use

Forest fertilization can improve financial yields and may improve forest health for some sites. Fertilization includes both aerial and ground applications. Other practices such as site preparation, and vegetation management are important management tools to either protect or increase financial yields. Site preparation includes a variety of techniques that includes aerial and ground herbicide applications, broadcast burns, ground mechanical treatments, and pile and burn. Vegetation management includes aerial and ground herbicide applications, and mechanical and hand vegetative control methods. The policy preference established in Forest Resource Plan Policy No. 33 determines operational application of these practices.

Forest Resource Plan Policy No. 34 (Fertilizing, Thinning, and Pruning) states that DNR is encouraged to conduct fertilization, thinning, and pruning activities only on sites that will produce an acceptable rate of return, such that the benefits must exceed the cost of any of these activities. Maintaining water quality is also cited as a concern related to fertilizer use.

Site Preparation

Forest Resource Plan Policy No. 30 (Silviculture Activities) states that DNR intends to minimize the need for all forms of site preparation (including burning, herbicide use, hand slashing, and tractor or mechanical clearing) by careful analysis and planning and selection of reforestation methods. The policy also states that DNR intends to select the most appropriate methods if necessary. Choice of a specific site preparation method would depend on quantity and type of residue and vegetation, topography, species selected for the site, soil characteristics, water, costs, laws, regulations, and local concerns.

C.4.1.5 Vegetation Management

Forest Resource Plan Policy No. 33 (Control of Competing Vegetation) ranks the potential methods used to control competing vegetation in order of preference:

1. No treatment

2. Non-herbicide (hand cutting)
3. Ground-applied herbicide
4. Aerial-applied herbicide

The use of any treatment method must balance the return on investment with the potentially adverse effects on public water supplies; public health; fish health; fish and wildlife habitat; or the effects on other trees, herbs and shrubs, erosion, or applicator safety.

C.4.2 Proposed Changes in Policies and Procedures

C.4.2.1 Mass Wasting

None of the proposed Alternatives would modify Procedure 14-004-050 (Assessing Slope Stability) or current Forest Practices Rules for potentially unstable slopes. As defined under Forest Practices Rules, Washington Administrative Code 222-16-050 1(d) for Class IV special harvest, these areas would continue to be either thoroughly evaluated for potential impacts and mitigation before harvest activities begin, or avoided, depending on the level of resources available.

C.4.2.2 Surface Erosion

Policies and procedures concerning harvest practices that would affect surface erosion would not be modified under any of the Alternatives. Changes to Procedure 14-005-020 (Identifying and Prioritizing Stands for Regeneration Harvest) under Alternatives 2 through 5 and the Preferred Alternative could adversely affect the risk of surface erosion under these Alternatives by allowing for more intensive management of stands. Resources dedicated to planning of harvest activities to prevent or mitigate surface erosion may need to be increased under these Alternatives as a result.

C.4.2.3 Soil Productivity

Changes are anticipated to Procedure 14-006-070 (Westside Smallwood Thinning Procedures), but direction on minimization of soil compaction would remain the same, causing no net loss of soil productivity as a result. Changes would occur in Procedure 14-005-020 (Identifying and Prioritizing Stands for Regeneration Harvest) under Alternatives 2 through 5 and the Preferred Alternative. These Alternatives propose more intensive use of variable density thinning, fertilizer, and tree-planting. Under Alternatives 1, 2, and 3, the average minimum age for regeneration harvests would be 60 years, while under Alternatives 4, 5, and the Preferred Alternative the average minimum rotation age would be 80 years, 50 years, and variable, respectively.

C.5 HYDROLOGY

C.5.1 Policies and Procedures

Policy No. 19 (Watershed Analysis) of the Forest Resource Plan addresses the potential risk of adverse effects from water quantity changes through the watershed risk assessment. Other policies such as Policy No. 16 (Landscape Planning), Policy No. 20 (Riparian Management Zones), Policy No. 30 (Silviculture Activities), and Policy No. 31 (Harvest and Reforestation Methods) also provide policy direction by describing objectives for the protection of water quality, fish, and other non-timber resources.

Under the Habitat Conservation Plan, conservation measures for avoiding changes to peak flows are covered under the riparian conservation strategy (DNR 1997, p. IV.68). Procedure 14-004-060, Assessing Hydrologic Maturity, defines the methodology to be used in basins where watershed analysis has not been conducted. With some exceptions, the basic protective measure is to maintain at least two-thirds of the western Washington forested state trust lands in the rain-on-snow and snow-dominated zones in hydrologically mature condition for sub-basins greater than 1,000 acres. A hydrologically mature stand is defined as a well-stocked conifer stand over the age of 25 years with a relative density of at least 25.

None of the Alternatives would modify DNR Procedure 14-004-060. Harvest is not allowed in at least two-thirds of the forested trust lands in the rain-on-snow and snow-dominated zones in hydrologically mature condition in each sub-basin greater than 1,000 acres. Because overall harvest levels would increase under Alternatives 2 through 5 and the Preferred Alternative, the amount of harvest in rain-on-snow zones would also likely increase in those Alternatives. Because these Alternatives do not propose changing DNR Procedure 14-004-060, at least two-thirds of the rain-on-snow and snow zones would be maintained in hydrologically mature forest in all sub-basins greater than 1,000 acres. Some harvests may be delayed to provide sufficient time for more forest to become hydrologically mature. As part of the DNR landscape planning and harvest scheduling activities, DNR would inspect rain-on-snow and snow dominated areas prior to planning harvests to ensure that Procedure 14-004-060 would be met under all Alternatives.

C.5.2 Stream Typing

Streams in western Washington forested state trust lands are classified according to the following system. (For the complete classification system, refer to Washington Administrative Code 222-16-030.)

- **Type 1**: All waters, within their ordinary high-water mark, inventoried as shorelines of the state.
- **Type 2**: Segments of natural waters that are not Type 1 and have a high use and are important from a water quality standpoint for domestic water supplies; public recreation; fish spawning, rearing, or migration or wildlife uses; or are highly significant to protect water quality.
- **Type 3**: Segments of natural waters that are not Type 1 or 2 and are moderately important for the uses listed under Type 2.
- **Type 4**: Segments of natural waters that are not Type 1, 2, or 3, and for the purpose of protecting water quality downstream are classified as Type 4 water upstream until the channel width becomes less than 2 feet in width between the ordinary high-water marks. These may be perennial or intermittent.
- **Type 5**: Natural waters that are not Type 1, 2, 3, or 4; including streams with or without well-defined channels, areas of perennial or intermittent seepage, ponds, natural sinks, and drainage ways having short periods of spring or storm runoff.

- **Type 9**: Streams of unknown classification.

C.6 WATER QUALITY

C.6.1 Current Policies and Procedures

The Washington State Forest Practices Rules comply with the federal Clean Water Act to meet state water quality standards for surface waters and groundwater (Table C.6-1). Water quality standards are set to provide for the protection of designated uses, including public water supply; wildlife habitat; and salmon spawning, rearing, and migration.

Section 303(d) of the federal Clean Water Act requires the state of Washington to periodically prepare a list of all surface waters in the state for which beneficial uses of the water are impaired by pollutants. As of 1998, about 2 percent of all the waters in Washington were identified as impaired. Segments of almost 250 streams were listed in western Washington in 1998 (see Appendix D, Section D.5). It is possible that other unmeasured water bodies also exceed water quality standards. The primary water quality problem on forestlands throughout the state is temperature. Elevated water temperature generally occurs as a result of timber harvest that removes vegetation that provides shade to water bodies (Forest Practices Rules Environmental Impact Statement [Washington Forest Practices Board 2001]). The Washington State Department of Ecology adopted updated water quality standards in June 2003 (Washington State Department of Ecology 2003). The updated standards must be approved by the federal Environmental Protection Agency, National Oceanic and Atmospheric Administration – Fisheries Service, and the U.S. Fish and Wildlife Service before they take effect.

Table C.6-1. Washington State Water Quality Standards for the Major Non-Chemical Parameters of Concern[1/]

Water Quality Parameter	Washington State Standard (Class AA, Excellent)	Washington State Standard (Class A, Good)
Temperature	Shall not exceed 16.0°C due to human activities. When natural conditions exceed 16°C, no temperature increase greater than 0.3°C is allowed. Incremental temperature changes from nonpoint source activities shall not exceed 2.8°C.	Shall not exceed 18.0°C due to human activities. When natural conditions exceed 18°C, no temperature increase greater than 0.3°C is allowed. Incremental temperature changes from nonpoint source activities shall not exceed 2.8°C.
Sediment	In regard to forest practices, implementation of approved best management practices will meet narrative water quality criteria such as support characteristic water uses, aesthetic values, etc.	Same as AA.
Turbidity[2/]	Shall not exceed 5 NTU (nephelometric turbidity units) over background when the background level is 50 NTUs or less, nor increase more than 10% of background when the background level is 50 NTUs or more.	Same as AA.

1/ New water quality standards have been proposed and are currently in a draft status. The new standards for temperature would be lower and more specific to fish populations (Washington State Department of Ecology 2003).

2/ Nephelometric turbidity units are the measurement units of turbidity using a nephelometer (light reflected surfaces of particles in suspension that are at right angles to the light source). 0 NTUs is clear and free of particles. >999 NTUs is essentially opaque.

NTU = nephelometric turbidity unit

Source: Forest Practices Rules Environmental Impact Statement (Washington Forest Practices Board 2001)

Included in the updated standards is a change in temperature requirements to protect critical life stages (incubation, spawning, and rearing) of salmon and bull trout. The Washington State Department of Ecology is now preparing a draft 303(d) list, which is expected to be ready for public comment in the summer of 2003.

Additional policies exist to protect water quality. Policy No. 19 (Watershed Analysis) of the Forest Resource Plan addresses water quality through a risk assessment process, as directed by Policy No. 19, of DNR harvest and silvicultural activities on water quality. Watershed analysis is conducted in conjunction with landscape planning (Policy No. 16).

Several other policies such as Policy No. 20 (Riparian Management Zones), Policy No. 30 (Silviculture Activities), and Policy No. 31 (Harvest and Reforestation Methods) also describe objectives for the protection of soils, water quality, fish, wildlife, and other non-timber resources. Policy No. 34 (Fertilization, Thinning and Pruning) is also indirectly related by considering water quality objectives when using fertilization. Under the Habitat Conservation Plan, conservation measures for the protection of water are covered under the Riparian Conservation Strategy of the Habitat Conservation Plan (DNR 1997, p. IV.55). The following DNR procedures are relevant to protection of water quality:

- Procedure 14-004-050 – Assessing Slope Stability,
- Procedure 14-006-040 – Controlling Competing Vegetation,

- Procedure 14-004-110 – Wetland Management,
- Procedure 14-004-230 – Protecting Mineral Springs, and
- Procedures 14-004-150 and 14-004-160 – Identifying and Protecting Riparian and Wetland Management Zones.

C.7 WETLANDS

For federal regulatory purposes, wetlands are considered a subclass of Special Aquatic Sites (40 Code of Federal Regulations Section 230.3) and have been deemed Waters of the United States (33 Code of Federal Regulations 328.3). All Waters of the United States are subject to regulation through the federal Clean Water Act by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency. Sections 404 and 401 of the Clean Water Act were created specifically with the intent "to restore and maintain the chemical, physical, and biological integrity of our Nation's waters." Exemptions granted under Section 404(f)(1) permit are normally for agricultural, ranching, and silvicultural activities, as well as maintenance of existing drains, farm ponds, and roads.

On DNR forested trust lands, the forest management activities are regulated by the Washington Forest Practices Rules, the DNR Forest Resource Plan, or the Habitat Conservation Plan, whichever is more restrictive. The regulations, policies, and procedures of each document guiding forest management activities on forested trust lands are described below.

C.7.1 Washington State Forest Practices Rules

The Washington State Forest Practices Rules recognize two primary types of wetlands: forested and non-forested. Forested wetland means any wetland or portion thereof that has, or if the trees were mature would have, a crown closure of 30 percent or more. Non-forested wetland means those wetlands that do not, or would not if the trees were mature, have crown closures of 30 percent or more.

All forested and non-forested wetlands and forested and non-forested bogs over 0.25 acre require designation of a Wetland Management Zone. Forested wetlands are not designated with Wetland Management Zones. The Wetland Management Zones are defined as specified areas where specific measures are taken to protect the wetland functions. The size of the Wetland Management Zone is determined by the Forest Practices classification of the individual wetland, and partial cutting or removal of group trees is allowed in Wetland Management Zones by the Forest Practices Rules. The Forest Practices Rules do not provide protection to wetlands under 0.25 acre in size.

The Washington State Forest Practices Board Manual describes two approaches for identifying and delineating wetlands: approximate determination and accurate delineation. Approximate determination of wetland boundaries uses maps, aerial photographs, other information, and field visits if necessary. It can be used to identify forested wetlands greater than 3 acres, classifying the type of wetland that is within or adjacent to the proposal, determining the acreage of non-forested wetlands, and determining the acreage of forested wetlands associated with a Riparian Management Zone. An accurate delineation of wetland boundaries is required to determine those portions of any wetland where road construction could result in filling or draining more than 0.1 acre.

C.7.2 DNR Forest Resource Plan

DNR management activities in and around wetlands on all forested trust lands follow DNR Forest Resource Plan Policy No. 21, which states “the Department will allow no overall net loss of naturally occurring wetland acreage and function.” The policy recognizes that some loss of function may occur in the course of its forest management activities. The policy emphasizes avoiding the loss of wetlands and allows for mitigation if it occurs. If mitigation is necessary, preference would be given to on-site and in-kind replacement of acreage and function.

DNR Procedures 14-004-110 and 150 provide wetland management guidance for implementation of the Forest Resource Plan and the Habitat Conservation Plan. These procedures define the wetland buffers and provide a basis for evaluating management activities. Under these procedures, all wetlands over 0.25 acre, forested and non-forested, are provided with buffers. Wetland buffers are defined below:

Olympic Experimental State Forest

- Wetlands 0.25 to 5 acres: two-thirds of the site potential tree height
- Wetlands larger than 5 acres: 1 site potential tree height

Other HCP Planning Units

- Wetlands 0.25 to 1 acre: 100 feet
- Wetlands greater than 1 acre: The larger of 100 feet or greater than or equal to 1 site potential tree height

DNR Procedure 14-004-110 describes forestry management activities allowed in forested wetlands and their associated forested buffers and also in forested and non-forested wetlands in Olympic Experimental State Forest. Procedure 14-004-150 specifies the type of forestry activities allowed in Wetland Management Zones (non-forested wetlands and their buffers) in the five Westside HCP Planning Units (not including the Olympic Experimental State Forest). The procedures for harvest in forested wetlands and their associated buffers are defined below:

Olympic Experimental State Forest

- Maintain and perpetuate a stand that is windfirm and has a minimum basal area of 120 square feet per acre.

Other HCP Planning Units

- Maintain and perpetuate a stand that is windfirm and has a minimum basal area of 120 square feet per acre.
- Provide on-site and in-kind mitigation for road construction requiring mitigation
- Limit disturbance in the area. Remediation of necessary disturbance should: 1) restore and maintain a condition that is as close to natural drainage as possible; and 2) restore water storage. Limit disturbance by imposing seasonal restrictions, conducting direct

felling activities to avoid ground equipment entry, carefully planning yarding corridors and skid trails, using low-pressure tire equipment or cable systems, and restoring natural drainage.

C.7.3 Habitat Conservation Plan

The DNR Habitat Conservation Plan defines the objective of the wetland protection strategy as maintaining hydrologic function through:

1. Continuously maintaining a plant canopy that provides a sufficient transpiration surface and established rooting,
2. Maintaining natural water flow, and
3. Ensuring stand regeneration.

Under the Habitat Conservation Plan, as under the Forest Resource Plan, all forested and non-forested wetlands over 0.25 acre are buffered. The buffers are the same as described above for Procedures 14-004-110 and 14-004-150.

The Habitat Conservation Plan also requires on-site and in-kind equal acreage mitigation for road-building in wetlands. In the Habitat Conservation Plan, direction for forest management in forested wetlands is to minimize entry and use practices that minimize disturbance. The Habitat Conservation Plan specifies that if ground disturbance alters the natural surface or subsurface drainage of a wetland, restoration is required; soil compaction and rutting usually preclude the use of ground-based equipment in wetlands; and salvage operations are permitted in buffers that are not periodically flooded.

Wetlands within Riparian Management Zones are also regulated by regulations, policies, and procedures that apply to Riparian Management Zones (discussed in Section C.2, Riparian Areas). Because of the restrictions described above, this does not impose additional regulations on non-forested wetlands. However, forested wetlands within a Riparian Management Zone receive incidental protection because the Riparian Management Zone requirements are more restrictive.

C.8 FISH AND FISH HABITAT

The Forest Resource Plan (DNR 1992) includes the following policies for protecting aquatic systems, including fish and fish habitat:

- Policy No. 19 – Watershed Analysis,
- Policy No. 20 – Riparian Management Zones, and
- Policy No. 21 – Wetlands.

Watershed analysis directs DNR to analyze the risk to public resources (such as water, air, fish, wildlife, and soil) and trust interests from major activities in a watershed. The analysis considers both state forestland and adjacent properties that could impact management of trust assets. The process directed under Policy No. 19 does not require the use of the Watershed Analysis Methodology developed by the Washington Forest Practices Board. Watershed analysis using the Watershed Analysis Methodology has been implemented by private forestland owners in some watersheds and by DNR for some forested trust lands (e.g., the Loomis State Forest in eastern Washington). The Forest Practices Rules Environmental Impact Statement (Washington Forest Practices Board 2001) indicated that approximately 10 percent of private and forested trust lands of Washington (state-wide) had watershed analysis completed using the Watershed Analysis Methodology, and about 10 analyses were expected to be completed annually.

Policy No. 20 requires that Riparian Management Zones be established along Types 1 through 4 streams and along Type 5 streams when necessary. Within the Riparian Management Zones, DNR is required to focus on protecting key non-timber resources, such as water quality, fish, wildlife habitat, and sensitive plant species.

Policy No. 21 requires that DNR allow no overall net loss of naturally occurring wetland acreage and function. As indicated above, wetlands are an important component to water quantity and water quality within a watershed. Consequently, wetlands are indirectly important to the maintenance of fish populations and fish habitat.

In addition to policies specific to aquatic resources, Policy No. 23, Endangered Species, requires DNR to meet the requirements of federal and state laws and other legal requirements that protect threatened, endangered, and sensitive species and to support efforts to recover and restore species listed under the federal Endangered Species Act to the extent that such participation is consistent with trust obligations.

One of the ways that DNR addresses Policy No. 23 is through their Habitat Conservation Plan. At the time the Habitat Conservation Plan was prepared, none of the salmon and trout species mentioned in Section 4.10 of this EIS was listed in western Washington, but all were included as covered species. The Habitat Conservation Plan strategy for protecting covered fish species was termed the Riparian Conservation Strategy and had the objectives of: (1) maintaining or restoring salmonid freshwater habitat on forested trust lands, and (2) contributing to the conservation of other aquatic and riparian-obligate species (DNR 1997, p. IV.55). Components to the Riparian Conservation Strategy include activity restrictions in Riparian Management Zones, protection of unstable hillslopes and mass-wasting areas, a road management strategy, requirements for hydrologic maturity in the rain-on-snow zone, and wetlands protection. Procedures designed to implement the Forest Resource Plan policies and the Riparian Conservation Strategy include the following:

- Procedure 14-004-050 – Assessing Slope Stability (see Section C.4, Geomorphology, Soils, and Sediment);
- Procedure 14-004-060 – Assessing Hydrologic Maturity (see Section C.5, Hydrology);
- Procedure 14-004-110 – Wetland Management (see Section C.7 Wetlands); and
- Procedures 14-004-150 and 14-004-160 – Identifying and Protecting Riparian and Wetland Management Zones (see Section C.2, Riparian Areas).

C.9 CULTURAL RESOURCES

The importance of protecting cultural resources on lands owned and under the jurisdiction of the state of Washington has been codified in law and policy, including Revised Code of

Washington 27.44 and 27.53, Policy No. 24 of the Forest Resource Plan, and the Habitat Conservation Plan.

- **Revised Code of Washington 27-44 – Indian Graves and Records Act.** This statute makes it a crime to knowingly disturb, remove, or damage American Indian graves and glyptic records, such as petroglyphs or pictographs.
- **Revised Code of Washington 27-53 – Archaeological Sites and Resources Act.** This statute prohibits any individual, corporation, or agency from knowingly removing, altering, or disturbing any archaeological site or object without a written permit from the Director of Community, Trade, and Economic Development, or designee.
- **DNR Forest Resource Plan – Policy No. 24.** Titled "Identifying Historic Sites," this policy declares that DNR will establish a program to identify and inventory historic and archaeological sites, and protect them at a level that, at a minimum, meets regulatory requirements. DNR will follow procedures equivalent to those required under Section 106 of the National Historic Preservation Act, which requires a consideration of the effects of a federal undertaking on properties eligible for or listed on the National Register of Historic Places.
- **DNR Habitat Conservation Plan – Cultural Resource Protections.** The Habitat Conservation Plan falls back on the above referenced statutes to ensure that archaeological sites and Indian graves are protected from disturbance. It identifies DNR's Total Resource Application Cross-Reference System as an important tool for ensuring that department activities do not damage such sites. The cultural resource portion of this system is based on the cultural resource database maintained by the Office of Archaeology and Historic Preservation.

C.10 SCENIC RESOURCES

The primary guiding principles for the management of the forest resource on forested trust lands are contained in Forest Resource Plan policies and DNR Forestry Handbook Procedures. The Visual Management procedure outlined in DNR Procedure 14-004-080 is used to identify timber production areas that should be managed for visual concerns. Although DNR primarily manages forested trust lands to produce income for the various trusts and maintain a healthy ecosystem, visual concerns are also considered. Visual concerns do not, however, apply to all areas. In cases where visual concerns do apply, management decisions seek a balanced solution between visual impact, income, and ecosystem objectives.

Areas where potential visual concerns exist include, but are not limited to:

- major highway corridors,
- cities and towns,
- adjacent housing developments, and
- trails and other recreation areas.

DNR's Visual Management Procedure 14-004-080 outlines the procedure whereby DNR regions locate areas that may be managed to reduce the visual impact of harvest and road-building activities. This involves considering the viewsheds of major highways, urban areas, and recreation areas, and identifying where forested trust lands are located within those viewsheds. The locations of proposed harvest areas are considered in terms of distance zone (immediate view, foreground, middleground, or background) and their size is compared to the overall size of the affected viewshed. Other factors considered include adjacent land uses, the level of neighbor involvement, and the duration of the view.

In addition to western Washington forested state trust lands that are managed for the support of trust beneficiaries, DNR also manages some forested trust lands as Natural Area Preserves (14,200 acres) and Natural Resource Conservation Areas (59,800 acres). These lands are managed to preserve the best remaining examples of many ecological communities and protect outstanding native ecosystems; habitat for endangered, threatened, and sensitive plants and animals; and scenic landscapes, respectively. These lands, which are "off-base" for harvest, help support management objectives by managing and conserving habitat for habitat conservation species, where appropriate.

C.11 RECREATION

The Forest Resource Plan (DNR 1992) includes policies for recreation on forested trust lands. These policies are as follows:

- Policy No. 25: Providing Public Access, and
- Policy No. 29: Recreation on State Forest Lands.

Statewide, DNR manages approximately 2.9 million acres of forested trust lands, with about 1.5 million acres located in westside counties (1.4 million acres of which are forested). These forested trust lands are managed for the support of trust beneficiaries with recreation being a secondary use allowed under the Multiple Use Act (79.68 RCW, recodified as Laws of 2003, Ch. 334, sec. 555(2)). The Multiple Use Act allows for recreational use as long as the uses do not damage resources and are compatible with trust management responsibilities (Forest Resource Plan Policy No. 29 [DNR 1992]). Recreation activities allowed on forested trust lands include hiking, fishing, and berry-picking activities that meet the above criteria. Recreation sites on forested trust lands also include public campgrounds, off-road vehicle sites, and other recreation areas leased from the trusts.

DNR generally provides public access for multiple uses on forested trust lands. There are, however, situations where the DNR controls vehicular or other access. Public access may be closed, restricted, or limited to protect public safety; to prevent theft, vandalism, and garbage-dumping; to protect soils, water quality, plants, and animals; or to meet other Forest Resources Plan objectives (Forest Resource Plan Policy No. 25 [DNR 1992]).

C.12 PUBLIC UTILITIES AND SERVICES

The policies that apply to the public utilities and services discussed in this document include:

State Forest Transfer Revenues

RCW 79.64.110 (1) directs the distribution of revenues generated from State Forest Transfer lands.

RCW 79.64.110 (1)(a) reads:

> "The expense incurred by the state for administration, reforestation, and protection, not to exceed twenty-five percent, which rate of percentage shall be determined by the board, must be returned to the forest development account in the state general fund."

The Board of Natural Resources has set the current Forest Development Account deduction at 22 percent, and the remaining 78 percent is distributed to the counties per RCW 79.64.110 (1)(b):

> "Any balance remaining must be paid to the county in which the land is located to be paid, distributed, and prorated, except as otherwise provided in this section, to the various funds in the same manner as general taxes are paid and distributed during the year of payment."

Most counties (the exceptions are Skamania and Wahkiakum Counties – see RCW 79.64.110 (1)(c) below) are required to distribute the revenue they receive from State Forest Transfer lands to the various taxing districts in the same manner (paid, distributed, and prorated) as general property taxes are distributed. The actual distribution of revenue from a timber sale depends on which taxing districts the harvest is located in and the tax rates during the year that harvest occurred.

RCW 79.64.110 (1)(c) provides an exception, and reads:

> "Any balance remaining, paid to a county with a population of less than sixteen thousand, must first be applied to the reduction of any indebtedness existing in the current expense fund of the county during the year of payment."

State Forest Purchase Revenues

RCW 79.64.110 (2) directs the distribution of revenues generated from State Forest Purchase lands. RCW 79.64.100 (2)(a) reads:

> "Fifty percent shall be placed in the forest development account."

Unlike the management fund deduction for the State Forest Transfer lands, the deduction for State Forest Purchase lands is a fixed amount rather than a maximum.

The remaining 50 percent is distributed to the counties per RCW 79.64.110 (2)(b):

> "Fifty percent shall be prorated and distributed to the state general fund, to be dedicated for the benefit of the public schools, and the county in which the land is located according to the relative proportions of tax levies of all taxing districts in the county. The portion to be distributed to the state general fund shall be based on the regular school levy rate under RCW 84.52.065 and the levy rate for any maintenance and operation special school levies. With regard to the portion to be distributed to the counties, the department shall certify to the state treasurer the amounts to be distributed

within seven working days of receipt of the money. The state treasurer shall distribute funds to the counties four times per month, with no more than ten days between each payment date. The money distributed to the county must be paid, distributed, and prorated to the various other funds in the same manner as general taxes are paid and distributed during the year of payment."

The portion distributed directly to the general fund is prorated based on the regular school, and maintenance and operation special school levies. The money distributed to the county is distributed to the taxing districts other than the schools in the same manner (paid, distributed, and prorated) as property taxes are distributed.

While the distribution of the revenues remaining after the forest development account deduction may seem different for the purchase and transfer lands, in fact only the administrative route is different, and the resulting distribution is the same. This is because the proportion distributed to the schools for State Forest Transfer is an offset to general fund revenue, while for State Forest Purchase, it is transferred directly to the state general fund.

C.13 REFERENCES

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Appendix D

Additional Information to Support Resource Analyses

Appendix D

D. ADDITIONAL INFORMATION TO SUPPORT RESOURCE ANALYSES

TABLES

FIGURES

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Appendix D

D.1 ADDITIONAL ANALYSES FOR THE FOREST STRUCTURE AND VEGETATION SECTION

D.1.1 Site Class

Site class indicates the productivity of an area to grow a given species of tree. Site class is based on site index, which is the expected height of a dominant tree at a specific index age (generally a 50 years breast-height age). Site Class I represents the highest productivity and Site Class V the lowest. Site class is a factor in determining the biological productivity and economic potential of a stand and will influence the frequency of harvest of a stand.

Table D-1 displays site class acres in each of DNR’s HCP Planning Units in western Washington. Site class is predominantly moderate to high on forested trust land in western Washington. Four percent of these lands are highly productive Site Class I. Site Class II covers 30 percent of the forested trust lands. Site Class III covers approximately 44 percent of the forested trust lands. Site Class IV and Site Class V are found on 18 and 5 percent of the area, respectively.

The Columbia, North Puget, and Straits HCP Planning Units contain the most productive forest sites. These three units contain over 90 percent of Site Class I lands and 80 percent of Site Class II lands in the western Washington forested state trust lands. Site Class III occurs on 10 to 25 percent of the forestland in each HCP Planning unit. More than 60 percent of Site Class V lands are in the North Puget HCP Planning Unit.

D.1.2 Additional Information on Current Conditions

Figure D-1 shows the age class distribution for forested trust lands. Table D-2 summarizes standing volume changes by land class, HCP Planning Unit, and Alternative.

Table D-1. Site Class for Western Washington Forested Trust Lands, by HCP Planning Unit

HCP Planning Unit	Site Class									
	I		II		III		IV		V	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Straits	9,275	3%	98,741	37%	102,651	38%	48,564	18%	8,299	3%
North Puget	15,506	4%	95,098	25%	152,378	40%	75,936	20%	42,598	11%
South Puget	3,076	1%	36,689	14%	156,465	61%	52,875	21%	7,554	3%
Columbia	23,844	10%	138,845	60%	64,177	28%	4,540	2%	1,526	1%
South Coast	1,580	1%	31,653	22%	69,255	49%	34,950	25%	4,405	3%
OESF	410	0%	10,456	9%	62,396	57%	32,864	30%	4,095	4%
Total Acres	**53,690**	**4%**	**411,482**	**30%**	**607,322**	**44%**	**249,729**	**18%**	**68,477**	**5%**

Data Source: Model output data – SDS. Some percentages do not sum to 100 due to rounding.

OESF = Olympic Experimental State Forest

Figure D-1. Age Class Distribution for Forested Trust Lands (2004)

D.1.3 Harvest Intensity

Figures D-2, D-3, and D-4 graphically display the variations in distribution of management intensity by land class that would result from differing policy and procedures among Alternatives. Harvest intensity under Alternative 1 would be low in all land classes when compared to other Alternatives because of constraints that reduce the land base for harvest. Under Alternative 4, harvest intensity would be similar to Alternative 1, reflecting the combination of harvest constraints in riparian areas and proposed longer harvest maturity criteria. Alternatives 2, 3, 5, and the Preferred Alternative would have higher harvest intensity. Some lands that currently have harvest restrictions would be available for harvest under these four Alternatives through policy change and increased commitment of resources. Under Alternative 5, a younger maturity criterion (50 years) would increase harvest intensity over Alternatives 1, 2, 3, and 4.

Figure D-5 displays harvest type (low, moderate, and high volume removal) over time by Alternative, expressed as a percent of the total forested trust lands. The figure graphically displays lower harvest intensity in Alternatives 1 and 4 that would use passive management strategies compared to Alternatives 5 and the PA, and, to a lesser extent, Alternative 3. Under Alternative 3, harvest intensity would show more variability over time because of the wider allowable fluctuation in decadal harvest targets. The intensive management strategy proposed under Alternatives 5 and the PA would result in higher harvest intensity levels, partly due to higher amounts of thinning. Under the PA, biodiversity pathways management would entail multiple harvest entries to encourage the development of stand structure needed for wildlife habitat and riparian structure.

Table D-2. Summary of Standing Volume Changes (billion board feet Scribner) by Land Class, HCP Planning Unit, and Alternative

Alternative	HCP Planning Unit	Year	Uplands with General Objectives	Uplands with Specific Objectives	Riparian and Wetland Areas	Total
Alt.1	Colombia	2004	1.9	2.4	2.2	**6.5**
		2013	1.8	2.8	2.7	**7.3**
		2031	1.8	3.4	3.7	**9.0**
		2067	2.0	4.0	5.1	**11.1**
	North Puget	2004	1.7	4.3	2.2	**8.3**
		2013	1.5	5.0	2.7	**9.2**
		2031	1.5	6.4	3.7	**11.6**
		2067	1.6	8.2	5.0	**14.7**
	OESF	2004	0.0	2.7	2.1	**4.8**
		2013	0.0	3.6	2.8	**6.4**
		2031	0.0	5.4	4.4	**9.7**
		2067	0.0	7.8	6.5	**14.4**
	South Coast	2004	2.6	1.1	2.1	**5.8**
		2013	2.7	1.3	2.7	**6.6**
		2031	3.1	1.5	3.7	**8.3**
		2067	3.7	1.9	5.1	**10.7**
	South Puget	2004	0.4	1.8	0.8	**3.0**
		2013	0.3	2.0	1.0	**3.3**
		2031	0.3	2.7	1.3	**4.3**
		2067	0.5	3.2	1.8	**5.4**
	Straits	2004	1.0	0.8	0.5	**2.3**
		2013	1.0	0.9	0.5	**2.5**
		2031	1.2	1.1	0.7	**3.0**
		2067	1.7	1.3	0.9	**4.0**
Alt.2	Colombia	2004	1.9	2.4	2.2	**6.5**
		2013	2.0	2.5	2.7	**7.2**
		2031	2.0	2.8	3.6	**8.4**
		2067	2.7	3.0	4.8	**10.5**
	North Puget	2004	1.8	4.3	2.2	**8.3**
		2013	1.7	4.6	2.7	**9.0**
		2031	1.9	5.3	3.6	**10.8**
		2067	1.9	5.8	4.7	**12.4**
	OESF	2004	0.0	2.7	2.1	**4.8**
		2013	0.0	3.3	2.8	**6.0**
		2031	0.0	4.3	4.1	**8.4**
		2067	0.0	4.6	5.5	**10.1**
	South Coast	2004	2.7	1.1	2.1	**5.9**
		2013	2.6	1.1	2.6	**6.3**
		2031	2.8	1.1	3.6	**7.5**
		2067	3.1	1.0	4.8	**8.9**

Table D-2. Summary of Standing Volume Changes (billion board feet Scribner) by Land Class, HCP Planning Unit, and Alternative (continued)

Alternative	HCP Planning Unit	Year	Uplands with General Objectives	Uplands with Specific Objectives	Riparian and Wetland Areas	Total
	South Puget	2004	0.4	1.8	0.8	**2.9**
		2013	0.4	1.8	0.9	**3.2**
		2031	0.4	2.0	1.3	**3.7**
		2067	0.6	2.3	1.7	**4.6**
	Straits	2004	1.0	0.8	0.5	**2.2**
		2013	1.0	0.8	0.5	**2.3**
		2031	1.1	0.8	0.7	**2.6**
		2067	1.4	0.9	0.9	**3.2**
Alt.3	Colombia	2004	1.9	2.4	2.2	**6.5**
		2013	1.6	2.4	2.6	**6.7**
		2031	1.2	2.5	3.5	**7.3**
		2067	1.8	2.7	4.6	**9.1**
	North Puget	2004	1.8	4.3	2.2	**8.3**
		2013	1.8	4.9	2.7	**9.4**
		2031	1.4	5.2	3.5	**10.1**
		2067	1.4	5.5	4.5	**11.4**
	OESF	2004	0.0	2.7	2.1	**4.8**
		2013	0.0	3.6	2.8	**6.4**
		2031	0.0	4.8	4.3	**9.1**
		2067	0.0	4.7	5.9	**10.5**
	South Coast	2004	2.7	1.1	2.1	**5.9**
		2013	2.1	1.1	2.6	**5.8**
		2031	1.8	1.0	3.5	**6.4**
		2067	2.4	0.9	4.6	**8.0**
	South Puget	2004	0.4	1.7	0.8	**2.9**
		2013	0.3	1.7	0.9	**2.9**
		2031	0.3	2.1	1.2	**3.6**
		2067	0.5	2.4	1.7	**4.6**
	Straits	2004	1.0	0.8	0.5	**2.2**
		2013	0.8	0.8	0.5	**2.1**
		2031	0.7	0.7	0.7	**2.0**
		2067	0.8	0.7	0.8	**2.3**
Alt.4	Colombia	2004	1.9	2.4	2.2	**6.5**
		2013	1.9	2.8	2.7	**7.4**
		2031	1.9	3.4	3.7	**9.0**
		2067	2.0	3.6	5.0	**10.6**
	North Puget	2004	1.7	4.3	2.2	**8.2**
		2013	1.7	4.8	2.7	**9.2**
		2031	1.7	5.9	3.6	**11.2**
		2067	1.8	7.2	4.9	**13.9**

Table D-2. Summary of Standing Volume Changes (billion board feet Scribner) by Land Class, HCP Planning Unit, and Alternative (continued)

Alternative	HCP Planning Unit	Year	Uplands with General Objectives	Uplands with Specific Objectives	Riparian and Wetland Areas	Total
	OESF	2004	0.0	2.7	2.1	**4.8**
		2013	0.0	3.6	2.8	**6.5**
		2031	0.0	5.6	4.4	**10.1**
		2067	0.0	8.6	6.8	**15.4**
	South Coast	2004	2.6	1.1	2.1	**5.8**
		2013	2.7	1.2	2.6	**6.5**
		2031	2.5	1.3	3.6	**7.5**
		2067	3.0	1.4	4.9	**9.3**
	South Puget	2004	0.4	1.8	0.8	**3.1**
		2013	0.4	2.1	1.0	**3.5**
		2031	0.5	2.7	1.3	**4.5**
		2067	0.5	3.4	1.7	**5.7**
	Straits	2004	1.0	0.8	0.5	**2.3**
		2013	1.0	0.8	0.5	**2.4**
		2031	1.1	0.9	0.7	**2.7**
		2067	1.3	1.0	0.9	**3.2**
Alt.5	Colombia	2004	1.7	2.3	2.2	**6.2**
		2013	1.6	2.2	2.6	**6.4**
		2031	1.2	2.0	3.5	**6.7**
		2067	1.5	1.9	4.6	**8.1**
	North Puget	2004	1.7	4.3	2.2	**8.2**
		2013	1.8	4.7	2.7	**9.1**
		2031	1.1	4.7	3.5	**9.4**
		2067	1.5	5.4	4.6	**11.5**
	OESF	2004	0.0	2.7	2.2	**4.9**
		2013	0.0	2.4	2.8	**5.2**
		2031	0.0	2.0	4.1	**6.1**
		2067	0.0	2.2	5.8	**7.9**
	South Coast	2004	2.5	1.1	2.1	**5.7**
		2013	2.4	1.0	2.6	**6.1**
		2031	1.9	0.9	3.5	**6.4**
		2067	2.3	1.0	4.7	**7.9**
	South Puget	2004	0.4	1.7	0.8	**2.9**
		2013	0.3	1.7	0.9	**2.9**
		2031	0.3	1.6	1.2	**3.1**
		2067	0.4	1.6	1.6	**3.6**
	Straits	2004	0.9	0.8	0.5	**2.2**
		2013	0.8	0.7	0.5	**2.0**
		2031	0.7	0.6	0.7	**2.0**
		2067	0.8	0.6	0.8	**2.3**

Table D-2. Summary of Standing Volume Changes (billion board feet Scribner) by Land Class, HCP Planning Unit, and Alternative (continued)

Alternative	HCP Planning Unit	Year	Uplands with General Objectives	Uplands with Specific Objectives	Riparian and Wetland Areas	Total
PA	Colombia	2004	1.9	2.4	2.2	**6.5**
		2013	1.4	2.3	2.6	**6.4**
		2031	1.4	2.5	3.2	**7.1**
		2067	1.9	2.4	3.9	**8.2**
	North Puget	2004	1.6	4.3	2.2	**8.1**
		2013	1.4	4.6	2.6	**8.6**
		2031	1.3	5.4	3.2	**10.0**
		2067	2.0	6.2	4.0	**12.3**
	OESF	2004	0.0	2.8	2.2	**5.0**
		2013	0.0	3.1	2.7	**5.8**
		2031	0.0	3.7	3.9	**7.5**
		2067	0.0	4.5	5.0	**9.5**
	South Coast	2004	2.6	1.1	2.1	**5.9**
		2013	2.1	1.1	2.6	**5.8**
		2031	2.1	1.2	3.1	**6.4**
		2067	3.2	1.3	3.7	**8.2**
	South Puget	2004	0.4	1.8	0.8	**3.0**
		2013	0.4	1.8	0.9	**3.0**
		2031	0.4	2.1	1.2	**3.7**
		2067	0.6	2.1	1.4	**4.1**
	Straits	2004	0.9	0.8	0.4	**2.1**
		2013	0.8	0.8	0.5	**2.0**
		2031	0.9	0.8	0.5	**2.2**
		2067	1.3	0.8	0.6	**2.7**

OESF = Olympic Experimental State Forest

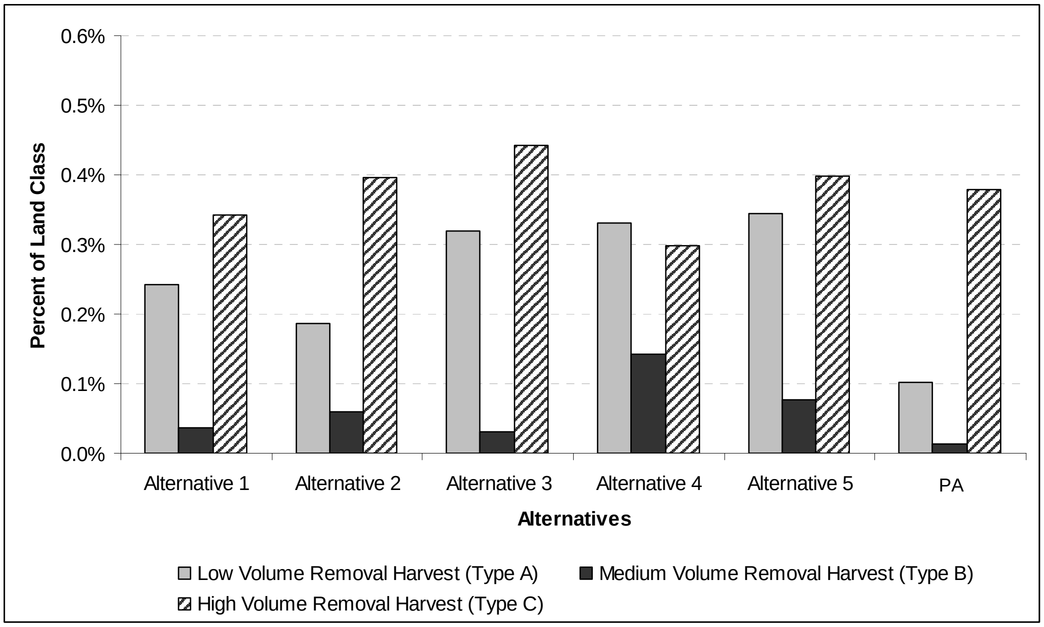

Figure D-2. Harvest Intensity in Forested Trust Uplands with General Management Objectives Land Class (annual average percent of total forest base area by harvest type over the analysis period)
Data Source: Model output data (Timber Flow Level)

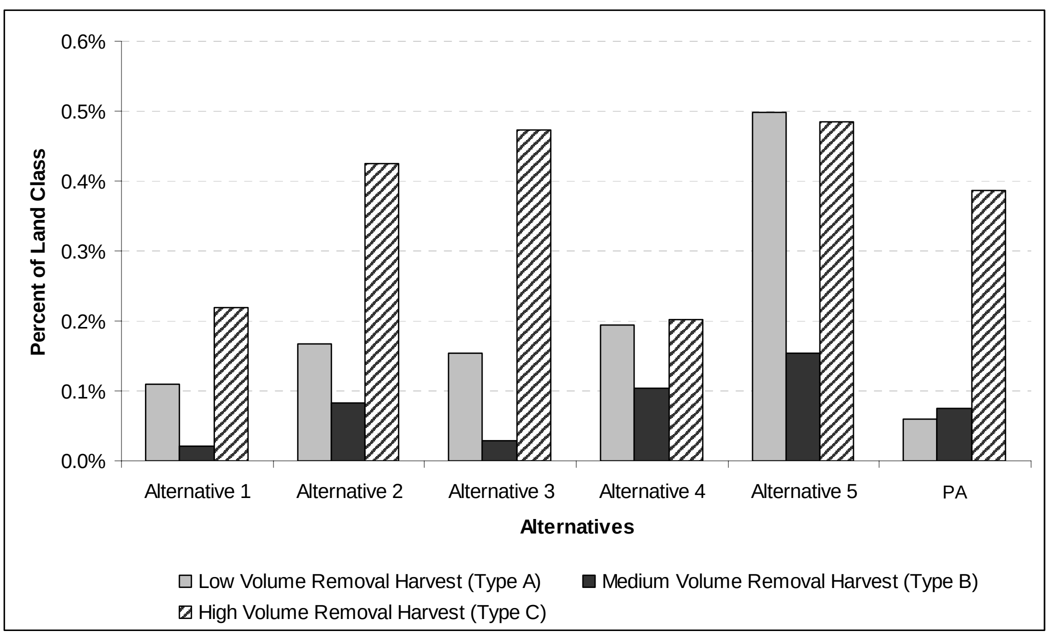

Figure D-3. Harvest Intensity in Forested Trust Uplands with Specific Management Objectives Land Class (annual average percent of total forest base area by harvest type over the analysis period)
Data Source: Model output data (Timber Flow Level)

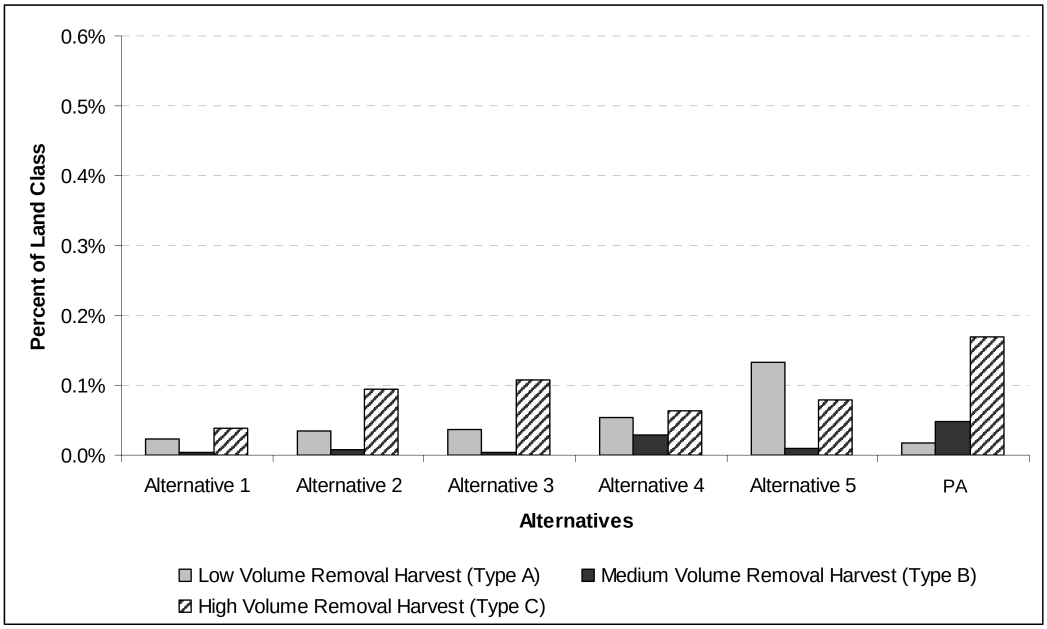

Figure D-4. Harvest Intensity on Forested Trust Lands in the Riparian and Wetland Land Class (annual average percent of total forest base area by harvest type over the analysis period)
Data Source: Model output data (Timber Flow Level)

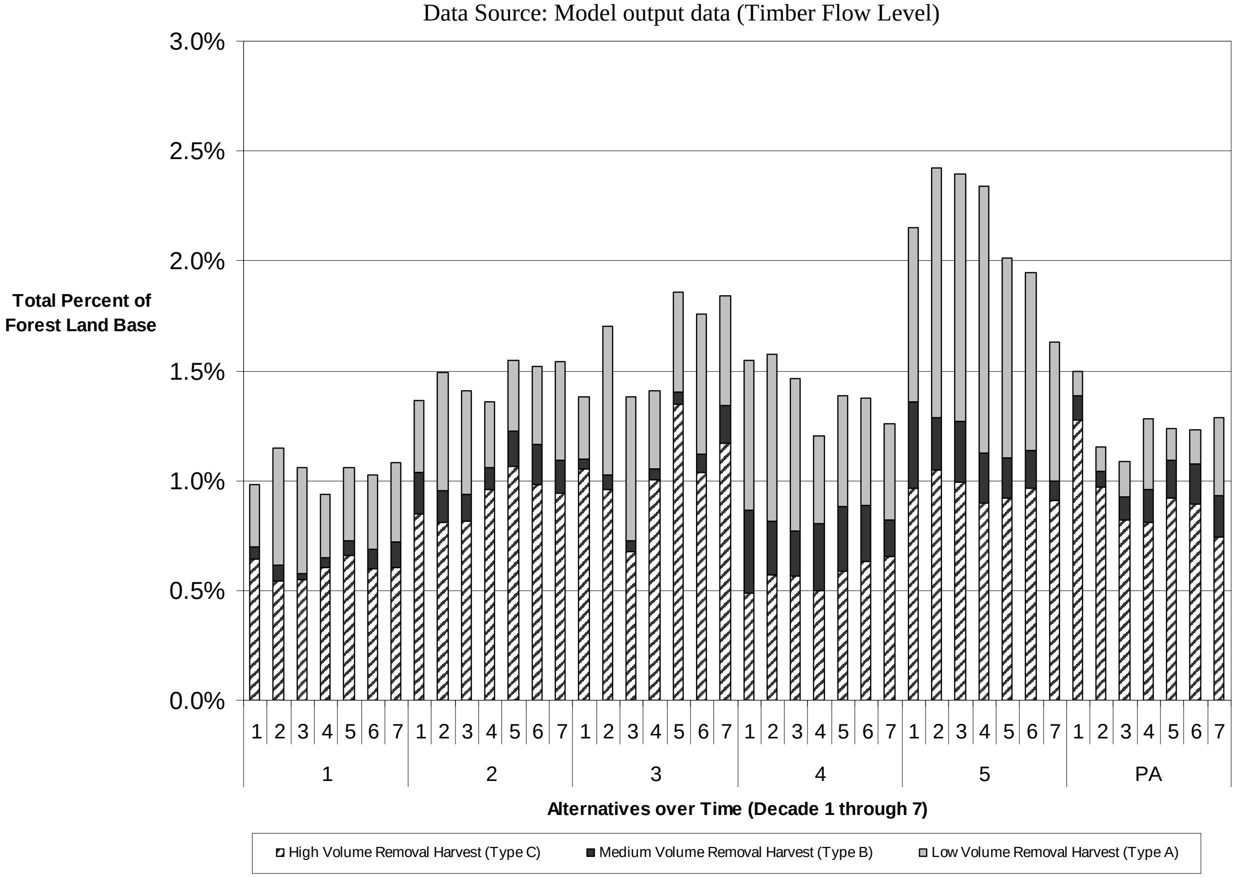

Figure D-5. Harvest Type by Alternative (average annual percent by decade of Forested Trust Lands by harvest type)
Data Source: Model output data (Timber Flow Level)

Harvest intensity viewed at the planning unit level shows a similar pattern, with the following exceptions (Tables D-3 and D-4). The Olympic Experimental State Forest HCP Planning Unit would consistently have lower harvest levels than the other HCP Planning units in Alternatives 1, 2, 3 and 4. Under Alternatives 5 and the PA, there is an increased percentage of low volume removal harvest in the Olympic Experimental State Forest. In Alternatives 1, 2, 3, and 4, the South Coast HCP Planning Unit would have a slightly higher harvest intensity than the other HCP Planning Units.

Tables D-5 through D-7 show the percent of each land class area in which timber harvest activities would occur per decade under each alternative by HCP Planning Unit. Table D-8 shows the percentage of land class area expected in three stand development stage categories by HCP Planning Unit and year for the alternatives.

Table D-3. Average Annual Harvest Area over 64 Years as a Percent of Forested Trust Lands within HCP Planning Units

Alternatives	HCP Planning Unit	Low Volume Removal Harvest (Harvest Type A)	Medium Volume Removal Harvest (Harvest Type B)	High Volume Removal Harvest (Harvest Type C)
Alt.1	Columbia	0.5%	0.1%	0.8%
	North Puget	0.4%	0.1%	0.6%
	OESF	0.0%	0.0%	0.2%
	South Coast	0.5%	0.1%	0.8%
	South Puget	0.5%	0.1%	0.7%
	Straits	0.3%	0.1%	0.5%
Alt.2	Columbia	0.3%	0.1%	0.7%
	North Puget	0.7%	0.2%	1.2%
	OESF	0.2%	0.0%	0.8%
	South Coast	0.8%	0.4%	1.9%
	South Puget	0.5%	0.2%	1.1%
	Straits	0.2%	0.1%	0.4%
Alt.3	Columbia	0.6%	0.1%	1.2%
	North Puget	1.0%	0.1%	1.4%
	OESF	0.1%	0.0%	1.5%
	South Coast	1.5%	0.1%	2.7%
	South Puget	0.2%	0.0%	0.5%
	Straits	0.2%	0.0%	0.4%
Alt.4	Columbia	0.7%	0.4%	0.8%
	North Puget	1.8%	0.7%	1.6%
	OESF	0.1%	0.1%	0.2%
	South Coast	0.7%	0.3%	0.8%
	South Puget	0.2%	0.1%	0.2%
	Straits	0.4%	0.2%	0.3%
Alt.5	Columbia	1.9%	0.5%	2.0%
	North Puget	2.5%	0.5%	2.9%
	OESF	1.2%	0.1%	0.9%
	South Coast	0.6%	0.2%	0.6%
	South Puget	0.6%	0.2%	0.5%
	Straits	0.6%	0.2%	0.5%
PA	Columbia	0.6%	0.3%	2.7%
	North Puget	0.2%	0.2%	1.1%
	OESF	0.0%	0.0%	0.5%
	South Coast	0.2%	0.1%	1.1%
	South Puget	0.1%	0.1%	0.5%
	Straits	0.3%	0.2%	0.7%

1/ OESF = Olympic Experimental State ForestData
Source: Model output data (Timber Flow Level)

Table D-4. Summary of Management Intensity for HCP Planning Units by Alternative

	Decadal Acres Harvested by Type of Harvest (Volume of Harvest Removed)			
Alternative 1				
HCP Planning Unit	**Low Volume Removal Harvest (Harvest Type A)**	**Medium Volume Removal Harvest (Harvest Type B)**	**High Volume Removal Harvest (Harvest Type C)**	**All Types**
Columbia	12,570	2,110	21,006	35,686
North Puget	16,834	1,914	22,238	40,987
Olympic Experimental State Forest	1,020	189	5,944	7,153
South Coast	11,316	1,736	19,010	32,062
South Puget	7,394	1,658	10,130	19,181
Straits	3,202	1,019	5,117	9,339
Grand Total	**52,335**	**8,626**	**83,446**	**144,407**
Alternative 2				
HCP Planning Unit	**Low Volume Removal Harvest (Harvest Type A)**	**Medium Volume Removal Harvest (Harvest Type B)**	**High Volume Removal Harvest (Harvest Type C)**	**All Types**
Columbia	10,291	3,659	27,249	41,199
North Puget	19,100	5,760	31,742	56,602
Olympic Experimental State Forest	4,079	477	17,909	22,465
South Coast	11,040	5,149	27,248	43,436
South Puget	5,298	2,409	12,596	20,303
Straits	4,379	3,352	10,520	18,250
Grand Total	**54,186**	**20,805**	**127,264**	**202,256**
Alternative 3				
HCP Planning Unit	**Low Volume Removal Harvest (Harvest Type A)**	**Medium Volume Removal Harvest (Harvest Type B)**	**High Volume Removal Harvest (Harvest Type C)**	**All Types**
Columbia	16,299	2,654	30,753	49,706
North Puget	22,751	2,444	32,945	58,141
Olympic Experimental State Forest	1,942	512	21,768	24,223
South Coast	16,696	1,628	29,633	47,956
South Puget	5,046	767	13,892	19,705
Straits	8,075	986	13,379	22,440
Grand Total	**70,810**	**8,991**	**142,370**	**222,171**
Alternative 4				
HCP Planning Unit	**Low Volume Removal Harvest (Harvest Type A)**	**Medium Volume Removal Harvest (Harvest Type B)**	**High Volume Removal Harvest (Harvest Type C)**	**All Types**
Columbia	17,453	8,900	18,396	44,749
North Puget	25,815	9,481	23,001	58,296
Olympic Experimental State Forest	1,130	1,348	2,161	4,639
South Coast	18,994	9,330	20,767	49,091
South Puget	7,883	3,938	6,630	18,450
Straits	9,208	5,140	7,305	21,653
Grand Total	**80,483**	**38,136**	**78,260**	**196,879**

Table D-4. Summary of Management Intensity for HCP Planning Units by Alternative (continued)

	Decadal Acres Harvested by Type of Harvest (Volume of Harvest Removed)			
Alternative 5				
HCP Planning Unit	**Low Volume Removal Harvest (Harvest Type A)**	**Medium Volume Removal Harvest (Harvest Type B)**	**High Volume Removal Harvest (Harvest Type C)**	**All Types**
Columbia	27,453	6,607	27,941	62,001
North Puget	27,530	6,044	31,978	65,552
Olympic Experimental State Forest	30,937	3,797	23,997	58,732
South Coast	21,188	8,160	24,763	54,111
South Puget	15,015	4,832	13,356	33,203
Straits	13,501	3,966	11,533	29,000
Grand Total	**135,625**	**33,406**	**133,568**	**302,599**
Preferred Alternative				
HCP Planning Unit	**Low Volume Removal Harvest (Harvest Type A)**	**Medium Volume Removal Harvest (Harvest Type B)**	**High Volume Removal Harvest (Harvest Type C)**	**All Types**
Columbia	6,463	3,781	29,694	39,938
North Puget	5,569	4,437	30,407	40,414
Olympic Experimental State Forest	1,649	1,577	20,157	23,383
South Coast	4,666	3,792	27,401	35,859
South Puget	2,796	2,735	11,899	17,430
Straits	3,756	2,576	10,458	16,791
Grand Total	**24,899**	**18,898**	**130,017**	**173,814**

Data Source: Model output data – TFL

1/ Type A removes up to 11 thousand board feet/acre.

2/ Type B removes 11-20 thousand board feet/acre.

3/ Type C removes more than 20 thousand board feet /acre.

Table D-5a. Percent of Riparian Area in which Timber Harvest Activities Would Occur per Decade under Alternative 1, by HCP Planning Unit

HCP Planning Unit (Riparian Acres)	Decade	Percent of Riparian Area Harvested - Alternative 1: Harvest Type: A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013			2.3%	2.3%
(86,443 acres)	2014-2023			2.7%	2.7%
	2024-2033			3.5%	3.5%
	2034-2043			2.4%	2.4%
	2044-2053			2.1%	2.1%
	2054-2063			3.7%	3.7%
	2064-2067			1.4%	1.4%
	Mean 2004-2067			2.8%	2.8%
N. PUGET	2004-2013			1.7%	1.7%
(92,724 acres)	2014-2023			2.3%	2.3%
	2024-2033			2.5%	2.5%
	2034-2043			1.9%	1.9%
	2044-2053			2.0%	2.0%
	2054-2063			1.6%	1.6%
	2064-2067			0.4%	0.4%
	Mean 2004-2067			2.0%	2.0%
OESF	2004-2013			1.2%	1.2%
(111,308 acres)	2014-2023			1.3%	1.3%
	2024-2033			1.8%	1.8%
	2034-2043			1.5%	1.5%
	2044-2053			1.2%	1.2%
	2054-2063			1.5%	1.5%
	2064-2067			0.6%	0.6%
	Mean 2004-2067			1.4%	1.4%
S. COAST	2004-2013			1.8%	1.8%
(80,966 acres)	2014-2023			3.1%	3.1%
	2024-2033			3.8%	3.8%
	2034-2043			2.6%	2.6%
	2044-2053			2.8%	2.8%
	2054-2063			2.0%	2.0%
	2064-2067			0.6%	0.6%
	Mean 2004-2067			2.6%	2.6%
S. PUGET	2004-2013			1.1%	1.1%
(34,606 acres)	2014-2023			2.4%	2.4%
	2024-2033			2.7%	2.7%
	2034-2043			2.8%	2.8%
	2044-2053			2.6%	2.6%
	2054-2063			2.6%	2.6%
	2064-2067			1.3%	1.3%
	Mean 2004-2067			2.4%	2.4%
STRAITS	2004-2013			1.0%	1.0%
(20,684 acres)	2014-2023			0.8%	0.8%
	2024-2033			2.0%	2.0%
	2034-2043			1.8%	1.8%
	2044-2053			1.3%	1.3%
	2054-2063			1.9%	1.9%
	2064-2067			0.7%	0.7%
	Mean 2004-2067			1.5%	1.5%
Total	2004-2013			1.7%	1.7%
(426,731 acres)	2014-2023			2.2%	2.2%
	2024-2033			2.8%	2.8%
	2034-2043			2.1%	2.1%
	2044-2053			2.0%	2.0%
	2054-2063			2.2%	2.2%
	2064-2067			0.8%	0.8%
	Mean 2004-2067			2.1%	2.1%

OESF = Olympic Experimental State Forest

Table D-5b. Percent of Riparian Area in which Timber Harvest Activities Would Occur per Decade under Alternative 2, by HCP Planning Unit

HCP Planning Unit (Riparian Acres)	Decade	Percent of Riparian Area Harvested - Alternative 2: Harvest Type: A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	1.7%	0.2%	1.8%	3.7%
(86,443 acres)	2014-2023	2.7%	0.2%	1.8%	4.6%
	2024-2033	2.2%	0.2%	2.9%	5.3%
	2034-2043	0.3%	0.2%	3.8%	4.3%
	2044-2053	0.2%	0.2%	4.2%	4.5%
	2054-2063	0.8%	0.2%	3.1%	4.1%
	2064-2067	0.2%	0.1%	0.8%	1.1%
	Mean 2004-2067	1.2%	0.2%	2.9%	4.3%
N. PUGET	2004-2013	1.0%	0.2%	1.8%	3.0%
(92,724 acres)	2014-2023	2.0%	0.1%	1.7%	3.8%
	2024-2033	2.0%	0.0%	2.2%	4.3%
	2034-2043	0.5%	0.1%	2.5%	3.1%
	2044-2053	0.7%	0.6%	3.1%	4.3%
	2054-2063	0.4%	0.1%	3.3%	3.7%
	2064-2067	0.2%	0.1%	0.8%	1.1%
	Mean 2004-2067	1.1%	0.2%	2.4%	3.7%
OESF	2004-2013	1.3%	0.1%	1.8%	3.3%
(111,308 acres)	2014-2023	1.6%	0.2%	2.2%	4.0%
	2024-2033	0.9%	0.2%	3.8%	4.9%
	2034-2043	0.4%	0.2%	5.4%	5.9%
	2044-2053	0.3%	0.1%	4.8%	5.2%
	2054-2063	0.4%	0.1%	5.7%	6.2%
	2064-2067	0.2%	0.0%	1.9%	2.1%
	Mean 2004-2067	0.8%	0.1%	4.0%	4.9%
S. COAST	2004-2013	1.6%	0.4%	2.4%	4.4%
(80,966 acres)	2014-2023	3.0%	0.1%	1.8%	4.9%
	2024-2033	2.9%	0.1%	3.3%	6.3%
	2034-2043	0.8%	0.2%	4.5%	5.5%
	2044-2053	0.9%	0.7%	4.0%	5.5%
	2054-2063	0.4%	0.5%	4.4%	5.3%
	2064-2067	0.1%	0.1%	1.1%	1.4%
	Mean 2004-2067	1.5%	0.3%	3.4%	5.2%
S. PUGET	2004-2013	0.5%	0.2%	1.3%	1.9%
(34,606 acres)	2014-2023	1.6%	0.2%	1.2%	3.1%
	2024-2033	1.9%	0.1%	1.5%	3.5%
	2034-2043	0.5%	0.1%	2.8%	3.4%
	2044-2053	0.4%	0.4%	2.9%	3.6%
	2054-2063	1.1%	0.5%	1.8%	3.5%
	2064-2067	0.2%	0.1%	0.7%	1.0%
	Mean 2004-2067	1.0%	0.3%	1.9%	3.1%
STRAITS	2004-2013	0.4%	0.6%	1.5%	2.5%
(20,684 acres)	2014-2023	0.7%	0.1%	2.2%	3.0%
	2024-2033	2.1%	0.4%	1.9%	4.4%
	2034-2043	1.6%	0.3%	2.2%	4.1%
	2044-2053	1.1%	0.5%	2.9%	4.5%
	2054-2063	2.5%	2.2%	3.1%	7.9%
	2064-2067	0.9%	0.4%	1.0%	2.3%
	Mean 2004-2067	1.4%	0.7%	2.3%	4.5%
Total	2004-2013	1.3%	0.2%	1.9%	3.4%
(426,731 acres)	2014-2023	2.1%	0.2%	1.8%	4.1%
	2024-2033	1.9%	0.2%	2.9%	5.0%
	2034-2043	0.6%	0.2%	3.9%	4.6%
	2044-2053	0.5%	0.4%	3.9%	4.8%
	2054-2063	0.6%	0.3%	4.0%	4.9%
	2064-2067	0.2%	0.1%	1.2%	1.5%
	Mean 2004-2067	1.1%	0.2%	3.1%	4.4%

OESF = Olympic Experimental State Forest

Table D-5c. Percent of Riparian Area in which Timber Harvest Activities Would Occur per Decade under Alternative 3, by HCP Planning Unit

HCP Planning Unit (Riparian Acres)	Decade	Percent of Riparian Area Harvested - Alternative 3: Harvest Type: A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	2.2%	0.1%	2.7%	5.0%
(86,443 acres)	2014-2023	3.2%	0.2%	2.1%	5.5%
	2024-2033	2.7%	0.2%	2.9%	5.8%
	2034-2043	0.5%	0.2%	4.4%	5.1%
	2044-2053	0.3%	0.3%	4.9%	5.4%
	2054-2063	0.8%	0.2%	3.6%	4.6%
	2064-2067	0.2%	0.1%	1.1%	1.4%
	Mean 2004-2067	1.6%	0.2%	3.4%	5.2%
N. PUGET	2004-2013	0.7%	0.1%	1.4%	2.2%
(92,724 acres)	2014-2023	2.3%	0.1%	2.5%	4.9%
	2024-2033	2.9%	0.1%	2.0%	4.9%
	2034-2043	0.9%	0.1%	3.1%	4.1%
	2044-2053	0.4%	0.2%	4.6%	5.1%
	2054-2063	0.6%	0.1%	2.6%	3.3%
	2064-2067	0.1%	0.0%	0.9%	1.1%
	Mean 2004-2067	1.2%	0.1%	2.7%	4.0%
OESF	2004-2013	0.4%	0.1%	1.2%	1.8%
(111,308 acres)	2014-2023	0.6%	0.2%	1.1%	1.9%
	2024-2033	0.8%	0.2%	3.7%	4.7%
	2034-2043	0.5%	0.3%	4.6%	5.3%
	2044-2053	0.5%	0.2%	8.2%	8.9%
	2054-2063	0.2%	0.2%	6.5%	6.9%
	2064-2067	0.1%	0.1%	3.9%	4.1%
	Mean 2004-2067	0.5%	0.2%	4.6%	5.3%
S. COAST	2004-2013	1.6%	0.1%	2.6%	4.4%
(80,966 acres)	2014-2023	4.7%	0.1%	2.8%	7.6%
	2024-2033	3.8%	0.0%	3.0%	6.9%
	2034-2043	0.6%	0.1%	5.6%	6.3%
	2044-2053	0.3%	0.1%	5.6%	6.0%
	2054-2063	0.2%	0.2%	2.9%	3.3%
	2064-2067	0.0%	0.0%	1.4%	1.4%
	Mean 2004-2067	1.8%	0.1%	3.7%	5.6%
S. PUGET	2004-2013	0.2%	0.0%	1.8%	2.1%
(34,606 acres)	2014-2023	1.5%	0.1%	1.2%	2.7%
	2024-2033	1.8%	0.2%	1.4%	3.3%
	2034-2043	0.6%	0.1%	3.1%	3.8%
	2044-2053	0.4%	0.1%	2.9%	3.5%
	2054-2063	0.5%	0.2%	2.3%	3.0%
	2064-2067	0.2%	0.0%	1.5%	1.7%
	Mean 2004-2067	0.8%	0.1%	2.2%	3.1%
STRAITS	2004-2013	0.7%	0.3%	3.6%	4.5%
(20,684 acres)	2014-2023	2.2%	0.1%	2.3%	4.7%
	2024-2033	3.3%	0.2%	1.4%	4.8%
	2034-2043	1.0%	0.4%	3.7%	5.1%
	2044-2053	0.5%	0.3%	5.4%	6.3%
	2054-2063	0.4%	0.1%	3.1%	3.6%
	2064-2067	0.1%	0.0%	1.1%	1.3%
	Mean 2004-2067	1.3%	0.2%	3.2%	4.7%
Total	2004-2013	1.1%	0.1%	2.0%	3.2%
(426,731 acres)	2014-2023	2.4%	0.1%	2.0%	4.6%
	2024-2033	2.4%	0.1%	2.7%	5.3%
	2034-2043	0.6%	0.2%	4.2%	5.1%
	2044-2053	0.4%	0.2%	5.7%	6.2%
	2054-2063	0.4%	0.2%	3.9%	4.5%
	2064-2067	0.1%	0.1%	1.9%	2.1%
	Mean 2004-2067	1.2%	0.2%	3.5%	4.8%

OESF = Olympic Experimental State Forest

Table D-5d. Percent of Riparian Area in which Timber Harvest Activities Would Occur per Decade under Alternative 4, by HCP Planning Unit

HCP Planning Unit (Riparian Acres)	Decade	Percent of Riparian Area Harvested - Alternative 4: Harvest Type A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013			5.0%	5.0%
(86,443 acres)	2014-2023			4.6%	4.6%
	2024-2033			5.7%	5.7%
	2034-2043			5.9%	5.9%
	2044-2053			6.5%	6.5%
	2054-2063			8.0%	8.0%
	2064-2067			2.9%	2.9%
	Mean 2004-2067			6.0%	6.0%
N. PUGET	2004-2013			3.6%	3.6%
(92,724 acres)	2014-2023			3.1%	3.1%
	2024-2033			4.3%	4.3%
	2034-2043			5.7%	5.7%
	2044-2053			6.5%	6.5%
	2054-2063			7.2%	7.2%
	2064-2067			2.5%	2.5%
	Mean 2004-2067			5.2%	5.2%
OESF	2004-2013			1.2%	1.2%
(111,308 acres)	2014-2023			1.3%	1.3%
	2024-2033			1.5%	1.5%
	2034-2043			1.6%	1.6%
	2044-2053			1.5%	1.5%
	2054-2063			1.5%	1.5%
	2064-2067			0.7%	0.7%
	Mean 2004-2067			1.4%	1.4%
S. COAST	2004-2013			5.8%	5.8%
(80,966 acres)	2014-2023			6.3%	6.3%
	2024-2033			6.6%	6.6%
	2034-2043			7.0%	7.0%
	2044-2053			8.0%	8.0%
	2054-2063			10.5%	10.5%
	2064-2067			4.1%	4.1%
	Mean 2004-2067			7.5%	7.5%
S. PUGET	2004-2013			2.4%	2.4%
(34,606 acres)	2014-2023			2.8%	2.8%
	2024-2033			3.4%	3.4%
	2034-2043			3.5%	3.5%
	2044-2053			3.6%	3.6%
	2054-2063			3.9%	3.9%
	2064-2067			1.9%	1.9%
	Mean 2004-2067			3.4%	3.4%
STRAITS	2004-2013			3.9%	3.9%
(20,684 acres)	2014-2023			3.5%	3.5%
	2024-2033			6.0%	6.0%
	2034-2043			7.4%	7.4%
	2044-2053			7.7%	7.7%
	2054-2063			7.6%	7.6%
	2064-2067			3.4%	3.4%
	Mean 2004-2067			6.2%	6.2%
Total	2004-2013			3.6%	3.6%
(426,731 acres)	2014-2023			3.5%	3.5%
	2024-2033			4.3%	4.3%
	2034-2043			4.8%	4.8%
	2044-2053			5.3%	5.3%
	2054-2063			6.2%	6.2%
	2064-2067			2.4%	2.4%
	Mean 2004-2067			4.7%	4.7%

OESF = Olympic Experimental State Forest

Table D-5e. Percent of Riparian Area in which Timber Harvest Activities Would Occur per Decade under Alternative 5, by HCP Planning Unit

HCP Planning Unit (Riparian Acres)	Decade	Percent of Riparian Area Harvested - Alternative 5: Harvest Type: A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	4.9%	0.6%	2.1%	7.7%
(86,443 acres)	2014-2023	6.4%	0.3%	2.1%	8.8%
	2024-2033	9.1%	0.3%	3.5%	12.9%
	2034-2043	4.0%	0.2%	2.6%	6.8%
	2044-2053	1.9%	0.1%	3.1%	5.1%
	2054-2063	1.1%	0.4%	3.2%	4.7%
	2064-2067	0.4%	0.1%	1.0%	1.5%
	Mean 2004-2067	4.3%	0.3%	2.8%	7.4%
N. PUGET	2004-2013	1.7%	0.1%	1.7%	3.5%
(92,724 acres)	2014-2023	4.3%	0.1%	2.1%	6.4%
	2024-2033	5.9%	0.2%	3.0%	9.1%
	2034-2043	2.0%	0.1%	2.1%	4.2%
	2044-2053	1.0%	0.1%	2.9%	4.1%
	2054-2063	0.4%	0.3%	2.2%	2.9%
	2064-2067	0.0%	0.0%	0.7%	0.7%
	Mean 2004-2067	2.4%	0.2%	2.3%	4.8%
OESF	2004-2013	5.7%	0.1%	1.8%	7.7%
(111,308 acres)	2014-2023	10.3%	0.2%	1.5%	12.0%
	2024-2033	11.8%	0.4%	2.4%	14.6%
	2034-2043	8.1%	1.0%	3.6%	12.6%
	2044-2053	3.4%	0.1%	3.4%	7.0%
	2054-2063	0.4%	0.1%	2.7%	3.1%
	2064-2067	0.0%	0.0%	0.6%	0.6%
	Mean 2004-2067	6.2%	0.3%	2.5%	9.0%
S. COAST	2004-2013	3.1%	0.7%	2.1%	5.9%
(80,966 acres)	2014-2023	7.7%	0.3%	2.2%	10.2%
	2024-2033	7.4%	0.4%	3.9%	11.7%
	2034-2043	2.4%	0.4%	2.4%	5.2%
	2044-2053	2.1%	0.3%	2.9%	5.3%
	2054-2063	2.7%	0.7%	3.3%	6.6%
	2064-2067	0.6%	0.1%	0.8%	1.5%
	Mean 2004-2067	4.1%	0.4%	2.8%	7.3%
S. PUGET	2004-2013	3.0%	0.7%	1.9%	5.6%
(34,606 acres)	2014-2023	5.8%	0.2%	1.7%	7.6%
	2024-2033	8.4%	0.7%	2.9%	12.0%
	2034-2043	3.3%	0.4%	2.4%	6.1%
	2044-2053	2.6%	0.3%	2.5%	5.4%
	2054-2063	2.3%	0.6%	2.4%	5.3%
	2064-2067	1.3%	0.2%	0.9%	2.4%
	Mean 2004-2067	4.2%	0.5%	2.3%	7.0%
STRAITS	2004-2013	3.1%	0.8%	2.8%	6.6%
(20,684 acres)	2014-2023	4.9%	0.2%	1.9%	7.0%
	2024-2033	7.8%	0.4%	3.1%	11.3%
	2034-2043	3.6%	0.4%	2.7%	6.8%
	2044-2053	3.0%	0.8%	1.8%	5.5%
	2054-2063	3.3%	0.4%	3.4%	7.1%
	2064-2067	1.3%	0.1%	1.0%	2.5%
	Mean 2004-2067	4.2%	0.5%	2.6%	7.3%
Total	2004-2013	3.8%	0.4%	2.0%	6.2%
(426,731 acres)	2014-2023	7.1%	0.2%	1.9%	9.2%
	2024-2033	8.7%	0.3%	3.1%	12.1%
	2034-2043	4.2%	0.5%	2.7%	7.4%
	2044-2053	2.3%	0.2%	3.0%	5.4%
	2054-2063	1.3%	0.4%	2.8%	4.4%
	2064-2067	0.4%	0.1%	0.8%	1.2%
	Mean 2004-2067	4.3%	0.3%	2.5%	7.2%

OESF = Olympic Experimental State Forest

Table D-5f. Percent of Riparian Area in which Timber Harvest Activities Would Occur per Decade under the Preferred Alternative, by HCP Planning Unit

HCP Planning Unit (Riparian Acres)	Decade	Percent of Riparian Area Harvested - Preferred Alternative			
		Harvest Type			
		A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	0.3%	0.9%	3.2%	4.4%
(86,443 acres)	2014-2023	1.3%	2.6%	11.9%	15.8%
	2024-2033	1.1%	1.7%	4.2%	7.0%
	2034-2043	0.1%	1.5%	4.8%	6.4%
	2044-2053	0.2%	1.8%	8.1%	10.1%
	2054-2063	0.5%	1.9%	5.9%	8.3%
	2064-2067	1.4%	0.7%	2.8%	4.9%
	Mean 2004-2067	0.8%	1.8%	6.4%	8.9%
N. PUGET	2004-2013	0.2%	0.3%	4.1%	4.5%
(92,724 acres)	2014-2023	0.6%	0.9%	6.3%	7.7%
	2024-2033	0.7%	0.7%	4.1%	5.5%
	2034-2043	0.1%	1.6%	3.1%	4.8%
	2044-2053	0.1%	2.2%	5.1%	7.4%
	2054-2063	0.4%	2.5%	4.2%	7.1%
	2064-2067	0.5%	0.9%	1.3%	2.7%
	Mean 2004-2067	0.4%	1.4%	4.4%	6.2%
OESF	2004-2013	0.2%	0.3%	4.1%	4.6%
(111,308 acres)	2014-2023	0.7%	0.3%	2.4%	3.5%
	2024-2033	0.6%	0.3%	4.7%	5.6%
	2034-2043	0.0%	0.6%	4.3%	4.9%
	2044-2053	0.0%	0.1%	6.1%	6.2%
	2054-2063	0.1%	0.2%	8.0%	8.3%
	2064-2067	0.6%	0.1%	1.8%	2.5%
	Mean 2004-2067	0.4%	0.3%	4.9%	5.6%
S. COAST	2004-2013	0.2%	0.4%	4.3%	4.8%
(80,966 acres)	2014-2023	0.6%	1.2%	12.4%	14.2%
	2024-2033	2.2%	2.2%	6.8%	11.2%
	2034-2043	0.4%	2.9%	8.5%	11.7%
	2044-2053	0.1%	5.1%	6.8%	11.9%
	2054-2063	0.4%	3.4%	6.4%	10.3%
	2064-2067	0.7%	2.2%	3.1%	6.0%
	Mean 2004-2067	0.7%	2.7%	7.5%	10.9%
S. PUGET	2004-2013	0.3%	0.5%	2.3%	3.1%
(34,606 acres)	2014-2023	1.4%	1.3%	7.0%	9.7%
	2024-2033	1.2%	0.7%	2.9%	4.8%
	2034-2043	0.2%	1.6%	3.0%	4.9%
	2044-2053	0.2%	2.1%	4.8%	7.1%
	2054-2063	0.2%	2.2%	3.1%	5.6%
	2064-2067	0.8%	0.8%	1.6%	3.1%
	Mean 2004-2067	0.7%	1.4%	3.9%	6.0%
STRAITS	2004-2013	0.8%	1.3%	3.2%	5.2%
(20,684 acres)	2014-2023	2.7%	4.1%	13.0%	19.8%
	2024-2033	1.6%	2.4%	6.6%	10.6%
	2034-2043	0.9%	4.0%	2.9%	7.9%
	2044-2053	0.4%	5.5%	5.0%	10.9%
	2054-2063	0.6%	4.8%	2.8%	8.2%
	2064-2067	0.7%	2.8%	1.6%	5.1%
	Mean 2004-2067	1.2%	3.9%	5.5%	10.6%
Total	2004-2013	0.2%	0.5%	3.7%	4.5%
(426,731 acres)	2014-2023	0.9%	1.3%	8.0%	10.2%
	2024-2033	1.1%	1.2%	4.8%	7.1%
	2034-2043	0.2%	1.7%	4.7%	6.6%
	2044-2053	0.1%	2.3%	6.3%	8.6%
	2054-2063	0.3%	2.1%	5.8%	8.2%
	2064-2067	0.8%	1.0%	2.1%	3.9%
	Mean 2004-2067	0.6%	1.6%	5.5%	7.7%

OESF = Olympic Experimental State Forest

Table D-6a. Percent of the Upland Areas with General Management Objectives Land Class in which Timber Harvest Activities Would Occur per Decade under Alternative 1, by HCP Planning Unit

		Upland Areas with General Management Objectives Alternative 1			
HCP Planning Unit		Harvest Type			
(General Acres)	Decade	A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	9.6%	0.9%	20.0%	30.5%
(81,625 acres)	2014-2023	13.4%	1.2%	15.9%	30.5%
	2024-2033	11.4%	0.4%	15.0%	26.8%
	2034-2043	7.8%	1.6%	15.1%	24.5%
	2044-2053	7.1%	0.9%	15.7%	23.7%
	2054-2063	10.5%	1.6%	13.1%	25.2%
	2064-2067	6.1%	1.6%	6.0%	13.7%
	Mean 2004-2067	10.3%	1.3%	15.8%	27.3%
N. PUGET	2004-2013	8.0%	1.7%	18.1%	27.8%
(83,817 acres)	2014-2023	15.2%	2.1%	14.6%	31.9%
	2024-2033	13.5%	1.1%	9.3%	23.8%
	2034-2043	10.6%	0.3%	13.5%	24.4%
	2044-2053	19.0%	0.9%	15.5%	35.4%
	2054-2063	10.8%	1.9%	13.8%	26.5%
	2064-2067	3.6%	1.4%	5.8%	10.9%
	Mean 2004-2067	12.6%	1.5%	14.1%	28.2%
OESF	2004-2013				
(0 acres)	2014-2023				
	2024-2033				
	2034-2043				
	2044-2053				
	2054-2063				
	2064-2067				
	Mean 2004-2067				
S. COAST	2004-2013	4.7%	1.0%	14.4%	20.1%
(115,307 acres)	2014-2023	15.4%	2.1%	12.1%	29.5%
	2024-2033	9.8%	0.3%	11.7%	21.8%
	2034-2043	5.9%	0.2%	15.0%	21.2%
	2044-2053	5.3%	2.0%	15.2%	22.5%
	2054-2063	8.6%	1.3%	13.8%	23.7%
	2064-2067	4.0%	0.6%	6.4%	11.0%
	Mean 2004-2067	8.4%	1.2%	13.8%	23.4%
S. PUGET	2004-2013	6.7%	3.3%	21.5%	31.4%
(25,183 acres)	2014-2023	9.6%	2.4%	11.4%	23.4%
	2024-2033	13.3%	2.3%	7.5%	23.1%
	2034-2043	15.4%	4.0%	6.0%	25.4%
	2044-2053	9.3%	1.9%	9.3%	20.4%
	2054-2063	7.5%	1.2%	9.2%	17.8%
	2064-2067	1.7%	1.1%	4.0%	6.8%
	Mean 2004-2067	9.9%	2.5%	10.8%	23.2%
STRAITS	2004-2013	2.5%	2.7%	12.7%	17.9%
(56,774 acres)	2014-2023	3.2%	0.9%	7.7%	11.7%
	2024-2033	8.0%	0.9%	6.9%	15.8%
	2034-2043	5.9%	1.4%	5.3%	12.6%
	2044-2053	4.9%	1.3%	6.1%	12.3%
	2054-2063	3.9%	1.8%	7.2%	12.9%
	2064-2067	1.8%	0.7%	3.0%	5.4%
	Mean 2004-2067	4.7%	1.5%	7.6%	13.9%
Total	2004-2013	6.4%	1.6%	16.7%	24.7%
(362,706 acres)	2014-2023	12.6%	1.7%	12.8%	27.1%
	2024-2033	11.0%	0.7%	10.9%	22.5%
	2034-2043	8.1%	1.0%	12.5%	21.6%
	2044-2053	9.1%	1.4%	13.5%	24.0%
	2054-2063	8.7%	1.6%	12.3%	22.6%
	2064-2067	3.9%	1.0%	5.5%	10.4%
	Mean 2004-2067	9.3%	1.4%	13.2%	23.9%

OESF = Olympic Experimental State Forest

Table D-6b. Percent of the Upland Areas with General Management Objectives Land Class in which Timber Harvest Activities Would Occur per Decade under Alternative 2, by HCP Planning Unit

HCP Planning Unit (General Acres)	Decade	Upland Areas with General Management Objectives Alternative 2 — Harvest Type: A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	5.5%	3.3%	16.7%	25.5%
(81,625 acres)	2014-2023	10.1%	1.8%	17.6%	29.5%
	2024-2033	7.7%	2.0%	12.6%	22.3%
	2034-2043	5.4%	1.4%	16.0%	22.9%
	2044-2053	5.0%	0.9%	16.7%	22.6%
	2054-2063	4.6%	0.9%	16.7%	22.2%
	2064-2067	3.9%	1.0%	7.9%	12.8%
	Mean 2004-2067	6.6%	1.8%	16.3%	24.6%
N. PUGET	2004-2013	7.5%	2.1%	15.3%	25.0%
(83,817 acres)	2014-2023	11.4%	1.2%	13.4%	26.0%
	2024-2033	8.8%	1.2%	9.7%	19.7%
	2034-2043	9.0%	0.6%	14.9%	24.5%
	2044-2053	8.9%	1.2%	17.9%	28.0%
	2054-2063	10.3%	3.6%	17.8%	31.7%
	2064-2067	5.1%	1.7%	5.5%	12.2%
	Mean 2004-2067	9.5%	1.8%	14.8%	26.1%
OESF	2004-2013				
(0 acres)	2014-2023				
	2024-2033				
	2034-2043				
	2044-2053				
	2054-2063				
	2064-2067				
	Mean 2004-2067				
S. COAST	2004-2013	6.4%	4.3%	16.9%	27.6%
(115,307 acres)	2014-2023	11.0%	1.9%	14.9%	27.8%
	2024-2033	8.3%	1.6%	13.4%	23.2%
	2034-2043	7.2%	1.7%	18.4%	27.4%
	2044-2053	5.1%	3.4%	19.4%	27.9%
	2054-2063	5.3%	4.0%	16.8%	26.1%
	2064-2067	2.2%	1.0%	6.6%	9.8%
	Mean 2004-2067	7.1%	2.8%	16.6%	26.5%
S. PUGET	2004-2013	5.6%	4.0%	17.3%	26.9%
(25,183 acres)	2014-2023	6.3%	2.4%	14.9%	23.6%
	2024-2033	9.5%	2.6%	8.9%	21.1%
	2034-2043	8.0%	3.3%	6.9%	18.2%
	2044-2053	5.9%	1.1%	12.4%	19.4%
	2054-2063	3.0%	1.7%	12.1%	16.8%
	2064-2067	0.7%	0.3%	8.9%	9.9%
	Mean 2004-2067	6.1%	2.4%	12.7%	21.2%
STRAITS	2004-2013	3.0%	4.1%	12.7%	19.8%
(56,774 acres)	2014-2023	4.6%	1.7%	16.0%	22.3%
	2024-2033	8.6%	2.3%	9.7%	20.6%
	2034-2043	5.6%	2.4%	8.2%	16.1%
	2044-2053	6.5%	2.7%	12.8%	22.0%
	2054-2063	3.6%	4.3%	15.0%	22.9%
	2064-2067	0.7%	0.5%	5.9%	7.1%
	Mean 2004-2067	5.1%	2.8%	12.5%	20.4%
Total	2004-2013	5.9%	3.5%	15.9%	25.2%
(362,706 acres)	2014-2023	9.6%	1.7%	15.3%	26.6%
	2024-2033	8.4%	1.8%	11.5%	21.7%
	2034-2043	7.0%	1.6%	14.7%	23.3%
	2044-2053	6.2%	2.1%	16.9%	25.2%
	2054-2063	5.9%	3.1%	16.4%	25.4%
	2064-2067	2.9%	1.0%	6.7%	10.6%
	Mean 2004-2067	7.2%	2.3%	15.2%	24.7%

OESF = Olympic Experimental State Forest

Table D-6c. Percent of the Upland Areas with General Management Objectives Land Class in which Timber Harvest Activities Would Occur per Decade under Alternative 3, by HCP Planning Unit

HCP Planning Unit (General Acres)	Decade	Upland Areas with General Management Objectives Alternative 3 — Harvest Type: A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	11.3%	0.8%	25.6%	37.7%
(81,625 acres)	2014-2023	15.6%	0.9%	21.5%	38.0%
	2024-2033	12.2%	0.3%	13.3%	25.8%
	2034-2043	9.2%	0.1%	12.7%	22.0%
	2044-2053	11.9%	0.3%	17.6%	29.8%
	2054-2063	14.9%	2.6%	20.3%	37.8%
	2064-2067	6.7%	2.5%	8.3%	17.5%
	Mean 2004-2067	12.8%	1.2%	18.6%	32.6%
N. PUGET	2004-2013	3.8%	0.7%	11.3%	15.8%
(83,817 acres)	2014-2023	14.6%	1.9%	25.5%	42.0%
	2024-2033	16.0%	1.1%	9.3%	26.4%
	2034-2043	9.2%	0.3%	11.7%	21.2%
	2044-2053	14.7%	0.8%	15.5%	31.0%
	2054-2063	26.5%	2.0%	17.2%	45.7%
	2064-2067	5.5%	2.1%	5.5%	13.0%
	Mean 2004-2067	14.1%	1.4%	15.0%	30.5%
OESF	2004-2013				
(0 acres)	2014-2023				
	2024-2033				
	2034-2043				
	2044-2053				
	2054-2063				
	2064-2067				
	Mean 2004-2067				
S. COAST	2004-2013	5.2%	0.8%	21.6%	27.5%
(115,307 acres)	2014-2023	18.7%	1.4%	21.1%	41.2%
	2024-2033	12.2%	0.4%	10.7%	23.3%
	2034-2043	10.2%	0.2%	16.6%	26.9%
	2044-2053	10.7%	0.1%	19.0%	29.9%
	2054-2063	15.7%	1.3%	21.9%	39.0%
	2064-2067	3.0%	2.6%	7.3%	12.9%
	Mean 2004-2067	11.8%	1.1%	18.5%	31.4%
S. PUGET	2004-2013	3.3%	1.5%	38.1%	42.9%
(25,183 acres)	2014-2023	7.8%	0.4%	7.9%	16.0%
	2024-2033	12.5%	1.1%	3.0%	16.6%
	2034-2043	9.1%	1.3%	7.3%	17.7%
	2044-2053	12.6%	0.5%	9.9%	23.0%
	2054-2063	6.5%	1.4%	13.9%	21.8%
	2064-2067	1.7%	0.1%	15.7%	17.5%
	Mean 2004-2067	8.3%	1.0%	15.0%	24.3%
STRAITS	2004-2013	5.2%	2.5%	33.8%	41.5%
(56,774 acres)	2014-2023	8.6%	0.9%	14.6%	24.1%
	2024-2033	12.8%	0.9%	4.2%	17.8%
	2034-2043	7.1%	0.2%	6.9%	14.2%
	2044-2053	13.2%	0.6%	15.6%	29.4%
	2054-2063	19.6%	1.3%	15.0%	36.0%
	2064-2067	6.6%	0.8%	9.1%	16.6%
	Mean 2004-2067	11.4%	1.1%	15.5%	28.1%
Total	2004-2013	6.1%	1.1%	23.2%	30.4%
(362,706 acres)	2014-2023	14.7%	1.2%	20.3%	36.2%
	2024-2033	13.2%	0.7%	9.4%	23.3%
	2034-2043	9.2%	0.3%	12.4%	21.9%
	2044-2053	12.4%	0.4%	16.7%	29.6%
	2054-2063	18.0%	1.8%	18.8%	38.6%
	2064-2067	4.9%	2.0%	7.9%	14.8%
	Mean 2004-2067	12.3%	1.2%	17.0%	30.4%

OESF = Olympic Experimental State Forest

Table D-6d. Percent of the Upland Areas with General Management Objectives Land Class in which Timber Harvest Activities Would Occur per Decade under Alternative 4, by HCP Planning Unit

HCP Planning Unit		Upland Areas with General Management Objectives Alternative 4			
		Harvest Type			
(General Acres)	Decade	A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	17.9%	11.9%	11.6%	41.4%
(81,625 acres)	2014-2023	18.9%	6.4%	16.2%	41.5%
	2024-2033	16.4%	4.0%	12.0%	32.4%
	2034-2043	6.8%	4.5%	12.1%	23.5%
	2044-2053	9.7%	2.2%	13.8%	25.6%
	2054-2063	8.5%	1.9%	12.3%	22.7%
	2064-2067	2.8%	0.6%	5.9%	9.2%
	Mean 2004-2067	12.7%	4.9%	13.1%	30.7%
N. PUGET	2004-2013	11.2%	4.3%	14.3%	29.9%
(83,817 acres)	2014-2023	16.3%	3.5%	13.4%	33.3%
	2024-2033	15.4%	3.6%	9.6%	28.7%
	2034-2043	11.6%	7.0%	5.9%	24.5%
	2044-2053	17.0%	7.4%	10.9%	35.3%
	2054-2063	14.1%	5.2%	12.0%	31.3%
	2064-2067	3.6%	0.8%	4.8%	9.2%
	Mean 2004-2067	14.0%	5.0%	11.1%	30.0%
OESF	2004-2013				
(0 acres)	2014-2023				
	2024-2033				
	2034-2043				
	2044-2053				
	2054-2063				
	2064-2067				
	Mean 2004-2067				
S. COAST	2004-2013	13.9%	10.3%	11.8%	36.0%
(115,307 acres)	2014-2023	22.4%	5.9%	15.4%	43.8%
	2024-2033	12.2%	4.0%	14.2%	30.4%
	2034-2043	7.0%	6.0%	9.4%	22.3%
	2044-2053	10.1%	6.4%	12.1%	28.6%
	2054-2063	8.5%	2.7%	14.1%	25.3%
	2064-2067	5.1%	0.8%	4.2%	10.2%
	Mean 2004-2067	12.4%	5.6%	12.7%	30.7%
S. PUGET	2004-2013	26.0%	15.0%	5.8%	46.9%
(25,183 acres)	2014-2023	15.9%	8.4%	11.1%	35.4%
	2024-2033	16.9%	3.1%	12.1%	32.1%
	2034-2043	7.4%	3.2%	7.5%	18.1%
	2044-2053	10.8%	3.0%	6.5%	20.3%
	2054-2063	7.5%	4.0%	6.6%	18.1%
	2064-2067	3.2%	0.6%	3.0%	6.8%
	Mean 2004-2067	13.7%	5.8%	8.2%	27.8%
STRAITS	2004-2013	12.0%	10.0%	10.7%	32.7%
(56,774 acres)	2014-2023	9.1%	4.5%	10.8%	24.4%
	2024-2033	16.1%	5.6%	8.9%	30.6%
	2034-2043	11.1%	5.5%	5.8%	22.4%
	2044-2053	9.0%	6.7%	7.5%	23.1%
	2054-2063	9.5%	6.8%	7.2%	23.6%
	2064-2067	2.9%	0.6%	3.1%	6.6%
	Mean 2004-2067	10.9%	6.2%	8.4%	25.5%
Total	2004-2013	14.7%	9.5%	11.7%	36.0%
(362,706 acres)	2014-2023	17.7%	5.4%	14.1%	37.2%
	2024-2033	14.8%	4.1%	11.7%	30.6%
	2034-2043	8.7%	5.6%	8.5%	22.8%
	2044-2053	11.5%	5.5%	11.1%	28.0%
	2054-2063	9.9%	3.8%	11.6%	25.3%
	2064-2067	3.8%	0.7%	4.5%	8.9%
	Mean 2004-2067	12.7%	5.4%	11.4%	29.5%

OESF = Olympic Experimental State Forest

Table D-6e. Percent of the Upland Areas with General Management Objectives Land Class in which Timber Harvest Activities Would Occur per Decade under Alternative 5, by HCP Planning Unit

HCP Planning Unit		Upland Areas with General Management Objectives Alternative 5			
		Harvest Type			
(General Acres)	Decade	A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	10.4%	7.7%	15.1%	33.2%
(81,625 acres)	2014-2023	12.7%	2.5%	20.9%	36.1%
	2024-2033	11.6%	1.9%	14.5%	28.0%
	2034-2043	19.7%	1.9%	12.4%	34.0%
	2044-2053	15.3%	1.0%	14.5%	30.9%
	2054-2063	12.4%	0.7%	18.9%	32.1%
	2064-2067	3.7%	0.4%	7.1%	11.2%
	Mean 2004-2067	13.4%	2.5%	16.1%	32.1%
N. PUGET	2004-2013	8.7%	2.2%	13.4%	24.3%
(83,817 acres)	2014-2023	16.7%	1.1%	23.5%	41.2%
	2024-2033	13.0%	2.0%	15.8%	30.7%
	2034-2043	14.5%	2.0%	15.2%	31.8%
	2044-2053	14.3%	1.6%	12.9%	28.8%
	2054-2063	8.5%	0.2%	15.0%	23.8%
	2064-2067	4.7%	0.1%	6.6%	11.3%
	Mean 2004-2067	12.6%	1.4%	16.0%	30.0%
OESF	2004-2013				
(0 acres)	2014-2023				
	2024-2033				
	2034-2043				
	2044-2053				
	2054-2063				
	2064-2067				
	Mean 2004-2067				
S. COAST	2004-2013	7.2%	9.9%	14.4%	31.4%
(115,307 acres)	2014-2023	16.7%	4.6%	19.9%	41.3%
	2024-2033	12.8%	2.5%	15.2%	30.5%
	2034-2043	15.0%	3.5%	15.6%	34.1%
	2044-2053	13.4%	3.2%	14.7%	31.2%
	2054-2063	10.7%	2.9%	14.4%	28.1%
	2064-2067	4.6%	0.7%	6.1%	11.4%
	Mean 2004-2067	12.6%	4.3%	15.7%	32.5%
S. PUGET	2004-2013	12.0%	8.6%	13.1%	33.8%
(25,183 acres)	2014-2023	11.6%	2.0%	10.7%	24.3%
	2024-2033	13.0%	4.0%	7.8%	24.8%
	2034-2043	19.8%	2.0%	6.8%	28.6%
	2044-2053	15.9%	2.5%	11.6%	30.0%
	2054-2063	15.7%	1.4%	17.0%	34.1%
	2064-2067	1.3%	0.1%	5.7%	7.1%
	Mean 2004-2067	14.0%	3.2%	11.3%	28.5%
STRAITS	2004-2013	15.2%	5.5%	19.2%	39.9%
(56,774 acres)	2014-2023	15.4%	2.0%	13.1%	30.5%
	2024-2033	13.5%	3.4%	10.4%	27.3%
	2034-2043	18.4%	2.8%	9.0%	30.2%
	2044-2053	15.6%	2.6%	14.2%	32.5%
	2054-2063	11.9%	1.8%	17.6%	31.3%
	2064-2067	3.5%	0.1%	5.4%	9.1%
	Mean 2004-2067	14.6%	2.8%	13.9%	31.4%
Total	2004-2013	9.8%	6.8%	15.0%	31.7%
(362,706 acres)	2014-2023	15.2%	2.7%	19.3%	37.2%
	2024-2033	12.7%	2.5%	13.9%	29.1%
	2034-2043	16.8%	2.6%	13.1%	32.5%
	2044-2053	14.6%	2.2%	13.9%	30.7%
	2054-2063	11.1%	1.5%	16.3%	28.9%
	2064-2067	4.0%	0.3%	6.3%	10.7%
	Mean 2004-2067	13.2%	2.9%	15.3%	31.4%

OESF = Olympic Experimental State Forest

Table D-6f. Percent of the Upland Areas with General Management Objectives Land Class in which Timber Harvest Activities Would Occur per Decade under the Preferred Alternative, by HCP Planning Unit

HCP Planning Unit (General Acres)	Decade	Upland Areas with General Management Objectives Preferred Alternative			
		Harvest Type			
		A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	3.7%	1.8%	27.8%	33.3%
(81,625 acres)	2014-2023	1.9%	0.3%	16.5%	18.7%
	2024-2033	3.2%	0.3%	11.0%	14.5%
	2034-2043	9.6%	0.4%	9.9%	19.9%
	2044-2053	1.6%	0.1%	13.9%	15.7%
	2054-2063	2.0%	0.0%	20.2%	22.2%
	2064-2067	0.5%	0.0%	5.3%	5.8%
	Mean 2004-2067	3.5%	0.4%	16.4%	20.3%
N. PUGET	2004-2013	3.5%	0.6%	22.2%	26.3%
(83,817 acres)	2014-2023	5.4%	0.8%	15.5%	21.7%
	2024-2033	4.3%	0.4%	12.7%	17.3%
	2034-2043	8.3%	0.4%	12.4%	21.2%
	2044-2053	2.3%	0.5%	11.7%	14.6%
	2054-2063	2.6%	0.1%	13.7%	16.4%
	2064-2067	1.2%	0.0%	5.6%	6.8%
	Mean 2004-2067	4.3%	0.4%	14.7%	19.4%
OESF	2004-2013				
(0 acres)	2014-2023				
	2024-2033				
	2034-2043				
	2044-2053				
	2054-2063				
	2064-2067				
	Mean 2004-2067				
S. COAST	2004-2013	2.3%	0.6%	27.2%	30.2%
(115,307 acres)	2014-2023	1.8%	0.4%	16.4%	18.6%
	2024-2033	2.7%	0.3%	11.2%	14.2%
	2034-2043	9.3%	0.8%	10.8%	20.9%
	2044-2053	1.8%	0.2%	10.9%	12.8%
	2054-2063	1.4%	0.0%	17.5%	19.0%
	2064-2067	0.4%	0.0%	4.1%	4.5%
	Mean 2004-2067	3.1%	0.4%	15.3%	18.8%
S. PUGET	2004-2013	2.2%	2.4%	12.2%	16.7%
(25,183 acres)	2014-2023	1.1%	1.2%	13.6%	16.0%
	2024-2033	2.7%	0.7%	7.1%	10.5%
	2034-2043	15.3%	1.0%	3.0%	19.3%
	2044-2053	2.9%	0.7%	6.4%	10.1%
	2054-2063	3.5%	0.0%	15.9%	19.4%
	2064-2067	0.5%	0.0%	2.1%	2.6%
	Mean 2004-2067	4.4%	1.0%	9.4%	14.8%
STRAITS	2004-2013	3.0%	2.3%	18.9%	24.2%
(56,774 acres)	2014-2023	2.1%	0.8%	16.0%	18.9%
	2024-2033	3.1%	0.9%	6.7%	10.7%
	2034-2043	14.3%	0.4%	7.7%	22.4%
	2044-2053	6.8%	0.5%	8.3%	15.6%
	2054-2063	3.7%	0.1%	16.7%	20.6%
	2064-2067	0.7%	0.0%	4.0%	4.6%
	Mean 2004-2067	5.3%	0.8%	12.2%	18.3%
Total	2004-2013	3.0%	1.3%	23.8%	28.1%
(362,706 acres)	2014-2023	2.7%	0.6%	16.0%	19.2%
	2024-2033	3.2%	0.4%	10.5%	14.2%
	2034-2043	10.3%	0.6%	9.9%	20.9%
	2044-2053	2.7%	0.3%	11.1%	14.1%
	2054-2063	2.3%	0.1%	17.0%	19.4%
	2064-2067	0.7%	0.0%	4.6%	5.2%
	Mean 2004-2067	3.9%	0.5%	14.5%	18.9%

OESF = Olympic Experimental State Forest

Table D-7a. Percent of the Upland Areas with Specific Management Objectives Land Class in which Timber Harvest Activities Would Occur per Decade under Alternative 1, by HCP Planning Unit

HCP Planning Unit (Specific Acres)	Decade	Upland Areas with Specific Management Objectives Alternative 1: Harvest Type A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	4.3%	0.3%	6.1%	**10.6%**
(99,462 acres)	2014-2023	2.6%	0.5%	6.4%	**9.6%**
	2024-2033	3.8%	0.3%	7.6%	**11.7%**
	2034-2043	1.9%	0.4%	6.8%	**9.0%**
	2044-2053	2.3%	0.5%	7.5%	**10.4%**
	2054-2063	4.4%	2.8%	7.3%	**14.5%**
	2064-2067	1.2%	0.3%	2.9%	**4.4%**
	Mean 2004-2067	3.2%	0.8%	7.0%	**11.0%**
N. PUGET	2004-2013	2.7%	0.3%	3.8%	**6.7%**
(204,975 acres)	2014-2023	5.4%	0.3%	3.8%	**9.5%**
	2024-2033	3.6%	0.1%	3.7%	**7.5%**
	2034-2043	1.2%	0.2%	4.7%	**6.1%**
	2044-2053	2.5%	0.6%	5.2%	**8.3%**
	2054-2063	1.6%	0.2%	5.7%	**7.4%**
	2064-2067	0.6%	0.2%	2.2%	**3.0%**
	Mean 2004-2067	2.7%	0.3%	4.5%	**7.6%**
OESF	2004-2013	1.2%	0.2%	2.5%	**3.8%**
(145,351 acres)	2014-2023	1.3%	0.2%	2.4%	**3.9%**
	2024-2033	0.5%	0.1%	3.3%	**3.8%**
	2034-2043	0.2%	0.0%	3.7%	**3.9%**
	2044-2053	0.0%	0.0%	4.3%	**4.3%**
	2054-2063	0.0%	0.0%	3.7%	**3.7%**
	2064-2067	0.0%	0.0%	1.2%	**1.2%**
	Mean 2004-2067	0.5%	0.1%	3.3%	**3.8%**
S. COAST	2004-2013	1.3%	0.3%	3.6%	**5.1%**
(36,659 acres)	2014-2023	4.3%	1.5%	4.2%	**10.0%**
	2024-2033	4.8%	0.1%	4.7%	**9.6%**
	2034-2043	0.7%	0.1%	5.5%	**6.3%**
	2044-2053	0.9%	1.5%	6.8%	**9.2%**
	2054-2063	2.0%	1.4%	5.7%	**9.0%**
	2064-2067	1.0%	0.2%	1.6%	**2.8%**
	Mean 2004-2067	2.3%	0.8%	5.0%	**8.1%**
S. PUGET	2004-2013	1.7%	0.4%	7.1%	**9.1%**
(82,055 acres)	2014-2023	6.5%	0.6%	8.5%	**15.5%**
	2024-2033	8.3%	0.5%	10.8%	**19.6%**
	2034-2043	4.7%	0.9%	9.1%	**14.8%**
	2044-2053	5.5%	1.6%	9.6%	**16.7%**
	2054-2063	6.0%	2.1%	7.1%	**15.2%**
	2064-2067	2.8%	1.3%	2.5%	**6.6%**
	Mean 2004-2067	5.5%	1.2%	8.5%	**15.2%**
STRAITS	2004-2013	0.5%	0.2%	2.1%	**2.8%**
(32,764 acres)	2014-2023	1.3%	1.1%	1.6%	**4.0%**
	2024-2033	3.1%	0.1%	1.7%	**4.9%**
	2034-2043	0.9%	0.4%	2.0%	**3.3%**
	2044-2053	0.6%	0.3%	2.4%	**3.3%**
	2054-2063	1.0%	0.2%	2.1%	**3.3%**
	2064-2067	0.5%	0.1%	0.7%	**1.3%**
	Mean 2004-2067	1.2%	0.4%	2.0%	**3.6%**
Total	2004-2013	2.2%	0.3%	4.2%	**6.7%**
(362,706 acres)	2014-2023	3.8%	0.5%	4.4%	**8.7%**
	2024-2033	3.6%	0.2%	5.2%	**8.9%**
	2034-2043	1.5%	0.3%	5.3%	**7.1%**
	2044-2053	2.1%	0.6%	5.9%	**8.6%**
	2054-2063	2.3%	0.9%	5.4%	**8.6%**
	2064-2067	0.9%	0.3%	2.0%	**3.2%**
	Mean 2004-2067	2.6%	0.5%	5.1%	**8.1%**

OESF = Olympic Experimental State Forest

Table D-7b. Percent of the Upland Areas with Specific Management Objectives Land Class in which Timber Harvest Activities Would Occur per Decade under Alternative 2, by HCP Planning Unit

HCP Planning Unit (Specific Acres)	Decade	Upland Areas with Specific Management Objectives Alternative 2 — Harvest Type: A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	3.3%	1.2%	11.1%	**15.7%**
(99,462 acres)	2014-2023	3.6%	3.7%	11.7%	**19.0%**
	2024-2033	4.2%	2.2%	11.2%	**17.6%**
	2034-2043	2.5%	1.5%	11.6%	**15.7%**
	2044-2053	3.8%	1.9%	12.5%	**18.1%**
	2054-2063	4.9%	2.2%	11.6%	**18.6%**
	2064-2067	2.4%	0.4%	4.1%	**6.9%**
	Mean 2004-2067	3.9%	2.1%	11.5%	**17.4%**
N. PUGET	2004-2013	3.3%	2.0%	8.0%	**13.3%**
(204,975 acres)	2014-2023	6.9%	1.4%	6.9%	**15.2%**
	2024-2033	4.6%	1.6%	7.2%	**13.4%**
	2034-2043	2.8%	1.2%	9.3%	**13.3%**
	2044-2053	4.5%	2.9%	9.7%	**17.1%**
	2054-2063	5.7%	2.5%	8.5%	**16.8%**
	2064-2067	3.6%	1.1%	4.0%	**8.8%**
	Mean 2004-2067	4.9%	2.0%	8.4%	**15.3%**
OESF	2004-2013	4.0%	0.3%	7.2%	**11.5%**
(145,351 acres)	2014-2023	3.3%	0.5%	6.5%	**10.3%**
	2024-2033	2.1%	0.2%	10.3%	**12.6%**
	2034-2043	0.7%	0.0%	10.2%	**10.9%**
	2044-2053	1.0%	0.1%	12.9%	**13.9%**
	2054-2063	1.9%	0.2%	9.2%	**11.3%**
	2064-2067	1.1%	0.1%	3.0%	**4.2%**
	Mean 2004-2067	2.2%	0.2%	9.3%	**11.7%**
S. COAST	2004-2013	2.7%	6.8%	13.6%	**23.1%**
(36,659 acres)	2014-2023	5.8%	5.0%	12.4%	**23.2%**
	2024-2033	5.6%	3.4%	19.4%	**28.3%**
	2034-2043	3.7%	2.9%	11.9%	**18.5%**
	2044-2053	3.1%	4.9%	16.8%	**24.8%**
	2054-2063	5.4%	4.5%	13.8%	**23.7%**
	2064-2067	2.4%	1.2%	5.7%	**9.2%**
	Mean 2004-2067	4.5%	4.5%	14.6%	**23.6%**
S. PUGET	2004-2013	2.0%	2.9%	8.2%	**13.1%**
(82,055 acres)	2014-2023	6.6%	2.7%	7.5%	**16.8%**
	2024-2033	7.8%	0.9%	10.8%	**19.5%**
	2034-2043	2.6%	1.1%	12.5%	**16.2%**
	2044-2053	3.4%	2.6%	12.7%	**18.8%**
	2054-2063	2.9%	2.5%	12.3%	**17.6%**
	2064-2067	1.4%	0.6%	4.2%	**6.2%**
	Mean 2004-2067	4.2%	2.1%	10.6%	**16.9%**
STRAITS	2004-2013	1.3%	4.0%	9.2%	**14.6%**
(32,764 acres)	2014-2023	2.8%	5.1%	10.4%	**18.3%**
	2024-2033	6.1%	7.1%	7.6%	**20.8%**
	2034-2043	3.1%	4.9%	10.6%	**18.7%**
	2044-2053	5.0%	3.9%	8.4%	**17.3%**
	2054-2063	4.1%	5.5%	7.7%	**17.3%**
	2064-2067	0.7%	1.0%	3.0%	**4.7%**
	Mean 2004-2067	3.6%	4.9%	8.9%	**17.4%**
Total	2004-2013	3.2%	2.0%	8.7%	**13.9%**
(362,706 acres)	2014-2023	5.2%	2.2%	8.2%	**15.5%**
	2024-2033	4.5%	1.7%	9.8%	**16.0%**
	2034-2043	2.3%	1.3%	10.6%	**14.1%**
	2044-2053	3.3%	2.2%	11.7%	**17.2%**
	2054-2063	4.2%	2.2%	10.0%	**16.3%**
	2064-2067	2.3%	0.7%	3.9%	**6.8%**
	Mean 2004-2067	3.9%	1.9%	9.8%	**15.6%**

OESF = Olympic Experimental State Forest

Table D-7c. Percent of the Upland Areas with Specific Management Objectives Land Class in which Timber Harvest Activities Would Occur per Decade under Alternative 3, by HCP Planning Unit

HCP Planning Unit (Specific Acres)	Decade	Upland Areas with Specific Management Objectives Alternative 3 — Harvest Type: A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	4.3%	0.7%	16.1%	**21.1%**
(99,462 acres)	2014-2023	5.0%	2.1%	11.1%	**18.3%**
	2024-2033	4.4%	1.9%	11.3%	**17.6%**
	2034-2043	3.0%	1.7%	11.4%	**16.1%**
	2044-2053	4.4%	1.6%	14.5%	**20.5%**
	2054-2063	5.3%	1.3%	10.9%	**17.5%**
	2064-2067	2.5%	0.4%	6.0%	**9.0%**
	Mean 2004-2067	4.5%	1.5%	12.7%	**18.7%**
N. PUGET	2004-2013	1.9%	0.1%	5.5%	**7.5%**
(204,975 acres)	2014-2023	7.2%	0.4%	10.0%	**17.5%**
	2024-2033	7.6%	0.4%	6.5%	**14.6%**
	2034-2043	3.0%	0.6%	9.7%	**13.3%**
	2044-2053	3.3%	0.9%	14.0%	**18.2%**
	2054-2063	5.6%	0.8%	7.3%	**13.7%**
	2064-2067	2.0%	0.5%	2.9%	**5.3%**
	Mean 2004-2067	4.8%	0.6%	8.7%	**14.1%**
OESF	2004-2013	0.8%	0.2%	4.4%	**5.4%**
(145,351 acres)	2014-2023	1.2%	0.5%	4.0%	**5.6%**
	2024-2033	0.9%	0.1%	9.0%	**10.0%**
	2034-2043	1.0%	0.2%	13.4%	**14.6%**
	2044-2053	1.2%	0.1%	24.2%	**25.5%**
	2054-2063	0.8%	0.1%	13.7%	**14.6%**
	2064-2067	0.2%	0.0%	4.9%	**5.2%**
	Mean 2004-2067	1.0%	0.2%	11.5%	**12.6%**
S. COAST	2004-2013	2.1%	0.4%	16.6%	**19.1%**
(36,659 acres)	2014-2023	8.5%	1.0%	13.6%	**23.2%**
	2024-2033	8.0%	0.9%	10.0%	**18.9%**
	2034-2043	1.4%	1.2%	19.9%	**22.5%**
	2044-2053	2.6%	1.2%	18.5%	**22.3%**
	2054-2063	3.1%	0.8%	9.9%	**13.8%**
	2064-2067	2.8%	0.0%	4.3%	**7.1%**
	Mean 2004-2067	4.5%	0.9%	14.5%	**19.8%**
S. PUGET	2004-2013	1.6%	0.2%	9.5%	**11.3%**
(82,055 acres)	2014-2023	4.8%	0.4%	6.8%	**11.9%**
	2024-2033	7.1%	0.6%	7.4%	**15.2%**
	2034-2043	2.5%	0.8%	16.3%	**19.6%**
	2044-2053	2.2%	0.6%	15.7%	**18.4%**
	2054-2063	1.7%	0.7%	9.2%	**11.7%**
	2064-2067	0.9%	0.4%	8.2%	**9.5%**
	Mean 2004-2067	3.2%	0.6%	11.4%	**15.2%**
STRAITS	2004-2013	2.6%	1.1%	20.4%	**24.1%**
(32,764 acres)	2014-2023	4.6%	0.4%	11.1%	**16.1%**
	2024-2033	6.5%	0.8%	3.1%	**10.4%**
	2034-2043	2.5%	1.2%	16.0%	**19.7%**
	2044-2053	1.9%	1.4%	15.1%	**18.5%**
	2054-2063	4.8%	0.7%	7.8%	**13.3%**
	2064-2067	2.9%	0.1%	3.0%	**6.0%**
	Mean 2004-2067	4.0%	0.9%	11.9%	**16.9%**
Total	2004-2013	2.0%	0.3%	9.0%	**11.4%**
(362,706 acres)	2014-2023	5.0%	0.7%	8.6%	**14.3%**
	2024-2033	5.4%	0.7%	8.1%	**14.1%**
	2034-2043	2.3%	0.8%	12.8%	**15.8%**
	2044-2053	2.7%	0.8%	17.1%	**20.6%**
	2054-2063	3.7%	0.7%	9.9%	**14.2%**
	2064-2067	1.6%	0.3%	4.7%	**6.6%**
	Mean 2004-2067	3.5%	0.7%	10.9%	**15.2%**

OESF = Olympic Experimental State Forest

Table D-7d. Percent of the Upland Areas with Specific Management Objectives Land Class in which Timber Harvest Activities Would Occur per Decade under Alternative 4, by HCP Planning Unit

HCP Planning Unit (Specific Acres)	Decade	Upland Areas with Specific Management Objectives Alternative 4 — Harvest Type: A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	7.7%	3.8%	3.3%	**14.8%**
(99,462 acres)	2014-2023	5.7%	4.2%	3.7%	**13.7%**
	2024-2033	6.7%	3.6%	6.6%	**16.9%**
	2034-2043	2.7%	3.8%	5.0%	**11.5%**
	2044-2053	3.6%	4.4%	7.0%	**15.0%**
	2054-2063	4.8%	3.8%	6.8%	**15.4%**
	2064-2067	1.7%	1.2%	3.1%	**6.0%**
	Mean 2004-2067	5.1%	3.9%	5.5%	**14.6%**
N. PUGET	2004-2013	7.4%	1.8%	4.2%	**13.3%**
(204,975 acres)	2014-2023	8.0%	1.3%	5.0%	**14.3%**
	2024-2033	6.7%	1.4%	6.1%	**14.1%**
	2034-2043	3.5%	2.7%	5.8%	**12.0%**
	2044-2053	5.1%	3.0%	5.8%	**13.9%**
	2054-2063	6.2%	3.0%	6.3%	**15.4%**
	2064-2067	1.8%	0.7%	3.0%	**5.5%**
	Mean 2004-2067	6.0%	2.2%	5.6%	**13.8%**
OESF	2004-2013	0.7%	0.6%	1.2%	**2.4%**
(145,351 acres)	2014-2023	0.8%	0.7%	0.9%	**2.3%**
	2024-2033	0.5%	0.5%	0.4%	**1.4%**
	2034-2043	0.3%	0.9%	0.4%	**1.6%**
	2044-2053	0.2%	0.7%	1.3%	**2.2%**
	2054-2063	0.1%	0.9%	1.6%	**2.6%**
	2064-2067	0.0%	0.4%	0.4%	**0.8%**
	Mean 2004-2067	0.4%	0.7%	1.0%	**2.1%**
S. COAST	2004-2013	8.5%	6.1%	7.7%	**22.3%**
(36,659 acres)	2014-2023	8.7%	4.7%	7.3%	**20.7%**
	2024-2033	9.6%	3.5%	11.4%	**24.5%**
	2034-2043	5.2%	4.8%	11.9%	**22.0%**
	2044-2053	4.3%	2.8%	9.3%	**16.4%**
	2054-2063	6.5%	3.6%	8.0%	**18.1%**
	2064-2067	2.7%	1.4%	4.3%	**8.3%**
	Mean 2004-2067	7.1%	4.2%	9.4%	**20.7%**
S. PUGET	2004-2013	5.5%	3.0%	3.4%	**11.9%**
(82,055 acres)	2014-2023	5.4%	1.7%	4.2%	**11.4%**
	2024-2033	6.9%	2.0%	4.4%	**13.3%**
	2034-2043	4.4%	4.5%	5.6%	**14.6%**
	2044-2053	4.0%	2.9%	4.9%	**11.9%**
	2054-2063	3.2%	2.6%	6.9%	**12.6%**
	2064-2067	1.2%	0.9%	2.5%	**4.6%**
	Mean 2004-2067	4.8%	2.8%	5.0%	**12.5%**
STRAITS	2004-2013	6.3%	5.2%	5.9%	**17.4%**
(32,764 acres)	2014-2023	7.5%	3.2%	7.6%	**18.3%**
	2024-2033	10.4%	4.6%	5.4%	**20.3%**
	2034-2043	5.7%	3.8%	6.9%	**16.4%**
	2044-2053	8.4%	4.5%	6.3%	**19.2%**
	2054-2063	7.3%	4.1%	5.2%	**16.6%**
	2064-2067	2.8%	1.3%	2.6%	**6.7%**
	Mean 2004-2067	7.6%	4.2%	6.2%	**18.0%**
Total	2004-2013	5.6%	2.4%	3.5%	**11.5%**
(362,706 acres)	2014-2023	5.6%	2.0%	4.0%	**11.5%**
	2024-2033	5.6%	1.9%	4.8%	**12.4%**
	2034-2043	3.0%	2.9%	4.7%	**10.6%**
	2044-2053	3.7%	2.7%	5.0%	**11.4%**
	2054-2063	4.1%	2.6%	5.4%	**12.1%**
	2064-2067	1.4%	0.8%	2.4%	**4.5%**
	Mean 2004-2067	4.5%	2.4%	4.7%	**11.6%**

OESF = Olympic Experimental State Forest

Table D-7e. Percent of the Upland Areas with Specific Management Objectives Land Class in which Timber Harvest Activities Would Occur per Decade under Alternative 5, by HCP Planning Unit

Unit (Specific Acres)	Decade	Upland Areas with Specific Management Objectives Alternative 5 — Harvest Type: A (Area Net)	B (Area Gross)	C (Area Gross)	Total
COLUMBIA	2004-2013	11.3%	6.9%	13.8%	**32.1%**
(99,462 acres)	2014-2023	10.2%	5.5%	11.5%	**27.2%**
	2024-2033	14.6%	4.9%	11.9%	**31.5%**
	2034-2043	17.6%	3.4%	11.3%	**32.3%**
	2044-2053	11.7%	2.4%	10.6%	**24.7%**
	2054-2063	13.2%	3.1%	13.5%	**29.8%**
	2064-2067	3.5%	1.2%	6.8%	**11.5%**
	Mean 2004-2067	12.8%	4.3%	12.4%	**29.6%**
N. PUGET	2004-2013	5.1%	2.4%	6.4%	**13.8%**
(204,975 acres)	2014-2023	9.5%	2.3%	8.6%	**20.4%**
	2024-2033	8.1%	3.0%	9.8%	**21.0%**
	2034-2043	8.8%	2.3%	8.1%	**19.3%**
	2044-2053	7.5%	3.1%	8.4%	**18.9%**
	2054-2063	4.9%	1.2%	7.0%	**13.1%**
	2064-2067	2.3%	0.4%	3.1%	**5.8%**
	Mean 2004-2067	7.2%	2.3%	8.0%	**17.5%**
OESF	2004-2013	14.1%	0.6%	18.8%	**33.5%**
(145,351 acres)	2014-2023	15.5%	2.0%	15.1%	**32.6%**
	2024-2033	17.2%	3.7%	15.2%	**36.2%**
	2034-2043	22.3%	3.4%	14.8%	**40.5%**
	2044-2053	14.6%	1.1%	15.0%	**30.8%**
	2054-2063	18.5%	4.1%	12.3%	**34.8%**
	2064-2067	3.5%	0.4%	2.1%	**6.1%**
	Mean 2004-2067	16.5%	2.4%	14.6%	**33.5%**
S. COAST	2004-2013	5.1%	12.6%	11.5%	**29.1%**
(36,659 acres)	2014-2023	10.2%	10.0%	12.9%	**33.0%**
	2024-2033	8.2%	10.2%	14.4%	**32.8%**
	2034-2043	12.7%	7.8%	10.5%	**31.0%**
	2044-2053	9.0%	4.3%	10.0%	**23.3%**
	2054-2063	11.6%	5.4%	13.1%	**30.1%**
	2064-2067	2.9%	0.3%	5.2%	**8.5%**
	Mean 2004-2067	9.3%	7.9%	12.1%	**29.3%**
S. PUGET	2004-2013	11.1%	9.2%	10.8%	**31.1%**
(82,055 acres)	2014-2023	14.7%	4.2%	10.7%	**29.6%**
	2024-2033	13.0%	6.0%	14.0%	**33.0%**
	2034-2043	15.5%	3.6%	11.2%	**30.2%**
	2044-2053	9.5%	3.8%	11.6%	**24.9%**
	2054-2063	10.4%	2.5%	12.4%	**25.4%**
	2064-2067	4.1%	0.7%	5.1%	**9.9%**
	Mean 2004-2067	12.2%	4.7%	11.8%	**28.8%**
STRAITS	2004-2013	13.9%	12.1%	12.5%	**38.5%**
(32,764 acres)	2014-2023	14.5%	6.2%	10.7%	**31.4%**
	2024-2033	11.5%	9.2%	9.6%	**30.3%**
	2034-2043	13.3%	5.6%	8.6%	**27.5%**
	2044-2053	15.5%	4.7%	5.7%	**26.0%**
	2054-2063	11.9%	5.6%	7.5%	**25.0%**
	2064-2067	4.0%	0.7%	5.7%	**10.4%**
	Mean 2004-2067	13.2%	6.9%	9.4%	**29.5%**
Total	2004-2013	9.6%	4.8%	11.8%	**26.2%**
(362,706 acres)	2014-2023	12.1%	3.7%	11.3%	**27.1%**
	2024-2033	12.3%	4.7%	12.3%	**29.3%**
	2034-2043	14.9%	3.4%	10.9%	**29.2%**
	2044-2053	10.7%	2.8%	10.8%	**24.2%**
	2054-2063	11.1%	2.9%	10.5%	**24.5%**
	2064-2067	3.2%	0.6%	4.0%	**7.8%**
	Mean 2004-2067	11.5%	3.6%	11.2%	**26.3%**

OESF = Olympic Experimental State Forest

Table D-7f. Percent of the Upland Areas with Specific Management Objectives Land Class in which Timber Harvest Activities Would Occur per Decade under the Preferred Alternative, by HCP Planning Unit

		Upland Areas with Specific Management Objectives Preferred Alternative			
HCP Planning Unit (Specific Acres)	**Decade**	**Harvest Type A (Area Net)**	**B (Area Gross)**	**C (Area Gross)**	**Total**
COLUMBIA	2004-2013	0.8%	3.2%	17.7%	**21.7%**
(99,462 acres)	2014-2023	0.3%	0.5%	9.7%	**10.6%**
	2024-2033	1.0%	1.6%	8.4%	**11.1%**
	2034-2043	2.4%	1.6%	8.9%	**12.9%**
	2044-2053	5.1%	2.0%	14.0%	**21.1%**
	2054-2063	5.7%	2.4%	7.1%	**15.2%**
	2064-2067	3.4%	0.8%	3.9%	**8.2%**
	Mean 2004-2067	2.9%	1.9%	10.9%	**15.7%**
N. PUGET	2004-2013	0.3%	0.8%	8.7%	**9.8%**
(204,975 acres)	2014-2023	0.3%	0.3%	5.4%	**6.1%**
	2024-2033	0.8%	0.8%	7.2%	**8.8%**
	2034-2043	0.6%	1.5%	7.1%	**9.2%**
	2044-2053	0.3%	1.4%	7.8%	**9.5%**
	2054-2063	1.0%	2.8%	5.5%	**9.4%**
	2064-2067	1.6%	0.9%	2.1%	**4.7%**
	Mean 2004-2067	0.8%	1.3%	6.8%	**9.0%**
OESF	2004-2013	0.6%	0.3%	10.8%	**11.6%**
(145,351 acres)	2014-2023	0.3%	0.3%	8.1%	**8.7%**
	2024-2033	0.7%	0.4%	13.3%	**14.4%**
	2034-2043	0.2%	1.9%	13.0%	**15.2%**
	2044-2053	0.8%	0.7%	10.1%	**11.6%**
	2054-2063	1.4%	1.4%	7.1%	**9.8%**
	2064-2067	1.6%	0.5%	2.3%	**4.3%**
	Mean 2004-2067	0.9%	0.8%	10.1%	**11.8%**
S. COAST	2004-2013	0.2%	0.6%	17.1%	**17.9%**
(36,659 acres)	2014-2023	0.0%	0.2%	7.2%	**7.5%**
	2024-2033	1.2%	3.9%	10.2%	**15.3%**
	2034-2043	1.1%	3.7%	10.8%	**15.6%**
	2044-2053	1.4%	5.8%	8.5%	**15.8%**
	2054-2063	1.3%	3.3%	6.4%	**11.0%**
	2064-2067	4.1%	2.9%	3.2%	**10.1%**
	Mean 2004-2067	1.5%	3.2%	9.9%	**14.6%**
S. PUGET	2004-2013	0.7%	2.3%	15.4%	**18.4%**
(82,055 acres)	2014-2023	0.7%	0.3%	6.6%	**7.7%**
	2024-2033	1.6%	1.6%	8.8%	**12.0%**
	2034-2043	1.7%	2.6%	9.4%	**13.8%**
	2044-2053	2.1%	3.5%	14.1%	**19.7%**
	2054-2063	1.7%	3.8%	6.6%	**12.0%**
	2064-2067	2.9%	1.5%	2.9%	**7.2%**
	Mean 2004-2067	1.8%	2.4%	10.0%	**14.2%**
STRAITS	2004-2013	1.2%	5.2%	14.2%	**20.6%**
(32,764 acres)	2014-2023	0.4%	0.6%	6.9%	**8.0%**
	2024-2033	1.6%	3.4%	6.8%	**11.8%**
	2034-2043	1.4%	3.5%	6.1%	**10.9%**
	2044-2053	1.4%	6.3%	5.9%	**13.5%**
	2054-2063	1.1%	4.8%	4.4%	**10.3%**
	2064-2067	3.0%	2.1%	2.1%	**7.2%**
	Mean 2004-2067	1.6%	4.0%	7.2%	**12.9%**
Total	2004-2013	0.5%	1.5%	12.4%	**14.4%**
(362,706 acres)	2014-2023	0.4%	0.4%	7.1%	**7.8%**
	2024-2033	1.0%	1.3%	9.3%	**11.5%**
	2034-2043	1.1%	2.0%	9.3%	**12.4%**
	2044-2053	1.6%	2.2%	10.2%	**13.9%**
	2054-2063	2.0%	2.7%	6.3%	**11.0%**
	2064-2067	2.3%	1.0%	2.6%	**6.0%**
	Mean 2004-2067	1.4%	1.7%	8.9%	**12.0%**

OESF = Olympic Experimental State Forest

Table D-8a. Percent of Land Class Area[1/] Expected in Three Stand Development Stage Categories by HCP Planning Unit and Year for Alternative 1

		Alternative 1								
		Land Class								
		Uplands with General Objectives			Riparian			Uplands with Specific Objectives		
HCP Planning Unit	Year	Ecosystem Initiation[2/]	Competitive Exclusion[3/]	Structurally Complex[4/]	Ecosystem Initiation[2/]	Competitive Exclusion[3/]	Structurally Complex[4/]	Ecosystem Initiation[2/]	Competitive Exclusion[3/]	Structurally Complex[4/]
COLUMBIA	2004	9.6%	72.7%	17.7%	4.7%	72.8%	22.6%	6.5%	67.8%	25.7%
	2013	22.5%	64.5%	13.0%	1.1%	76.4%	22.4%	4.2%	71.0%	24.9%
	2031	15.6%	69.0%	15.4%	1.0%	76.5%	22.6%	7.8%	68.5%	23.7%
	2067	20.7%	64.3%	15.0%	1.8%	72.6%	25.6%	11.7%	62.5%	25.7%
N. PUGET	2004	13.9%	66.2%	19.9%	5.4%	64.6%	30.0%	7.3%	62.8%	29.9%
	2013	21.8%	64.8%	13.4%	1.7%	68.5%	29.8%	5.0%	66.2%	28.8%
	2031	14.9%	68.3%	16.7%	1.2%	68.7%	30.1%	5.2%	65.5%	29.3%
	2067	23.9%	60.0%	16.1%	1.5%	63.2%	35.3%	7.0%	58.9%	34.1%
OESF	2004				5.3%	66.4%	28.3%	8.2%	65.8%	26.0%
	2013				0.6%	70.7%	28.7%	2.5%	71.7%	25.8%
	2031				0.9%	69.7%	29.4%	3.6%	69.8%	26.6%
	2067				1.6%	66.9%	31.5%	3.4%	67.9%	28.7%
S. COAST	2004	9.4%	73.8%	16.8%	4.8%	76.1%	19.1%	5.8%	73.0%	21.2%
	2013	15.7%	70.3%	13.9%	1.1%	79.9%	19.1%	3.7%	75.4%	20.9%
	2031	11.2%	74.4%	14.4%	1.0%	79.5%	19.5%	5.9%	72.4%	21.7%
	2067	13.4%	68.4%	18.2%	1.5%	71.1%	27.4%	4.7%	65.6%	29.7%
S. PUGET	2004	12.0%	65.6%	22.4%	5.1%	66.7%	28.2%	8.3%	67.1%	24.6%
	2013	27.1%	56.5%	16.4%	1.0%	71.0%	28.0%	7.8%	69.5%	22.7%
	2031	15.8%	65.3%	18.9%	0.8%	71.0%	28.2%	6.1%	70.0%	23.9%
	2067	26.6%	54.9%	18.5%	1.3%	68.1%	30.6%	11.6%	63.4%	25.0%
STRAITS	2004	11.0%	66.9%	22.1%	4.9%	66.7%	28.4%	5.8%	64.7%	29.5%
	2013	16.1%	66.2%	17.7%	1.0%	70.8%	28.2%	2.3%	68.7%	29.0%
	2031	14.0%	67.9%	18.0%	1.0%	70.5%	28.5%	3.6%	66.9%	29.5%
	2067	18.6%	61.4%	20.0%	1.3%	68.0%	30.7%	4.6%	62.7%	32.7%
Total	**2004**	**10.9%**	**59.6%**	**11.4%**	**5.9%**	**69.2%**	**18.3%**	**12.2%**	**92.5%**	**27.0%**
	2013	**19.5%**	**56.2%**	**8.7%**	**1.3%**	**73.2%**	**18.3%**	**7.3%**	**97.9%**	**26.1%**
	2031	**13.8%**	**59.6%**	**9.7%**	**1.2%**	**72.8%**	**18.6%**	**8.9%**	**96.0%**	**26.5%**
	2067	**19.2%**	**54.0%**	**10.4%**	**1.9%**	**68.2%**	**21.4%**	**12.1%**	**88.6%**	**29.8%**

1. Approximate acreage for each land class and HCP Planning Unit are present in Table 4.2-9.
2. Includes the ecosystem initiation stand development stage.
3. Includes the sapling exclusion, pole exclusion, large tree exclusion, and understory development stand development stages.
4. Includes the botanical diversity, niche diversification, and fully functional stand development stages.

OESF = Olympic Experimental State Forest

Table D-8b. Percent of Land Class Area[1/] Expected in Three Stand Development Stage Categories by HCP Planning Unit and Year for Alternative 2

		Alternative 2								
		Land Class								
		Uplands with General Objectives			Riparian			Uplands with Specific Objectives		
HCP Planning Unit	**Year**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**
COLUMBIA	2004	9.3%	72.9%	17.7%	4.8%	72.7%	22.5%	8.1%	66.9%	25.1%
	2013	16.7%	69.1%	14.3%	2.1%	75.7%	22.2%	12.8%	65.4%	21.7%
	2031	15.5%	69.7%	14.8%	2.2%	75.6%	22.2%	10.8%	66.7%	22.5%
	2067	14.4%	69.6%	16.0%	3.1%	71.8%	25.1%	11.6%	63.8%	24.6%
N. PUGET	2004	11.3%	67.8%	20.9%	5.3%	64.7%	30.0%	7.4%	62.7%	29.9%
	2013	17.7%	67.7%	14.7%	2.4%	68.1%	29.5%	8.7%	63.7%	27.6%
	2031	10.9%	70.8%	18.3%	2.0%	68.1%	29.8%	8.7%	63.1%	28.2%
	2067	17.4%	60.4%	22.2%	2.4%	62.4%	35.2%	10.4%	55.6%	34.1%
OESF	2004				5.2%	66.4%	28.3%	7.9%	66.1%	26.0%
	2013				1.3%	70.3%	28.4%	6.1%	69.4%	24.5%
	2031				2.9%	68.3%	28.7%	8.2%	66.1%	25.7%
	2067				5.6%	63.3%	31.1%	10.3%	61.4%	28.3%
S. COAST	2004	8.5%	74.4%	17.1%	4.8%	76.1%	19.1%	5.4%	73.4%	21.2%
	2013	17.2%	69.8%	13.0%	2.2%	79.1%	18.7%	12.2%	69.3%	18.5%
	2031	15.7%	70.9%	13.4%	1.9%	78.9%	19.2%	11.8%	68.9%	19.3%
	2067	15.7%	69.4%	15.0%	3.3%	70.9%	25.8%	13.0%	64.9%	22.1%
S. PUGET	2004	10.1%	67.2%	22.7%	4.9%	67.2%	28.0%	9.3%	67.3%	23.4%
	2013	14.5%	65.3%	20.1%	1.8%	70.6%	27.6%	12.7%	67.3%	20.0%
	2031	12.2%	67.4%	20.4%	2.2%	70.2%	27.6%	11.3%	66.9%	21.9%
	2067	15.7%	62.6%	21.7%	2.0%	67.7%	30.4%	11.5%	65.6%	22.9%
STRAITS	2004	12.9%	66.0%	21.1%	4.9%	66.8%	28.3%	6.2%	64.7%	29.1%
	2013	18.1%	65.1%	16.8%	2.3%	70.0%	27.7%	12.0%	62.5%	25.4%
	2031	12.3%	67.9%	19.8%	2.2%	69.6%	28.2%	7.2%	64.1%	28.7%
	2067	14.8%	63.1%	22.1%	2.7%	67.1%	30.2%	6.4%	61.6%	31.9%
Total	**2004**	**10.1%**	**60.1%**	**11.5%**	**5.9%**	**69.2%**	**18.3%**	**12.8%**	**92.4%**	**26.7%**
	2013	**17.1%**	**57.9%**	**8.9%**	**2.3%**	**72.6%**	**18.1%**	**16.1%**	**93.2%**	**24.2%**
	2031	**13.8%**	**59.4%**	**9.9%**	**2.7%**	**72.0%**	**18.3%**	**15.6%**	**92.1%**	**25.3%**
	2067	**15.6%**	**56.0%**	**11.1%**	**4.2%**	**66.8%**	**21.1%**	**17.7%**	**85.4%**	**28.7%**

1. Approximate acreage for each land class and HCP Planning Unit are present in Table 4.2-9.
2. Includes the ecosystem initiation stand development stage.
3. Includes the sapling exclusion, pole exclusion, large tree exclusion, and understory development stand development stages.
4. Includes the botanical diversity, niche diversification, and fully functional stand development stages.

OESF = Olympic Experimental State Forest

Table D-8c. Percent of Land Class Area[1/] Expected in Three Stand Development Stage Categories by HCP Planning Unit and Year for Alternative 3

		Alternative 3								
		Land Class								
		Uplands with General Objectives			Riparian			Uplands with Specific Objectives		
HCP Planning Unit	**Year**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**
COLUMBIA	2004	8.9%	73.4%	17.7%	4.8%	72.7%	22.5%	8.2%	66.7%	25.1%
	2013	30.6%	57.9%	11.5%	2.6%	75.3%	22.0%	14.7%	64.2%	21.2%
	2031	15.0%	69.5%	15.5%	2.6%	75.3%	22.1%	11.8%	65.8%	22.4%
	2067	21.6%	63.7%	14.7%	3.7%	71.6%	24.7%	12.9%	63.1%	23.9%
N. PUGET	2004	11.4%	67.9%	20.7%	5.4%	64.7%	30.0%	7.5%	62.7%	29.9%
	2013	13.7%	70.1%	16.3%	1.9%	68.4%	29.7%	6.4%	65.2%	28.4%
	2031	23.5%	61.7%	14.8%	3.3%	67.3%	29.4%	12.3%	61.0%	26.8%
	2067	16.8%	65.5%	17.7%	2.9%	62.6%	34.5%	10.8%	56.8%	32.4%
OESF	2004				5.2%	66.5%	28.3%	7.9%	66.2%	26.0%
	2013				0.6%	70.7%	28.7%	2.1%	72.1%	25.8%
	2031				2.1%	69.0%	29.0%	10.4%	64.2%	25.4%
	2067				3.2%	65.9%	30.9%	4.9%	66.7%	28.4%
S. COAST	2004	8.1%	74.7%	17.2%	4.7%	76.1%	19.2%	5.0%	73.8%	21.2%
	2013	28.8%	60.8%	10.4%	2.9%	78.5%	18.6%	16.7%	65.8%	17.5%
	2031	13.5%	71.9%	14.5%	2.3%	78.5%	19.2%	9.2%	71.1%	19.7%
	2067	19.6%	66.5%	13.8%	4.7%	70.2%	25.2%	17.2%	62.5%	20.3%
S. PUGET	2004	10.3%	67.0%	22.7%	4.9%	67.1%	28.0%	9.5%	67.0%	23.4%
	2013	30.2%	55.1%	14.6%	2.5%	70.2%	27.3%	17.8%	64.2%	18.0%
	2031	17.8%	63.4%	18.9%	2.3%	70.2%	27.5%	9.5%	68.5%	22.0%
	2067	18.3%	60.9%	20.8%	2.1%	67.6%	30.3%	15.5%	63.1%	21.4%
STRAITS	2004	12.5%	66.3%	21.2%	4.9%	66.8%	28.3%	5.7%	65.0%	29.3%
	2013	28.2%	58.6%	13.1%	3.2%	69.4%	27.4%	15.8%	60.4%	23.9%
	2031	23.5%	61.3%	15.2%	4.1%	68.6%	27.3%	18.9%	58.4%	22.7%
	2067	21.7%	60.0%	18.2%	3.1%	67.3%	29.6%	10.6%	61.4%	27.9%
Total	**2004**	**9.9%**	**60.3%**	**11.5%**	**5.9%**	**69.2%**	**18.3%**	**12.8%**	**92.4%**	**26.7%**
	2013	**25.7%**	**52.3%**	**7.7%**	**2.4%**	**72.5%**	**18.1%**	**15.6%**	**93.4%**	**24.2%**
	2031	**18.0%**	**56.7%**	**9.2%**	**3.0%**	**71.8%**	**18.2%**	**19.1%**	**90.3%**	**24.4%**
	2067	**19.7%**	**54.6%**	**9.7%**	**4.0%**	**67.3%**	**20.7%**	**17.8%**	**87.0%**	**27.5%**

1. Approximate acreage for each land class and HCP Planning Unit are present in Table 4.2-9.
2. Includes the ecosystem initiation stand development stage.
3. Includes the sapling exclusion, pole exclusion, large tree exclusion, and understory development stand development stages.
4. Includes the botanical diversity, niche diversification, and fully functional stand development stages.

OESF = Olympic Experimental State Forest

Table D-8d. Percent of Land Class Area[1/] Expected in Three Stand Development Stage Categories by HCP Planning Unit and Year for Alternative 4

		Alternative 4								
		Land Class								
		Uplands with General Objectives			Riparian			Uplands with Specific Objectives		
HCP Planning Unit	**Year**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**
COLUMBIA	2004	8.7%	73.5%	17.7%	4.5%	72.9%	22.5%	6.7%	67.9%	25.4%
	2013	12.7%	72.7%	14.6%	1.0%	76.5%	22.4%	3.3%	72.0%	24.7%
	2031	21.6%	65.0%	13.4%	0.9%	76.5%	22.6%	6.8%	68.6%	24.6%
	2067	15.9%	66.2%	17.9%	1.4%	72.8%	25.7%	11.8%	62.4%	25.8%
N. PUGET	2004	12.1%	67.3%	20.7%	5.2%	64.8%	30.0%	7.2%	62.9%	29.9%
	2013	14.6%	69.1%	16.3%	1.5%	68.6%	29.8%	5.0%	66.2%	28.8%
	2031	19.8%	65.0%	15.2%	1.1%	68.7%	30.2%	7.6%	63.5%	28.9%
	2067	21.8%	57.9%	20.3%	1.2%	63.3%	35.5%	8.2%	57.5%	34.4%
OESF	2004				5.2%	66.5%	28.3%	8.2%	65.7%	26.1%
	2013				0.5%	70.8%	28.8%	1.8%	71.9%	26.3%
	2031				0.5%	70.1%	29.4%	1.9%	71.3%	26.7%
	2067				0.4%	68.0%	31.6%	2.2%	68.7%	29.2%
S. COAST	2004	9.1%	74.2%	16.7%	4.7%	76.2%	19.1%	5.1%	73.7%	21.2%
	2013	11.0%	74.7%	14.3%	1.0%	80.0%	19.1%	5.3%	74.7%	20.0%
	2031	22.0%	65.5%	12.4%	1.4%	79.2%	19.4%	8.9%	70.2%	20.9%
	2067	16.0%	66.7%	17.3%	1.8%	71.2%	27.1%	10.7%	63.8%	25.5%
S. PUGET	2004	7.5%	69.0%	23.4%	4.4%	67.3%	28.2%	6.3%	68.5%	25.2%
	2013	5.6%	72.3%	22.1%	0.6%	71.3%	28.2%	3.5%	71.9%	24.6%
	2031	15.1%	65.9%	19.0%	0.7%	71.2%	28.2%	5.9%	71.0%	23.1%
	2067	15.6%	63.6%	20.8%	1.0%	68.1%	30.9%	7.2%	65.9%	26.9%
STRAITS	2004	9.5%	68.5%	22.0%	4.5%	67.1%	28.4%	5.2%	65.4%	29.4%
	2013	11.3%	70.1%	18.6%	1.1%	70.7%	28.2%	5.2%	67.2%	27.6%
	2031	22.1%	62.2%	15.7%	1.3%	70.2%	28.5%	7.8%	63.5%	28.8%
	2067	13.8%	65.2%	20.9%	1.3%	68.3%	30.5%	8.2%	61.5%	30.3%
Total	**2004**	**9.6%**	**60.5%**	**11.6%**	**5.7%**	**69.3%**	**18.3%**	**11.6%**	**92.9%**	**27.0%**
	2013	**11.9%**	**61.3%**	**9.7%**	**1.1%**	**73.2%**	**18.3%**	**6.3%**	**98.5%**	**26.3%**
	2031	**20.9%**	**55.1%**	**8.6%**	**1.1%**	**72.9%**	**18.6%**	**9.9%**	**95.3%**	**26.4%**
	2067	**16.9%**	**54.5%**	**11.4%**	**1.3%**	**68.6%**	**21.5%**	**12.2%**	**88.4%**	**29.9%**

1. Approximate acreage for each land class and HCP Planning Unit are present in Table 4.2-9.
2. Includes the ecosystem initiation stand development stage.
3. Includes the sapling exclusion, pole exclusion, large tree exclusion, and understory development stand development stages.
4. Includes the botanical diversity, niche diversification, and fully functional stand development stages.

OESF = Olympic Experimental State Forest

Table D-8e. Percent of Land Class Area[1/] Expected in Three Stand Development Stage Categories by HCP Planning Unit and Year for Alternative 5

		Alternative 5								
		Land Class								
		Uplands with General Objectives			Riparian			Uplands with Specific Objectives		
HCP Planning Unit	**Year**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**
COLUMBIA	2004	18.5%	66.1%	15.4%	5.3%	72.3%	22.4%	10.4%	64.8%	24.9%
	2013	23.3%	64.0%	12.7%	2.9%	75.3%	21.8%	17.0%	62.0%	21.0%
	2031	18.8%	65.8%	15.4%	3.3%	74.7%	22.0%	15.9%	63.7%	20.4%
	2067	18.6%	66.9%	14.5%	3.1%	72.2%	24.6%	18.2%	60.0%	21.8%
N. PUGET	2004	13.9%	66.2%	19.9%	5.6%	64.6%	29.8%	8.3%	62.3%	29.4%
	2013	16.2%	67.6%	16.1%	2.5%	68.1%	29.4%	8.1%	64.3%	27.5%
	2031	22.8%	62.4%	14.9%	3.3%	67.3%	29.4%	13.0%	60.2%	26.8%
	2067	16.7%	66.3%	17.0%	2.3%	63.1%	34.6%	9.1%	58.6%	32.3%
OESF	2004				5.5%	66.3%	28.3%	10.6%	64.5%	24.9%
	2013				2.2%	69.9%	27.8%	21.0%	61.0%	18.0%
	2031				2.8%	69.2%	27.9%	21.3%	60.7%	18.0%
	2067				2.9%	68.4%	28.7%	16.5%	67.6%	15.9%
S. COAST	2004	15.0%	69.4%	15.6%	5.6%	75.5%	18.9%	8.2%	71.1%	20.7%
	2013	19.1%	68.0%	12.9%	2.8%	78.5%	18.7%	12.8%	68.8%	18.4%
	2031	19.1%	68.5%	12.4%	3.5%	77.6%	18.9%	14.6%	66.5%	18.9%
	2067	15.8%	69.6%	14.5%	3.1%	71.0%	25.9%	14.0%	64.3%	21.7%
S. PUGET	2004	17.0%	61.9%	21.1%	5.1%	67.0%	28.0%	11.1%	65.2%	23.7%
	2013	25.1%	57.4%	17.5%	2.5%	70.1%	27.4%	14.4%	65.2%	20.4%
	2031	15.8%	65.6%	18.6%	2.8%	69.6%	27.5%	17.0%	62.7%	20.2%
	2067	20.8%	59.3%	19.9%	2.7%	67.4%	29.9%	15.1%	63.3%	21.7%
STRAITS	2004	14.9%	64.7%	20.4%	5.1%	66.7%	28.2%	6.5%	64.3%	29.3%
	2013	25.2%	60.1%	14.7%	3.2%	69.4%	27.4%	14.4%	60.3%	25.2%
	2031	17.3%	65.7%	17.0%	2.9%	69.3%	27.8%	14.2%	61.0%	24.8%
	2067	21.6%	59.9%	18.5%	4.0%	66.5%	29.4%	13.2%	59.6%	27.2%
Total	**2004**	**15.6%**	**56.7%**	**10.7%**	**6.4%**	**68.9%**	**18.2%**	**15.7%**	**90.6%**	**26.2%**
	2013	**20.7%**	**55.3%**	**8.6%**	**3.0%**	**72.2%**	**17.9%**	**23.5%**	**89.2%**	**22.5%**
	2031	**19.4%**	**56.0%**	**8.9%**	**3.7%**	**71.5%**	**18.0%**	**26.9%**	**86.9%**	**22.1%**
	2067	**17.9%**	**56.1%**	**9.7%**	**3.4%**	**68.4%**	**20.4%**	**22.7%**	**87.4%**	**24.2%**

1. Approximate acreage for each land class and HCP Planning Unit are present in Table 4.2-9.
2. Includes the ecosystem initiation stand development stage.
3. Includes the sapling exclusion, pole exclusion, large tree exclusion, and understory development stand development stages.
4. Includes the botanical diversity, niche diversification, and fully functional stand development stages.

OESF = Olympic Experimental State Forest

Table D-8f. Percent of Land Class Area[1/] Expected in Three Stand Development Stage Categories by HCP Planning Unit and Year for the Preferred Alternative

		Preferred Alternative								
		Land Class								
		Uplands with General Objectives			Riparian			Uplands with Specific Objectives		
HCP Planning Unit	**Year**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**	**Ecosystem Initiation[2/]**	**Competitive Exclusion[3/]**	**Structurally Complex[4/]**
COLUMBIA	2004	10.8%	72.0%	17.2%	4.8%	72.7%	22.5%	7.4%	67.3%	25.2%
	2013	35.0%	55.5%	9.6%	3.0%	75.1%	22.0%	11.0%	64.1%	24.9%
	2031	16.1%	68.5%	15.4%	2.1%	67.7%	30.3%	10.2%	58.7%	31.0%
	2067	21.6%	64.9%	13.5%	8.5%	60.4%	31.1%	10.3%	54.6%	35.1%
N. PUGET	2004	14.8%	65.8%	19.4%	5.4%	64.6%	30.0%	7.1%	62.9%	30.0%
	2013	25.6%	62.3%	12.1%	3.8%	67.1%	29.1%	7.3%	64.0%	28.7%
	2031	16.0%	66.4%	17.6%	2.2%	65.7%	32.1%	6.0%	63.0%	31.0%
	2067	15.2%	66.1%	18.6%	5.9%	56.9%	37.3%	8.4%	56.0%	35.6%
OESF	2004				5.5%	66.2%	28.3%	7.9%	66.2%	26.0%
	2013				4.3%	68.3%	27.4%	10.0%	67.8%	22.2%
	2031				3.7%	67.6%	28.7%	10.7%	64.0%	25.2%
	2067				7.9%	62.5%	29.6%	8.2%	65.1%	26.7%
S. COAST	2004	9.0%	74.0%	17.0%	4.8%	76.0%	19.2%	5.0%	73.8%	21.2%
	2013	30.2%	59.6%	10.2%	3.1%	78.3%	18.6%	8.5%	68.1%	23.5%
	2031	16.6%	69.5%	13.8%	2.3%	72.0%	25.7%	6.5%	65.2%	28.4%
	2067	16.9%	68.7%	14.4%	9.4%	58.3%	32.3%	10.2%	54.2%	35.6%
S. PUGET	2004	13.2%	65.0%	21.7%	4.8%	67.1%	28.1%	8.0%	67.8%	24.2%
	2013	23.4%	59.7%	17.0%	2.1%	70.1%	27.8%	9.4%	68.0%	22.7%
	2031	15.0%	65.6%	19.3%	1.1%	66.7%	32.2%	6.6%	62.2%	31.2%
	2067	17.1%	63.2%	19.7%	5.3%	61.2%	33.4%	10.6%	56.1%	33.3%
STRAITS	2004	16.8%	63.3%	19.9%	5.0%	66.7%	28.4%	5.4%	65.2%	29.5%
	2013	29.8%	57.4%	12.8%	3.4%	69.2%	27.4%	7.3%	62.6%	30.2%
	2031	16.4%	65.4%	18.2%	3.1%	61.4%	35.5%	4.9%	57.6%	37.5%
	2067	19.8%	62.2%	18.0%	9.3%	53.7%	37.0%	11.8%	48.0%	40.2%
Total	**2004**	**12.3%**	**58.9%**	**11.1%**	**6.0%**	**69.1%**	**18.3%**	**12.0%**	**92.8%**	**26.9%**
	2013	**29.7%**	**50.1%**	**6.8%**	**4.1%**	**71.5%**	**17.8%**	**14.8%**	**92.5%**	**25.4%**
	2031	**16.2%**	**57.5%**	**9.7%**	**3.0%**	**67.7%**	**21.1%**	**13.1%**	**87.7%**	**29.8%**
	2067	**18.0%**	**56.0%**	**9.7%**	**9.1%**	**59.5%**	**23.2%**	**15.3%**	**80.9%**	**33.3%**

1. Approximate acreage for each land class and HCP Planning Unit are present in Table 4.2-9.
2. Includes the ecosystem initiation stand development stage.
3. Includes the sapling exclusion, pole exclusion, large tree exclusion, and understory development stand development stages.
4. Includes the botanical diversity, niche diversification, and fully functional stand development stages.

OESF = Olympic Experimental State Forest

D.2 ADDITIONAL DATA FOR THREATENED, ENDANGERED, AND SENSITIVE PLANTS

Table D-9 provides detailed information on Washington threatened, endangered, and sensitive vascular plants.

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Table D-9. Washington Threatened, Endangered, and Sensitive Vascular Plants for Counties with Forested Trust Lands - 2003

Species	State Rank	Global Rank	New State Status	US ESA Status	No. of WAUs with recorded occurrences	Habitat
Habitats May Occur in Harvestable Forests						
Botrychium pedunculosum	S2S3	G2G3	S	SC		Mesic to moist meadows or forests
Chrysolepis chrysophylla	S2	G5	S		7	Dry, open to thick wooded areas
Cimicifuga elata	S3	G3	S	SC	49	Moist, shady woods, lower elevation
Claytonia lanceolata var pacifica	S1S2	G5T3	T			Foothills to alpine
Coptis aspleniifolia	S2	G4G5	S			Moist coniferous forests
Cypripedium fasciculatum	S3	G4	S	SC		Coniferous forest
Euonymus occidentalis	S1	G5	T		5	Woods
Lathyrus torreyi	S1	G5	T	SC	6	Mixed conifer forest
Pityopus californica	S1	G4G5	T			Deep coniferous forests
Platanthera obtusata	S2	G5	S			Damp to wet forests
Viola renifolia	S2	G5	S			Lowland forest to subalpine slopes
May Occur in Areas Adjacent to or within Harvestable Forests						
Agoseris elata	S3	G4	S		5	Meadows, open woods
Arenaria paludicola	SX	G1	X	LE	1	Wetlands, freshwater marshes at low elevations
Botrychium ascendens	S2S3	G2G3?	S	SC		Mid - upper elevations, ridges and meadows
Campanula lasiocarpa	S2	G5	S			Rock crevices in alpine
Carex comosa	S2	G5	S		10	Marshes, lake margins, wet meadows, other wet places
Carex densa	S1	G5	T			Eroding hummocks in marshland
Carex flava	S3	G5	S			Wet places
Carex magellanica ssp irrigua	S2S3	G5T5	S		3	Bogs, fens, wet meadows
Carex pauciflora	S2	G5	S		10	Sphagnum bogs
Carex pluriflora	S1S2	G4	S		1	Boggy lake margins, streambanks, saturated areas
Carex scirpoidea var scirpoidea	S2	G5T4T5	S			Moist meadows, rock outcrops, near and above timberline
Carex stylosa	S1S2	G5	S		10	Spagnum peat or sloping wetlands with surface seepage
Cassiope lycopodioides	S1	G4	T		2	Occurs in Alaska; here found on cliffs, cold deep ravine
Castilleja cryptantha	S2S3	G2G3	S	SC		Subalpine meadows; endemic to Mt. Ranier National Park
Castilleja levisecta	S1	G1	E	ST	13	grasslands
Cicuta bulbifera	S2	G5	S			Wet places or standing water
Cochlearia officinalis	S1S2	G5	S		3	Coastal beaches
Collinsia sparsiflora var bruceae	S1S2	G4T4	S			Open slopes and swales
Corydalis aquae-gelidae	S2S3	G3	S	SC	2	Creeks and seeps above 2,500 ft.
Crassula connata	S1S2	G5	T			Open areas
Cyperus bipartitus	S2	G5	S			Streambanks, wet low places
Delphinium leucophaeum	S1	G2Q	E			Lowland praries
Dryas drummondii	S2	G5	S			Cliff crevices, talus, rocky ridges
Erigeron aliceae	S2	G4	S		1	Meadows, openings in woods
Erigeron howellii	S2	G2	T	SC	5	Non-forested areas
Erigeron oreganus	S2	G3	T	SC		Exposed basalt
Erigeron peregrinus ssp peregrinus var	S2	G5T2	S			Bogs
Eryngium petiolatum	S1	G4	T			Areas submerged in spring, dry late summer
Erythronium revolutum	S3	G4	S		50	Along streams and edges of bogs
Filipendula occidentalis	S2S3	G2G3	T	SC	8	Riparian areas
Fritillaria camschatcensis	S2	G5	S		3	Moist to wet meadows, riparian
Gaultheria hispidula	S2	G5	S			Bogs
Gentiana douglasiana	S2S3	G4	S		4	Bogs
Githopsis specularioides	S3	G5	S		2	Dry, open areas
Hedysarum occidentale	S1	G5	S			Open areas with dry, rocky soils
Howellia aquatilis	S2S3	G3	T	LT		Shallow ponds in lowland forested areas
Hydrocotyle ranunculoides	S2	G5	S			Marshes and wet ground
Hypericum majus	S2	G5	S		3	Wet ground
Isoetes nuttallii	S1	G4?	S		1	Terrestrial in wet ground or seeps and mud near vernal pools
Lathyrus holochlorus	S1	G3	E			Forest borders and openings
Liparis loeselii	S1	G5	E			Springs, bogs, wet sunny places
Lobelia dortmanna	S2S3	G4	T		14	Shallow water at lake margins
Loiseleuria procumbens	S1	G5	T			Moist meadow
Lomatium bradshawii	S1	G2	E	LE		Moist to wet meadows
Lycopodiella inundata	S2	G5	S		1	Sphagnum bogs
Lycopodium dendroideum	S2	G5	S			Dry rocky slopes and open coniferous forests
Meconella oregana	S2	G3?	T	SC		Grasslands and savannahs
Microseris borealis	S2	G4?	S			Sphagnum bogs and wet to moist meadows
Montia diffusa	S2S3	G4	S		5	Moist woods at lower elevation

Table D-9. Washington Threatened, Endangered, and Sensitive Vascular Plants for Counties with Forested Trust Lands - 2003 (continued)

Species	State Rank	Global Rank	New State Status	US ESA Status	No. of WAUs with recorded occurrences	Habitat
Ophioglossum pusillum	S1S2	G5	T		13	Mesic to moist meadows in low to subalpine
Orthocarpus bracteosus	S1	G3?	E		8	Moist meadows
Oxalis suksdorfii	S1	G4	T		2	Moist coastal woods to dry open slopes
Parnassia fimbriata var hoodiana	S1	G4T3	T			Streambanks, bogs,wet meadows
Parnassia palustris var neogaea	S2	G4T4	S		6	Shaded areas in mountains to alpine
Platanthera chorisiana	S2	G3	T		1	Wet meadows, rocky seeps, lake shores
Platanthera sparsiflora	S1	G4G5	T			Moist to wet or boggy areas
Poa laxiflora	S1S2	G3	T		1	Moist woods to rocky slopes
Poa nervosa	S2	G3?	S			Montaine
Polemonium carneum	S1S2	G4	T		49	Thickets, woodland, forest openings
Polystichum californicum	S1S2	G4	S		1	Woods, streambanks, open rocky places
Ranunculus populago	S2	G4	S			Wet montaine areas
Ribes oxyacanthoides ssp irriguum	S2	G5T3T4	S		1	Prairie and lower mountains
Rorippa columbiae	S1S2	G3	E	SC		Moist to marshy places
Rotala ramosior	S1	G5	T			Wet places
Salix sessilifolia	S2	G4	S		4	Streambanks
Samolus parviflorus	S1	G5	S			Moist sites
Sidalcea hirtipes	S1	G2	E		11	Prairies, openings along drainages
Sidalcea malviflora ssp virgata	S1	G5T?	E			Prairie, grassland
Sidalcea nelsoniana	S1	G2	E	LT		Moist meadows
Sisyrinchium sarmentosum	S1S2	G1G2	T	SC		Meadows
Sparganium fluctuans	S1	G5	T			aquatic or marshy areas
Spiranthes porrifolia	S2	G4	S			Wet meadows, stream banks, seepage slopes
Synthyris pinnatifida var lanuginosa	S2	G4T2	T			Olympic Mountains
Trillium parviflorum	S2S3	G2G3	S		8	Moist areas dominated by hardwoods
Utricularia intermedia	S2	G5	S		1	Shallow ponds, slow-moving streams, high elevation
Woodwardia fimbriata	S2	G5	S		22	Streambanks and wet places
Habitats are in Non-Forested Areas not Likely to be Adjacent to Harvestable Forests						
Abronia umbellata	SX	G4G5T1	X	SC	9	Sandy beach
Aster borealis	S1	G5	T			Prairie
Aster curtus	S3	G3	S	SC	4	Lowland praries
Aster sibiricus var meritus	S1S2	G5T5	S			Unstable, rocky or gravelly substrate
Astragalus australis var olympicus	S2	G5T2	T	SC		Talus slopes, ridges, and knolls of calcareous substrates
Astragalus microcystis	S2	G5	S			Dry, gravelly soils in alpine; Olympic Mnts
Bolandra oregana	S2	G3	S		6	Moist, shady cliffs, rock outcrops
Carex anthoxanthea	S1	G5	S			Subalpine at seepage sites
Carex circinata	S1	G4	S			rock outcrops at high elevations
Carex macrochaeta	S1	G5	T			Seepage areas and around waterfalls
Carex obtusata	S2	G5	S			Grassy places to high mountains
Chaenactis thompsonii	S2S3	G2G3	S			Serpentine slopes; subalpine slopes
Draba aurea	S2	G5	S			Alpine,sunny rock crevasses
Draba cana	S1S2	G5	S			Subalpine to alpine, rock crevices
Draba longipes	S1	G4	T			Rocky, alpine slopes
Dodecatheon austrofrigidum	S1	G2	E			S. Olympics
Gentiana glauca	S2S3	G4G5	S			Dry to moist alpine meadows
Hackelia cinerea	S1	G4?	S			Cliffs, talus slopes
Hackelia diffusa var diffusa	S2	G4T3	T			Cliffs, talus slopes
Lepidium oxycarpum	S1	G4	T		2	fields, vernal pools, alkaline flats
Lupinus sulphureus var kincaidii	S1	G5T2	E	SL		Lowland praries
Luzula arcuata	S1	G5	S			Rocky or gravelly soil; above timberline or moraines
Nymphaea tetragona	SH	G5	X		3	Water
Oxytropis borealis var viscida	S1S2	G5T4?	S			Mid to high elevation, meadows to alpine
Pedicularis rainierensis	S2S3	G2G3	S			Mt Rainier area
Pellaea breweri	S2	G5	S			Rocky places, crevaces or talus
Penstemon barrettiae	S2	G2	T	SC		Exposed basalt
Plantago macrocarpa	S2	G4	S		5	Cold, wet places; subcoastal
Poa unilateralis	S2	G3	T			Coastal grassy bluffs
Potamogeton obtusifolius	S2	G5	S			Aquatic, submerged
Puccinellia nutkaensis	S2	G4?	S		33	Sea coast
Ranunculus californicus	S1	G5	T			Grassy, coastal bluffs
Ranunculus cooleyae	S1S2	G4	S		2	Damp rocky slopes and rock crevices
Sanguisorba menziesii	S1	G3G4	S			Coastal bogs and marshes

Table D-9. Washington Threatened, Endangered, and Sensitive Vascular Plants for Counties with Forested Trust Lands - 2003 (continued)

Species	State Rank	Global Rank	New State Status	US ESA Status	No. of WAUs with recorded occurrences	Habitat
Sanicula arctopoides	S1	G5	E		1	Coastal bluffs
Saxifraga rivularis	S3	G5?	S			Moist crevices, shady rocky areas
Sullivantia oregana	S1	G2	E	SC	2	Exposed rock

State Rank characterizes the relative rarity or endangerment within the state of Washington. Two codes (e.g. S1 and S2) represents an intermediate rank. S1 = Critically imperiled (5 or fewer occurrences); S2 = Vulnerable to extirpation (6 to 20 occurrences); S3 = Rare or uncommon (21 to 100 occurrences); S4 = Apparently secure, with many occurrences; S5 = Demonstrably secure in state; S H = Historical occurrences only but still expected to occur; SX = Apparently extirpated from the state.

Global Rank characterizes the relative rarity or endangerment of the element world-wide. Two codes (e.g. G1 and G2) represent an intermediate rank. G1 = Critically imperiled globally (5 or fewer occurrences); G2 = Imperiled globally (6 to 20 occurrences); G3 = Either very rare and local throughout its range or found locally in a restricted range (21 to 100 occurrences); G4 = Apparently secure globally; G5 = Demonstrably secure globally; GH = Of historical occurrence throughout its range; GU = Possibly in peril range-wide but status uncertain; GX = Believed to be extinct throughout former range; G? = Not ranked to date; Tn = Rarity of an infraspecific taxon. Numbers similar to those for Gn ranks above; Q = Questionable.

State Status of the species is determined by the Washington Department of Fish and Wildlife. Factors considered include abundance, occurrence patterns, vulnerability, threats, existing protection, and taxonomic distinctness. Values include: E = Endangered. In danger of becoming extinct or extirpated from Washington; T = Threatened. Likely to become Endangered in Washington; S = Sensitive. Vulnerable or declining and could become Endangered or Threatened in the state.

US ESA Status under the U.S. Endangered Species Act as published in the Federal Register: LE = Listed Endangered. In danger of extinction; LT = Listed Threatened. Likely to become endangered; PE = Proposed Endangered; PT = Proposed Threatened; C = Candidate species. Sufficient information exists to support listing as Endangered or Threatened; SC = Species of Concern. An unofficial status, the species appears to be in jeopardy, but insufficient information to support listing; NL = Not Listed.

Sources: Rankings from WNHP TES Database 2003. Habitats from Hitchcock 1976, WDNR 1999, Sensitive Plants and Noxious Weeds of the Nt. Baker-Snoqualmie National Forest, HCP EIS 1996, University of California and Jepson Herbaria 2003, Pacific Biodiversity Institute 2003, Wisconsin State Herbarium 2003,

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D.3 ADDITIONAL ANALYSES FOR THE RIPARIAN AREAS SECTION

Tables D-10a through D-10f present detailed riparian data by Alternative.

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Table D-10a. Percentage Distribution of Stand Development Stages in Riparian Areas under Alternative 1, by HCP Planning Unit and Year

HCP Planning Unit (Riparian Acres)	Year	Percent of Riparian Areas - Alternative 1							
		Ecosystem Initiation	Sapling Exclusion	Pole Exclusion	Large Tree Exclusion	Understory Development	Botanically Diverse	Niche Diversification	Fully Functioning
COLUMBIA	2004	4.7%	12.4%	22.3%	26.6%	11.5%	21.6%	0.1%	0.9%
(86,443 acres)	2013	1.1%	8.4%	23.9%	29.5%	14.6%	21.4%	0.2%	0.8%
	2031	1.0%	1.1%	20.0%	28.9%	26.6%	21.4%	0.3%	0.9%
	2067	1.8%	0.5%	7.7%	18.7%	45.7%	23.0%	1.7%	0.9%
N. PUGET	2004	5.4%	14.6%	16.4%	15.5%	18.1%	27.9%	0.2%	1.8%
(92,724 acres)	2013	1.7%	9.3%	20.6%	17.0%	21.6%	27.7%	0.2%	1.9%
	2031	1.2%	2.3%	19.8%	16.6%	30.0%	27.5%	0.4%	2.2%
	2067	1.5%	0.6%	7.2%	8.8%	46.7%	28.5%	1.9%	4.9%
OESF	2004	5.3%	25.0%	29.6%	5.5%	6.3%	26.3%	0.7%	1.3%
(111,308 acres)	2013	0.6%	12.9%	36.7%	11.5%	9.7%	26.2%	0.7%	1.9%
	2031	0.9%	1.6%	30.8%	16.7%	20.6%	24.7%	2.5%	2.2%
	2067	1.6%	0.8%	12.1%	7.7%	46.4%	14.8%	7.1%	9.5%
S. COAST	2004	4.8%	13.7%	16.4%	26.8%	19.1%	19.1%	0.0%	0.1%
(80,966 acres)	2013	1.1%	6.0%	22.5%	26.8%	24.6%	19.0%	0.0%	0.1%
	2031	1.0%	0.7%	18.0%	26.7%	34.1%	19.3%	0.1%	0.1%
	2067	1.5%	0.6%	3.9%	19.2%	47.5%	25.1%	2.2%	0.1%
S. PUGET (34,606	2004	5.1%	14.7%	22.2%	14.3%	15.5%	28.1%	0.1%	0.0%
acres)	2013	1.0%	11.8%	25.8%	16.3%	17.1%	27.8%	0.1%	0.0%
	2031	0.8%	1.6%	25.8%	17.8%	25.7%	27.7%	0.5%	0.0%
	2067	1.3%	0.4%	8.4%	8.4%	50.8%	28.9%	1.6%	0.2%
STRAITS	2004	4.9%	13.6%	18.3%	14.0%	20.7%	28.3%	0.1%	0.0%
(20,684 acres)	2013	1.0%	10.6%	22.1%	14.9%	23.2%	28.1%	0.1%	0.0%
	2031	1.0%	1.2%	22.3%	14.5%	32.4%	28.2%	0.2%	0.0%
	2067	1.3%	0.3%	6.5%	2.9%	58.3%	29.6%	1.0%	0.1%
Total (426,731	2004	5.0%	16.6%	21.6%	17.1%	13.8%	24.6%	0.3%	0.9%
acres)	2013	1.1%	9.7%	26.3%	19.8%	17.4%	24.4%	0.3%	1.1%
	2031	1.0%	1.4%	23.0%	21.0%	27.4%	24.0%	0.9%	1.3%
	2067	1.6%	0.6%	8.0%	12.1%	47.5%	23.2%	3.2%	3.8%

OESF = Olympic Experimental State Forest

Table D-10b. Percentage Distribution of Stand Development Stages in Riparian Areas under Alternative 2, by HCP Planning Unit and Year

HCP Planning Unit (Riparian Acres)	Year	Percent of Riparian Areas - Alternative 2							
		Ecosystem Initiation	Sapling Exclusion	Pole Exclusion	Large Tree Exclusion	Understory Development	Botanically Diverse	Niche Diversification	Fully Functioning
COLUMBIA	2004	4.8%	12.6%	22.2%	26.4%	11.5%	21.4%	0.2%	0.9%
(86,443 acres)	2013	2.1%	8.4%	23.7%	29.0%	14.7%	21.1%	0.2%	0.8%
	2031	2.2%	1.7%	20.2%	27.7%	26.0%	21.1%	0.3%	0.9%
	2067	3.1%	1.8%	11.3%	17.3%	41.4%	22.5%	1.6%	1.0%
N. PUGET	2004	5.3%	14.7%	16.4%	15.5%	18.2%	27.9%	0.2%	1.8%
(92,724 acres)	2013	2.4%	9.3%	20.5%	16.8%	21.5%	27.4%	0.2%	1.9%
	2031	2.0%	2.8%	19.9%	16.1%	29.3%	27.2%	0.4%	2.2%
	2067	2.4%	1.4%	10.1%	8.3%	42.6%	28.6%	1.8%	4.7%
OESF	2004	5.2%	25.0%	29.6%	5.4%	6.4%	26.3%	0.7%	1.3%
(111,308 acres)	2013	1.3%	12.9%	37.0%	11.4%	9.1%	25.9%	0.7%	1.9%
	2031	2.9%	1.9%	31.9%	17.1%	17.5%	24.1%	2.5%	2.2%
	2067	5.6%	1.4%	17.7%	6.8%	37.4%	14.6%	6.9%	9.5%
S. COAST	2004	4.8%	13.8%	16.4%	26.7%	19.2%	19.1%	0.0%	0.1%
(80,966 acres)	2013	2.2%	6.0%	22.5%	26.4%	24.3%	18.6%	0.0%	0.1%
	2031	1.9%	1.5%	18.7%	25.4%	33.2%	19.0%	0.1%	0.1%
	2067	3.3%	1.4%	7.8%	17.3%	44.4%	23.8%	1.9%	0.1%
S. PUGET	2004	4.9%	15.2%	22.2%	14.2%	15.5%	27.9%	0.1%	0.0%
(34,606 acres)	2013	1.8%	11.8%	25.7%	16.3%	16.8%	27.5%	0.1%	0.0%
	2031	2.2%	2.0%	26.0%	17.2%	25.0%	27.1%	0.4%	0.0%
	2067	2.0%	1.5%	12.7%	7.3%	46.1%	28.8%	1.4%	0.2%
STRAITS	2004	4.9%	14.1%	18.1%	13.9%	20.8%	28.2%	0.1%	0.0%
(20,684 acres)	2013	2.3%	10.6%	21.8%	14.6%	22.9%	27.6%	0.1%	0.0%
	2031	2.2%	2.3%	22.7%	13.6%	31.0%	28.0%	0.2%	0.0%
	2067	2.7%	1.5%	11.7%	2.4%	51.5%	29.1%	1.0%	0.1%
Total (426,731	2004	5.0%	16.8%	21.6%	17.0%	13.9%	24.5%	0.3%	0.9%
acres)	2013	1.9%	9.7%	26.3%	19.5%	17.1%	24.1%	0.3%	1.1%
	2031	2.3%	2.0%	23.5%	20.4%	26.0%	23.6%	0.8%	1.3%
	2067	3.5%	1.5%	12.2%	11.1%	42.0%	22.9%	3.0%	3.8%

OESF = Olympic Experimental State Forest

Table D-10c. Percentage Distribution of Stand Development Stages in Riparian Areas under Alternative 3, by HCP Planning Unit and Year

HCP Planning Unit (Riparian Acres)	Year	Percent of Riparian Areas - Alternative 3							
		Ecosystem Initiation	Sapling Exclusion	Pole Exclusion	Large Tree Exclusion	Understory Development	Botanically Diverse	Niche Diversification	Fully Functioning
COLUMBIA	2004	4.8%	12.6%	22.2%	26.5%	11.5%	21.4%	0.2%	0.9%
(86,443 acres)	2013	2.6%	8.4%	23.7%	28.9%	14.3%	21.0%	0.2%	0.8%
	2031	2.6%	1.9%	20.9%	27.3%	25.2%	21.1%	0.2%	0.8%
	2067	3.7%	1.8%	12.1%	17.5%	40.1%	22.6%	1.4%	0.8%
N. PUGET	2004	5.4%	14.7%	16.4%	15.5%	18.1%	27.9%	0.2%	1.8%
(92,724 acres)	2013	1.9%	9.3%	20.6%	17.0%	21.5%	27.6%	0.2%	1.9%
	2031	3.3%	2.7%	20.0%	16.1%	28.5%	26.8%	0.4%	2.2%
	2067	2.9%	1.9%	10.9%	8.8%	41.0%	28.1%	1.7%	4.7%
OESF	2004	5.2%	25.0%	29.6%	5.4%	6.4%	26.3%	0.7%	1.3%
(111,308 acres)	2013	0.6%	12.9%	36.6%	11.4%	9.8%	26.2%	0.7%	1.9%
	2031	2.1%	1.5%	30.7%	16.4%	20.3%	24.3%	2.5%	2.2%
	2067	3.2%	3.5%	14.9%	7.2%	40.3%	14.7%	6.8%	9.4%
S. COAST	2004	4.7%	13.8%	16.4%	26.7%	19.2%	19.1%	0.0%	0.1%
(80,966 acres)	2013	2.9%	6.0%	22.5%	26.2%	23.7%	18.5%	0.0%	0.1%
	2031	2.3%	1.9%	18.9%	25.9%	31.9%	19.0%	0.1%	0.1%
	2067	4.7%	1.4%	9.2%	18.4%	41.2%	23.3%	1.7%	0.1%
S. PUGET	2004	4.9%	15.2%	22.2%	14.2%	15.5%	27.9%	0.1%	0.0%
(34,606 acres)	2013	2.5%	11.7%	25.7%	16.1%	16.7%	27.2%	0.1%	0.0%
	2031	2.3%	2.2%	26.2%	17.2%	24.6%	27.1%	0.4%	0.0%
	2067	2.1%	1.5%	12.8%	8.2%	45.1%	28.7%	1.4%	0.2%
STRAITS	2004	4.9%	14.1%	18.1%	13.9%	20.8%	28.2%	0.1%	0.0%
(20,684 acres)	2013	3.2%	10.6%	21.8%	14.5%	22.5%	27.3%	0.1%	0.0%
	2031	4.1%	2.3%	23.0%	13.5%	29.8%	27.1%	0.2%	0.0%
	2067	3.1%	2.7%	12.4%	3.5%	48.6%	29.0%	0.5%	0.1%
Total (426,731	2004	5.0%	16.8%	21.6%	17.0%	13.8%	24.5%	0.3%	0.9%
acres)	2013	2.0%	9.7%	26.2%	19.5%	17.1%	24.1%	0.3%	1.1%
	2031	2.6%	2.0%	23.4%	20.3%	26.1%	23.6%	0.8%	1.2%
	2067	3.4%	2.2%	12.1%	11.7%	41.4%	22.7%	2.9%	3.7%

OESF = Olympic Experimental State Forest

Table D-10d. Percentage Distribution of Stand Development Stages in Riparian Areas under Alternative 4, by HCP Planning Unit and Year

HCP Planning Unit (Riparian Acres)	Year	Percent of Riparian Areas - Alternative 4							
		Ecosystem Initiation	Sapling Exclusion	Pole Exclusion	Large Tree Exclusion	Understory Development	Botanically Diverse	Niche Diversification	Fully Functioning
COLUMBIA	2004	4.5%	12.6%	22.3%	26.7%	11.4%	21.5%	0.2%	0.9%
(86,443 acres)	2013	1.0%	8.6%	23.8%	29.8%	14.4%	21.3%	0.2%	0.9%
	2031	0.9%	1.0%	20.6%	29.1%	25.8%	21.4%	0.3%	1.0%
	2067	1.4%	0.2%	8.5%	21.0%	43.1%	23.0%	1.6%	1.1%
N. PUGET	2004	5.2%	14.7%	16.5%	15.5%	18.1%	28.0%	0.2%	1.8%
(92,724 acres)	2013	1.5%	9.3%	20.7%	17.3%	21.3%	27.7%	0.2%	1.9%
	2031	1.1%	2.2%	20.2%	17.2%	29.1%	27.5%	0.4%	2.2%
	2067	1.2%	0.2%	7.7%	10.7%	44.7%	29.0%	1.7%	4.9%
OESF	2004	5.2%	25.0%	29.6%	5.4%	6.4%	26.3%	0.7%	1.3%
(111,308 acres)	2013	0.5%	12.8%	36.7%	11.5%	9.8%	26.2%	0.7%	1.9%
	2031	0.5%	1.6%	30.8%	16.8%	20.9%	24.7%	2.5%	2.2%
	2067	0.4%	0.3%	10.9%	7.9%	48.8%	15.0%	7.0%	9.5%
S. COAST	2004	4.7%	13.8%	16.4%	26.8%	19.2%	19.1%	0.0%	0.1%
(80,966 acres)	2013	1.0%	6.2%	22.4%	27.4%	24.0%	18.9%	0.0%	0.1%
	2031	1.4%	0.9%	18.7%	26.9%	32.7%	19.2%	0.1%	0.1%
	2067	1.8%	0.2%	4.1%	22.9%	43.9%	25.3%	1.6%	0.1%
S. PUGET	2004	4.4%	15.2%	22.3%	14.4%	15.6%	28.1%	0.1%	0.0%
(34,606 acres)	2013	0.6%	12.0%	25.8%	16.8%	16.7%	28.0%	0.1%	0.0%
	2031	0.7%	1.5%	26.0%	18.2%	25.5%	27.7%	0.5%	0.0%
	2067	1.0%	0.2%	10.6%	9.3%	48.0%	29.1%	1.6%	0.2%
STRAITS	2004	4.5%	14.1%	18.3%	14.0%	20.7%	28.3%	0.1%	0.0%
(20,684 acres)	2013	1.1%	10.5%	22.5%	15.3%	22.3%	28.1%	0.1%	0.0%
	2031	1.3%	1.3%	23.0%	15.0%	31.0%	28.2%	0.2%	0.0%
	2067	1.3%	0.2%	8.9%	3.8%	55.4%	29.6%	0.8%	0.1%
Total (426,731	2004	4.9%	16.8%	21.6%	17.1%	13.8%	24.6%	0.3%	0.9%
acres)	2013	1.0%	9.8%	26.3%	20.1%	17.1%	24.4%	0.3%	1.1%
	2031	0.9%	1.4%	23.4%	21.3%	26.8%	24.0%	0.9%	1.3%
	2067	1.1%	0.3%	8.3%	13.9%	46.1%	23.5%	3.0%	3.8%

OESF = Olympic Experimental State Forest

Table D-10e. Percentage Distribution of Stand Development Stages in Riparian Areas under Alternative 5, by HCP Planning Unit and Year

HCP Planning Unit (Riparian Acres)	Year	Percent of Riparian Areas - Alternative 5							
		Ecosystem Initiation	Sapling Exclusion	Pole Exclusion	Large Tree Exclusion	Understory Development	Botanically Diverse	Niche Diversification	Fully Functioning
COLUMBIA	2004	5.3%	13.1%	20.9%	26.6%	11.6%	21.4%	0.1%	0.8%
(86,443 acres)	2013	2.9%	9.1%	23.2%	28.6%	14.3%	20.9%	0.2%	0.8%
	2031	3.3%	1.9%	19.3%	27.6%	25.9%	21.0%	0.2%	0.8%
	2067	3.1%	2.0%	11.7%	15.7%	42.8%	22.4%	1.3%	0.9%
N. PUGET	2004	5.6%	14.4%	15.9%	15.6%	18.8%	28.4%	0.2%	1.2%
(92,724 acres)	2013	2.5%	8.7%	20.4%	16.8%	22.2%	27.7%	0.2%	1.5%
	2031	3.3%	2.7%	18.0%	16.2%	30.4%	27.1%	0.4%	1.9%
	2067	2.3%	1.7%	9.9%	7.5%	43.9%	30.8%	1.4%	2.4%
OESF	2004	5.5%	23.5%	30.1%	5.8%	6.9%	26.6%	0.7%	0.9%
(111,308 acres)	2013	2.2%	12.7%	34.9%	12.0%	10.3%	25.8%	0.7%	1.3%
	2031	2.8%	2.4%	29.8%	17.1%	19.9%	24.0%	2.1%	1.8%
	2067	2.9%	1.4%	18.0%	8.3%	40.8%	20.9%	4.7%	3.2%
S. COAST	2004	5.6%	13.2%	16.0%	27.1%	19.1%	18.9%	0.0%	0.1%
(80,966 acres)	2013	2.8%	6.0%	21.9%	26.8%	23.8%	18.6%	0.0%	0.1%
	2031	3.5%	1.3%	15.9%	26.9%	33.5%	18.8%	0.0%	0.1%
	2067	3.1%	1.6%	8.0%	14.8%	46.6%	24.1%	1.6%	0.1%
S. PUGET	2004	5.1%	14.7%	22.4%	14.4%	15.5%	27.9%	0.1%	0.0%
(34,606 acres)	2013	2.5%	10.2%	27.1%	16.2%	16.6%	27.3%	0.1%	0.0%
	2031	2.8%	2.1%	23.0%	17.8%	26.8%	27.1%	0.3%	0.0%
	2067	2.7%	1.5%	10.4%	7.8%	47.7%	28.4%	1.3%	0.2%
STRAITS	2004	5.1%	12.1%	19.9%	14.4%	20.3%	28.1%	0.1%	0.0%
(20,684 acres)	2013	3.2%	9.5%	23.2%	15.0%	21.7%	27.4%	0.1%	0.0%
	2031	2.9%	2.5%	21.4%	13.7%	31.7%	27.7%	0.2%	0.0%
	2067	4.0%	1.2%	8.9%	4.2%	52.3%	28.7%	0.7%	0.1%
Total (426,731	2004	5.5%	16.2%	21.3%	17.3%	14.1%	24.7%	0.3%	0.7%
acres)	2013	2.6%	9.5%	25.7%	19.7%	17.3%	24.1%	0.3%	0.8%
	2031	3.2%	2.1%	21.5%	20.8%	27.1%	23.5%	0.7%	1.1%
	2067	2.9%	1.6%	12.0%	10.6%	44.1%	24.9%	2.2%	1.6%

OESF = Olympic Experimental State Forest

Table D-10f. Percentage Distribution of Stand Development Stages in Riparian Areas under the Preferred Alternative, by HCP Planning Unit and Year

HCP Planning Unit (Riparian Acres)	Year	Percent of Riparian Areas - Preferred Alternative							
		Ecosystem Initiation	Sapling Exclusion	Pole Exclusion	Large Tree Exclusion	Understory Development	Botanically Diverse	Niche Diversification	Fully Functioning
COLUMBIA	2004	4.8%	12.4%	21.3%	26.6%	12.4%	21.5%	0.1%	0.9%
(86,443 acres)	2013	3.0%	8.6%	22.7%	28.1%	15.6%	20.8%	0.3%	0.9%
	2031	2.1%	3.0%	19.6%	23.0%	22.1%	18.9%	10.4%	0.9%
	2067	8.5%	1.7%	11.0%	15.3%	32.3%	17.1%	6.1%	7.9%
N. PUGET	2004	5.4%	14.2%	15.4%	14.8%	20.2%	28.6%	0.2%	1.3%
(92,724 acres)	2013	3.8%	9.3%	19.4%	15.2%	23.3%	27.3%	0.2%	1.5%
	2031	2.2%	4.6%	19.7%	12.9%	28.5%	25.6%	4.6%	1.9%
	2067	5.9%	1.2%	10.9%	7.6%	37.1%	26.3%	5.1%	5.9%
OESF	2004	5.5%	24.1%	29.4%	5.4%	7.2%	26.7%	0.7%	0.9%
(111,308 acres)	2013	4.3%	13.1%	34.5%	10.4%	10.2%	25.4%	0.6%	1.3%
	2031	3.7%	3.2%	30.6%	14.0%	19.9%	23.8%	2.9%	2.0%
	2067	7.9%	4.8%	16.7%	7.9%	33.0%	16.5%	6.4%	6.6%
S. COAST	2004	4.8%	13.4%	15.3%	26.0%	21.3%	19.1%	0.0%	0.1%
(80,966 acres)	2013	3.1%	6.3%	21.5%	23.4%	27.0%	18.4%	0.1%	0.1%
	2031	2.3%	4.3%	18.4%	18.6%	30.7%	17.2%	8.4%	0.1%
	2067	9.4%	1.0%	11.0%	15.5%	30.8%	16.1%	10.5%	5.8%
S. PUGET	2004	4.8%	14.7%	21.9%	14.2%	16.3%	28.1%	0.1%	0.0%
(34,606 acres)	2013	2.1%	11.7%	25.2%	14.9%	18.4%	27.6%	0.2%	0.0%
	2031	1.1%	2.8%	22.5%	14.6%	26.8%	25.4%	6.7%	0.0%
	2067	5.3%	1.2%	10.3%	6.1%	43.6%	24.2%	4.7%	4.5%
STRAITS	2004	5.0%	12.9%	18.9%	13.5%	21.4%	28.3%	0.1%	0.0%
(20,684 acres)	2013	3.4%	10.5%	21.2%	12.5%	24.9%	27.3%	0.1%	0.0%
	2031	3.1%	4.1%	22.0%	8.4%	26.9%	22.1%	13.4%	0.0%
	2067	9.3%	1.3%	11.3%	1.4%	39.6%	20.2%	7.1%	9.7%
Total (426,731	2004	5.1%	16.2%	20.9%	16.8%	15.2%	24.8%	0.3%	0.7%
acres)	2013	3.5%	9.8%	25.0%	18.0%	18.7%	23.8%	0.3%	0.9%
	2031	2.5%	3.7%	22.6%	16.2%	25.1%	22.0%	6.6%	1.1%
	2067	7.7%	2.2%	12.4%	10.3%	34.5%	19.5%	6.7%	6.5%

OESF = Olympic Experimental State Forest

D.4 ADDITIONAL ANALYSES FOR THE WILDLIFE SECTION

Tables D-11 through D-17 support discussions of effects to wildlife species and habitats.

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Table D-11. Status, Habitat Associations, and Distribution of Threatened, Endangered, and Sensitive Wildlife Species that May Occur on Western Washington Forested State Trust Lands

Species	Status[1/]	Habitat Association and Distribution [2/]
Mardon Skipper *Polites mardon*	SE FC	Open grasslands on glacial outwash prairies in the Puget lowlands; may occur in the South Puget and South Coast HCP Planning Units.
Oregon Silverspot Butterfly *Speyeria zerene hippolyta*	SE FT	Coastal grasslands with *Viola adunca* on the Long Beach peninsula.
Larch Mountain Salamander *Plethodon larselli*	SS FCo	Talus with organic debris, structurally complex forest; may occur in the North Puget, South Puget, and Columbia HCP Planning Units (Crisafulli 1999).
Oregon Spotted Frog *Rana pretiosa*	SE FC	Marshy ponds, streams, and lakes; three extant populations in the South Puget and Columbia HCP Planning Units (McAllister and Leonard 1997).
Northwestern Pond Turtle *Clemmys marmorata*	SE FCo	Marshes, sloughs, ponds, and nearby uplands; may occur in North Puget, South Puget, Columbia, and South Coast HCP Planning Units.
Common Loon *Gavia immer*	SS	Large wooded lakes with abundant fish; may occur in the North Puget, South Puget, South Coast, OESF, or Straits HCP Planning Units.
Aleutian Canada Goose *Branta canadensis leucopareia*	ST	Migrant or winter resident in lakes, ponds, wetlands, grasslands, or agricultural fields in southwest Washington or Puget lowlands.
Bald Eagle *Haliaeetus leucocephalus*	ST FT	Riparian and coastal areas, mature and old-growth forest within 1 mile of water; found in all HCP Planning Units.
Peregrine Falcon *Falco peregrinus*	SS FCo	Cliffs provide breeding habitat; foraging habitat includes wetlands and open habitats; found in all HCP Planning Units.
Sandhill Crane *Grus canadensis*	SE	Nests in extensive shallow marshes with dense emergent plant cover, forages in wet meadows and grasslands; may occur in the Columbia HCP Planning Unit.
Marbled Murrelet *Brachyramphus marmoratus*	ST FT	Structurally complex and old-growth forests; found in all HCP Planning Units, mostly within 40 miles of marine waters, maximum 52 miles inland.
Northern Spotted Owl *Strix occidentalis caurina*	SE FT	Structurally complex and old-growth forests; found in all HCP Planning Units.
Western Gray Squirrel *Sciurus griseus*	ST FCo	Closed-canopy white-oak/Douglas-fir or oak/ponderosa pine forest; may occur in the South Puget and Columbia HCP Planning Units.
Gray Wolf *Canis lupus*	SE FT	Areas with an ungulate prey base and low levels of human activity; may occur in North Puget, South Puget, and Columbia HCP Planning Units.
Grizzly Bear *Ursus arctos*	SE FT	Areas with low levels of human activity; may occur in North Puget and South Puget HCP Planning Units.
Pacific Fisher *Martes pennanti*	SE FCo	Structurally complex forest, especially at low to moderate elevations; may occur in all HCP Planning Units, although extensive surveys have resulted in no detections (Lewis and Stinson 1998).
Canada Lynx *Lynx canadensis*	ST FT	Subalpine fir vegetation and interspersed patches of other forest types, generally above 4,000 feet elevation (Ruediger et al. 2000); may occur in North Puget, South Puget, and Columbia HCP Planning Units.
Columbian White-Tailed Deer *Odocoileus virginianus leucurus*	SE FE	Bottomland riparian forests, grassland, and agricultural lands along an 18-mile stretch of the Columbia River.

1/ SE = State Endangered; ST = State Threatened; SS = State Sensitive; FE = Federal Endangered; FT = Federal Threatened; FCo = Federal Species of Concern

2/ Unless otherwise indicated, all distribution and habitat association information is drawn from the HCP.

HCP = Habitat Conservation Plan, OESF = Oregon Experimental State Forest

Table D-12. Estimated Proportion of Western Washington Forested State Trust Lands in Different Forest Habitat Types under Each Alternative

Forest Type	Alternative	2004[1/]	2013	2031	2067
Ecosystem Initiation	1	8%	7%	6%	9%
	2	8%	9%	8%	10%
	3	7%	11%	10%	11%
	4	7%	5%	8%	8%
	5	10%	12%	13%	11%
	PA	8%	13%	8%	11%
Competitive Exclusion	1	68%	70%	70%	65%
	2	68%	69%	69%	64%
	3	68%	67%	67%	64%
	4	68%	71%	69%	65%
	5	66%	67%	66%	65%
	PA	68%	66%	65%	60%
Structurally Complex	1	25%	23%	24%	27%
	2	24%	22%	23%	26%
	3	24%	22%	22%	25%
	4	25%	23%	23%	27%
	5	24%	21%	21%	23%
	PA	24%	22%	26%	29%

Source: DNR Alternative modeling output data
1/ Model runs used to estimate the future availability of different forest structure classes under the Alternatives were started in 2001 to "clean" the inventory of sales sold between 2001 and 2003. In addition, the models for Alternative 5 and the Preferred Alternative used a different method than the other Alternatives for calculating yield (which was used as the basis for determining forest structure classes). The models for Alternative 5 and the Preferred Alternative used value-based yield tables, whereas those for Alternatives 1 through 4 were volume-based. These two factors account for the differences in Year 2004 values among the Alternatives. Notwithstanding the dissimilar starting points, the differences among the general trends in the rates at which the amount of the forest structure classes change provides a basis for comparing the effects of the Alternatives.
PA = Preferred Alternative

Table D-13. Estimate of Percent Change from the Current Amount of Spotted Owl Dispersal Habitat under Each Alternative

Alternative	2013	2031	2067
1	– 6	– 3	+ 9
2	– 10	– 6	+ 8
3	– 11	– 8	+ 3
4	– 5	– 6	+ 10
5	– 11	– 11	– 1
PA	– 11	+ 8	+ 18

Source: DNR Alternative modeling output data
Note: The current amount of dispersal habitat does not refer to designated dispersal habitat, but rather uses the structurally complex forest structure as surrogate.
PA = Preferred Alternative

Table D-14. Estimated Proportion of Western Washington Forested State Trust Lands Comprising Structurally Complex Forest Relative to Total Forested Trust Lands under Each Alternative over Time

Alternative	Acres of Structurally Complex Forest				Percentage			
	2004 1/	2013	2031	2067	2004 1/	2013	2031	2067
1	340,841	319,127	329,133	371,003	25%	23%	24%	27%
2	339,728	307,371	321,042	366,358	24%	22%	23%	26%
3	339,667	300,674	311,273	348,670	24%	22%	22%	25%
4	342,026	326,583	321,895	377,794	25%	23%	23%	27%
5	331,215	294,211	294,619	326,788	24%	21%	21%	23%
PA	338,212	300,819	365,015	398,464	24%	22%	26%	29%

Source: DNR Alternative modeling output data

1/ Model runs used to estimate the future availability of different forest structure classes under the Alternatives were started in 2001 to "clean" the inventory of sales sold between 2001 and 2003. In addition, the models for Alternatives 5 and the Preferred Alternative used a different method than the other Alternatives for calculating yield (which was used as the basis for determining forest structure classes). The models for Alternative 5 and the Preferred Alternative used value-based yield tables, whereas those for Alternatives 1 through 4 were volume-based. These two factors account for the differences in Year 2004 values among the Alternatives. Notwithstanding the dissimilar starting points, the differences among the general trends in the rates at which the amount of the forest structure classes change provides a basis for comparing the effects of the Alternatives.

Table D-15. Estimated Proportion of Low-Elevation[1/] Western Washington Forested State Trust Lands Comprising Structurally Complex Forest Relative to Total Forested Trust Lands under Each Alternative over Time

Alternative	Low-Elevation			
	2004[2/]	2013	2031	2067
1	19%	18%	18%	21%
2	19%	17%	18%	21%
3	19%	16%	17%	20%
4	19%	18%	18%	21%
5	19%	16%	17%	19%
PA	19%	17%	21%	23%

Source: DNR Alternative modeling output data

1/ Defined as lands in the western hemlock or Sitka spruce vegetation zones. Note that, in contrast with how this table was calculated in the Draft Environmental Impact Statement, this information was not compiled by selecting Watershed Administrative Units (WAUs) that met certain criteria, but by applying the vegetation zone cover without regard for where it fell within a WAU.

2/ Model runs used to estimate the future availability of different forest structure classes under the Alternatives were started in 2001 to “clean” the inventory of sales sold between 2001 and 2003. In addition, the models for Alternative 5 and the Preferred Alternative used a different method than the other Alternatives for calculating yield (which was used as the basis for determining forest structure classes). The models for Alternative 5 and the Preferred Alternative used value-based yield tables, whereas those for Alternatives 1 through 4 were volume-based. These two factors account for the differences in Year 2004 values among the Alternatives. Notwithstanding the dissimilar starting points, the differences among the general trends in the rates at which the amount of the forest structure classes change provide a basis for comparing the effects of the Alternatives.

PA = Preferred Alternative

Table D-16. Estimated Proportion of Structurally Complex Forest within 40 Miles of Marine Waters Relative to all Western Washington Forested State Trust Lands under Each Alternative over Time

	Percent of Structurally Complex Forest Within 40 miles of Marine Waters			
Alternative	**2004** [1/]	**2013**	**2031**	**2067**
1	21%	19%	20%	23%
2	21%	19%	19%	22%
3	21%	18%	19%	21%
4	21%	20%	19%	23%
5	20%	18%	18%	20%
PA	21%	18%	22%	24%

Source: DNR Alternative modeling output data

1/ Model runs used to estimate the future availability of different forest structure classes under the Alternatives were started in 2001 to "clean" the inventory of sales sold between 2001 and 2003. In addition, the models for Alternative 5 and the Preferred Alternative used a different method than the other Alternatives for calculating yield (which was used as the basis for determining forest structure classes). The models for Alternative 5 and the Preferred Alternative used value-based yield tables, whereas those for Alternatives 1 through 4 were volume-based. These two factors account for the differences in Year 2004 values among the Alternatives. Notwithstanding the dissimilar starting points, the differences among the general trends in the rates at which the amount of the forest structure classes change provide a basis for comparing the effects of the Alternatives.

Table D-17 Average Proportion of Western Washington Forested State Trust Lands Harvested by Decade Within 10 Watersheds Identified as Containing Suitable Canada Lynx Habitat[1/]

Decade	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	PA
1	5.3%	4.9%	3.0%	6.0%	4.8%	6.1%
2	3.2%	4.4%	5.2%	5.3%	7.1%	3.3%
3	3.1%	4.1%	5.6%	6.2%	8.4%	2.4%
4	3.1%	3.7%	5.1%	5.0%	4.9%	3.4%
5	4.9%	7.2%	7.9%	6.8%	8.9%	5.4%
6	4.4%	6.6%	8.4%	5.6%	3.1%	4.6%
7	1.0%	3.1%	2.7%	1.1%	1.7%	1.7%
Average Decadal Harvest	3.6%	4.9%	5.4%	5.1%	5.6%	3.8%

PA = Preferred Alternative

[1/] A total of 10 watersheds (all in the North Puget HCP Planning Unit) met the criterion used to assess potential Canada lynx habitat of greater than 1 percent forested trust lands in the alpine or parkland vegetative zone.

Data Source: Model output data – timber flow levels

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D.5 LIST OF SURFACE WATER SEGMENTS

As of 1998, segments of the following surface waters were included in the 303(d) list prepared by the Washington Department of Ecology because pollutants impair beneficial uses of these waters (Department of Ecology 2003).

Abernathy Creek
Alder Creek
Allen Creek
Anderson Creek
Bagley Creek
Baird Creek
Barker Creek
Bear Creek
Bear Creek
Beaver Creek
Bertrand Creek
Berwick Creek
Big Beef Creek
Big Quilcene River
Big Soos Creek
Black Creek
Blackjack Creek
Bogachiel River
Boulder Creek
Boyce Creek
Burley Creek
Burnt Bridge Creek
Campbell Creek
Canyon Creek
Carpenter Creek
Cassalery Creek
Cavanaugh Creek
Cedar River
Chambers Creek
Chehalis River
Chimacum Creek
Church Creek
Cispus River
Clallam River
Clarks Creek
Clear Creek
Clearwater River
Clover Creek
Coal Creek
Columbia River
Cornell Creek
Cougar Canyon
Coweman River
Cowlitz River
Crisp Creek
Cumberland Creek
Curtin Creek
Day Creek
Deep Creek
Deer Creek
Dempsey Creek
Des Moines Creek
Deschutes River
Dillenbaugh Creek
Dry Creek
Dungeness River
Duwamish Waterway
East Canyon Creek
East Fork Dickey River
East Fork Lewis River
East Fork Nookachamps Creek
East Fork North River
East Fork Wildcat Creek
Eaton Creek
Elk Creek
Elkhorn Creek
Elochoman River
Elwha River
Evans Creek
Fifth Plain Creek
Finney Creek
Fishtrap Creek
Fork Creek
Fox Creek
French Creek
Friday Creek

Gaddis Creek
Gale Creek
Gallop Creek
Germany Creek
Goldborough Creek
Gorst Creek
Grandy Creek
Green Creek
Greenwater River
Hansen Creek
Harrington Creek
Harvey Creek
Hat Slough
Hatchery Creek
Honey Dew Creek
Howard Creek
Huge Creek
Humptulips River
Hylebos Creek
Native American Creek
Issaquah Creek
Jackman Creek
Jackson Creek
Jenkins Creek
Jim Creek
Joe Creek
Johnson Creek
Kalaloch Creek
Kalama River
Kennedy Creek
Kings Creek
Lacamas Creek
Leland Creek
Lincoln Creek
Little Deer Creek
Little Hoko River
Little Quilcene River
Little Soos Creek
Lockwood Creek
Lummi River
Lyon Creek
Mannser Creek
Maple Creek
Marple Creek
Matney Creek
Matriotti Creek
Maxfield Creek
May Creek
McAleer Creek
McAllister Creek
McClane Creek
McCormick Creek
Mercer Slough
Middle Fork Dickey River
Middle Fork Nooksack River
Middle Fork Quilceda Creek
Mill Creek
Minter Creek
Morey Creek
Muck Creek
Mulholland Creek
Naselle River
Newaukum Creek
Nisqually River
Nolan Creek
Nookachamps Creek
Nooksack River
North Creek
North Fork Cispus River
North Fork Clover Creek
North Fork Crooked Creek
North Fork Goble Creek
North Fork Issaquah Creek
North Fork Nooksack River
North Fork Sekiu River
North Fork Skokomish River
North Fork Stillaguamish River
North River
Owl Creek
Panther Creek
Pepin Creek
Perry Creek
Pigeon Creek
Pilchuck Creek
Portage Creek
Purdy Creek

Puyallup River
Quilceda Creek
Rabbit Creek
Racehorse Creek
Raging River
Rattlesnake Creek
Reichel Creek
Ripley Creek
Roaring Creek
Rock Creek
Salmon Creek
Salzer Creek
Samish River
Sammamish River
Scatter Creek
Schneider Creek
Sekiu River
Shanghai Creek
Shelton Creek
Shoofly Creek
Silver Creek
Simons Creek
Skagit River
Skokomish River
Skookum Creek
Skookumchuck River
Skykomish River
Smith Creek
Snohomish River
Snoqualmie River
Soleduck River
Sorenson Creek
South Fork Dakota Creek
South Fork Hoh River
South Fork Nooksack River
South Fork Sekiu River
South Fork Skagit River
South Fork Snoqualmie River
South Fork Stillaguamish River
South Prairie Creek
Sponenbergh Creek
Squaw Creek
Squire Creek
Stavis Creek
Stevens Creek
Stickney Slough
Stillaguamish River
Stimson Creek
Sumas River
Swamp Creek
Swan Creek
Tarboo Creek
Thorndike Creek
Thornton Creek
Tibbetts Creek
Tower Creek
Turner Creek
Union River
Voight Creek
Wapato Creek
Weaver Creek
West Branch Big Soos Creek
West Fork Dickey River
West Fork Woods Creek
Whatcom Creek
White River
White Salmon River
Wiley Slough
Wilkeson Creek
Willapa River
Willoughby Creek
Winfield Creek
Woodland Creek
Woods Creek
Woodward Creek
Wynoochee River
Yacolt Creek

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D.6 POTENTIAL EFFECTS OF THE PROPOSED ALTERNATIVES ON SEDIMENT DELIVERY

The amount of sediment that reaches a stream depends primarily on two processes: the availability of sediment and the ability of sediment to travel from its source to the stream. Sediment is produced through mass wasting and surface erosion, as described in Section 4.6, Geomorphology, Soils and Sediment, and in Section 4.15, Cumulative Effects. Mass wasting is not expected to increase as a result of implementation of any of the Alternatives; however, increased harvest would increase the risk of surface erosion from road use and other harvest-related activities.

The ability of sediment to travel from its source to streams could be affected through changes in harvest in riparian areas. In general, the vegetation in riparian areas serves as a filter, removing sediment before it reaches a water body. In most cases, vegetation immediately adjacent to a stream channel is most important in maintaining bank integrity (Forest Ecosystem Management Assessment Team 1993). Protection of stream bank integrity, and adequate soil filtering of surface erosion is generally maintained with a fully functioning stand within 30 feet of a stream. Other than restoration activities, roads, and yarding corridors, none of the Alternatives proposes activities within the 25-foot no-harvest zone. The adjoining 75 feet is the minimal-harvest zone that would include restricted activities that vary between Alternatives. This level of Riparian Management Zone protection reduces the differences in sediment delivery between Alternatives.

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D.7 ARCHAEOLOGICAL OVERVIEW OF WESTERN WASHINGTON

The first human occupation of the state of Washington may date back about 14,000 years to the Manis Mastodon site at Sequim, where a possible bone point and the spirally fractured bones of an extinct relative of the elephant indicate possible human hunting and butchering. (Dates given here are in calendric years, based on approximate calibration of radiocarbon ages.) Artifacts of the Clovis culture, which dates between 13,000 and 13,500 years ago elsewhere in North America, have been found on the ground surface in such places as Thurston County and Whidbey Island, but no campsite of this culture has yet been found in Washington. This early culture is generally believed to have relied heavily on big game for subsistence, although there is evidence they consumed a more diverse diet that also included plants and smaller animals.

The post-Clovis prehistory of western Washington has been divided into three periods, designated simply as early, middle, and late. The early period, which lasted from approximately 12,000 to 7,000 years ago, includes the Proto-Western and Old Cordilleran Traditions (Matson and Copeland 1995). (Old Cordilleran is called “Olcott” in the Puget Sound and Straits HCP Planning Units, and Cascade in the Columbia HCP Planning Unit and at other high mountain sites where a greater likeness is seen to cultures east of the Cascades.) Sites left by these traditions typically occur on high marine and river terraces, sometimes at a significant distance from modern water courses, and consist of concentrations of cobble cores, flakes, large ovate knives, and broad-stemmed and leaf-shaped projectile points (Wessen 1990). Sites of both traditions occur near the saltwater coastline and larger river valleys in all HCP Planning Units. In the South Puget, Straits, and Columbia HCP Planning Units, they also have been documented along mountain streams in open sites, rockshelters, and caves (Wessen and Stilson 1986; Lewarch and Benson 1989). Because of an apparent inland focus, the people of this era are thought to have been more oriented to land animal hunting and less to marine and fish resources. Finds at nearby sites in British Columbia, northern Oregon, and eastern Washington, however, show that people also exploited aquatic resources during this early time period.

The middle period, lasting from 7,000 to 3,500 years ago sees a continuation of the Old Cordilleran Tradition until around 4,500 years ago, but few sites can be attributed to this time interval (Morgan 1999). Sites dating after 4,500 are more common and are technologically more complex. The focus of subsistence activity seems to have changed from terrestrial to marine resources, and most sites appear along the coasts or major river systems. The oldest shell midden sites thus far found in the region date to this period. Little evidence of activity is found in the higher mountains. Tools are more complex, including tools and ornaments of bone and antler along with chipped stone. On the basis of work at West Point, one of the few well-studied sites of this era, the lifestyle is interpreted as highly mobile and oriented to foraging for seasonally available foods with little emphasis on mass harvesting or food storage (Larson and Lewarch 1995).

The concentration on aquatic resources intensified during the late period (3,500 to 150 years ago), and the number and diversity of sites increased markedly. People maintained permanent villages on the coast and along the lower reaches of inland rivers. They used these villages as home bases and storage warehouses for food amassed during systematic fish, game, and plant harvesting throughout the warm seasons. Huge shell middens were built up at some villages and at the best clam beaches. Cemeteries and petroglyph sites are often associated with village and midden sites and fishing camps and occur occasionally in higher montane settings. Blazed cedars, stripped of bark for basketry or with planks removed from their living trunks, can still be found throughout the lowlands. Small open camps left by hunters, fishers, plant gatherers, and traders have been found from the lowlands well into the subalpine zone of the mountains, but usually remain close to larger, permanent sources of water. The camps typically are concentrated along trade routes that linked communities living east and west of the Cascades. People usually strayed from larger streams and lakes only in the larger prairies of the lowlands, such as those around Fort Lewis and Sequim (Morgan 1999), in the huckleberry fields of the uplands, and near natural outcroppings of favored tool stone. Open, temporary camps, manifest as lithic scatters, are common in these settings. Extensive evidence of late period huckleberry processing has been documented in the sub alpine forests of the Columbia HCP Planning Unit, where they occur as shallow, charcoal-filled trenches (Mack and McClure 2002). Ethnographic reports indicate such sites should also be expected to occur in the South Puget Sound HCP Planning Unit (Larson 1988).

D.7.1 Ethnographic Overview of Western Washington

Historic native cultures of the region can generally be seen as a continuation of the lifeways indicated by late period archaeological sites. The people of this region belonged to five linguistic groups: Wakashan, Salishan, Chimakuan, Chinookan, and Sahaptian. Wakashan, Chinookan, Chimakuan, and most Salishan peoples were marine oriented, occupying villages on the major rivers or saltwater shorelines and focusing on shellfish and salmon and/or saltwater fish for their subsistence. These peoples abandoned their villages in summer, moving among fishing sites, and hunting, root-gathering, and berrying camps in mountains and prairies (Haeberlin and Gunther 1930). The Salishan Snoqualmie and the Sahaptian-speaking Klikitat differed, spending most of their time in foothill and mountain settings, where they emphasized hunting, berrying, and root-gathering, and served as intermediaries in the transmontane trade.

For all groups, forests provided many raw materials, including bark for baskets, planks for housing, and plants for medical uses, as well as subsistence resources (Gunther 1973). To maintain game and berry supplies, people regularly fired prairies and subalpine forests to keep plant communities at earlier successional stages. Forests also provided solitude that was necessary for individuals’ quests for personal spirit helpers. This quest for spiritual guidance began at around puberty and continued throughout a person’s life (Haeberlin and Gunther 1930).

Today, Native American tribes maintain a strong interest in Washington’s upland forests, exercising rights guaranteed by treaty (Table D-18). Their members continue to fish at usual and accustomed places; hunt big game; and collect berries, bark, and medicinal plants. Some tribal people maintain the tradition of fasting for spiritual guidance and so continue to require the solitude of older, isolated forest lands. Tribes hold many landscape features to be sacred or at least important to the continued practice of their traditional cultures.

Table D-18. Major Native American Tribes Associated with the HCP Planning Units in Western Washington

HCP Planning Unit	Major Tribes
Columbia	Chinook, Yakama
South Coast	Shoalwater Bay Chinook, Chehalis, Quinault
Straits	Makah, Lower Elwah, Jamestown, Port Gamble S'Klallum
Olympic Experimental State Forest	Makah, Quileute, Hoh, Quinault, S'Klallum groups
North Puget	Nooksack, Lummi, Swinomish, SaukSuiattle, Stillaguamish, Tulalip, Muckleshoot
South Puget	Suquamish, Muckleshoot, Puyallup, Nisqually, Squaxin Island, Skokomish

D.7.2 Overview of Regional History

Washington's coastline was first charted and described by English and American explorers in the last decades of the eighteenth century. Fur traders, primarily associated with Hudson's Bay Company posts at Vancouver and Nisqually, traveled into the interior in the first half of the nineteenth century. Except for the increasing presence of beads, metal, and other trade goods among the local Native American tribes, however, they left few traces outside their fort compounds. By the 1830s, the Hudson's Bay Company had expanded into agricultural production, maintaining large farms in the lowlands around Forts Vancouver and Nisqually and in the lower Cowlitz. Settlers, some drawn by the promise of farmland, but most coming to exploit the region's timber and mineral wealth began flowing into the lowlands of the South Puget and Columbia HCP Planning Units by the late 1840s. In the upland areas that include most of the forested trust lands, their principal interests were coal and timber (Avery 1965).

Mining has left its traces throughout the uplands of western Washington. Although the Cascade Mountains contain a variety of gems and minerals, their most abundant mineral resource is coal. Coal was discovered in the vicinity of Seattle in 1853 and, by the early 1860s, veins had been documented in the Cascade foothills of the North and South Puget HCP Planning Units from Bellingham Bay to Olympia. In addition to large, open pit mines and haul roads, traces of past mining occur as mining prospects, mine shafts, and miners' camps.

Timber has always been the premier natural resource of the region and continues to be the focus of resource management on forested trust lands. When the region's timber industry began in the 1850s, loggers first focused on large trees close to coastlines and the banks of larger streams, which enabled them to float logs to lumber mills. Once this easily extracted timber had been cut, loggers used teams of oxen to haul logs to water along wooden skid roads. Such roads can still be found in boggy soils along streams, where the moisture and soil acidity have preserved them. By the 1880s, steam engines, including locomotives and steam donkeys, came into use and logs were transported on flatcars that ran on wooden rails. By the beginning of the 20th century, most of the timber in lowland and foothill settings had been cut and operations moved into higher mountains, using locomotives on steel rails and later trucks on logging roads to extract their product (Avery 1965).

In addition to skid roads, sites associated with logging include railroad grades and tracks, trestles, construction and logging camps, stumps cut with springboard notches, and a variety of equipment. It is a paradox of the long-term planning process that in some plots with a long duration between harvests, artifacts and structures left by the loggers who make the first harvest will be more than 50 years old and thus potential cultural resources before the second harvest is made.

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Appendix E

Additional Information to Support Cumulative Effects Analyses

Appendix E

E. ADDITIONAL INFORMATION TO SUPPORT CUMULATIVE EFFECTS ANALYSES

TABLES

FIGURES

Appendix E

E.1 INTRODUCTION

The following discussions provide additional information to support the analyses of cumulative effects regarding the distribution of western Washington forested trust lands, and fish and water resources in Section 4.15 of this Final Environmental Impact Statement. The tables in this section summarize conditions at the watershed scale for each of the resource areas addressed in Section 4.15.

E.1.1 Distribution of Forested Trust Lands by HCP Planning Unit

This section includes tables and figures that are referenced in the text or were used in an understanding of the forested trust lands ownership as part of the western Washington landscape.

Watersheds are represented by the Watershed Administrative Unit (WAU) Geographic Information System coverage that was created in 1992. This coverage is managed by the Washington State Department of Ecology and has been recently updated. This analysis corresponds to the status of that coverage on March 2002. DNR manages forested trust lands in 324 watersheds in western Washington (Table E-1)

The distribution of forested trust lands by watershed size class in the six HCP Planning Units in western Washington is presented in Table E-2.

The upper quartile (greater than or equal to 22 percent forested trust lands ownership) is considered to be one group and the remainder is considered to be another group. A watershed size class is developed into three class (based on percentile): small watersheds (between 0 to 25,550 acres—up to the 33rd percentile), medium watersheds (between 25,550 acres and 40,200 acres), and large watersheds (greater than 40,200 acres). Table E-3 and Figure E-1 provide information on the distribution of forested trust lands ownership across these classes.

Table E-1. Distribution of DNR-Managed Forested Trust Lands by HCP Planning Unit

HCP Planning Unit	Number of Watersheds	Total Area (acres) in Western Washington	Forested Trust Lands Area (acres)	Forested Trust Lands as a Percentage of Total Area
Columbia	66	2,429,900	267,500	11%
North Puget	100	3,545,200	381,500	11%
OESF	31	1,072,300	256,500	24%
South Coast	54	2,116,900	232,900	11%
South Puget	46	2,356,300	141,800	6%
Straits	27	1,240,900	110,400	9%
Western Washington Area Total	**324**	**12,761,500**	**1,390,700**	**11%**

Note: OESF = Olympic Experimental State Forest

Table E-2. Size Class Distribution of DNR-Managed Forested Trust Lands

Forested Trust Lands to Total Watershed Area Class (% of total area)	Number of Watersheds	Area (acres) of Forested Trust Lands in Western Washington Area	% Forested Trust Lands in Western Washington Area
<10%	192	174,600	13%
10-20%	42	196,300	14%
20-30%	37	326,100	23%
30-40%	24	249,800	18%
40-50%	7	79,800	6%
50-60%	9	100,200	7%
60-70%	5	90,600	7%
70-80%	4	75,300	5%
80-90%	3	43,200	3%
90-100%	1	54,800	4%
Grand Total	**324**	**1,390,700**	**100%**

Table E-3. Distribution of Watershed by Ownership and Size Class

	Watershed Size Classes (acres)	Forested Trust Lands Ownership Class (Percentage of total watershed area)	
		Less than 22%	More than 22%
Forested trust lands ownership in class (acres)	0-25,550	73,800	241,000
	25,550-40,200	148,500	323,500
	40,200 +	224,200	379,700
Average size of forested trust lands ownership (acres)	0-25,550	1,000	6,900
	25,550-40,200	1,800	12,400
	40,200 +	2,500	17,300
Number of watersheds	0-25,550	71	35
	25,550-40,200	82	26
	40,200 +	88	22
Average size of forested trust lands ownership (acres/watershed)		446,498	944,200
Total average size of forested trust lands ownership (acres)		1,660	11,400
Total number of watersheds		269	83

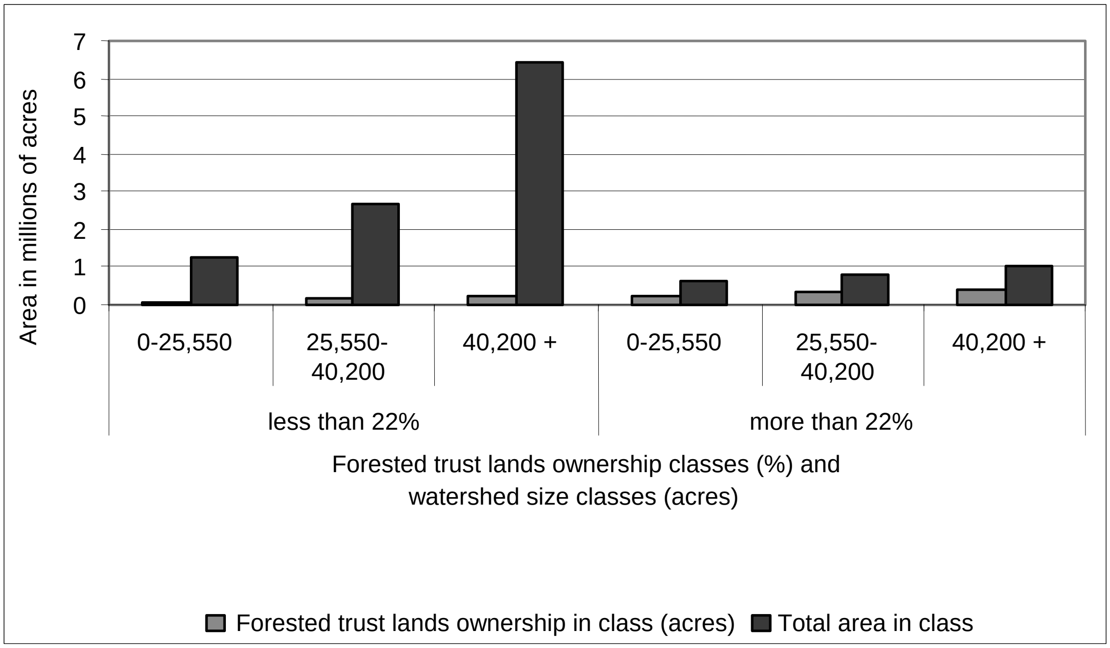

Figure E-1. Distribution of Forested Trust Lands by Ownership and Size Class

The upper quartile is represented by 83 watersheds with approximately 944,200 acres or about 68 percent of forested trust land ownership in western Washington.

Tables E-4 through E-9 below provide the information by HCP Planning Unit.

Table E-10 provides information on the distribution of DNR-Managed forested trust lands by land class and watershed.

Table E-4. Distribution of Forested Trust Lands Ownership and Watershed Size Class by Columbia HCP Planning Unit

HCP Planning Unit		Watershed Size Class (acres)	Forested Trust Lands Ownership Class: Less than 22%	Forested Trust Lands Ownership Class: More than 22%
Columbia	Total area in all ownerships in class (acres)	0-25,550	361,575	54,128
		25,550-40,200	506,319	204,819
		40,200 +	1,406,394	169,651
	Forested trust lands total ownership in class (acres)	0-25,550	13,953	19,785
		25,550-40,200	38,001	71,436
		40,200 +	64,020	60,334
	Average area of forested trust lands ownership in class (acres)	0-25,550	734	6,595
		25,550-40,200	2,375	11,906
		40,200 +	2,561	15,084
	Number of watersheds	0-25,550	19	3
		25,550-40,200	16	6
		40,200 +	25	4
Columbia total area in all ownerships in class (acres)			2,274,287	428,598
Columbia forested trust lands total ownership in class (acres)			115,974	151,555
Columbia average area of forested trust lands ownership in class (acres)			1,933	11,658
Columbia number of watersheds			60	13

Table E-5. Distribution of Forested Trust Lands Ownership and Watershed Size Class by North Puget HCP Planning Unit

HCP Planning Unit		Watershed Size Class (acres)	Forested Trust Lands Ownership Class: Less than 22%	Forested Trust Lands Ownership Class: More than 22%
North Puget	Total area in all ownerships in class (acres)	0-25,550	533,385	352,592
		25,550-40,200	931,268	121,584
		40,200 +	1,674,550	218,095
	Forested trust lands total ownership in class (acres)	0-25,550	31,328	133,641
		25,550-40,200	57,678	51,826
		40,200 +	42,214	64,828
	Average area of forested trust lands ownership in class (acres)	0-25,550	1,011	7,425
		25,550-40,200	2,136	12,957
		40,200 +	2,111	12,966
	Number of watersheds	0-25,550	31	18
		25,550-40,200	27	4
		40,200 +	20	5
N. Puget total area in all ownerships in class (acres)			3,139,203	692,271
N. Puget forested trust lands total ownership in class (acres)			131,220	250,296
N. Puget average area of forested trust lands ownership in class (acres)			1,682	9,270
N. Puget number of watersheds			78	27

Table E-6. Distribution of Forested Trust Lands Ownership and Watershed Size Class by Olympic Experimental State Forest HCP Planning Unit

HCP Planning Unit		Watershed Size Class (acres)	Forested Trust Lands Ownership Class: Less than 22%	Forested Trust Lands Ownership Class: More than 22%
OESF	Total area in all ownerships in class (acres)	0-25,550	55,792	107,489
		25,550-40,200	253,263	160,270
		40,200 +	517,579	287,032
	Forested trust lands total ownership in class (acres)	0-25,550	8,086	30,986
		25,550-40,200	11,629	48,127
		40,200 +	12,720	145,111
	Average area of forested trust lands ownership in class (acres)	0-25,550	2,695	5,164
		25,550-40,200	1,454	9,625
		40,200 +	2,120	24,185
	Number of watersheds	0-25,550	3	6
		25,550-40,200	8	5
		40,200 +	6	6
OESF total area in all ownerships in class (acres)			826,634	554,791
OESF forested trust lands total ownership in class (acres)			32,435	224,224
OESF average area of state trust lands ownership in class (acres)			1,908	13,190
OESF number of watersheds			17	17

OESF = Olympic Experimental State Forest

Table E-7. Distribution of Forested Trust Lands Ownership and Watershed Size Class by South Coast HCP Planning Unit

HCP Planning Unit		Watershed Size Class (acres)	Forested Trust Lands Ownership Class: Less than 22%	Forested Trust Lands Ownership Class: More than 22%
South Coast				
	Total area in all ownerships in class (acres)	0-25,550	90,880	61,406
		25,550-40,200	713,829	189,217
		40,200 +	1,093,292	201,505
	Forested trust lands total ownership in class (acres)	0-25,550	5,413	23,072
		25,550-40,200	22,580	89,419
		40,200 +	32,154	60,293
	Average area of forested trust lands ownership in class (acres)	0-25,550	1,083	7,691
		25,550-40,200	1,026	14,903
		40,200 +	1,531	15,073
	Number of watersheds	0-25,550	5	3
		25,550-40,200	22	6
		40,200 +	21	4
S. Coast total area in all ownerships in class (acres)			1,898,002	452,129
S. Coast forested trust lands total ownership in class (acres)			60,147	172,784
S. Coast average area of forested trust lands ownership in class (acres)			1,253	13,291
S. Coast number of watersheds			48	13

Table E-8. Distribution of Forested Trust Lands Ownership and Watershed Size Class by South Puget HCP Planning Unit

HCP Planning Unit		Watershed Size Class (acres)	Forested Trust Lands Ownership Class: Less than 22%	Forested Trust Lands Ownership Class: More than 22%
South Puget				
	Total area in all ownerships in class (acres)	0-25,550	264,252	90,074
		25,550-40,200	370,801	118,953
		40,200 +	1,843,912	144,321
	Forested trust lands total ownership in class (acres)	0-25,550	10,584	32,982
		25,550-40,200	4,703	15,383
		40,200 +	40,570	37,621
	Average area of forested trust lands ownership in class (acres)	0-25,550	756	5,497
		25,550-40,200	392	3,846
		40,200 +	2,254	12,540
	Number of watersheds	0-25,550	14	6
		25,550-40,200	12	4
		40,200 +	18	3
S. Puget total area in all ownerships in class (acres)			2,478,965	353,348
S. Puget forested trust lands total ownership in class (acres)			55,858	85,986
S. Puget average area of forested trust lands ownership in class (acres)			1,269	6,614
S. Puget number of watersheds			44	13

Table E-9. Distribution of Forested Trust Lands Ownership and Watershed Size Class by Straits HCP Planning Unit

HCP Planning Unit		Watershed Size Class (acres)	Forested Trust Lands Ownership Class: Less than 22%	Forested Trust Lands Ownership Class: More than 22%
Straits				
	Total area in all ownerships in class (acres)	0-25,550	103,813	49,595
		25,550-40,200	164,951	118,983
		40,200 +	1,042,693	
	Forested trust lands total ownership in class (acres)	0-25,550	8,902	17,570
		25,550-40,200	12,187	41,789
		40,200 +	29,775	
	Average area of forested trust lands ownership in class (acres)	0-25,550	1,484	5,857
		25,550-40,200	2,437	10,447
		40,200 +	2,707	
	Number of watersheds	0-25,550	6	3
		25,550-40,200	5	4
		40,200 +	11	
Straits total area in all ownerships in class (acres)			1,311,457	168,577
Straits forested trust lands total ownership in class (acres)			50,863	59,359
Straits average area of forested trust lands ownership in class (acres)			2,312	8,480
Straits number of watersheds			22	7

Table E-10. Distribution of DNR-Managed Forested Trust Lands by Land Class and Watershed

HCP Planning Unit	Percent of Forested Trust Land Ownership	Watershed Number	Forested Trust Lands Ownership in Watershed (acres)	Riparian and Wetlands	Uplands with Specific Objectives	Uplands with General Objectives
Columbia	Less than 22%	250105	55	54%	0%	46%
		250203	4,162	43%	23%	33%
		250208	7,722	35%	20%	45%
		250209	10,642	43%	31%	27%
		250301	101	43%	3%	54%
		250310	4,649	47%	19%	34%
		250311	1,787	50%	24%	26%
		260101	132	11%	3%	86%
		260107	107	21%	14%	66%
		260108	198	12%	88%	0%
		260109	638	22%	3%	75%
		260303	515	24%	16%	60%
		260304	258	0%	100%	
		260316	260	23%	13%	64%
		260317	17	27%	73%	
		260318	399	41%	59%	
		260330	1,159	25%	70%	5%
		260331	2,737	31%	59%	10%
		260333	1	2%	98%	
		260334	3	10%	90%	
		260336	120	27%	71%	2%
		260338	95	31%	6%	63%
		260421	3,134	32%	2%	66%
		260427	1,830	29%	3%	68%
		260428	877	28%	2%	70%
		260429	2,487	29%	6%	65%
		260507	4,587	37%	58%	5%
		260512	115	11%		89%
		260513	8,362	38%	28%	34%
		260515	2,426	31%	22%	47%
		260522	3		1%	99%
		260623	1,787	32%	2%	66%
		260625	1,777	35%	8%	56%
		260626	2,321	41%	7%	52%
		260710	391	28%	16%	56%

Table E-10. Distribution of DNR-Managed Forested Trust Lands by Land Class and Watershed (continued)

HCP Planning Unit	Percent of Forested Trust Lands Ownership	Watershed Number	Forested Trust Lands Ownership in Watershed (acres)	Riparian and Wetlands	Uplands with Specific Objectives	Uplands with General Objectives
Columbia (cont)		260711	521	16%	3%	81%
		270113	2,725	28%	36%	36%
		270114	3,408	29%	1%	69%
		270118	510	41%	3%	57%
		270201	45	23%	77%	0%
		270304	5,454	32%	60%	8%
		270406	528	26%	73%	0%
		270412	4,206	36%	3%	61%
		270416	3,788	22%	3%	75%
		270508	5,419	23%	17%	60%
		270510	822	29%	5%	66%
		270511	101	4%	73%	24%
		280106	6,080	21%	78%	1%
		280107	661	13%	87%	
		280202	3,475	18%	23%	59%
		280203	6,331	22%	19%	58%
		280301	2,502	15%	10%	75%
		290413	672	19%	81%	
		290414	2,871	32%	67%	1%
	more than 22%	250104	19,710	38%	13%	49%
		250302	4,396	43%	31%	26%
		260320	6,389	33%	2%	65%
		260508	11,502	37%	53%	10%
		260514	10,539	32%	54%	14%
		270305	14,643	28%	71%	0%
		270317	10,875	34%	54%	12%
		270415	14,534	33%	26%	40%
		270509	15,389	22%	22%	56%
		280204	7,952	22%	55%	23%
		280205	20,076	35%	65%	0%
		290415	15,551	35%	65%	0%
Columbia Total			**267,530**	**32%**	**37%**	**31%**
N. Puget	less than 22%	010125	3,171	19%	66%	15%
		010131	2,958	15%	50%	35%
		010230	164	5%	35%	59%

Table E-10. Distribution of DNR-Managed Forested Trust Lands by Land Class and Watershed (continued)

HCP Planning Unit	Percent of Forested Trust Lands Ownership	Watershed Number	Forested Trust Lands Ownership in Watershed (acres)	Riparian and Wetlands	Uplands with Specific Objectives	Uplands with General Objectives
N. Puget (cont)		010232	4,910	22%	31%	46%
		010306	4,840	25%	66%	8%
		010307	856	22%	78%	1%
		010308	5,456	30%	39%	30%
		010324	99	38%	47%	15%
		010415	20			100%
		010518	8	91%	9%	
		010519	207	36%	61%	3%
		010520	428	26%	61%	13%
		010521	3	81%		19%
		010523	328	28%	72%	
		010617	600		100%	
		019999	83		97%	3%
		020004	245		100%	0%
		020006	17		100%	
		020007	79		100%	
		020008	404	14%	86%	
		029999	206		100%	0%
		030102	3,616	31%	68%	1%
		030104	1,134	23%	77%	0%
		030105	1,827	23%	71%	6%
		030106	2,855	23%	53%	24%
		030208	15		5%	95%
		030301	7,542	30%	18%	52%
		030313	3,987	11%	41%	47%
		030414	123	1%	99%	
		039999	363	3%	96%	1%
		040128	116	0%	100%	
		040224	6,675	19%	81%	0%
		040316	838	9%	90%	1%
		040317	229	28%	72%	0%
		040318	348	32%	64%	3%
		040319	4,707	20%	77%	3%
		040322	952	13%	86%	0%
		040435	2,455	25%	75%	0%

Table E-10. Distribution of DNR-Managed Forested Trust Lands by Land Class and Watershed (continued)

HCP Planning Unit	Percent of Forested Trust Lands Ownership	Watershed Number	Forested Trust Lands Ownership in Watershed (acres)	Riparian and Wetlands	Uplands with Specific Objectives	Uplands with General Objectives
N. Puget (cont)		040436	3,045	27%	73%	0%
		040523	1,710	14%	86%	
		040529	976	15%	85%	0%
		040530	65	12%	88%	
		040531	1,301	25%	75%	
		040532	955	24%	76%	0%
		040533	641	16%	84%	
		040534	2,889	27%	73%	0%
		050105	685	23%	14%	63%
		050106	2,050	25%	75%	
		050107	1,316	24%	56%	19%
		050108	638	13%	40%	47%
		050109	4,885	15%	22%	63%
		050201	6,882	31%	40%	29%
		050202	3,270	21%	79%	0%
		050204	6,518	24%	76%	0%
		050313	1,129	19%	3%	78%
		050411	603	21%	65%	14%
		060001	1,045	5%	95%	
		060002	569	3%	97%	
		070102	702	35%	61%	4%
		070103	588	30%	70%	
		070104	144	27%	73%	
		070115	1,795	21%	79%	
		070218	138	25%	75%	
		070219	2,697	22%	25%	53%
		070222	948	23%	38%	39%
		070305	240	12%	88%	
		070306	3,686	26%	70%	4%
		070313	3,327	29%	55%	16%
		070409	614	8%	92%	
		070410	619	17%	83%	
		070412	245	36%	5%	59%
		070415	4,667	20%	20%	59%
		070420	6,523	25%	16%	58%

Table E-10. Distribution of DNR-Managed Forested Trust Lands by Land Class and Watershed (continued)

HCP Planning Unit	Percent of Forested Trust Lands Ownership	Watershed Number	Forested Trust Lands Ownership in Watershed (acres)	Riparian and Wetlands	Uplands with Specific Objectives	Uplands with General Objectives
N. Puget (cont)		070527	252	14%	86%	0%
	more than 22%	010226	10,036	17%	57%	26%
		010229	17,007	27%	56%	18%
		010309	5,747	39%	29%	32%
		010310	4,872	33%	35%	32%
		010311	6,126	21%	36%	43%
		010327	6,184	24%	47%	29%
		010328	6,936	27%	72%	1%
		010412	13,393	26%	51%	24%
		010414	3,541	15%	83%	2%
		030103	11,531	30%	69%	1%
		030107	12,951	24%	35%	41%
		030415	4,108	7%	93%	0%
		040320	4,352	22%	76%	2%
		040321	8,267	24%	76%	0%
		050203	7,986	27%	65%	8%
		050214	6,935	25%	56%	19%
		050215	7,456	33%	55%	12%
		050316	16,059	25%	38%	38%
		070216	15,902	24%	76%	0%
		070217	6,932	17%	83%	0%
		070223	9,532	23%	11%	66%
		070224	12,456	24%	24%	53%
		070225	6,852	23%	54%	23%
		070226	26,439	29%	44%	27%
		070307	12,339	27%	58%	14%
		070408	6,357	25%	75%	
N. Puget Total			**381,516**	**24%**	**54%**	**22%**
S. Coast	less than 22%	210406	374	9%	53%	38%
		210407	1,790	22%	14%	64%
		210408	3,616	27%	15%	58%
		220105	20	7%	93%	
		220106	4,803	25%	35%	40%
		220107	1,340	31%	6%	63%
		220311	17	100%		

Table E-10. Distribution of DNR-Managed Forested Trust Lands by Land Class and Watershed (continued)

HCP Planning Unit	Percent of Forest Trust Lands Ownership	Watershed number	Forested Trust Lands Ownership in Watershed (acres)	Riparian and Wetlands	Uplands with Specific Objectives	Uplands with General Objectives
S. Coast (cont)		220416	400	38%	9%	53%
		220417	600	35%	8%	56%
		220418	568	37%	8%	54%
		220419	653	40%	19%	41%
		220423	11	1%	13%	86%
		220514	437	41%	6%	52%
		220518	920	34%	9%	57%
		220520	778	26%	17%	56%
		220521	1,329	31%	19%	50%
		220522	331	43%	9%	48%
		220612	555	68%	32%	1%
		220625	547	16%	50%	34%
		229999	31	21%	71%	8%
		230112	7,138	41%	9%	50%
		230113	21	18%	16%	65%
		230114	16	37%	19%	45%
		230115	3	43%		57%
		230211	1,395	47%	21%	31%
		230309	190	10%	78%	11%
		230310	284	28%	68%	4%
		230403	1,543	40%	8%	52%
		230404	7,776	38%	4%	58%
		230405	887	41%	11%	48%
		230502	1,839	22%	64%	14%
		240107	4,858	47%	28%	26%
		240108	5,511	42%	27%	32%
		240109	1,497	51%	18%	32%
		240213	2,014	44%	31%	25%
		240304	627	53%	14%	33%
		240315	1,658	42%	9%	49%
		240402	3,184	35%	23%	42%
		240403	62	38%	17%	46%
		240416	124	46%	21%	33%
		240510	346	39%	36%	26%
		249999	56	13%	41%	46%

Table E-10. Distribution of DNR-Managed Forested Trust Lands by Land Class and Watershed (continued)

HCP Planning Unit	Percent of Forested Trust Lands Ownership	Watershed Number	Forested Trust Lands Ownership in Watershed (acres)	Riparian and Wetlands	Uplands with Specific Objectives	Uplands with General Objectives
S. Coast (cont)	more than 22%	230116	6,672	41%	8%	51%
		230117	12,405	42%	11%	47%
		230218	6,306	38%	18%	44%
		230219	13,720	34%	19%	48%
		230220	18,958	34%	18%	49%
		230501	16,978	24%	8%	68%
		230521	24,755	24%	13%	63%
		230522	26,007	23%	20%	57%
		240212	10,027	46%	15%	39%
		240305	10,094	44%	14%	41%
		240306	17,588	46%	13%	41%
		240314	9,274	45%	8%	47%
S. Coast Total			**232,932**	**35%**	**16%**	**50%**
S. Puget	less than 22%	080106	546	33%	7%	60%
		080304	40	16%	84%	
		080402	281	11%	89%	0%
		090107	56	13%	87%	
		090108	566	12%	88%	
		090202	2,560	16%	44%	40%
		090209	250	9%	91%	0%
		090301	272	18%	81%	0%
		090410	24	4%	96%	
		100203	540	18%	58%	24%
		100204	119	26%	73%	1%
		100302	9	100%	0%	
		100416	195	0%	100%	0%
		100418	39		92%	8%
		100519	289	7%	93%	
		110107	507	15%	85%	0%
		110110	4,321	33%	67%	0%
		110114	240	38%	62%	
		110203	122	15%	84%	1%
		110215	286	28%	4%	68%
		110301	582	19%	80%	0%
		110316	498	5%	93%	2%

Table E-10. Distribution of DNR-Managed Forested Trust Lands by Land Class and Watershed (continued)

HCP Planning Unit	Percent of Forested Trust Lands Ownership	Watershed Number	Forested Trust Lands Ownership in Watershed (acres)	Riparian and Wetlands	Uplands with Specific Objectives	Uplands with General Objectives
S. Puget (cont)		110317	31		100%	
		120000	17	14%	86%	
		130104	375	25%	1%	75%
		130201	34		98%	2%
		130202	3,550	19%	79%	2%
		130203	247	25%	42%	33%
		140001	2,587	22%	10%	68%
		140003	231	6%	92%	2%
		140004	267	13%	87%	
		149999	67	0%	100%	0%
		150102	270	13%	82%	5%
		150103	4,762	16%	56%	28%
		150201	31,038	20%	21%	59%
		159999	38	14%	85%	1%
	more than 22%	080303	9,451	23%	77%	
		090103	13,473	27%	73%	0%
		090104	6,148	23%	76%	1%
		110104	7,082	26%	74%	0%
		110106	4,359	31%	69%	0%
		110108	6,597	34%	66%	0%
		110112	12,792	35%	65%	0%
		110113	3,081	29%	69%	1%
		110204	14,701	28%	72%	0%
		140002	8,300	17%	66%	17%
S. Puget Total			**141,842**	**24%**	**58%**	**18%**
Straits	less than 22%	160106	332	11%	89%	
		160107	389	15%	76%	9%
		160108	491	26%	13%	61%
		160109	1,830	25%	21%	53%
		160203	9,518	19%	22%	58%
		160302	1,092	22%	17%	61%
		170104	1,998	17%	57%	27%
		170105	1,395	22%	8%	70%
		170107	2,711	14%	9%	76%
		170108	3,351	19%	14%	66%

Table E-10. Distribution of DNR-Managed Forested Trust Lands by Land Class and Watershed (continued)

HCP Planning Unit	Percent of Forested Trust Lands Ownership	Watershed Number	Forested Trust Lands Ownership in Watershed (acres)	Riparian and Wetlands	Uplands with Specific Objectives	Uplands with General Objectives
Straits (cont)		170202	7,185	16%	28%	56%
		170203	1,288	17%	5%	78%
		179999	24		100%	0%
		180103	5,442	16%	43%	41%
		180104	322	16%	63%	22%
		180201	1,383	14%	35%	51%
		180211	4,466	17%	41%	42%
		180310	6,306	16%	56%	28%
		190109	503	13%	51%	35%
		199999	1,003	12%	64%	25%
	more than 22%	160204	14,961	23%	20%	57%
		170106	4,479	21%	15%	64%
		170201	7,685	15%	30%	54%
		180202	8,456	18%	39%	43%
		190107	5,937	23%	33%	44%
		190108	10,686	17%	32%	52%
		190206	7,154	22%	20%	57%
Straits Total			**110,387**	**19%**	**30%**	**51%**
OESF	less than 22%	190204	1,886	39%	61%	
		190205	548	37%	63%	
		190301	3,495	40%	60%	
		200120	4,848	38%	62%	
		200121	1,374	35%	65%	
		200122	604	34%	66%	
		200202	1,633	31%	69%	
		200306	178	24%	76%	
		200314	153	76%	24%	
		200315	895	56%	44%	
		200416	4,074	33%	67%	
		200419	3,218	42%	58%	
		200505	5,874	47%	53%	
		210201	26	7%	93%	
		210211	3,464	17%	83%	
	more than 22%	190302	10,350	39%	61%	
		190303	10,423	37%	63%	

Table E-10. Distribution of DNR-Managed Forested Trust Lands by Land Class and Watershed (continued)

HCP Planning Unit	Percent of Forested Trust Lands Ownership	Watershed Number	Forested Trust Lands Ownership in Watershed (acres)	Riparian and Wetlands	Uplands with Specific Objectives	Uplands with General Objectives
OESF (cont)		200201	13,639	33%	67%	
		200316	3,961	51%	49%	
		200412	15,978	45%	55%	
		200417	6,242	42%	58%	
		200418	11,324	36%	64%	
		200607	31,094	50%	50%	
		200608	7,523	48%	52%	
		200609	4,353	49%	51%	
		200610	11,786	48%	52%	
		210114	19,283	55%	45%	
		210115	6,007	58%	42%	
		210116	54,767	47%	53%	
		210212	6,834	17%	83%	
		210213	10,659	29%	71%	
OESF Total			**256,494**	**43%**	**57%**	

OESF = Olympic Experimental State Forest

E.1.2 Distribution of Patch Size for Forested Trust Lands and Other Ownerships in Western Washington

Figures E-2 and E-3 graphically illustrates the number of forest patches and the total area in each patch.

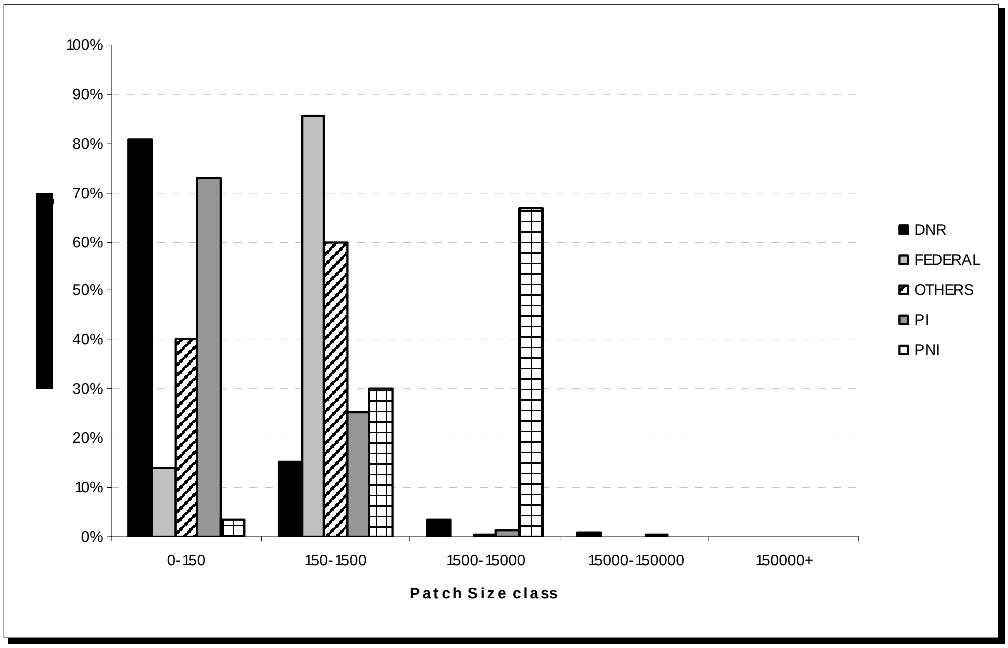

Figure E-2. Number of Individual Forest Patches

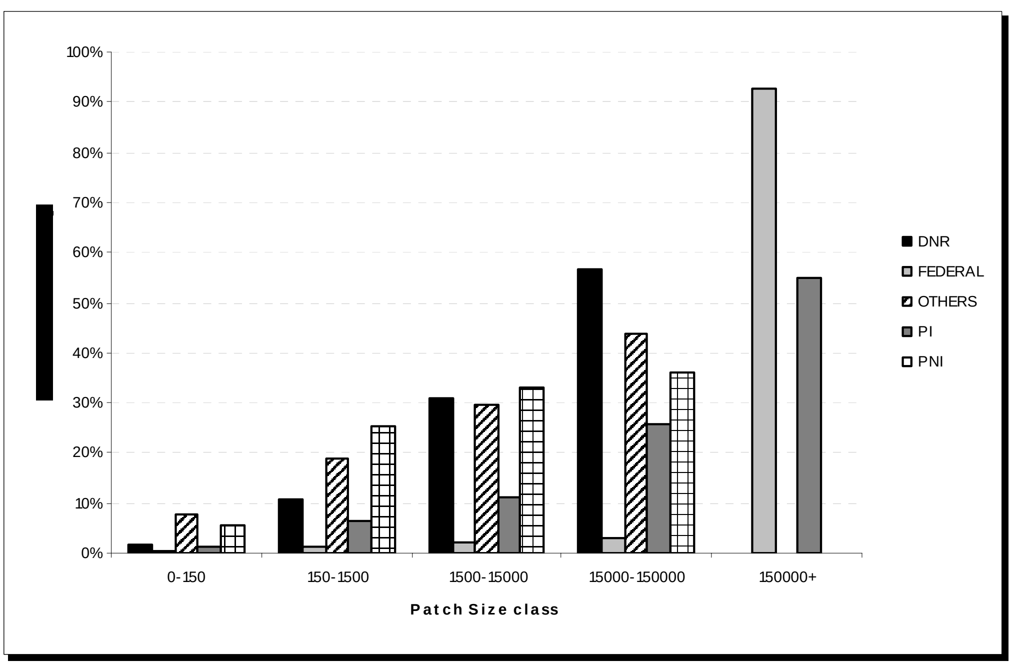

Figure E-3. Total Area in Forest Patch

Patch size is defined as contiguous piece of ownership area. These patches are classified into one or five classes (Spies et al. 2002).

E.1.3 References

Spies T.A., G.H. Reeves, K. M. Burnett, W.C. McComb, K. N. Johnson, G. Grant, J.L. Ohmann, S.L. Garman and P.Bettinger 2002 Assessing the Ecological Consequences of Forest Policies in a Multi-ownership Province in Oregon *In:* Liu, J. and W.W. Taylor (editors), Integrating Landscape Ecology into Natural Resource Management. Cambridge University Press. Pages 179-207.

E.1.4 Fish

E.1.4.1 Columbia HCP Planning Unit

DNR-Managed forested trust lands make up at least 5 percent of the total area in 38 watersheds in the Columbia Planning Unit (Table E-11). Forested trust lands represent the majority (over 50 percent of watershed) of 3 watersheds (Cold Creek, Upper Washougal, and Abernethy) and substantial proportion (25 to 50 percent of watershed) in 8 others. Most of the watersheds (32) include anadromous fish streams and 9 watersheds have bull trout, but none of the watersheds with bull trout has a majority in forested trust lands. In addition:

- Stream density in the Columbia HCP Planning Unit is relatively high compared to other HCP Planning Units.
- Ten watersheds have a higher percentage (greater than 33 percent) of the riparian zone as small trees (less than 10 inches in diameter). Of these, forested trust lands are a majority owner in the Upper Washougal and a substantial owner in the North Fork and Upper South Fork watersheds.
- Just over half of the watersheds with 5 percent forest trust lands ownership are in the significant rain-on-snow zones, with more than 20 percent of the trees in a hydrologically immature status.
- Six watersheds have streams on the 303(d) list for temperature. Forested trust lands are major owners in the Abernethy and substantial owners in the Upper South Fork.
- Only 1 watershed (Main Fork) has a high proportion with unstable slopes, and forested trust lands are only a minor owner (less than 25 percent of the watershed).
- Urban and agricultural land use is moderate in the Columbia HCP Planning Unit relative to other HCP Planning Units (averaging 7.5 percent of watershed area). Just over one-quarter of the watersheds in the HCP Planning Unit were in the upper quartile for the percentage of area in the urban or agricultural land use categories (Table E-11).

The Columbia HCP Planning Unit has a moderate risk of cumulative effects to fish resources relative to other HCP Planning Units. The measures for which the Columbia HCP Planning Unit ranked high relative to other HCP Planning Units include the number of watersheds in the upper quartile for small trees in riparian areas, stream density, area of hydrologic

Table E.11. Number of Watersheds in the Upper Quartile, Percent of Upper Quartile, and Percent of Watersheds in a HCP Planning Unit with at Least 5 Percent Forest Trust Lands Ownership

	Columbia			South Coast			Olympic Experimental State Forest			Straits			North Puget			South Puget			
Measure	**Number**	**% of Upper Quartile**	**% of Planning Unit watersheds**	**Number**	**% of Upper Quartile**	**% of Planning Unit watersheds**	**Number**	**% of Upper Quartile**	**% of Planning Unit watersheds**	**Number**	**% of Upper Quartile**	**% of Planning Unit watersheds**	**Number**	**% of Upper Quartile**	**% of Planning Unit watersheds**	**Number**	**% of Upper Quartile**	**% of Planning Unit watersheds**	**Total Number of watersheds in Upper Quartile**
Small Trees	11	24.4%	28.9%	9	20.0%	37.5%	6	13.3%	26.1%	5	11.1%	27.8%	6	13.3%	9.8%	8	17.8%	53.3%	45
Bull Trout Stream Density	3	6.7%	7.9%	2	4.4%	8.3%	5	11.1%	21.7%	1	2.2%	5.6%	33	73.3%	54.1%	1	2.2%	6.7%	45
Anadromous Fish Stream Density	2	4.4%	5.3%	7	15.6%	29.2%	16	35.6%	69.6%	0	0.0%	0.0%	18	40.0%	29.5%	2	4.4%	13.3%	45
Resident Fish Stream Density	3	6.7%	7.9%	11	24.4%	45.8%	12	26.7%	52.2%	1	2.2%	5.6%	16	35.6%	26.2%	2	4.4%	13.3%	45
Stream Density	19	42.2%	50.0%	15	33.3%	62.5%	6	13.3%	26.1%	0	0.0%	0.0%	1	2.2%	1.6%	4	8.9%	26.7%	45
Hydrologic Maturity in Significant Rain-on-Snow Zones	20	44.4%	52.6%	0	0.0%	0.0%	5	11.1%	21.7%	4	8.9%	22.2%	11	24.4%	18.0%	5	11.1%	33.3%	45
303(d) list for temperature	4	8.9%	10.5%	4	8.9%	16.7%	13	28.9%	56.5%	5	11.1%	27.8%	16	35.6%	26.2%	3	6.7%	20.0%	45
303(d) list for fine sediment	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%	2	100.0%	3.3%	0	0.0%	0.0%	2
Shallow rapid landslides	1	2.2%	2.6%	1	2.2%	4.2%	8	17.8%	34.8%	5	11.1%	27.8%	29	64.4%	47.5%	1	2.2%	6.7%	45
Urban and Agricultural Land Use	10	22.2%	26.3%	9	20.0%	37.5%	1	2.2%	4.3%	6	13.3%	33.3%	17	37.8%	27.9%	2	4.4%	13.3%	45
Average	7.2	16.0%	18.9%	6.2	13.8%	25.8%	7.5	16.7%	32.6%	2.6	5.8%	14.4%	14.6	42.0%	23.9%	2.6	5.8%	17.3%	
Number of watersheds with at least 5% forest trust lands ownership	38			24			23			18			61			15			179

Data Source: DNR MASK Geographic Information System layer immaturity in the significant rain-on-snow zones, and the percent area in urban or agricultural land use (Table E-11). Watersheds of potential concern to DNR because of major amounts of forested trust lands ownership and high rankings in two or more of the measures include the Upper Washougal and Abernethy. The Upper Washougal has a high percentage of small trees in the riparian zone (37 percent), a high proportion of the rain-on-snow zone in hydrologically immature forest (26 percent), and high stream density (7.7 miles per square mile). Abernethy includes a substantial stream length (over 1 mile) on the 303(d) list for temperature and high stream density (7.7 miles per square mile).

Private ownership predominates in the Columbia HCP Planning Unit, with private industrial or private non-industrial ownership averaging about 64 percent of the area of watersheds with at least 5 percent forested trust lands. DNR-Managed forested trust lands and federal ownership averages about 21 percent and 20 percent, respectively. Consequently, forest management activities on private lands under the Forest Practices Rules will predominate. During the first decade, Alternatives 1 to 5 are expected to have forest management activities on between 3 percent and 9 percent of the riparian land class, while the Preferred Alternative is expected to have forest management activities on about 17 percent of the riparian land class. Alternatives that propose more riparian harvest (particularly the Preferred Alternative) on forested trust lands would have a higher relative risk of contributing to adverse cumulative effects to fish resources.

E.1.4.2 South Coast HCP Planning Unit

DNR-Managed forested trust lands make up at least 5 percent of the total area in 24 watersheds in the South Coast HCP Planning Unit, and most of these are located in the southern part of the unit. Forested trust lands represent the majority of 4 watersheds (Porter Creek, Cedar Creek, Waddel Creek, and Mill Creek), and a substantial proportion of 8 others. All of the watersheds with forested trust lands ownership include anadromous fish streams, and 7 watersheds have bull trout, but none of the watersheds with bull trout has a majority proportion in forested trust lands. In addition:

- Anadromous fish stream density (0.45 miles per square mile), resident fish stream density (2.03 miles per square mile), and overall stream density (8.34 miles per square mile) are relatively high compared to other HCP Planning Units.
- Six watersheds have a high percentage (greater than 33 percent) of the riparian zone as small trees, and forested trust lands are a substantial owner in the Rock-Jones, South Fork Willapa, Elk Creek, and Nemah watersheds.
- None of the watersheds with 5 percent forested trust lands ownership have rain-on-snow areas with more than 20 percent of the trees in a hydrologically immature status.
- Ten watersheds have streams on the 303(d) list for temperature. Forested trust lands are substantial owners in three of them—the Garrard Creek, Cedar Creek, and Porter Creek watersheds.
- One of the watersheds (Lower Naselle) has a high proportion with unstable slopes.

- The South Coast HCP Planning Unit has a high amount of land use (averaging 9.3 percent of watershed area) in the urban and agricultural categories relative to other HCP Planning Units and over one-third of the watersheds were in the upper quartile for this measure.

Similar to the Columbia HCP Planning Unit, the South Coast HCP Planning Unit is considered to be at moderate relative risk of adverse cumulative effects relative to the other HCP Planning Units. The measures for which the South Coast HCP Planning Unit ranked high were small trees in riparian areas, urban and agricultural land use, and anadromous fish, resident fish, and overall stream density. Watersheds of potential concern to the DNR because of substantial or major amounts of forested trust lands ownership and high rankings in three or more of the measures include Mill Creek, Garrard Creek, and South Fork Willapa. Mill Creek ranked high in unstable slopes (18.1 percent of watershed area), overall stream density (10.87 miles per square mile), and area of the riparian zone with small trees (33 percent of riparian area). Garrard Creek ranked high in anadromous fish stream density (0.63 miles per square mile), resident fish stream density (2.08 miles per square mile), urban and agricultural land use (13.9 percent of watershed area), and amount of stream on the 303(d) list for temperature (3.9 miles). The South Fork Willapa has a high proportion (38 percent) of small trees in the riparian zone, and a high density of anadromous fish, resident fish, and overall stream density (0.59, 2.15, and 11.16 miles per square mile, respectively).

There is almost no federal ownership in any of the watersheds that have at least 5 percent forested trust lands ownership. Private forest ownership accounts for an average of about 65 percent of watershed area, while forested trust lands account for an average of about 29 percent. Over the first decade of the planning period, harvest activities in riparian zones on forested trust lands for the South Coast HCP Planning Unit are fairly similar among Alternatives 2 through 5 (range 5 to 8 percent of the riparian land class). Alternative 1 is somewhat lower at about 2 percent of the riparian land class, while the Preferred Alternative is higher at about 26 percent of the riparian land class. Planning of harvest activities at the higher levels may require caution, particularly because of the relatively large areas with private ownership, which are more likely to receive more intensive management.

E.1.4.3 Olympic Experimental State Forest HCP Planning Unit

DNR-Managed forested trust lands make up at least 5 percent of the total area in 23 watersheds in the Olympic Experimental State Forest Planning Unit. Forested trust lands represent the majority of 4 watersheds (Upper Clearwater, Middle Hoh, Kalaloch Ridge, and Clallam River) and a substantial proportion of 10 others. All of the watersheds with at least 5 percent forested trust lands ownership include anadromous fish streams, and 9 watersheds have bull trout. In addition:

- The Olympic Experimental State Forest has relatively high levels of resident fish, anadromous fish, and bull trout stream density of the HCP Planning Units with an average of 2.09, 0.70, and 0.07 miles per square mile, respectively.

- Six watersheds have a high percentage (greater than 33 percent) of the riparian zone as small trees. Of these, forested trust lands are a majority owner in the Kalaloch Ridge watershed and a substantial owner in the Lower Clearwater, Cedar, and Goodman-Mosquito watersheds.
- Five of the watersheds with 5 percent forested trust land ownership have rain-on-snow areas with more than 20 percent of the trees in a hydrologically immature status.
- Sixteen watersheds have streams on the 303(d) list for temperature. Forested trust lands are major owners in 3 of them (Middle Hoh, Kalaloch Ridge, and Clallam River) and have substantial ownership in the Sol Duc Valley (01 and 02), Bogachiel, and East Dickey watersheds.

Five watersheds have a high proportion with unstable slopes. Forested trust lands are a majority owner in four of the watersheds with a high proportion of unstable slopes.

Relative to other HCP Planning Units, the Olympic Experimental State Forest is considered to be at high relative risk of adverse cumulative effects to fish resources because of the relatively high density of resident fish, anadromous, and bull trout streams. Measures that suggest relatively poor conditions or higher relative risk of adverse effects include the amount of area in the rain-on-snow zone with immature forest, the amount of streams on the 303(d) list for temperature, and the amount of area at potential risk of mass wasting. Nine watersheds in the Olympic Experimental State Forest with at least one-third forest trust lands ownership had 2 or more measures ranked in the upper quartile. The Lower Clearwater and the Middle Hoh had 6 and 7, respectively, of the 10 measures in the upper quartile.

Ownership patterns in the Olympic Experimental State Forest are fairly mixed. Federal ownership (averaging 22 percent of the watershed area) is concentrated in the upper watersheds as part of the Olympic National Forest, while private (43 percent average) and forested trust lands (33 percent average) ownership is concentrated in lower watersheds along with most fish resources. Future forest management activities on federal lands under the Northwest Forest Plan are expected to be minimal, while activities under private ownership are expected to be more intensive. Forest management activities in riparian areas on forested trust lands over the next decade are expected to be relatively low under Alternatives 1 through 4 (about 1 to 4 percent of the riparian land class), but relatively high under Alternatives 5 and 6 (about 21 percent and 41 percent, respectively, of the riparian land class). However, under the Preferred Alternative, 90 percent of the harvest area would be impacted with light volume removal harvests, such as light thinnings and single tree removals. These activities are targeted at restoration activities. Because of the relatively high sensitivity, relatively poor conditions, or relatively high levels of relative risk-prone areas in the Olympic Experimental State Forest compared to other HCP Planning Units, forest management activities on forested trust lands will require careful planning and monitoring to reduce potential adverse cumulative effects, especially at the levels proposed under Alternative 5.

E.1.4.4 Straits HCP Planning Unit

DNR-Managed forested trust lands make up at least 5 percent of the total area in 18 watersheds in the Straits HCP Planning Unit. Forested trust lands represent the majority of 2 watersheds (Lyre and Lilliwaup) and a substantial proportion of 4 other watersheds (Salt, Twins, Sequim Bay, and Dabob). Anadromous fish are found in all of the watersheds with at least 5 percent forested trust land ownership and 6 watersheds that have bull trout. Forested trust lands make up a small proportion of all of the watersheds with bull trout. In addition:

- Five watersheds have a high percentage (greater than 33 percent) of the riparian zone as small trees. Of these, forested trust lands are a majority owner in the Lyre watershed and a substantial owner in the Dabob and Twins watersheds.
- Few of the watersheds (4) with 5 percent forested trust lands ownership have rain-on-snow areas with more than 20 percent of the trees in a hydrologically immature status, and only one of these (Twins) has substantial forested trust lands ownership.
- Five watersheds have streams on the 303(d) list for temperature, of which forested trust lands are substantial owners in the Dabob watershed.
- Approximately one-third of the watersheds in the Straits HCP Planning Unit ranked in the upper quartile for urban or agricultural land use, and two of these also ranked high for having streams on the 303(d) list.
- More than one-quarter (5) of the watersheds have a high proportion with unstable slopes, and forested trust lands ownership is major in one these watersheds (Lyre) and substantial in another (Twins).

Relative to other HCP Planning Units, the Straits HCP Planning Unit is considered to be at low relative risk of adverse cumulative effects resulting from forest management activities. Watersheds of relative potential concern from DNR forest management activities include the Dabob, Lyre, and Twins watersheds. In the Dabob, forested trust lands ownership is relatively low in the watershed (about 28 percent), but about 2 miles of stream have been placed on the 303(d) list for temperature. The Lyre and Twins watersheds each have a major forested trust lands ownership, and both ranked high for high percentage of small trees in the riparian zone (36 percent and 34 percent, respectively) and the amount of unstable slopes (20 percent and 51 percent, respectively). The Twins also ranked high for the level of hydrologically immature forest in the rain-on-snow zone (about 26 percent of the rain-on-snow zone).

Ownership in the Straits HCP Planning Unit is predominately private, averaging about 52 percent of the watersheds with at least 5 percent forested trust lands ownership, and most of this is non-industrial ownership. Federal ownership is concentrated in upper watersheds as part of the Olympic National Forest. Federal and forested trust lands ownership in lower watersheds is fairly even, with an average of about 28 and 22 over the watersheds, respectively. Forest management activities in riparian areas on forested trust lands over the next decade are expected to be relatively low under Alternatives 1 through 5 (range 2 to 8 percent of the riparian land class). Activity under the Preferred Alternative is expected to be relatively higher, at about 24 percent of the riparian land class. While the relative risk of adverse cumulative effects to fish resources from DNR forest management is generally low for the Straits HCP Planning Unit, care is needed at the higher activity levels to avoid potentially contributing to adverse effects in particular watersheds that may be at higher relative risk.

E.1.4.5 North Puget HCP Planning Unit

DNR-Managed forested trust lands make up at least 5 percent of the total area in 61 watersheds in the North Puget HCP Planning Unit. Forested trust lands represent the majority owner of 9 watersheds (Cypress, Warnick, Pilchuck Mountain, Spada, Cavanaugh, Sultan River, Alder, Lower Middle, and Clearwater Creek) and a substantial proportion of 16 other watersheds (Table E-11). Most of the watersheds (51) include anadromous fish streams and 48 watersheds have bull trout. The North Puget HCP Planning Unit has the highest density of bull trout streams of all the HCP Planning Units (average of 0.22 miles per square mile). In addition:

- Six watersheds have a high percentage (greater than 33 percent) of the riparian zone as small trees. Of these, forested trust lands are a majority owner in the Warnick and a substantial owner in the Skookum Creek, Hutchinson Creek, and Porter Canyon watersheds.
- Eleven of the watersheds with 5 percent forested trust lands ownership have rain-on-snow areas with more than 20 percent of the trees in a hydrologically immature status.
- Twenty-three watersheds have streams on the 303(d) list for temperature, of which forested trust lands are major owners in the Warnick watershed and substantial owners in the Nookachamps, Raging River, Porter Canyon, Skookum Creek, Wallace River, Acme, and Ebey Hill watersheds.
- Two watersheds (Howard Creek and Warnick) have streams on the 303(d) list for sediment.
- A relatively high number of watersheds (29) have a high proportion with unstable slopes. Forested trust lands are a major owner in four of these watersheds (Spada, Clearwater Creek, Lower Middle, and Warnick) and a substantial owner in four (Porter Canyon, Wallace River, Skookum Creek, and Hazel).
- The North Puget HCP Planning Unit has 17 watersheds within the upper quartile for the amount of urban and agricultural land use.

Compared to other HCP Planning Units, the North Puget HCP Planning Unit has a relatively high risk for adverse cumulative effects to fish resources. The HCP Planning Unit has relatively high sensitivity with high anadromous, resident fish, and bull trout stream densities. Other measures contributing the determination of relative high risk include hydrologic maturity in the rain-on-snow zone, 303(d) listings for temperature and sediment, risk of mass wasting, and levels of urban and agricultural land use. The following five watersheds have at least one-third forested trust lands ownership and ranked in the upper quartile for three or more measures: Warnick, Hutchinson Creek, Ebey Hill, Rinker, and Alder.

Forested trust lands in the North Puget HCP Planning Unit are predominately in mid-elevation watersheds. High-elevation watersheds towards the Cascade Crest are predominately under federal ownership in the Mount Baker National Forest. In contrast, lowland areas are highly urbanized or have agricultural land use. Private land ownership predominates (51 percent of area) on average for watersheds with at least 5 percent Forested trust lands, followed by federal ownership (35 percent), and forested trust lands (26 percent). Consequently, in addition to DNR strategies, both private forest management strategies and federal strategies can be important in any given watershed. Over the next decade, activities in riparian areas on forested trust lands are expected to be relatively low under Alternatives 1 through 5 (about 2 to 5 percent of the riparian land class), but relatively higher under the Preferred Alternative (about 20 percent of the riparian land class, although half of the activities will be low-volume removal harvests). Consequently, planning and monitoring will be relatively more important under the Preferred Alternative to avoid potentially contributing to adverse cumulative effects in watersheds that are relatively higher at-risk.

E.1.4.6 South Puget HCP Planning Unit

DNR-Managed forested trust lands make up at least 5 percent of the total area in 15 watersheds in the South Puget HCP Planning Unit. Forested trust lands represent the majority of 3 watersheds (Reese Creek, North Fork Mineral, and Catt) and a substantial proportion of 5 other watersheds (North Fork Green, Howard Hansen, Summit Lake, Ashford, and Busy Wild). About half of the watersheds (8) include anadromous fish streams and 3 watersheds have bull trout (Cumberland, Tiger, and Howard Hansen). Forested trust lands are not a majority of any watersheds with bull trout. In addition:

- Eight watersheds have a high percentage (greater than 33 percent) of the riparian zone as small trees. Forested trust lands are a majority owner in the North Fork Mineral, Catt, and Reese Creek, and a substantial owner in the Busy Wild, North Fork Green, and Howard Hansen watersheds.
- One-third of the watersheds with 5 percent forested trust land ownership have rain-on-snow areas with more than 20 percent of the trees in a hydrologically immature status. Forested trust lands have substantial ownership in Howard Hansen, North Fork Green, and Busy Wild watersheds.
- Three watersheds have streams on the 303(d) list for temperature. Forested trust lands are major owners in the Catt watershed and substantial owners in the Howard Hansen watershed.
- Only one of the watersheds (Tiger) has a high proportion with unstable slopes, and forested trust lands are a minor component.

The South Puget HCP Planning Unit is considered to be at low-to-moderate relative risk of adverse cumulative effects to fish resources compared to other HCP Planning Units. Just over half (8) of the 15 watersheds with at least 5 percent forested trust lands ranked in the upper quartile for having small trees in riparian areas, and one-third of the watersheds ranked in the upper quartile for high percentages of immature forest in the rain-on-snow zone. Watersheds of relative potential concern from DNR forest management activities include the Catt, North Fork Mineral, North Fork Green, and Reese Creek watersheds. Each of these has at least one-third of the watershed in forested trust lands ownership and ranked high for the percentage of small trees in the riparian zone (49 percent, 60 percent, 38 percent, and 49 percent, respectively). The Catt watershed also has 1.4 miles of stream on the 303(d) list for temperature. The North Fork Green also ranked high for the amount of immature forest in the rain-on-snow zone (27 percent).

Forested trust lands ownership is primarily in the upper watersheds in the South Puget HCP Planning Unit, and is concentrated in two blocks located to the north and south in the HCP Planning Unit. Similar to the North Puget HCP Planning Unit, the South Puget HCP Planning Unit is dominated by federal ownership in the upper watersheds (Snoqualmie National Forest), and urban and agricultural land use in the lowlands. Private ownership (47 percent on average) and federal (20 percent on average) are also important in watersheds with at least 5 percent forested trust lands. Forest management activities on forested trust lands in riparian areas over the next decade are expected to be relatively low under Alternatives 1 through 5 (range about 2 percent to 7 percent of the riparian land class) in the South Puget HCP Planning Unit, and relatively higher under the Preferred Alternative (about 16 percent of the riparian land class, in which 70 percent are projected to be low-volume removal harvests).

E.1.5 Hydrologic Maturity

This section analyzes the areas (HCP Planning Units, and individual watersheds) in terms of their relative potential for high peak flows associated with hydrologic maturity, and identifies opportunities for DNR to reduce potential peak flows from rain-on-snow events by maintaining mature forest in the significant rain-on-snow zones. In attempting to identify westside areas with significant DNR ownership that were potentially at relatively higher risk for high peak flows, the data were analyzed by watershed and HCP Planning Unit levels, but not at the sub-basin level. The Procedure for Assessing Hydrologic Maturity (PR 14-004-060) was not followed for this analysis because appropriate data were not available for all ownerships at the sub-basin level, and other ownerships do not follow this DNR procedure. Instead, watersheds and HCP Planning Units are discussed in terms of percent area that is hydrologically immature in the significant rain-on-snow zones, and by ownership.

Table E-12 summarizes the distribution of watersheds that rank in the top quartile of the 159 watersheds analyzed for area of immature forest in the significant rain-on-snow zones. The amount of immature forest in significant rain-on-snow zones varies by HCP Planning Unit. The South Coast HCP Planning Unit has no watersheds in the top quartile for this analysis, while the Columbia HCP Planning Unit has almost half of the units in this category, including the three watersheds with the greatest area classified as immature forest in the significant rain-on-snow zone. Additionally, 11 watersheds have more than one-third of their area classified as immature in the significant rain-on-snow zone, as shown in Table E-27. Ten of these units have forested trust lands ownership in less than 5 percent of the classified areas, and one watershed has forested trust lands ownership of 18 percent of the classified areas. Of the HCP Planning Units ranked in the top quartile for this analysis, DNR ownership is most significant in the Olympic Experimental State Forest, meaning that DNR forest management has potentially the greatest risk, as well as the greatest ability to control and prevent potential peak flow impacts in the Olympic Experimental State Forest HCP Planning Unit.

None of the Alternatives would alter the amount of harvest allowable in the significant rain-on-snow zones or change the policies or procedures related to harvest in the DNR Habitat Conservation Plan-determined rain-on-snow zones. In all of the Alternatives, the

Table E-12. Percent of Area and Ownership Distribution in Watersheds[1/] (Top Quartile) with the Largest Area of Immature Forest in the Significant Rain-On-Snow Zones

HCP Planning Unit	Number of Watersheds	Average Percent of Area Classified as Immature in the Significant Rain-On-Snow Zones in Watershed	Average Percent Area Classified as Immature in the Significant Rain-on-Snow Zones in Different Ownerships			
			DNR	Federal	Private	Other
Columbia	18	33%	12%	24%	61%	3%
North Puget	9	28%	11%	39%	43%	4%
OESF	5	33%	30%	58%	0%	9%
South Coast	0	NA	NA	NA	NA	NA
South Puget	4	27%	15%	7%	67%	7%
Straits	4	35%	3%	94%	0%	0%
Westside	**40**	**31%**	**13%**	**48%**	**32%**	**6%**

Data Source: DNR MASK Geographic Information System layer
OESF = Olympic Experimental State Forest
1/ The term watershed is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.

percentage of mature forest on forested trust lands within the “significant” rain-on-snow zones (the rain on snow and snow dominated zones) of watersheds will not drop below 66 percent, as defined in the Habitat Conservation Plan (page IV. 68) and procedure 14-004-060. The Olympic Experimental State Forest has the largest percent immature forest in the significant rain-on-snow zones under forested trust lands ownership, meaning that this is the HCP Planning Unit in which DNR has relatively the greatest opportunity, and it also carries relatively the greatest risk, for increasing peak flows.

Management intensity (indicated by decadal average values for acreage of higher-volume harvest) and forest management activity type in the Olympic Experimental State Forest can be ranked by Alternative to address the potential for relative impacts to this area in terms of potential risk of increasing hydrologic immaturity in the significant rain-on-snow zones. Alternative 4 would have the least intensive management of the Olympic Experimental State Forest, approximately 800 acres per decade, and would therefore require the least commitment of planning resources to prevent increases in peak flows. Alternative 1 and the Preferred Alternative would essentially be identical in terms of high-volume removal harvest in the Olympic Experimental State Forest, with an average of approximately 5,200 acres per decade. Under Alternatives 2, 3, and 5, higher volume removal harvest would occur on an average of approximately 23,000, 22,000, and 31,000 acres per decade, respectively.

E.1.6 Water Quality

E.1.6.1 Temperature

Temperature of stream water is partially a function of climate, shade, and elevation. Stream water temperature may be increased due to forest management activities by removal of vegetation, which shades streams, and increased runoff in the watershed. Watersheds that have the greatest stream length listed for temperature are considered at the greatest relative risk; this criteria may be useful in allocating planning resources to assess temperature and forest management interactions.

Of the 63 watersheds with 303(d) listings for temperature that have greater than 5 percent forested trust lands ownership, 41 are located in the North Puget and Olympic Experimental State Forest HCP Planning Units. As shown in Table E-13, the HCP Planning Unit where DNR has the largest ownership along 303(d) listed streams is Columbia. South Puget, Columbia, and Straits HCP Planning Units have the greatest length of listed streams for temperature, followed by OESF and North Puget and South Coast. There is no correlation between average elevation of a given watershed and miles of stream listed for temperature. In all cases, at the HCP Planning Unit level, the lengths of stream listed by HCP Planning Unit are dominated by private timber ownership.

Table E-13. Miles of 303(d) Listed Streams that are Listed for Temperature, by HCP Planning Unit and Ownership

HCP Planning Unit	Number of Watersheds[1/] Affected	Average Elevation (feet) of Affected Watersheds	Miles of 303(d) Listed Streams	Stream Mileage by Ownership			
				DNR	Federal	Private	Other
Columbia	7	1,249	11.69	2.17	0.57	8.42	0.53
North Puget	24	1,681	3.95	0.88	0.00	3.05	0.02
OESF	17	595	6.70	0.24	0.00	6.34	0.12
South Coast	11	590	3.94	0.00	0.00	3.58	0.36
South Puget	4	2,015	13.30	0.72	1.40	6.79	4.39
Straits	6	715	10.67	0.00	0.00	9.61	1.06
Total	**69**		**50.25**	**4.00**	**1.97**	**37.80**	**6.48**

Data Source: DNR MASK Geographic Information System layer

OESF = Olympic Experimental State Forest

* The term “watershed” is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations.

The watersheds where 303(d) listings occur for temperature under majority forested trust lands ownership along listed length are:

- Abernethy (250104) and Upper South Fork Toutle (260508) in the Columbia HCP Planning Unit;

- Skookum Creek (010309), French Boulder (050204), and Ebey Hill (050214) in the North Puget HCP Planning Unit; and
- Middle Hoh (200607) and Rain Forest (200505) in the Olympic Experimental State Forest HCP Planning Unit.

These watersheds carry the greatest relative risk for temperature.

E.1.6.2 Dissolved Oxygen

As discussed in Section 4.8, Water Quality of the Final Environmental Impact Statement, dissolved oxygen content is a function of stream chemistry, biology, and physics. Temperature and nutrient levels are partial variables controlling the dissolved oxygen levels in a stream. If dissolved oxygen levels drop too low, the health of aquatic life in the stream will be affected.

Ten watersheds with 303(d) listings for dissolved oxygen have greater than 5 percent forested trust lands ownership on the west side of the Cascade crest, for a total of 38.57 miles of 303(d) listed streams for Fine Sediment on these watersheds. Of these, DNR owns land along a total of 0.04 miles of listed stream in the Sol Duc Lowlands (200416) in the Olympic Experimental State Forest HCP Planning Unit. The majority of ownership along these stream miles is privately held forestland. All watersheds with streams listed for dissolved oxygen are below 530 feet average elevation (see Table E-14). If forest management activities are planned in these watersheds, the 303 (d) listing may be useful in allocating planning resources to assess temperature and forest management interactions. In particular, the use of fertilizers in these watersheds should be planned to avoid effects on these streams.

E.1.6.3 Fine Sediment

As discussed in Section 2.8, Water Quality, fine sediment may increase due to increased road use, new road construction, or surface erosion due to harvest activities. Fine sediment is of particular concern, because chronic inputs of fine sediment can damage spawning habitat.

As shown in Table E-15, only two westside watersheds where DNR owns at least 5 percent of the total area that have 303(d) listings for fine sediment: Howard Creek (010308) at 2,393 feet average elevation, and Warnick (010229) at 2406 feet average elevation. Both of these watersheds are in the North Puget HCP Planning Unit. The 303(d) listings for fine sediment streams in westside watersheds total 2.64 miles in length. DNR owns land along 0.02 mile of this length of Warnick (010229). These two streams should be evaluated for potential impacts from harvest if harvest is planned in these watersheds. New forest roads and additional forest road traffic that would affect these streams should be evaluated carefully in terms of mitigation and avoidance of increased surface erosion.

Table E-14. Lengths of Streams in Each Watershed that Have 303(d) Listings for Dissolved Oxygen[1/]

Watershed Name (and Number)	Total Acres	Average Elevation of Watershed (feet)	Miles of 303(d) listed Stream	Miles Breakdown by Ownership			
				DNR	Federal	Private[2/]	Other[3/]
Columbia HCP Planning Unit							
Lacamas (280202)	41,185	525	8.57		0.57	7.80	0.20
HCP Planning Unit Total			***8.57***	***0.00***	***0.57***	***7.80***	***0.20***
North Puget HCP Planning Unit							
Sumas River (010125)	36,444	408	17.17			17.04	0.14
Jordan (050108)	21,252	398	1.16			1.16	0.00
Lower Pilchuck Creek (050313)	19,364	399	1.14			1.14	0.00
Woods Creek (070223)	42,463	503	0.04			0.04	0.00
HCP Planning Unit Total			***19.51***	***0.00***	***0.00***	***19.37***	***0.14***
Olympic Experimental State Forest						**0.00**	**0.00**
Bogachiel (200412)	44,993	395	2.86		0.34	2.16	0.35
Sol Duc Lowlands (200416)	22,368	448	2.78	0.04		2.73	0.00
Sol Duc Valley (200201)	47,220	949	1.37			1.37	0.00
HCP Planning Unit Total			***7.01***	***0.04***	***0.34***	***6.27***	***0.35***
South Coast HCP Planning Unit						**0.00**	**0.00**
Joe-Moclips (210408)	50,805	152	2.27			2.14	0.13
Lower Willapa (240315)	32,329	191	1.22			1.22	0.00
HCP Planning Unit Total			***3.49***	***0.00***	***0.00***	***3.36***	***0.13***

1/ Includes all streams in watershed with DNR ownership of >5%, listed for dissolved oxygen.

2/ Includes privately owned industrial and non-industrial (i.e., small landowner) forestland.

3/ Includes, municipal, tribal, non-DNR state lands, and other lands.

Table E-15. Lengths of Streams in Each Watershed that Have 303(d) Listings for Fine Sediment[1/]

Watershed Name (and Number)	Total Acres	Average Elevation of Watershed (feet)	Miles of 303(d) listed Stream	Miles Breakdown by Ownership		
				DNR	Private[2/]	Other[3/]
North Puget HCP Planning Unit						
Howard Creek (010308)	39,040	2,393	1.73		1.44	0.28
Warnick (010229)	**25,436**	**2,406**	**0.91**	**0.02**	**0.89**	
Total			***2.64***	***0.02***	***2.33***	***0.28***

1/ Includes all streams in watershed with DNR ownership of >5%, listed for fine sediment.
2/ Includes privately owned industrial and non-industrial (i.e., small landowner) forestland.
3/ Includes, municipal, tribal, non-DNR state lands, and other lands.

E.1.7 Distribution of Harvest Disturbance at the Watershed Scale

Figures E-4 through E-9 graphically illustrate harvest disturbance at the watershed level by Alternative. Table E-16 summarizes the results of regeneration harvests in the watersheds by decade.

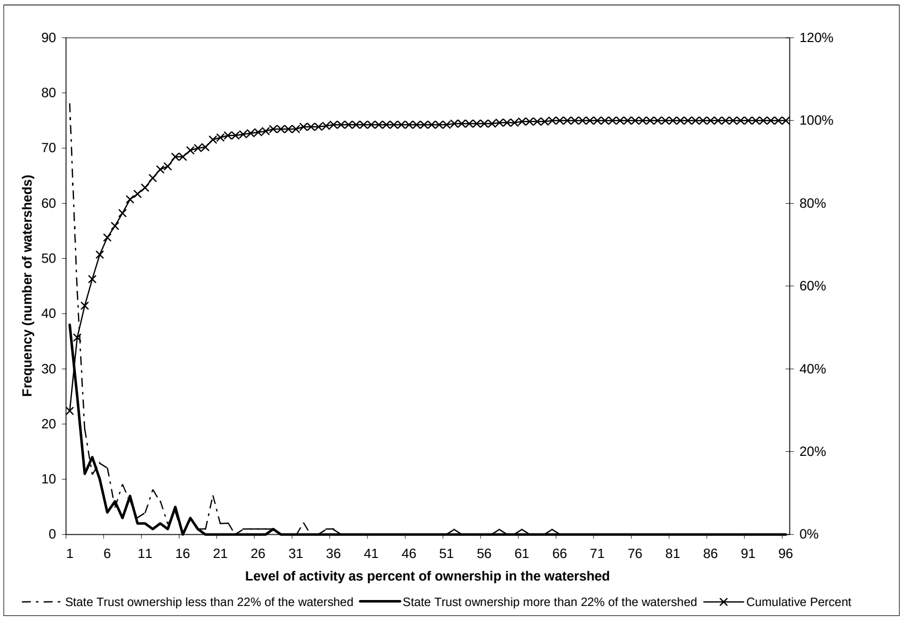

Figure E-4. Alternative 1 Regeneration Harvest Disturbance in Decade 1

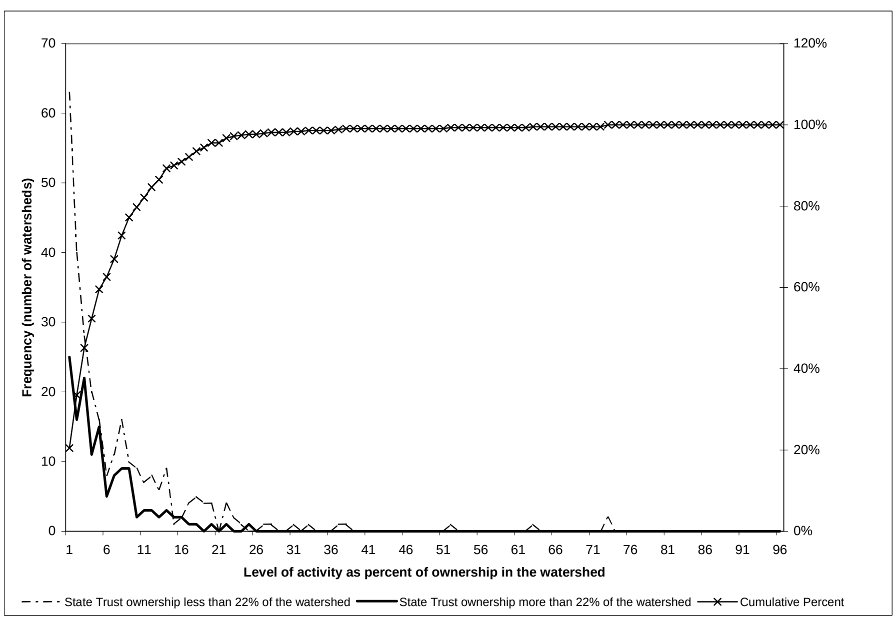

Figure E-5. Alternative 2 Regeneration Harvest Disturbance in Decade 1

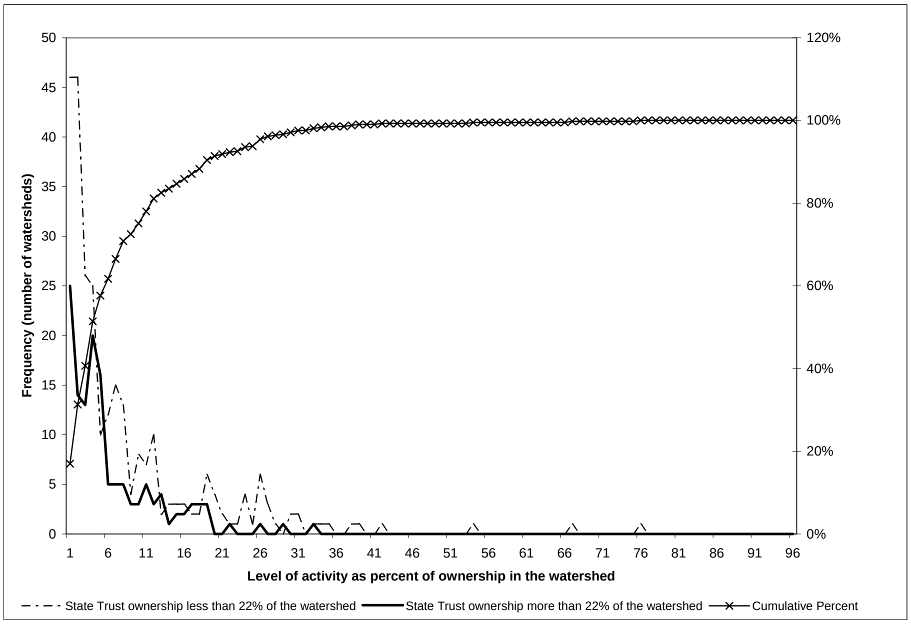

Figure E-6. Alternative 3 Regeneration Harvest Disturbance in Decade 1

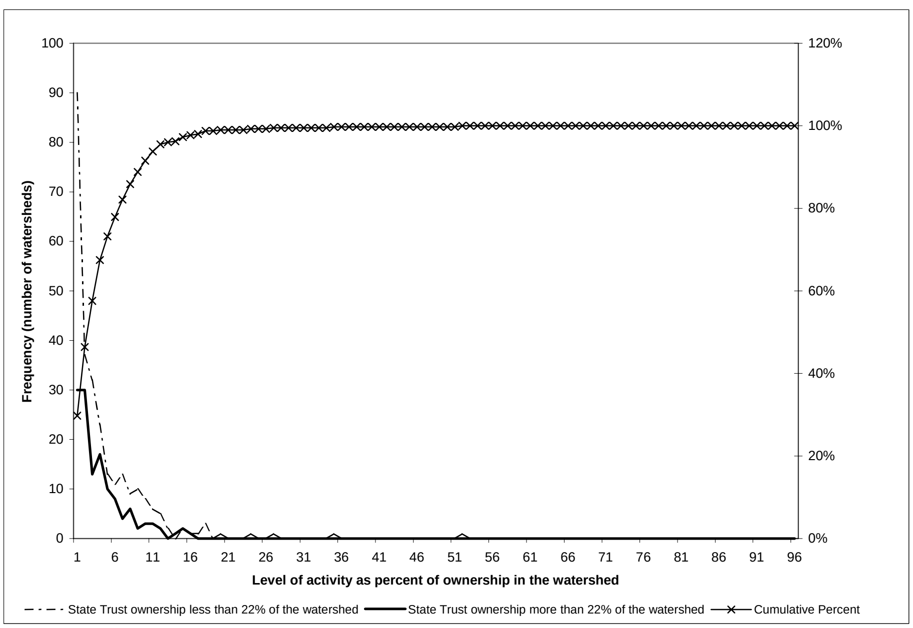

Figure E-7. Alternative 4 Regeneration Harvest Disturbance in Decade 1

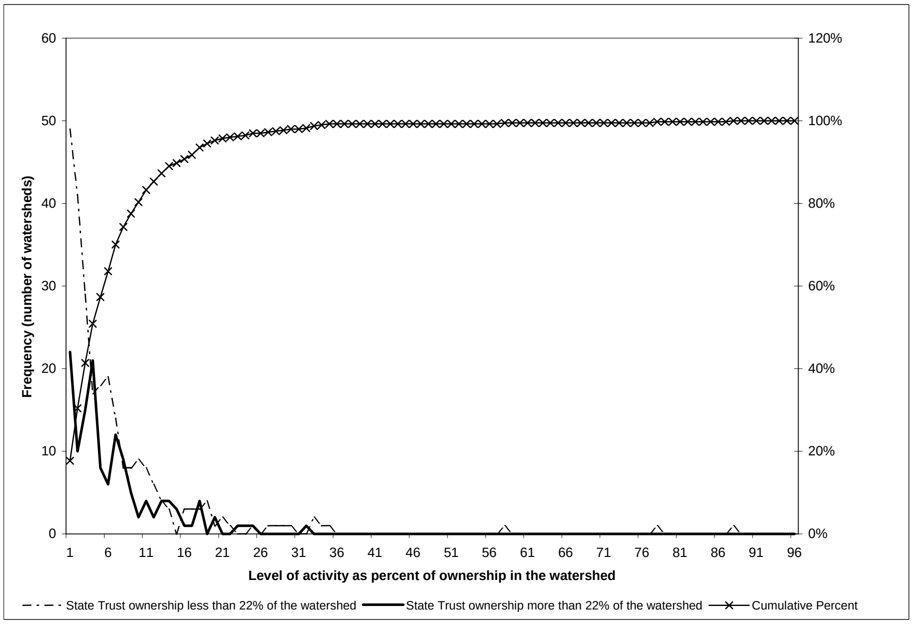

Figure E-8. Alternative 5 Regeneration Harvest Disturbance in Decade 1

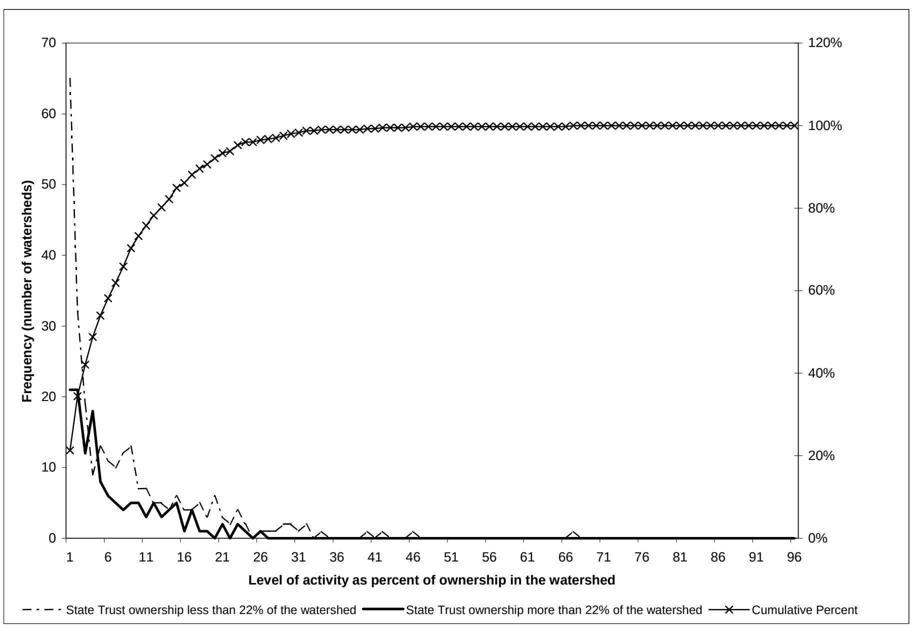

Figure E-9. Preferred Alternative Regeneration Harvest Disturbance in Decade 1

Table E-16. Number of Watersheds that have Modeled Decade Levels of Regeneration Harvest Greater than 20 Percent of the Forested Trust Lands in the Watershed

Decade	HCP Planning Unit	Alt.1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	PA
1	Columbia	4	1	4	6	8	8
	N. Puget	4	2	1	6	3	4
	OESF		2			8	2
	S. Coast	1	5	6	11	9	6
	S. Puget		2	1	1	8	3
	Straits	2	2	4	1	6	1
1 Total		**11**	**14**	**16**	**25**	**42**	**24**
2	Columbia	1	4	3	3	7	
	N. Puget	6	5	11	9	14	1
	OESF					9	
	S. Coast	3	6	9	9	11	1
	S. Puget		2		1	7	
	Straits		1	4	2	5	2
2 Total		**10**	**18**	**27**	**24**	**53**	**4**
3	Columbia	1			4	6	
	N. Puget	2	2	4	4	14	1
	OESF		1			11	
	S. Coast		1	1	5	7	1
	S. Puget	1	2		1	9	
	Straits	1	2	1	5	6	
3 Total		**5**	**8**	**6**	**19**	**53**	**2**
4	Columbia	3	2	1	1	9	1
	N. Puget	1	3	3	1	13	1
	OESF					15	1
	S. Coast	1	4	4	2	8	3
	S. Puget	1	1	2	1	7	
	Straits				1	5	1
4 Total		**6**	**10**	**10**	**6**	**57**	**7**
5	Columbia	1	1	3	2	5	3
	N. Puget	3	6	10	8	4	1
	OESF		1	6		4	
	S. Coast	2	2	5	4	5	
	S. Puget		2	2	1	3	3
	Straits			4	2	6	
5 Total		**6**	**12**	**30**	**17**	**27**	**7**
6	Columbia	2	2	5	2	9	3
	N. Puget	3	6	7	7	3	
	OESF			1		6	
	S. Coast	2	3	6	2	6	4
	S. Puget		2		1	5	
	Straits		1	5	2	5	1
6 Total		**7**	**14**	**24**	**14**	**34**	**8**
7[1/]	Columbia	0	0	0	0	0	0
	N. Puget	0	0	0	0	0	0
	OESF	0	0	0	0	0	0
	S. Coast	0	0	0	0	0	0
	S. Puget	0	0	0	0	0	0
	Straits	0	0	0	0	0	0
7 Total		**0**	**0**	**0**	**0**	**0**	**0**

OESF = Olympic Experimental State Forest PA = Preferred Alternative

1/ Decade 7 is represented by only 4 years, and therefore not enough time has passed for any watersheds to have accumulated a 20 percent harvest level. This explains why all values are 0.

E.2 SUPPORTING TABLES

This section contains supporting information for each watershed in the form of Tables E-17 through E-32.

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Table E-17. Percent of the Forested Area in Each Watershed in the Small-Diameter, Open Forest Condition Class[1/]

Watershed Name (and Number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Columbia HCP Planning Unit							
Green River (260515)	46,383	46,092	37%	1%		35%	1%
North Fork Toutle (260514)	41,051	37,985	33%	8%		23%	2%
Silverstar (280204)	32,719	31,912	29%	6%	2%	19%	1%
Hamilton Creek (280106)	32,845	31,299	29%	6%	10%	8%	5%
Bremer (260331)	19,894	19,253	27%	4%	2%	21%	1%
Winston (260320)	28,321	27,909	27%	4%		23%	0%
Upper SF Toutle (260508)	40,031	38,141	25%	10%	2%	13%	1%
Swift Creek (270304)	74,150	66,002	22%	2%	5%	15%	0%
Delameter (260623)	37,243	33,641	22%	2%		21%	0%
Rock Creek Clark (270508)	35,440	34,297	22%	3%	5%	13%	0%
Cedar Creek (260428)	14,441	14,072	22%	1%		20%	1%
Stillwater (260625)	28,905	27,450	22%	1%		21%	0%
Upper Washougal (280205)	31,719	31,708	21%	12%	3%	5%	0%
Harmony (260330)	22,546	12,574	20%	3%		16%	2%
Middle Kalama (270114)	51,534	50,826	20%	1%		19%	0%
Cedar Creek (270416)	36,416	31,133	20%	2%	0%	17%	0%
Salmon Creek (260421)	43,837	36,964	19%	1%		18%	1%
Little Washougal (280203)	30,269	22,282	19%	5%		13%	0%
Rock Creek (290415)	41,733	39,142	19%	7%	3%	8%	0%
Lower Kalama (270113)	49,823	43,903	19%	1%		17%	0%
Skamokawa (250209)	51,687	44,179	18%	3%	0%	14%	0%
Lake Merwin (270415)	46,439	40,524	18%	6%	0%	11%	0%
Grays Bay (250310)	56,613	43,943	18%	1%		17%	0%
Cold Creek (270509)	21,281	18,899	18%	13%	1%	4%	0%
Main Elochoman (250208)	37,009	26,884	18%	3%	0%	14%	0%
North Elochoman (250203)	23,518	23,222	16%	3%		13%	0%
South Fork Toutle (260513)	42,623	41,212	16%	4%		11%	0%
Cougar (270317)	32,888	29,908	15%	5%	4%	6%	0%
West Fork Grays River (250311	10,347	10,188	15%	3%		13%	0%
Mill Creek (260429)	26,163	20,431	14%	2%		12%	0%
Wind River (290414)	30,669	29,091	14%	2%	10%	2%	0%
Olequa (260626)	35,017	22,162	13%	1%		11%	0%
South Fork Grays River (25030	16,774	16,193	12%	5%		8%	0%
Woodland (270412)	37,827	23,086	12%	3%	0%	10%	0%
Abernethy (250104)	40,071	38,700	12%	6%	0%	6%	0%
Lacamas (280202)	41,185	20,775	10%	1%	2%	7%	1%
Siouxon (270305)	39,066	38,827	9%	4%	5%	0%	0%
Spirit Lake (260507)	52,151	34,924	7%	4%	3%	1%	0%
HCP Planning Unit Average			***19%***	***4%***	***1%***	***13%***	***0%***
North Puget HCP Planning Unit							
Kenney Creek (010230)	2,791	2,633	34%	2%		32%	0%
Deming (010226)	27,527	23,676	28%	13%		15%	0%
Porter Canyon (010327)	18,550	18,139	26%	9%		15%	3%
Vedder (010131)	21,272	17,850	24%	7%	0%	18%	0%
Hansen Creek (030102)	29,010	20,993	24%	6%		17%	0%
Acme (010311)	23,518	18,723	23%	6%		17%	0%

Table E-17. Percent of the Forested Area in Each Watershed in the Small-Diameter, Open Forest Condition Class[1/]

Watershed Name (and Number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/]			
				DNR	Federal	Private[5/]	Other[6/]
Lower MF Snoqualmie (07030	28,375	26,901	23%	13%	5%	4%	0%
West Shannon (040435)	14,333	13,458	23%	5%	0%	18%	0%
Tate (070409)	9,798	7,772	23%	2%		21%	0%
Cherry (070420)	38,183	31,531	21%	4%		17%	0%
Hutchinson Creek (010310)	13,975	13,525	21%	8%		13%	0%
Howard Creek (010308)	39,040	38,766	21%	4%	0%	16%	1%
Skookum Creek (010309)	23,905	23,675	20%	8%	0%	12%	0%
Warnick (010229)	25,436	24,817	20%	13%	0%	6%	0%
Canyon Creek (010232)	36,807	36,235	19%	4%	6%	9%	0%
Alder (030103)	22,865	20,294	18%	12%		6%	0%
Lower Pilchuck Creek (050313	19,364	17,101	18%	2%		16%	0%
Raging River (070408)	22,853	21,307	18%	5%		13%	0%
Samish Bay (010414)	13,258	10,390	18%	4%		11%	2%
Grandy (040534)	18,856	17,804	17%	3%		14%	0%
Friday Creek (030313)	24,129	20,498	17%	4%		13%	0%
Gilligan (030106)	18,879	17,089	17%	3%		13%	1%
Jordan (050108)	21,252	17,364	17%	0%	0%	16%	0%
Ebey Hill (050214)	19,812	15,819	17%	9%		8%	0%
Verlot (050107)	23,540	21,900	16%	1%	10%	6%	0%
Lake Whatcom (010412)	35,957	28,708	16%	7%		9%	0%
Woods Creek (070223)	42,463	35,484	16%	4%		11%	0%
Clearwater Creek (010328)	14,330	14,277	16%	11%	3%	2%	0%
Pilchuck Mtn (070226)	42,517	40,350	16%	9%	0%	6%	0%
Upper NF Stilly (050202)	32,833	32,818	16%	2%	11%	3%	0%
Wallace River (070217)	24,667	23,219	16%	6%	3%	5%	2%
Olney Creek (070225)	20,655	18,579	15%	5%		10%	0%
South Snoqualmie (070306)	57,077	53,758	15%	2%	6%	5%	2%
Day Creek (030105)	22,203	22,077	15%	2%	1%	12%	0%
Loretta (030104)	15,769	15,010	15%	1%	4%	9%	0%
Tolt (070415)	63,357	60,617	14%	1%	1%	10%	2%
Spada (070216)	44,197	40,479	14%	10%	2%	0%	2%
Sauk Prairie (040320)	14,137	13,412	14%	5%	2%	7%	0%
Youngs Creek (070219)	23,776	21,907	14%	2%	0%	12%	0%
Nookachamps (030107)	47,730	38,077	14%	5%		9%	0%
Samish River (030301)	57,397	33,587	14%	3%		10%	0%
Sumas River (010125)	36,444	13,828	14%	1%		12%	0%
Rinker (040321)	20,481	19,434	13%	5%	2%	5%	0%
Deer Creek (050201)	41,881	41,615	11%	3%	4%	4%	0%
Jim Creek (050109)	30,690	29,514	11%	3%	2%	7%	0%
North Fork Snoqualmie (07031	66,707	64,395	11%	1%	3%	7%	0%
Cavanaugh (050316)	29,722	28,792	11%	7%		4%	0%
Hazel (050203)	24,179	23,812	11%	5%	3%	2%	0%
Stimson Hill (050215)	18,833	17,449	10%	4%		6%	0%
Hilt (040322)	12,453	12,152	10%	1%	5%	4%	0%
Jackman (040529)	16,399	16,255	10%	1%	3%	6%	0%
Lummi Island (010617)	5,063	4,109	10%	0%		9%	0%
Corkindale (040531)	24,194	23,228	10%	1%	5%	4%	0%

Table E-17. Percent of the Forested Area in Each Watershed in the Small-Diameter, Open Forest Condition Class[1/]

Watershed Name (and Number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Sultan River (070224)	24,388	22,591	9%	4%	1%	3%	0%
Silverton (050106)	46,399	43,646	9%	0%	8%	1%	0%
East Shannon (040436)	34,065	30,874	9%	3%	2%	4%	0%
Marmot Ridge (010306)	31,794	26,657	7%	2%	3%	2%	0%
Tenas (040319)	36,688	35,609	7%	2%	4%	1%	0%
Jordan-Boulder (040224)	32,726	31,796	7%	1%	1%	4%	0%
French Boulder (050204)	45,327	42,831	6%	2%	3%	1%	0%
Cypress (030415)	4,950	4,825	2%	2%		0%	
Planning Unit Average			***16%***	***4%***	***2%***	***9%***	***0%***
Olympic Experimental State Forest							
Hoh Lowlands (200608)	30,244	28,838	21%	5%	0%	16%	1%
Pysht River (190204)	32,972	32,676	20%	1%	3%	16%	0%
Lower Clearwater (210114)	45,246	44,771	20%	7%	0%	12%	1%
Queets Corridor North (210213	39,496	37,320	18%	5%	5%	3%	9%
Sol Duc Valley (200201)	47,220	44,780	17%	5%	7%	4%	0%
Middle Hoh (200607)	46,272	44,758	17%	11%	0%	6%	0%
West Dickey (200419)	28,311	27,784	16%	2%		14%	0%
Kalaloch Ridge (210115)	11,472	11,410	15%	8%	0%	7%	0%
Hoko (190302)	44,534	44,167	15%	3%	0%	12%	0%
East Dickey (200418)	26,657	26,635	15%	7%		8%	0%
Matheney-Salmon (210211)	21,630	21,378	14%	3%	3%	0%	16%
Upper Clearwater (210116)	58,265	57,986	13%	12%	0%	0%	0%
Sol Duc Valley (200316)	16,585	14,408	13%	4%	1%	8%	0%
Cedar (200609)	12,310	12,238	13%	5%	1%	7%	0%
Clallam River (190303)	22,235	21,407	12%	7%	0%	5%	0%
Goodman-Mosquito (200610)	33,529	33,427	10%	4%	0%	6%	0%
Sol Duc Lowlands (200416)	22,368	21,077	10%	2%	1%	6%	0%
Queets Corridor South (210212	29,667	29,275	10%	4%	6%		
Quillayute Bottom (200417)	23,180	21,898	10%	2%	0%	6%	1%
Bogachiel (200412)	44,993	44,021	9%	3%	1%	6%	0%
Sekiu Coastal (190301)	27,412	27,309	9%	1%		7%	2%
Ozette Lake (200120)	35,130	34,895	7%	1%	0%	6%	0%
Rain Forest (200505)	56,435	52,643	3%	2%	1%	0%	0%
Planning Unit Average			***13%***	***4%***	***1%***	***7%***	***1%***
South Coast HCP Planning Unit							
Mox Chehalis (220106)	23,315	18,778	22%	6%		16%	0%
Mill Creek (240305)	15,699	15,508	21%	15%		7%	0%
Rock-Jones (230116)	22,917	20,045	20%	6%		14%	0%
Lincoln Creek (230219)	48,086	40,597	20%	7%		13%	0%
Bunker Creek (230218)	22,788	21,126	20%	7%		13%	0%
Garrard Creek (230220)	49,056	41,682	20%	9%		10%	0%
Curtis (230112)	43,351	37,274	19%	4%		15%	0%
Scatter Creek (230403)	31,680	15,813	17%	3%		14%	0%
Porter Creek (230522)	32,023	30,994	17%	14%		2%	0%
Willapa Headwaters (240306)	62,581	58,273	16%	6%		10%	0%
Lower Willapa (240315)	32,329	23,097	16%	1%		15%	0%
Elk Creek (230117)	38,773	37,975	16%	5%		10%	1%

Table E-17. Percent of the Forested Area in Each Watershed in the Small-Diameter, Open Forest Condition Class[1/]

Watershed Name (and Number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Waddel Creek (230501)	28,982	25,600	15%	11%		4%	0%
Lower Skookumchuck (230404	44,616	33,729	15%	4%		11%	0%
North River Headwaters (2404C	34,532	33,558	14%	1%		13%	0%
Cedar Creek (230521)	32,505	29,481	14%	11%		2%	0%
Lower Naselle (240108)	36,688	34,540	14%	1%	0.1%	12%	0%
Naselle Headwaters (240107)	48,336	47,324	12%	1%		11%	0%
Elk River (220625)	32,340	29,390	12%	2%		7%	3%
Palix (240213)	35,825	34,395	9%	2%		7%	0%
Nemah (240212)	40,522	39,754	9%	1%		8%	0%
Joe-Moclips (210408)	50,805	50,028	9%	1%		4%	8%
Copalis River (210407)	40,529	39,032	9%	1%		7%	1%
South Fork Willapa (240314)	26,664	25,538	8%	3%		5%	0%
Planning Unit Average			***15%***	***5%***	***0.0%***	***10%***	***0.7%***
South Puget HCP Planning Unit							
East Creek (110113)	14,429	13,514	31%	9%	5%	16%	0%
Ashford (110104)	27,680	25,170	27%	9%	4%	13%	1%
Mineral Creek (110110)	23,047	22,885	27%	7%		20%	1%
Howard Hansen (090103)	46,472	45,732	26%	9%	0.0%	12%	5%
Busy Wild (110204)	56,966	55,477	23%	6%		17%	1%
North Fork Mineral (110112)	16,072	16,070	23%	19%		3%	0%
Catt (110108)	13,279	13,240	21%	13%	8%	0%	0%
Cumberland (090202)	26,260	24,347	21%	2%		18%	1%
Reese Creek (110106)	5,036	4,991	20%	20%		0%	0%
Summit Lake (140002)	29,140	26,337	20%	6%		13%	0%
Tiger (080303)	40,881	32,948	19%	5%		12%	3%
Squaxin (140003)	1,066	1,040	19%	6%		0%	27%
North Fork Green (090104)	18,410	18,335	18%	6%		10%	2%
Olympia (130202)	18,529	14,863	18%	4%		13%	1%
Hood (150201)	145,611	129,375	14%	2%	0.4%	10%	2%
Planning Unit Average			***22%***	***8%***	***1%***	***10%***	***3%***
Straits HCP Planning Unit							
Chimakum (170203)	28,202	22,477	30%	2%	1%	26%	1%
Dabob (170106)	16,871	16,660	28%	8%		20%	1%
Ludlow (170104)	22,897	21,543	28%	2%	0.0%	26%	0%
Salt (190108)	26,336	22,900	21%	8%		12%	1%
Twins (190206)	20,351	20,288	20%	12%	5%	3%	0%
Lyre (190107)	11,021	10,813	19%	11%	1%	7%	0%
Thorndike (170105)	16,587	16,374	19%	2%	1%	15%	1%
Discovery Bay (170202)	58,871	54,002	17%	3%	1%	12%	0%
Little Quil (170107)	28,536	27,161	17%	3%	2%	12%	0%
Port Angeles (180211)	24,883	16,437	15%	4%	1%	9%	0%
Siebert McDonald (180202)	35,481	29,862	14%	3%	1%	10%	0%
Sequim Bay (170201)	26,752	24,339	13%	5%	2%	6%	0%
Dungeness Valley (180103)	43,200	27,406	12%	3%	3%	7%	0%
Bell Creek (180104)	5,969	2,185	10%	0%		10%	0%
Sutherland-Aldwell (180310)	35,109	31,830	9%	2%	2%	4%	1%
Lilliwaup (160204)	29,080	28,383	8%	4%	1%	4%	0%

Table E-17. Percent of the Forested Area in Each Watershed in the Small-Diameter, Open Forest Condition Class[1/]

Watershed Name (and Number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/]			
				DNR	Federal	Private[5/]	Other[6/]
Big Quil (170108)	51,823	47,083	6%	2%	2%	3%	0%
Hamma Hamma (160203)	69,941	63,458	4%	1%	2%	1%	0%
Planning Unit Average			***16%***	***4%***	***1%***	***10%***	***0.4%***

1/ Interagency Vegetation Mapping Project data do not identify Stand Development Stages; for this analysis, stands identified as having conifer cover less than 70% and a Quadratic Mean Diameter less than 10 inches are classified as small-diameter, open forests, which can be used as an approximation of the Ecosystem Initiation stage.

2/ Includes areas identified by Interagency Vegetation Mapping Project data as "vegetation," "<70% veg," "<30% conifer," or "100% veg." Stands in the latter three classes could not be assigned size classes, and therefore were not grouped into forest condition classes. Approximately 70% of forested areas were identified as "vegetation" and grouped into forest condition classes.

3/ Equals acres of small/open forest divided by total forested acres in the watershed.

4/ Equals the amount of small/open forest on each ownership class, divided by total forested acres in the watershed.

5/ Includes privately owned industrial and non-industrial (i.e., small landowner) lands.

6/ Includes municipal, tribal, non-DNR state lands, and other lands.

Table E-18. Percent of the Forested Area in Each Watershed in the Medium- to Large-Diameter and Closed Forest Condition Class[1/]

Watershed Name (and number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Columbia HCP Planning Unit							
Siouxon (270305)	39,066	38,827	71%	25%	46%	0%	0%
South Fork Grays River (25030	16,774	16,193	66%	18%		47%	0%
Wind River (290414)	30,669	29,091	61%	6%	46%	7%	1%
Cold Creek (270509)	21,281	18,899	60%	51%	2%	7%	0%
Upper Washougal (280205)	31,719	31,708	59%	46%	6%	7%	1%
Cedar Creek (260428)	14,441	14,072	57%	4%		51%	2%
South Fork Toutle (260513)	42,623	41,212	57%	15%		41%	0%
Rock Creek (290415)	41,733	39,142	56%	28%	14%	14%	1%
West Fork Grays River (250311	10,347	10,188	53%	11%		42%	0%
Cougar (270317)	32,888	29,908	53%	26%	21%	6%	0%
Middle Kalama (270114)	51,534	50,826	51%	4%		47%	0%
Swift Creek (270304)	74,150	66,002	49%	5%	22%	22%	0%
Salmon Creek (260421)	43,837	36,964	49%	6%		41%	1%
Rock Creek Clark (270508)	35,440	34,297	48%	10%	13%	24%	1%
Winston (260320)	28,321	27,909	48%	15%		31%	2%
North Elochoman (250203)	23,518	23,222	48%	12%		36%	0%
Abernethy (250104)	40,071	38,700	47%	32%	0%	13%	2%
Grays Bay (250310)	56,613	43,943	46%	8%		39%	0%
Lake Merwin (270415)	46,439	40,524	45%	24%	0%	21%	0%
Lacamas (280202)	41,185	20,775	44%	11%	9%	21%	3%
Green River (260515)	46,383	46,092	43%	2%		39%	2%
Hamilton Creek (280106)	32,845	31,299	43%	12%	11%	13%	7%
Skamokawa (250209)	51,687	44,179	42%	13%	0%	28%	1%
Main Elochoman (250208)	37,009	26,884	42%	21%	1%	19%	1%
Upper SF Toutle (260508)	40,031	38,141	41%	9%	7%	24%	1%
Little Washougal (280203)	30,269	22,282	41%	18%	0%	23%	0%
North Fork Toutle (260514)	41,051	37,985	40%	18%		22%	1%
Silverstar (280204)	32,719	31,912	37%	15%	2%	19%	1%
Olequa (260626)	35,017	22,162	34%	5%		29%	0%
Lower Kalama (270113)	49,823	43,903	34%	3%		30%	1%
Mill Creek (260429)	26,163	20,431	32%	8%		24%	0%
Bremer (260331)	19,894	19,253	29%	7%	5%	17%	1%
Stillwater (260625)	28,905	27,450	29%	4%		25%	0%
Cedar Creek (270416)	36,416	31,133	28%	6%	0%	22%	1%
Woodland (270412)	37,827	23,086	28%	12%	0%	16%	0%
Delameter (260623)	37,243	33,641	25%	3%		22%	0%
Harmony (260330)	22,546	12,574	16%	6%		9%	1%
Spirit Lake (260507)	52,151	34,924	7%	3%	4%	0%	0%
HCP Planning Unit Average			***44%***	***14%***	***6%***	***24%***	***1%***
North Puget HCP Planning Unit							
Cypress (030415)	4,950	4,825	92%	83%		8%	0%
Lummi Island (010617)	5,063	4,109	73%	13%	0%	45%	15%
Sultan River (070224)	24,388	22,591	67%	47%	4%	8%	9%
Loretta (030104)	15,769	15,010	61%	5%	25%	30%	0%
Cavanaugh (050316)	29,722	28,792	58%	42%		16%	0%
Marmot Ridge (010306)	31,794	26,657	57%	11%	38%	9%	0%

Table E-18. Percent of the Forested Area in Each Watershed in the Medium- to Large-Diameter and Closed Forest Condition Class[1/]

Watershed Name (and number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Tolt (070415)	63,357	60,617	56%	5%	7%	38%	7%
Deer Creek (050201)	41,881	41,615	55%	10%	30%	15%	0%
Jim Creek (050109)	30,690	29,514	55%	12%	13%	27%	3%
Hilt (040322)	12,453	12,152	53%	4%	25%	23%	0%
Clearwater Creek (010328)	14,330	14,277	53%	23%	28%	2%	0%
Olney Creek (070225)	20,655	18,579	53%	27%		25%	1%
Warnick (010229)	25,436	24,817	53%	40%	1%	12%	0%
Pilchuck Mtn (070226)	42,517	40,350	52%	41%	0%	10%	1%
North Fork Snoqualmie (07031	66,707	64,395	52%	4%	18%	28%	2%
Wallace River (070217)	24,667	23,219	50%	21%	14%	11%	4%
Upper NF Stilly (050202)	32,833	32,818	50%	6%	39%	4%	0%
Youngs Creek (070219)	23,776	21,907	50%	7%	1%	42%	0%
Canyon Creek (010232)	36,807	36,235	49%	6%	28%	15%	0%
Day Creek (030105)	22,203	22,077	49%	5%	6%	39%	0%
Hutchinson Creek (010310)	13,975	13,525	49%	18%		31%	0%
Stimson Hill (050215)	18,833	17,449	48%	29%		19%	0%
Lake Whatcom (010412)	35,957	28,708	48%	31%		17%	0%
East Shannon (040436)	34,065	30,874	48%	6%	33%	9%	0%
Corkindale (040531)	24,194	23,228	47%	3%	36%	7%	1%
Raging River (070408)	22,853	21,307	47%	20%		26%	1%
Sumas River (010125)	36,444	13,828	47%	18%		29%	0%
Gilligan (030106)	18,879	17,089	46%	11%		33%	2%
Verlot (050107)	23,540	21,900	45%	4%	31%	10%	0%
Howard Creek (010308)	39,040	38,766	45%	9%	5%	29%	2%
Skookum Creek (010309)	23,905	23,675	44%	15%	3%	27%	0%
Jordan-Boulder (040224)	32,726	31,796	43%	11%	14%	17%	0%
Ebey Hill (050214)	19,812	15,819	43%	24%		19%	0%
Samish Bay (010414)	13,258	10,390	43%	20%		13%	10%
Tenas (040319)	36,688	35,609	42%	6%	32%	5%	0%
Lower MF Snoqualmie (07030	28,375	26,901	42%	24%	12%	6%	0%
Spada (070216)	44,197	40,479	42%	29%	9%	1%	3%
Hazel (050203)	24,179	23,812	42%	16%	20%	5%	0%
Porter Canyon (010327)	18,550	18,139	42%	17%		20%	5%
French Boulder (050204)	45,327	42,831	42%	8%	29%	4%	0%
Acme (010311)	23,518	18,723	42%	19%		23%	0%
Nookachamps (030107)	47,730	38,077	41%	23%		18%	0%
South Snoqualmie (070306)	57,077	53,758	41%	7%	22%	6%	6%
Silverton (050106)	46,399	43,646	41%	3%	37%	1%	0%
Jackman (040529)	16,399	16,255	41%	2%	21%	17%	0%
Rinker (040321)	20,481	19,434	39%	19%	6%	13%	1%
Jordan (050108)	21,252	17,364	38%	6%	1%	30%	1%
Tate (070409)	9,798	7,772	37%	4%		34%	0%
Cherry (070420)	38,183	31,531	37%	12%		25%	0%
Sauk Prairie (040320)	14,137	13,412	36%	12%	10%	14%	0%
Vedder (010131)	21,272	17,850	35%	5%	0%	30%	0%
Woods Creek (070223)	42,463	35,484	33%	14%		18%	1%
Alder (030103)	22,865	20,294	33%	26%		7%	0%

Table E-18. Percent of the Forested Area in Each Watershed in the Medium- to Large-Diameter and Closed Forest Condition Class[1/]

Watershed Name (and number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/]			
				DNR	Federal	Private[5/]	Other[6/]
Samish River (030301)	57,397	33,587	33%	14%		19%	1%
Friday Creek (030313)	24,129	20,498	33%	10%		21%	1%
Deming (010226)	27,527	23,676	33%	18%		15%	0%
Kenney Creek (010230)	2,791	2,633	31%	2%		29%	0%
Lower Pilchuck Creek (050313	19,364	17,101	30%	2%		28%	0%
West Shannon (040435)	14,333	13,458	27%	8%	3%	16%	0%
Hansen Creek (030102)	29,010	20,993	27%	6%		21%	0%
Grandy (040534)	18,856	17,804	22%	7%		15%	0%
HCP Planning Unit Average			***45%***	***16%***	***10%***	***19%***	***1%***
Olympic Experimental State Forest							
Sekiu Coastal (190301)	27,412	27,309	74%	8%		62%	4%
Clallam River (190303)	22,235	21,407	64%	36%	0%	28%	0%
Hoko (190302)	44,534	44,167	62%	15%	0%	45%	1%
Kalaloch Ridge (210115)	11,472	11,410	58%	31%	5%	21%	0%
Goodman-Mosquito (200610)	33,529	33,427	57%	18%	8%	31%	0%
Sol Duc Valley (200316)	16,585	14,408	56%	20%	9%	26%	1%
Sol Duc Valley (200201)	47,220	44,780	55%	18%	27%	8%	1%
Matheney-Salmon (210211)	21,630	21,378	55%	10%	19%	1%	25%
Sol Duc Lowlands (200416)	22,368	21,077	54%	11%	10%	31%	1%
Queets Corridor South (210212	29,667	29,275	51%	11%	40%		
Lower Clearwater (210114)	45,246	44,771	50%	23%	2%	24%	1%
Bogachiel (200412)	44,993	44,021	49%	21%	10%	17%	1%
Cedar (200609)	12,310	12,238	49%	19%	12%	18%	0%
Ozette Lake (200120)	35,130	34,895	48%	8%	23%	17%	1%
West Dickey (200419)	28,311	27,784	48%	6%		41%	0%
Upper Clearwater (210116)	58,265	57,986	46%	45%	1%	0%	0%
Rain Forest (200505)	56,435	52,643	46%	6%	41%	0%	0%
Middle Hoh (200607)	46,272	44,758	46%	36%	1%	9%	0%
East Dickey (200418)	26,657	26,635	45%	25%		20%	0%
Hoh Lowlands (200608)	30,244	28,838	43%	12%	2%	28%	1%
Queets Corridor North (210213	39,496	37,320	40%	14%	17%	2%	7%
Quillayute Bottom (200417)	23,180	21,898	40%	14%	10%	13%	3%
Pysht River (190204)	32,972	32,676	31%	3%	9%	19%	0%
HCP Planning Unit Average			***51%***	***18%***	***11%***	***20%***	***2%***
South Coast HCP Planning Unit							
Palix (240213)	35,825	34,395	75%	6%		66%	3%
Nemah (240212)	40,522	39,754	74%	24%		49%	1%
South Fork Willapa (240314)	26,664	25,538	71%	29%		40%	3%
Elk River (220625)	32,340	29,390	63%	8%		32%	23%
Cedar Creek (230521)	32,505	29,481	58%	56%		1%	1%
Porter Creek (230522)	32,023	30,994	58%	56%		2%	0%
Elk Creek (230117)	38,773	37,975	57%	21%		35%	2%
Naselle Headwaters (240107)	48,336	47,324	53%	7%		46%	0%
Lower Naselle (240108)	36,688	34,540	53%	13%	0%	39%	0%
North River Headwaters (2404	34,532	33,558	52%	8%		44%	0%
Joe-Moclips (210408)	50,805	50,028	52%	4%	0%	24%	24%
Copalis River (210407)	40,529	39,032	51%	3%		34%	14%

Table E-18. Percent of the Forested Area in Each Watershed in the Medium- to Large-Diameter and Closed Forest Condition Class[1/]

Watershed Name (and number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Willapa Headwaters (240306)	62,581	58,273	45%	16%		28%	0%
Bunker Creek (230218)	22,788	21,126	41%	17%		24%	0%
Waddel Creek (230501)	28,982	25,600	41%	37%		4%	0%
Mill Creek (240305)	15,699	15,508	40%	33%		7%	0%
Lower Willapa (240315)	32,329	23,097	40%	3%		36%	0%
Rock-Jones (230116)	22,917	20,045	39%	17%		21%	1%
Lincoln Creek (230219)	48,086	40,597	38%	19%		19%	0%
Garrard Creek (230220)	49,056	41,682	38%	22%		16%	0%
Curtis (230112)	43,351	37,274	36%	11%		24%	1%
Mox Chehalis (220106)	23,315	18,778	35%	14%		21%	0%
Scatter Creek (230403)	31,680	15,813	31%	5%		25%	1%
Lower Skookumchuck (230404	44,616	33,729	30%	13%		17%	0%
HCP Planning Unit Average			***49%***	***18%***	***0.0%***	***27%***	***3.1%***
South Puget HCP Planning Unit							
Squaxin (140003)	1,066	1,040	70%	13%		0%	57%
North Fork Mineral (110112)	16,072	16,070	64%	57%		6%	1%
Catt (110108)	13,279	13,240	61%	33%	29%	0%	0%
Reese Creek (110106)	5,036	4,991	61%	60%		1%	0%
Hood (150201)	145,611	129,375	60%	20%	2%	33%	5%
North Fork Green (090104)	18,410	18,335	56%	18%		29%	8%
Busy Wild (110204)	56,966	55,477	49%	18%		27%	4%
Mineral Creek (110110)	23,047	22,885	45%	9%		33%	3%
Howard Hansen (090103)	46,472	45,732	44%	19%	1%	20%	4%
Tiger (080303)	40,881	32,948	41%	19%		17%	6%
Summit Lake (140002)	29,140	26,337	41%	19%		22%	0%
Ashford (110104)	27,680	25,170	41%	14%	17%	8%	1%
Cumberland (090202)	26,260	24,347	36%	8%		23%	5%
East Creek (110113)	14,429	13,514	36%	10%	13%	12%	1%
Olympia (130202)	18,529	14,863	31%	10%		19%	2%
HCP Planning Unit Average			***49%***	***22%***	***4%***	***17%***	***6.5%***
Straits HCP Planning Unit							
Lilliwaup (160204)	29,080	28,383	60%	42%	5%	14%	0%
Twins (190206)	20,351	20,288	52%	16%	33%	3%	0%
Sutherland-Aldwell (180310)	35,109	31,830	51%	13%	29.7%	7%	1%
Lyre (190107)	11,021	10,813	50%	32%	7%	10%	0%
Big Quil (170108)	51,823	47,083	50%	4%	42%	3%	0%
Thorndike (170105)	16,587	16,374	49%	5%	2%	42%	1%
Hamma Hamma (160203)	69,941	63,458	46%	13%	29%	5%	0%
Sequim Bay (170201)	26,752	24,339	46%	17%	16%	10%	2%
Siebert McDonald (180202)	35,481	29,862	44%	18%	16%	9%	0%
Port Angeles (180211)	24,883	16,437	40%	18%	10%	11%	1%
Discovery Bay (170202)	58,871	54,002	40%	7%	13%	15%	4%
Dabob (170106)	16,871	16,660	36%	15%		20%	1%
Dungeness Valley (180103)	43,200	27,406	36%	9%	19%	7%	1%
Salt (190108)	26,336	22,900	35%	21%		12%	2%
Little Quil (170107)	28,536	27,161	34%	3%	24%	7%	0%
Ludlow (170104)	22,897	21,543	30%	4%		26%	0%

Table E-18. Percent of the Forested Area in Each Watershed in the Medium- to Large-Diameter and Closed Forest Condition Class[1/]

Watershed Name (and number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Chimakum (170203)	28,202	22,477	29%	3%	5%	19%	3%
Bell Creek (180104)	5,969	2,185	28%	7%		20%	1%
Planning Unit Average			***42%***	***14%***	***14%***	***13%***	***1%***

1/ Interagency Vegetation Mapping Project data do not identify Stand Development Stages; for this analysis, stands identified as having a Quadratic Mean Diameter between 10 and 30 inches, plus those with a Quadratic Mean Diameter less than 10 inches and conifer cover greater than 70%, are classified as medium/large/closed forest, which can be used as an approximation of the Competetive Exclusion stages.

2/ Includes areas identified by Interagency Vegetation Mapping Project data as "vegetation," "<70% veg," "<30% conifer," or "100% veg." Stands in the latter three classes could not be assigned size classes, and therefore were not grouped into forest condition classes. Approximately 70% of forested areas were identified as "vegetation" and grouped into forest condition classes.

3/ Equals acres of medium/large/closed forest divided by total forested acres in the watershed.

4/ Equals the amount of medium/large/closed forest on each ownership class, divided by total forested acres in the watershed.

5/ Includes privately owned industrial and non-industrial (i.e., small landowner) lands.

6/ Includes municipal, tribal, non-DNR state lands, and other lands.

Table E-19. Percent of the Forested Area in Each Watershed in the Very Large Diameter Forest Condition Class[1/]

Watershed Name (and number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Columbia HCP Planning Unit							
Grays Bay (250310)	56,613	43,943	0%	0%		0%	0%
Cedar Creek (260428)	14,441	14,072	0%	0%		0%	0%
Skamokawa (250209)	51,687	44,179	0%	0%	0%	0%	0%
South Fork Grays River (25030	16,774	16,193	0%	0%		0%	0%
Delameter (260623)	37,243	33,641	0%	0%		0%	0%
Salmon Creek (260421)	43,837	36,964	0%	0%		0%	0%
Mill Creek (260429)	26,163	20,431	0%	0%		0%	0%
Stillwater (260625)	28,905	27,450	0%	0%		0%	0%
West Fork Grays River (250311	10,347	10,188	1%	0%		0%	
Harmony (260330)	22,546	12,574	1%	0%		0%	0%
Olequa (260626)	35,017	22,162	1%	0%		0%	0%
Green River (260515)	46,383	46,092	1%	0%		1%	0%
Lower Kalama (270113)	49,823	43,903	1%	0%		1%	0%
North Fork Toutle (260514)	41,051	37,985	1%	0%		0%	0%
Winston (260320)	28,321	27,909	1%	1%		0%	0%
Main Elochoman (250208)	37,009	26,884	1%	1%	0%	0%	0%
South Fork Toutle (260513)	42,623	41,212	1%	1%		1%	0%
Abernethy (250104)	40,071	38,700	1%	1%	0%	0%	0%
North Elochoman (250203)	23,518	23,222	2%	0%		1%	0%
Middle Kalama (270114)	51,534	50,826	2%	1%		1%	0%
Woodland (270412)	37,827	23,086	2%	2%	0%	1%	0%
Bremer (260331)	19,894	19,253	2%	1%	1%	1%	0%
Cedar Creek (270416)	36,416	31,133	3%	0%	0%	2%	0%
Spirit Lake (260507)	52,151	34,924	3%	0%	2%	0%	0%
Hamilton Creek (280106)	32,845	31,299	3%	1%	1%	1%	1%
Rock Creek Clark (270508)	35,440	34,297	4%	1%	1%	2%	0%
Silverstar (280204)	32,719	31,912	5%	2%	0%	2%	0%
Rock Creek (290415)	41,733	39,142	6%	2%	1%	3%	0%
Upper Washougal (280205)	31,719	31,708	6%	5%	0%	1%	0%
Upper SF Toutle (260508)	40,031	38,141	6%	1%	4%	1%	0%
Lacamas (280202)	41,185	20,775	6%	3%	1%	2%	1%
Swift Creek (270304)	74,150	66,002	7%	1%	5%	1%	0%
Lake Merwin (270415)	46,439	40,524	7%	4%	0%	3%	0%
Cold Creek (270509)	21,281	18,899	7%	6%	0%	1%	0%
Little Washougal (280203)	30,269	22,282	9%	4%	0%	5%	0%
Siouxon (270305)	39,066	38,827	10%	5%	6%	0%	0%
Wind River (290414)	30,669	29,091	12%	1%	10%	1%	0%
Cougar (270317)	32,888	29,908	16%	5%	9%	2%	0%
HCP Planning Unit Average			***3.4%***	***1.3%***	***1.1%***	***1.0%***	***0.1%***
North Puget HCP Planning Unit							
Lower Pilchuck Creek (050313	19,364	17,101	0%	0%		0%	
Friday Creek (030313)	24,129	20,498	0%	0%		0%	0%
Nookachamps (030107)	47,730	38,077	0%	0%		0%	0%
Samish Bay (010414)	13,258	10,390	0%	0%		0%	0%
Samish River (030301)	57,397	33,587	0%	0%		0%	0%
Lummi Island (010617)	5,063	4,109	0%	0%		0%	0%
Cypress (030415)	4,950	4,825	0%	0%		0%	0%

Table E-19. Percent of the Forested Area in Each Watershed in the Very Large Diameter Forest Condition Class[1/]

Watershed Name (and number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Hansen Creek (030102)	29,010	20,993	0%	0%		0%	
Lake Whatcom (010412)	35,957	28,708	0%	0%		0%	0%
Sumas River (010125)	36,444	13,828	1%	0%		0%	0%
Kenney Creek (010230)	2,791	2,633	1%	0%		1%	
Woods Creek (070223)	42,463	35,484	1%	0%		0%	0%
Deming (010226)	27,527	23,676	1%	0%		0%	0%
Hutchinson Creek (010310)	13,975	13,525	1%	0%		0%	0%
Gilligan (030106)	18,879	17,089	1%	0%		1%	0%
Skookum Creek (010309)	23,905	23,675	1%	0%	0%	1%	0%
Tate (070409)	9,798	7,772	1%	0%		1%	0%
Porter Canyon (010327)	18,550	18,139	1%	1%		0%	0%
Cherry (070420)	38,183	31,531	1%	1%		1%	0%
Vedder (010131)	21,272	17,850	1%	0%	0%	1%	0%
Warnick (010229)	25,436	24,817	2%	1%	0%	0%	
Acme (010311)	23,518	18,723	2%	1%		1%	0%
Grandy (040534)	18,856	17,804	2%	0%		2%	0%
Day Creek (030105)	22,203	22,077	2%	0%	1%	1%	0%
Jordan (050108)	21,252	17,364	3%	0%	0%	2%	0%
Howard Creek (010308)	39,040	38,766	3%	0%	1%	1%	0%
Raging River (070408)	22,853	21,307	3%	1%		2%	0%
Cavanaugh (050316)	29,722	28,792	3%	1%		2%	0%
Stimson Hill (050215)	18,833	17,449	3%	2%		1%	0%
Alder (030103)	22,865	20,294	3%	2%		1%	0%
Loretta (030104)	15,769	15,010	4%	0%	3%	1%	0%
Youngs Creek (070219)	23,776	21,907	4%	1%	0%	3%	0%
Ebey Hill (050214)	19,812	15,819	5%	3%		2%	0%
Canyon Creek (010232)	36,807	36,235	5%	0%	5%	0%	0%
Clearwater Creek (010328)	14,330	14,277	5%	1%	4%	0%	0%
West Shannon (040435)	14,333	13,458	6%	1%	3%	1%	0%
Sultan River (070224)	24,388	22,591	6%	3%	2%	0%	1%
Jim Creek (050109)	30,690	29,514	6%	2%	2%	1%	0%
Marmot Ridge (010306)	31,794	26,657	6%	0%	6%	0%	0%
Tolt (070415)	63,357	60,617	8%	1%	4%	3%	1%
Olney Creek (070225)	20,655	18,579	10%	7%		3%	0%
Hazel (050203)	24,179	23,812	10%	2%	7%	1%	0%
Deer Creek (050201)	41,881	41,615	10%	1%	8%	1%	0%
Pilchuck Mtn (070226)	42,517	40,350	10%	9%	0%	1%	0%
Rinker (040321)	20,481	19,434	12%	7%	3%	2%	0%
Sauk Prairie (040320)	14,137	13,412	13%	6%	5%	2%	0%
Hilt (040322)	12,453	12,152	15%	2%	10%	4%	0%
Corkindale (040531)	24,194	23,228	16%	1%	11%	1%	2%
Upper NF Stilly (050202)	32,833	32,818	16%	0%	16%	0%	0%
Lower MF Snoqualmie (07030	28,375	26,901	16%	7%	6%	2%	0%
South Snoqualmie (070306)	57,077	53,758	17%	1%	12%	2%	1%
Wallace River (070217)	24,667	23,219	18%	3%	12%	3%	1%
Jordan-Boulder (040224)	32,726	31,796	19%	4%	12%	3%	0%
North Fork Snoqualmie (07031	66,707	64,395	21%	1%	17%	2%	0%
Jackman (040529)	16,399	16,255	21%	0%	20%	1%	0%

Table E-19. Percent of the Forested Area in Each Watershed in the Very Large Diameter Forest Condition Class[1/]

Watershed Name (and number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/]			
				DNR	Federal	Private[5/]	Other[6/]
French Boulder (050204)	45,327	42,831	23%	2%	20%	1%	0%
Spada (070216)	44,197	40,479	23%	15%	7%	0%	1%
Verlot (050107)	23,540	21,900	23%	1%	20%	2%	0%
East Shannon (040436)	34,065	30,874	25%	0%	25%	1%	0%
Tenas (040319)	36,688	35,609	30%	3%	26%	1%	0%
Silverton (050106)	46,399	43,646	37%	2%	35%	0%	0%
HCP Planning Unit Average			***7.9%***	***1.7%***	***5.0%***	***1.1%***	***0.2%***
Olympic Experimental State Forest							
West Dickey (200419)	28,311	27,784	1%	0%		1%	0%
Sekiu Coastal (190301)	27,412	27,309	2%	0%		2%	0%
Hoko (190302)	44,534	44,167	2%	1%	0%	1%	0%
East Dickey (200418)	26,657	26,635	2%	1%		1%	0%
Pysht River (190204)	32,972	32,676	2%	0%	1%	1%	0%
Hoh Lowlands (200608)	30,244	28,838	3%	1%	2%	0%	0%
Clallam River (190303)	22,235	21,407	4%	2%	0%	1%	0%
Lower Clearwater (210114)	45,246	44,771	4%	3%	1%	0%	0%
Sol Duc Valley (200201)	47,220	44,780	4%	1%	2%	1%	0%
Quillayute Bottom (200417)	23,180	21,898	4%	2%	2%	0%	0%
Ozette Lake (200120)	35,130	34,895	5%	1%	3%	0%	0%
Goodman-Mosquito (200610)	33,529	33,427	5%	2%	2%	0%	0%
Cedar (200609)	12,310	12,238	5%	1%	3%	1%	0%
Sol Duc Lowlands (200416)	22,368	21,077	7%	1%	3%	2%	0%
Kalaloch Ridge (210115)	11,472	11,410	7%	5%	2%	0%	0%
Middle Hoh (200607)	46,272	44,758	8%	7%	1%	0%	0%
Bogachiel (200412)	44,993	44,021	8%	3%	5%	0%	0%
Sol Duc Valley (200316)	16,585	14,408	8%	2%	6%	1%	0%
Matheney-Salmon (210211)	21,630	21,378	12%	0%	6%	0%	6%
Upper Clearwater (210116)	58,265	57,986	13%	13%	0%	0%	0%
Queets Corridor North (210213	39,496	37,320	14%	4%	10%	0%	0%
Queets Corridor South (210212	29,667	29,275	21%	1%	20%		
Rain Forest (200505)	56,435	52,643	44%	1%	42%	0%	0%
HCP Planning Unit Average			***8.0%***	***2.3%***	***4.8%***	***0.6%***	***0.3%***
South Coast HCP Planning Unit							
Elk River (220625)	32,340	29,390	0%	0%		0%	0%
Lower Willapa (240315)	32,329	23,097	0%	0%		0%	0%
Elk Creek (230117)	38,773	37,975	0%	0%		0%	0%
Mill Creek (240305)	15,699	15,508	0%	0%		0%	0%
Garrard Creek (230220)	49,056	41,682	0%	0%		0%	0%
Rock-Jones (230116)	22,917	20,045	0%	0%		0%	0%
Nemah (240212)	40,522	39,754	0%	0%		0%	0%
Palix (240213)	35,825	34,395	0%	0%		0%	0%
North River Headwaters (2404(	34,532	33,558	0%	0%		0%	
Cedar Creek (230521)	32,505	29,481	0%	0%		0%	0%
South Fork Willapa (240314)	26,664	25,538	0%	0%		0%	0%
Mox Chehalis (220106)	23,315	18,778	0%	0%		0%	
Porter Creek (230522)	32,023	30,994	0%	0%		0%	
Willapa Headwaters (240306)	62,581	58,273	0%	0%		0%	0%
Lower Naselle (240108)	36,688	34,540	0%	0%	0%	0%	0%

Table E-19. Percent of the Forested Area in Each Watershed in the Very Large Diameter Forest Condition Class[1/]

Watershed Name (and number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Lincoln Creek (230219)	48,086	40,597	0%	0%		0%	0%
Naselle Headwaters (240107)	48,336	47,324	0%	0%		0%	0%
Lower Skookumchuck (230404	44,616	33,729	0%	0%		0%	0%
Bunker Creek (230218)	22,788	21,126	0%	0%		0%	0%
Curtis (230112)	43,351	37,274	0%	0%		0%	0%
Waddel Creek (230501)	28,982	25,600	1%	0%		0%	0%
Scatter Creek (230403)	31,680	15,813	1%	0%		1%	0%
Copalis River (210407)	40,529	39,032	2%	0%		1%	0%
Joe-Moclips (210408)	50,805	50,028	3%	0%		1%	2%
HCP Planning Unit Average			***0.4%***	***0.1%***	***0.0%***	***0.2%***	***0.1%***
South Puget HCP Planning Unit							
Hood (150201)	145,611	129,375	0%	0%	0%	0%	0%
Summit Lake (140002)	29,140	26,337	0%	0%		0%	0%
Squaxin (140003)	1,066	1,040	1%	0%			0%
Olympia (130202)	18,529	14,863	1%	0%		1%	0%
Busy Wild (110204)	56,966	55,477	1%	0%		0%	0%
Tiger (080303)	40,881	32,948	2%	1%		0%	0%
Reese Creek (110106)	5,036	4,991	2%	2%		0%	
Cumberland (090202)	26,260	24,347	2%	0%		1%	0%
North Fork Mineral (110112)	16,072	16,070	2%	2%		0%	0%
Mineral Creek (110110)	23,047	22,885	2%	1%		1%	0%
Ashford (110104)	27,680	25,170	3%	0%	2%	1%	0%
East Creek (110113)	14,429	13,514	3%	1%	1%	1%	0%
Catt (110108)	13,279	13,240	4%	1%	2%	0%	
North Fork Green (090104)	18,410	18,335	4%	2%		1%	1%
Howard Hansen (090103)	46,472	45,732	4%	2%	0.0%	1%	1%
HCP Planning Unit Average			***2.0%***	***0.8%***	***0.4%***	***0.6%***	***0.2%***
Straits HCP Planning Unit							
Chimakum (170203)	28,202	22,477	1%	0%	0%	1%	0%
Dabob (170106)	16,871	16,660	2%	1%		1%	0%
Ludlow (170104)	22,897	21,543	3%	0%		3%	0%
Discovery Bay (170202)	58,871	54,002	3%	1%	1%	1%	0%
Lyre (190107)	11,021	10,813	3%	1%	2%	0%	0%
Twins (190206)	20,351	20,288	3%	0%	3%	0%	0%
Salt (190108)	26,336	22,900	4%	3%		1%	0%
Siebert McDonald (180202)	35,481	29,862	4%	1%	2%	1%	0%
Little Quil (170107)	28,536	27,161	6%	0%	5%	1%	0%
Bell Creek (180104)	5,969	2,185	6%	2%		3%	0%
Thorndike (170105)	16,587	16,374	6%	0%	0%	5%	0%
Sequim Bay (170201)	26,752	24,339	7%	2%	4%	1%	0%
Port Angeles (180211)	24,883	16,437	7%	2%	3%	2%	0%
Lilliwaup (160204)	29,080	28,383	7%	4%	1%	2%	0%
Dungeness Valley (180103)	43,200	27,406	8%	2%	5%	2%	0%
Sutherland-Aldwell (180310)	35,109	31,830	15%	1%	13%	1%	0%
Hamma Hamma (160203)	69,941	63,458	20%	1%	18%	1%	0%
Big Quil (170108)	51,823	47,083	22%	1%	20%	0%	0%
HCP Planning Unit Average			***7.1%***	***1.3%***	***4.3%***	***1.5%***	***0.1%***

Table E-19. Percent of the Forested Area in Each Watershed in the Very Large Diameter Forest Condition Class[1/]

Watershed Name (and number)	Total Acres	Forested Acres[2/]	Percent of Forested Land in Class[3/]	Percentage Breakdown by Ownership[4/]			
				DNR	Federal	Private[5/]	Other[6/]

1/ Interagency Vegetation Mapping Project data do not identify Stand Development Stages; for this analysis, stands identified as having a Quadratic Mean Diameter greater than 30 inches are classified as very large forest, and can be used as an approximation of the Structurally Complex stage. Values of "0%" indicate amounts representing less than 0.5 percent of the forested area; blanks indicate zero percent.

2/ Includes areas identified by Interagency Vegetation Mapping Project data as "vegetation," "<70% veg," "<30% conifer," or "100% veg." Stands in the latter three classes could not be assigned size classes, and therefore were not grouped into forest condition classes. Approximately 70% of forested areas were identified as "vegetation" and grouped into forest condition classes.

3/ Equals acres of very large forest divided by total forested acres in the watershed.

4/ Equals the amount of very large forest on each ownership class, divided by total forested acres in the watershed.

5/ Includes privately owned industrial and non-industrial (i.e., small landowner) lands.

6/ Includes municipal, tribal, non-DNR state lands, and other lands.

Table E-20. Percent of Each Watershed in Each Ownership Class

Watershed Name (and number)	Total Acres	Forested Acres1/	Percentage of Watershed in Each Ownership Class: DNR	Federal	Private2/	Other3/
Columbia HCP Planning Unit						
Abernethy (250104)	40,071	38,700	53%	0%	41%	5%
Bremer (260331)	19,894	19,253	15%	8%	74%	3%
Cedar Creek (260428)	14,441	14,072	6%		89%	5%
Cedar Creek (270416)	36,416	31,133	11%	0%	86%	2%
Cold Creek (270509)	21,281	18,899	76%	5%	18%	1%
Cougar (270317)	32,888	29,908	36%	37%	26%	0%
Delameter (260623)	37,243	33,641	5%		94%	0%
Grays Bay (250310)	56,613	43,943	9%		76%	15%
Green River (260515)	46,383	46,092	5%		90%	4%
Hamilton Creek (280106)	32,845	31,299	21%	27%	30%	21%
Harmony (260330)	22,546	12,574	5%		91%	4%
Lacamas (280202)	41,185	20,775	9%	7%	80%	4%
Lake Merwin (270415)	46,439	40,524	38%	0%	62%	0%
Little Washougal (280203)	30,269	22,282	23%	0%	74%	3%
Lower Kalama (270113)	49,823	43,903	6%		90%	4%
Main Elochoman (250208)	37,009	26,884	22%	3%	63%	12%
Middle Kalama (270114)	51,534	50,826	9%		91%	1%
Mill Creek (260429)	26,163	20,431	10%		90%	0%
North Elochoman (250203)	23,518	23,222	18%		82%	0%
North Fork Toutle (260514)	41,051	37,985	28%	0%	62%	11%
Olequa (260626)	35,017	22,162	7%		92%	1%
Rock Creek (290415)	41,733	39,142	40%	19%	36%	6%
Rock Creek Clark (270508)	35,440	34,297	16%	25%	58%	1%
Salmon Creek (260421)	43,837	36,964	8%		90%	3%
Silverstar (280204)	32,719	31,912	26%	11%	60%	3%
Siouxon (270305)	39,066	38,827	39%	60%	1%	0%
Skamokawa (250209)	51,687	44,179	21%	2%	68%	8%
South Fork Grays River (25030	16,774	16,193	28%		72%	0%
South Fork Toutle (260513)	42,623	41,212	21%		77%	2%
Spirit Lake (260507)	52,151	34,924	10%	85%	4%	1%
Stillwater (260625)	28,905	27,450	7%		93%	0%
Swift Creek (270304)	74,150	66,002	10%	40%	49%	1%
Upper SF Toutle (260508)	40,031	38,141	33%	21%	44%	2%
Upper Washougal (280205)	31,719	31,708	68%	13%	18%	1%
West Fork Grays River (250311	10,347	10,188	18%		82%	0%
Wind River (290414)	30,669	29,091	10%	69%	18%	3%
Winston (260320)	28,321	27,909	24%		73%	3%
Woodland (270412)	37,827	23,086	15%	0%	81%	4%
HCP Planning Unit Average			***21.2%***	***11.4%***	***63.8%***	***3.5%***
North Puget HCP Planning Unit						
Acme (010311)	23,518	18,723	28%		72%	0%
Alder (030103)	22,865	20,294	54%		46%	1%
Canyon Creek (010232)	36,807	36,235	14%	47%	38%	1%
Cavanaugh (050316)	29,722	28,792	57%		43%	0%
Cherry (070420)	38,183	31,531	19%		78%	2%
Clearwater Creek (010328)	14,330	14,277	51%	43%	6%	1%
Corkindale (040531)	24,194	23,228	5%	60%	30%	5%
Cypress (030415)	4,950	4,825	90%		10%	0%
Day Creek (030105)	22,203	22,077	9%	9%	83%	0%
Deer Creek (050201)	41,881	41,615	18%	52%	30%	0%

Table E-20. Percent of Each Watershed in Each Ownership Class

Watershed Name (and number)	Total Acres	Forested Acres1/	Percentage of Watershed in Each Ownership Class: DNR	Federal	Private2/	Other3/
Deming (010226)	27,527	23,676	38%		61%	0%
East Shannon (040436)	34,065	30,874	10%	65%	22%	3%
Ebey Hill (050214)	19,812	15,819	37%		62%	1%
French Boulder (050204)	45,327	42,831	16%	70%	13%	1%
Friday Creek (030313)	24,129	20,498	17%		80%	3%
Gilligan (030106)	18,879	17,089	17%		77%	6%
Grandy (040534)	18,856	17,804	16%		83%	1%
Hansen Creek (030102)	29,010	20,993	13%		84%	4%
Hazel (050203)	24,179	23,812	35%	39%	26%	0%
Hilt (040322)	12,453	12,152	8%	50%	41%	1%
Howard Creek (010308)	39,040	38,766	17%	11%	67%	5%
Hutchinson Creek (010310)	13,975	13,525	37%		63%	0%
Jackman (040529)	16,399	16,255	6%	55%	39%	0%
Jim Creek (050109)	30,690	29,514	22%	20%	54%	4%
Jordan (050108)	21,252	17,364	6%	1%	91%	2%
Jordan-Boulder (040224)	32,726	31,796	24%	40%	35%	1%
Kenney Creek (010230)	2,791	2,633	6%		94%	0%
Lake Whatcom (010412)	35,957	28,708	39%		51%	10%
Loretta (030104)	15,769	15,010	7%	37%	54%	1%
Lower MF Snoqualmie (070307	28,375	26,901	52%	27%	20%	0%
Lower Pilchuck Creek (050313)	19,364	17,101	6%		93%	1%
Lummi Island (010617)	5,063	4,109	12%	0%	75%	13%
Marmot Ridge (010306)	31,794	26,657	16%	73%	11%	0%
Nookachamps (030107)	47,730	38,077	30%		69%	1%
North Fork Snoqualmie (07031	66,707	64,395	7%	45%	45%	3%
Olney Creek (070225)	20,655	18,579	39%		59%	2%
Pilchuck Mtn (070226)	42,517	40,350	67%	1%	29%	3%
Porter Canyon (010327)	18,550	18,139	36%		52%	12%
Raging River (070408)	22,853	21,307	30%		68%	2%
Rinker (040321)	20,481	19,434	45%	13%	40%	2%
Samish Bay (010414)	13,258	10,390	29%		59%	12%
Samish River (030301)	57,397	33,587	14%		83%	3%
Sauk Prairie (040320)	14,137	13,412	34%	18%	48%	1%
Silverton (050106)	46,399	43,646	7%	91%	2%	1%
Skookum Creek (010309)	23,905	23,675	25%	12%	62%	0%
South Snoqualmie (070306)	57,077	53,758	10%	55%	24%	11%
Spada (070216)	44,197	40,479	63%	26%	2%	10%
Stimson Hill (050215)	18,833	17,449	41%		58%	0%
Sultan River (070224)	24,388	22,591	56%	7%	25%	12%
Sumas River (010125)	36,444	13,828	9%		90%	0%
Tate (070409)	9,798	7,772	7%		92%	0%
Tenas (040319)	36,688	35,609	15%	76%	9%	0%
Tolt (070415)	63,357	60,617	8%	14%	67%	12%
Upper NF Stilly (050202)	32,833	32,818	10%	80%	10%	0%
Vedder (010131)	21,272	17,850	15%	0%	85%	0%
Verlot (050107)	23,540	21,900	6%	64%	27%	2%
Wallace River (070217)	24,667	23,219	31%	36%	26%	8%
Warnick (010229)	25,436	24,817	70%	2%	29%	0%
West Shannon (040435)	14,333	13,458	18%	9%	67%	6%
Woods Creek (070223)	42,463	35,484	24%		73%	3%

Table E-20. Percent of Each Watershed in Each Ownership Class

Watershed Name (and number)	Total Acres	Forested Acres1/	Percentage of Watershed in Each Ownership Class DNR	Federal	Private2/	Other3/
Youngs Creek (070219)	23,776	21,907	12%	2%	85%	0%
HCP Planning Unit Average			***25.6%***	***20.5%***	***51.0%***	***2.9%***
Olympic Experimental State Forest						
Bogachiel (200412)	44,993	44,021	37%	18%	44%	1%
Cedar (200609)	12,310	12,238	37%	22%	41%	1%
Clallam River (190303)	22,235	21,407	50%	0%	49%	1%
East Dickey (200418)	26,657	26,635	45%		54%	1%
Goodman-Mosquito (200610)	33,529	33,427	37%	12%	51%	0%
Hoh Lowlands (200608)	30,244	28,838	26%	4%	67%	2%
Hoko (190302)	44,534	44,167	24%	1%	72%	2%
Kalaloch Ridge (210115)	11,472	11,410	56%	9%	35%	0%
Lower Clearwater (210114)	45,246	44,771	45%	4%	48%	2%
Matheney-Salmon (210211)	21,630	21,378	17%	31%	1%	51%
Middle Hoh (200607)	46,272	44,758	71%	3%	25%	1%
Ozette Lake (200120)	35,130	34,895	15%	39%	45%	1%
Pysht River (190204)	32,972	32,676	6%	14%	79%	0%
Queets Corridor North (210213	39,496	37,320	29%	38%	8%	25%
Queets Corridor South (210212	29,667	29,275	25%	75%		
Quillayute Bottom (200417)	23,180	21,898	28%	16%	47%	9%
Rain Forest (200505)	56,435	52,643	11%	89%	0%	0%
Sekiu Coastal (190301)	27,412	27,309	14%		80%	6%
Sol Duc Lowlands (200416)	22,368	21,077	19%	15%	64%	2%
Sol Duc Valley (200201)	47,220	44,780	30%	40%	26%	4%
Sol Duc Valley (200316)	16,585	14,408	25%	18%	55%	2%
Upper Clearwater (210116)	58,265	57,986	98%	1%	1%	0%
West Dickey (200419)	28,311	27,784	12%		86%	2%
HCP Planning Unit Average			***33.0%***	***19.5%***	***42.5%***	***5.0%***
South Coast HCP Planning Unit						
Bunker Creek (230218)	22,788	21,126	29%		71%	0%
Cedar Creek (230521)	32,505	29,481	80%		15%	5%
Copalis River (210407)	40,529	39,032	6%		75%	19%
Curtis (230112)	43,351	37,274	17%		81%	2%
Elk Creek (230117)	38,773	37,975	33%		63%	4%
Elk River (220625)	32,340	29,390	11%		61%	28%
Garrard Creek (230220)	49,056	41,682	40%		59%	1%
Joe-Moclips (210408)	50,805	50,028	7%	0%	43%	49%
Lincoln Creek (230219)	48,086	40,597	30%		69%	1%
Lower Naselle (240108)	36,688	34,540	16%	1%	83%	1%
Lower Skookumchuck (230404	44,616	33,729	19%		81%	0%
Lower Willapa (240315)	32,329	23,097	5%		94%	0%
Mill Creek (240305)	15,699	15,508	67%		32%	0%
Mox Chehalis (220106)	23,315	18,778	22%		77%	1%
Naselle Headwaters (240107)	48,336	47,324	11%		89%	0%
Nemah (240212)	40,522	39,754	26%		72%	2%
North River Headwaters (2404(	34,532	33,558	10%		90%	0%
Palix (240213)	35,825	34,395	10%		87%	3%
Porter Creek (230522)	32,023	30,994	88%		11%	1%
Rock-Jones (230116)	22,917	20,045	31%		68%	2%
Scatter Creek (230403)	31,680	15,813	5%		91%	4%
South Fork Willapa (240314)	26,664	25,538	37%		60%	3%
Waddel Creek (230501)	28,982	25,600	68%		31%	1%

Table E-20. Percent of Each Watershed in Each Ownership Class

Watershed Name (and number)	Total Acres	Forested Acres1/	Percentage of Watershed in Each Ownership Class: DNR	Federal	Private2/	Other3/
Willapa Headwaters (240306)	62,581	58,273	30%		69%	1%
HCP Planning Unit Average			***29.1%***	***0.0%***	***65.5%***	***5.4%***
South Puget HCP Planning Unit						
Ashford (110104)	27,680	25,170	30%	24%	43%	3%
Busy Wild (110204)	56,966	55,477	27%		65%	8%
Catt (110108)	13,279	13,240	53%	46%	0%	0%
Cumberland (090202)	26,260	24,347	11%		80%	9%
East Creek (110113)	14,429	13,514	23%	23%	52%	3%
Hood (150201)	145,611	129,375	23%	4%	64%	8%
Howard Hansen (090103)	46,472	45,732	35%	1%	49%	15%
Mineral Creek (110110)	23,047	22,885	20%		74%	6%
North Fork Green (090104)	18,410	18,335	36%		50%	14%
North Fork Mineral (110112)	16,072	16,070	84%		14%	2%
Olympia (130202)	18,529	14,863	20%		74%	5%
Reese Creek (110106)	5,036	4,991	96%		4%	0%
Squaxin (140003)	1,066	1,040	22%		0%	78%
Summit Lake (140002)	29,140	26,337	31%		68%	1%
Tiger (080303)	40,881	32,948	25%		61%	14%
HCP Planning Unit Average			***35.8%***	***6.5%***	***46.6%***	***11.1%***
Straits HCP Planning Unit						
Bell Creek (180104)	5,969	2,185	6%		93%	2%
Big Quil (170108)	51,823	47,083	7%	83%	10%	0%
Chimakum (170203)	28,202	22,477	6%	8.5%	82%	4%
Dabob (170106)	16,871	16,660	28%		70%	2%
Discovery Bay (170202)	58,871	54,002	13%	17%	64%	6%
Dungeness Valley (180103)	43,200	27,406	13%	23%	62%	2%
Hamma Hamma (160203)	69,941	63,458	15%	74%	10%	0%
Lilliwaup (160204)	29,080	28,383	56%	10%	33%	1%
Little Quil (170107)	28,536	27,161	10%	35%	54%	0%
Ludlow (170104)	22,897	21,543	9%	0%	90%	1%
Lyre (190107)	11,021	10,813	56%	12%	30%	2%
Port Angeles (180211)	24,883	16,437	18%	12%	67%	2%
Salt (190108)	26,336	22,900	43%		53%	4%
Sequim Bay (170201)	26,752	24,339	31%	26%	40%	3%
Siebert McDonald (180202)	35,481	29,862	25%	17%	58%	1%
Sutherland-Aldwell (180310)	35,109	31,830	19%	50%	27%	5%
Thorndike (170105)	16,587	16,374	9%	4%	86%	2%
Twins (190206)	20,351	20,288	37%	45%	17%	1%
HCP Planning Unit Average			***22.3%***	***23.1%***	***52.5%***	***2.1%***

1/ Includes areas identified by Interagency Vegetation Mapping Project data as "vegetation," "<70% veg," "<30% conifer," or "100% veg." Areas not classified as Forested include those identified as agricultural or urban areas, water and wetlands, and unvegetated or unclassifiable sites such as snow, barren ground, and topographic shadow.

2/ Includes privately owned industrial and non-industrial (i.e., small landowner) lands.

3/ Includes municipal, tribal, non-DNR state lands, and other lands.

Table E-21. Percent of the Riparian Area in Each Watershed in the Small Tree Stages [1/]

Watershed Name (and number)	Total Acres	Riparian Acres[2/]	Percent of Riparian Area[3/]	Percentage Breakdown by Ownership[4/]			
				DNR	Federal	Private[5/]	Other[6/]
Columbia HCP Planning Unit							
Green River (260515)	46,383	17,668	54%	2%	0%	50%	2%
North Fork Toutle (260514)	41,051	14,159	47%	15%	0%	30%	2%
Winston (260320)	28,321	8,943	46%	8%	0%	37%	1%
Cedar Creek (260428)	14,441	4,839	42%	2%	0%	39%	1%
Upper SF Toutle (260508)	40,031	16,140	39%	12%	3%	23%	1%
Upper Washougal (280205)	31,719	10,543	37%	26%	5%	6%	0%
Hamilton Creek (280106)	32,845	7,271	36%	10%	11%	9%	6%
Swift Creek (270304)	74,150	25,760	35%	2%	7%	25%	0%
Bremer (260331)	19,894	7,651	34%	5%	3%	26%	1%
Rock Creek Clark (270508)	35,440	8,523	33%	5%	8%	20%	0%
Middle Kalama (270114)	51,534	19,484	33%	1%	0%	32%	0%
Silverstar (280204)	32,719	7,476	32%	8%	2%	20%	1%
South Fork Toutle (260513)	42,623	15,345	30%	10%	0%	21%	0%
Salmon Creek (260421)	43,837	11,846	30%	3%	0%	27%	1%
Stillwater (260625)	28,905	11,799	29%	1%	0%	28%	0%
Rock Creek (290415)	41,733	13,043	29%	14%	5%	9%	0%
Wind River (290414)	30,669	6,909	27%	5%	20%	3%	0%
West Fork Grays River (250311)	10,347	5,644	27%	3%	0%	24%	0%
Delameter (260623)	37,243	13,983	27%	2%	0%	25%	0%
Cold Creek (270509)	21,281	4,405	27%	19%	1%	6%	0%
North Elochoman (250203)	23,518	10,534	26%	5%	0%	21%	0%
Grays Bay (250310)	56,613	25,821	26%	2%	0%	23%	0%
South Fork Grays River (250302)	16,774	7,517	26%	9%	0%	16%	0%
Skamokawa (250209)	51,687	22,368	23%	5%	0%	19%	0%
Lower Kalama (270113)	49,823	14,901	23%	1%	0%	22%	0%
Cougar (270317)	32,888	10,845	23%	10%	6%	6%	0%
Cedar Creek (270416)	36,416	9,339	21%	2%	0%	19%	1%
Mill Creek (260429)	26,163	6,561	21%	3%	0%	18%	0%
Lake Merwin (270415)	46,439	15,175	20%	9%	0%	11%	0%
Siouxon (270305)	39,066	10,192	19%	8%	11%	0%	0%
Little Washougal (280203)	30,269	7,142	17%	7%	0%	10%	0%
Main Elochoman (250208)	37,009	15,789	16%	4%	0%	12%	0%
Abernethy (250104)	40,071	13,465	16%	10%	0%	6%	1%
Olequa (260626)	35,017	7,915	14%	2%	0%	11%	0%
Harmony (260330)	22,546	5,136	12%	3%	0%	8%	1%
Woodland (270412)	37,827	13,843	10%	2%	0%	7%	0%
Lacamas (280202)	41,185	5,777	7%	1%	1%	5%	0%
Spirit Lake (260507)	52,151	26,647	5%	2%	2%	0%	0%
HCP Planning Unit Average			***27%***	***6%***	***2%***	***18%***	***1%***
North Puget HCP Planning Unit							
Skookum Creek (010309)	23,905	8,621	45%	16%	1%	28%	0%
Hutchinson Creek (010310)	13,975	4,754	39%	13%	0%	26%	0%
Warnick (010229)	25,436	8,208	38%	28%	0%	10%	0%
Porter Canyon (010327)	18,550	5,855	36%	10%	0%	22%	4%
Howard Creek (010308)	39,040	11,411	36%	7%	0%	28%	1%
Canyon Creek (010232)	36,807	6,131	35%	7%	4%	24%	0%
Clearwater Creek (010328)	14,330	3,163	31%	25%	3%	3%	0%
Kenney Creek (010230)	2,791	765	31%	1%	0%	30%	0%

Table E-21. Percent of the Riparian Area in Each Watershed in the Small Tree Stages [1/]

Watershed Name (and number)	Total Acres	Riparian Acres [2/]	Percent of Riparian Area [3/]	Percentage Breakdown by Ownership [4/] DNR	Federal	Private [5/]	Other [6/]
Day Creek (030105)	22,203	6,183	30%	3%	1%	26%	0%
Upper NF Stilly (050202)	32,833	6,648	27%	4%	19%	5%	0%
Loretta (030104)	15,769	3,748	27%	5%	5%	18%	0%
Gilligan (030106)	18,879	5,182	27%	6%	0%	20%	1%
Vedder (010131)	21,272	2,920	27%	8%	0%	19%	0%
Alder (030103)	22,865	4,499	27%	22%	0%	4%	0%
Deming (010226)	27,527	6,199	25%	15%	0%	11%	0%
Hansen Creek (030102)	29,010	7,622	25%	6%	0%	18%	0%
Jackman (040529)	16,399	3,006	25%	1%	5%	18%	0%
Marmot Ridge (010306)	31,794	5,308	24%	8%	4%	11%	0%
Raging River (070408)	22,853	5,514	23%	6%	0%	16%	0%
Lower Pilchuck Creek (050313)	19,364	3,838	22%	2%	0%	20%	0%
Acme (010311)	23,518	6,190	21%	8%	0%	14%	0%
Deer Creek (050201)	41,881	11,971	21%	4%	8%	9%	0%
Lake Whatcom (010412)	35,957	8,891	20%	12%	0%	9%	0%
Sauk Prairie (040320)	14,137	3,672	20%	8%	3%	9%	0%
Lower MF Snoqualmie (070307)	28,375	9,071	20%	13%	5%	3%	0%
Jim Creek (050109)	30,690	6,580	20%	3%	3%	14%	0%
Tolt (070415)	63,357	18,242	20%	1%	2%	14%	4%
Samish River (030301)	57,397	10,240	20%	6%	0%	13%	0%
East Shannon (040436)	34,065	6,254	19%	6%	3%	9%	0%
Hilt (040322)	12,453	2,416	19%	1%	7%	10%	0%
South Snoqualmie (070306)	57,077	14,262	18%	3%	9%	4%	2%
North Fork Snoqualmie (070313)	66,707	19,488	18%	2%	4%	11%	1%
Grandy (040534)	18,856	4,076	18%	5%	0%	12%	0%
West Shannon (040435)	14,333	3,819	18%	5%	0%	13%	0%
Friday Creek (030313)	24,129	3,639	18%	3%	0%	14%	0%
Verlot (050107)	23,540	6,013	17%	1%	9%	6%	0%
Pilchuck Mtn (070226)	42,517	12,926	17%	12%	0%	5%	0%
Cherry (070420)	38,183	8,079	17%	4%	0%	12%	0%
Samish Bay (010414)	13,258	2,306	17%	4%	0%	10%	2%
Cavanaugh (050316)	29,722	7,839	16%	11%	0%	5%	0%
Tate (070409)	9,798	2,605	16%	1%	0%	15%	0%
Ebey Hill (050214)	19,812	5,191	16%	8%	0%	8%	0%
Nookachamps (030107)	47,730	11,001	15%	6%	0%	9%	0%
Youngs Creek (070219)	23,776	5,381	15%	2%	0%	13%	0%
Spada (070216)	44,197	13,855	15%	10%	2%	0%	2%
Stimson Hill (050215)	18,833	5,632	14%	7%	0%	8%	0%
Rinker (040321)	20,481	6,277	14%	5%	1%	8%	0%
Jordan-Boulder (040224)	32,726	6,733	14%	2%	1%	11%	0%
Olney Creek (070225)	20,655	5,528	14%	5%	0%	9%	0%
Woods Creek (070223)	42,463	9,893	14%	5%	0%	9%	1%
Wallace River (070217)	24,667	6,382	14%	5%	4%	3%	1%
Hazel (050203)	24,179	6,144	13%	7%	3%	3%	0%
Silverton (050106)	46,399	12,922	12%	1%	10%	1%	0%
Cypress (030415)	4,950	675	11%	9%	0%	1%	0%
Tenas (040319)	36,688	8,833	11%	2%	6%	3%	0%
Corkindale (040531)	24,194	5,339	11%	1%	6%	4%	0%
Sumas River (010125)	36,444	4,972	10%	3%	0%	7%	0%

Table E-21. Percent of the Riparian Area in Each Watershed in the Small Tree Stages [1/]

Watershed Name (and number)	Total Acres	Riparian Acres[2/]	Percent of Riparian Area[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Lummi Island (010617)	5,063	504	10%	0%	0%	8%	2%
Jordan (050108)	21,252	5,609	10%	0%	0%	10%	0%
French Boulder (050204)	45,327	9,837	10%	2%	6%	1%	0%
Sultan River (070224)	24,388	6,980	9%	5%	2%	2%	1%
HCP Planning Unit Average			***20%***	***6%***	***2%***	***11%***	***0%***
Olympic Experimental State Forest							
Kalaloch Ridge (210115)	11,472	4,739	40%	23%	1%	16%	0%
Hoko (190302)	44,534	13,700	39%	8%	0%	31%	1%
Lower Clearwater (210114)	45,246	17,727	37%	16%	0%	19%	1%
West Dickey (200419)	28,311	8,407	34%	4%	0%	30%	0%
Cedar (200609)	12,310	3,683	34%	15%	2%	16%	0%
Goodman-Mosquito (200610)	33,529	11,858	34%	9%	0%	25%	0%
East Dickey (200418)	26,657	7,274	32%	14%	0%	18%	0%
Hoh Lowlands (200608)	30,244	10,976	32%	8%	0%	23%	1%
Sekiu Coastal (190301)	27,412	9,872	31%	3%	0%	26%	2%
Pysht River (190204)	32,972	8,682	30%	3%	7%	19%	0%
Matheney-Salmon (210211)	21,630	5,577	30%	3%	9%	0%	17%
Sol Duc Valley (200201)	47,220	13,008	29%	9%	13%	6%	0%
Upper Clearwater (210116)	58,265	19,964	28%	28%	0%	0%	0%
Middle Hoh (200607)	46,272	18,410	26%	18%	0%	7%	0%
Clallam River (190303)	22,235	5,625	26%	16%	0%	9%	0%
Sol Duc Valley (200316)	16,585	5,329	23%	11%	2%	10%	0%
Bogachiel (200412)	44,993	14,984	22%	9%	1%	11%	0%
Queets Corridor South (210212)	29,667	6,439	21%	5%	17%	0%	0%
Queets Corridor North (210213)	39,496	9,905	20%	6%	5%	3%	5%
Sol Duc Lowlands (200416)	22,368	6,545	20%	4%	5%	11%	0%
Quillayute Bottom (200417)	23,180	7,176	19%	6%	1%	11%	1%
Ozette Lake (200120)	35,130	10,132	19%	4%	1%	14%	0%
Rain Forest (200505)	56,435	12,578	8%	4%	4%	0%	0%
HCP Planning Unit Average			***28%***	***10%***	***3%***	***13%***	***1%***
South Coast HCP Planning Unit							
Elk River (220625)	32,340	12,792	51%	8%	0%	27%	17%
Palix (240213)	35,825	15,918	49%	5%	0%	43%	2%
Nemah (240212)	40,522	19,123	42%	8%	0%	34%	0%
Elk Creek (230117)	38,773	16,767	39%	11%	0%	27%	1%
South Fork Willapa (240314)	26,664	12,941	38%	13%	0%	23%	1%
Rock-Jones (230116)	22,917	9,502	34%	12%	0%	22%	0%
Lower Naselle (240108)	36,688	18,388	33%	5%	0%	27%	0%
Willapa Headwaters (240306)	62,581	28,873	33%	12%	0%	20%	0%
Mill Creek (240305)	15,699	7,283	33%	22%	0%	11%	0%
Porter Creek (230522)	32,023	7,373	31%	27%	0%	4%	0%
Bunker Creek (230218)	22,788	8,564	29%	9%	0%	20%	0%
North River Headwaters (240402)	34,532	12,663	29%	3%	0%	25%	0%
Naselle Headwaters (240107)	48,336	24,664	29%	3%	0%	26%	0%
Lincoln Creek (230219)	48,086	15,260	28%	11%	0%	17%	0%
Lower Willapa (240315)	32,329	17,220	27%	2%	0%	25%	0%
Mox Chehalis (220106)	23,315	6,228	26%	6%	0%	19%	0%
Curtis (230112)	43,351	18,356	26%	7%	0%	19%	0%
Garrard Creek (230220)	49,056	16,414	25%	11%	0%	13%	0%

Table E-21. Percent of the Riparian Area in Each Watershed in the Small Tree Stages [1/]

Watershed Name (and number)	Total Acres	Riparian Acres[2/]	Percent of Riparian Area[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Copalis River (210407)	40,529	10,699	24%	2%	0%	15%	7%
Waddel Creek (230501)	28,982	6,550	22%	18%	0%	4%	0%
Cedar Creek (230521)	32,505	7,724	22%	19%	0%	2%	0%
Joe-Moclips (210408)	50,805	12,496	21%	2%	0%	11%	8%
Lower Skookumchuck (230404)	44,616	15,981	17%	5%	0%	12%	0%
Scatter Creek (230403)	31,680	6,533	16%	3%	0%	13%	0%
HCP Planning Unit Average			***30%***	***9%***	***0%***	***19%***	***2%***
South Puget HCP Planning Unit							
North Fork Mineral (110112)	16,072	5,707	60%	53%	0%	7%	1%
Mineral Creek (110110)	23,047	8,281	53%	10%	0%	41%	2%
Catt (110108)	13,279	4,649	49%	31%	18%	0%	0%
Reese Creek (110106)	5,036	1,248	49%	49%	0%	0%	0%
Busy Wild (110204)	56,966	17,975	48%	11%	0%	37%	1%
East Creek (110113)	14,429	5,171	38%	10%	12%	15%	1%
North Fork Green (090104)	18,410	5,005	38%	10%	0%	25%	3%
Howard Hansen (090103)	46,472	14,423	34%	14%	0%	14%	6%
Cumberland (090202)	26,260	4,411	29%	6%	0%	22%	1%
Ashford (110104)	27,680	9,164	28%	9%	6%	11%	1%
Summit Lake (140002)	29,140	5,095	25%	9%	0%	16%	0%
Squaxin (140003)	1,066	185	25%	7%	0%	0%	19%
Tiger (080303)	40,881	6,899	20%	7%	0%	11%	2%
Hood (150201)	145,611	29,448	19%	4%	0%	14%	2%
Olympia (130202)	18,529	2,751	17%	4%	0%	12%	0%
HCP Planning Unit Average			***36%***	***16%***	***2%***	***15%***	***3%***
Straits HCP Planning Unit							
Dabob (170106)	16,871	3,678	39%	13%	0%	25%	1%
Ludlow (170104)	22,897	4,737	36%	3%	0%	33%	0%
Lyre (190107)	11,021	2,128	36%	24%	3%	8%	1%
Thorndike (170105)	16,587	3,738	34%	4%	2%	27%	1%
Twins (190206)	20,351	4,302	34%	15%	14%	5%	0%
Chimakum (170203)	28,202	4,547	29%	2%	1%	26%	1%
Discovery Bay (170202)	58,871	7,162	29%	6%	6%	16%	1%
Sequim Bay (170201)	26,752	4,192	29%	12%	6%	11%	1%
Siebert McDonald (180202)	35,481	5,179	26%	8%	7%	11%	0%
Salt (190108)	26,336	3,854	25%	10%	0%	13%	1%
Lilliwaup (160204)	29,080	6,242	23%	16%	2%	6%	0%
Little Quil (170107)	28,536	4,660	23%	3%	7%	13%	0%
Port Angeles (180211)	24,883	3,332	21%	7%	2%	12%	1%
Big Quil (170108)	51,823	6,674	19%	3%	12%	4%	0%
Hamma Hamma (160203)	69,941	9,272	18%	6%	8%	3%	0%
Sutherland-Aldwell (180310)	35,109	5,667	17%	5%	5%	5%	1%
Dungeness Valley (180103)	43,200	8,670	12%	3%	4%	5%	0%
Bell Creek (180104)	5,969	849	8%	1%	0%	8%	0%
HCP Planning Unit Average			***26%***	***8%***	***4%***	***13%***	***1%***

Table E-21. Percent of the Riparian Area in Each Watershed in the Small Tree Stages [1/]

Watershed Name (and number)	Total Acres	Riparian Acres[2/]	Percent of Riparian Area[3/]	Percentage Breakdown by Ownership[4/]			
				DNR	Federal	Private[5/]	Other[6/]

1/ Interagency Vegetation Mapping Project data do not identify Stand Development Stages; for this analysis, stands identified as having a Quadratic Mean Diameter less than 10 inches are considered small trees. Values of "0%" indicate amounts representing less than 0.5 percent of the riparian area.

2/ Includes areas identified by Interagency Vegetation Mapping Project data as "vegetation," "<70% veg," "<30% conifer," or "100% veg.' Stands in the latter three classes could not be assigned size classes, and therefore were not grouped into Stand Development Stages. Approximately 70% of forested areas were identified as "vegetation" and grouped into Stand Development Stages. Riparian widths were assumed to be 155 feet on each side of Type 1, 2, and 3 streams and 100 feet on each side of Type 4 streams using the upgraded stream typing described in Appendix A.

3/ Equals acres of small tree forest divided by total riparian acres in the watershed.

4/ Equals the amount of small tree forest on each ownership class, divided by total riparian acres in the watershed.

5/ Includes privately owned industrial and non-industrial (i.e., small landowner) lands.

6/ Includes municipal, tribal, non-DNR state lands, and other lands.

Table E-22. Anadromous Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Anadromous Stream Density mi/sq mi	Total Anadromous Stream Miles	Miles Breakdown by Ownership			
				DNR	Federal	Private1/	Other2/
Columbia HCP Planning Unit							
Wind River (290414)	30,669	0.59	28.5	0.4	18.7	8.8	0.6
Grays Bay (250310)	56,613	0.57	50.0	0.0	0.0	38.6	11.5
Cedar Creek (270416)	36,416	0.56	31.8	1.0	0.3	29.5	1.1
North Fork Toutle (260514)	41,051	0.55	35.2	0.9	0.0	21.2	13.0
Hamilton Creek (280106)	32,845	0.51	26.2	0.0	5.6	8.0	12.6
Skamokawa (250209)	51,687	0.51	41.1	6.1	0.7	26.1	8.2
Cold Creek (270509)	21,281	0.49	16.5	10.9	0.0	5.5	0.1
Little Washougal (280203)	30,269	0.48	22.9	0.2	0.2	21.1	1.4
South Fork Grays River (250302)	16,774	0.48	12.5	6.7	0.0	5.7	0.0
Upper Washougal (280205)	31,719	0.45	22.5	17.4	0.0	4.7	0.4
Olequa (260626)	35,017	0.45	24.6	0.0	0.0	24.6	0.0
Delameter (260623)	37,243	0.44	25.9	0.0	0.0	25.9	0.0
Woodland (270412)	37,827	0.44	26.2	0.0	0.0	24.0	2.2
Salmon Creek (260421)	43,837	0.44	30.3	0.0	0.0	26.7	3.6
Silverstar (280204)	32,719	0.43	21.9	1.4	1.5	17.7	1.3
West Fork Grays River (250311)	10,347	0.43	6.9	1.4	0.0	5.4	0.2
South Fork Toutle (260513)	42,623	0.42	27.8	4.3	0.0	23.4	0.2
Main Elochoman (250208)	37,009	0.42	24.1	1.9	0.6	14.0	7.6
Abernethy (250104)	40,071	0.40	25.2	8.2	0.4	12.5	4.1
Green River (260515)	46,383	0.38	27.6	0.0	0.0	24.7	2.9
North Elochoman (250203)	23,518	0.37	13.5	3.7	0.0	9.6	0.1
Stillwater (260625)	28,905	0.36	16.3	0.0	0.0	16.3	0.0
Rock Creek Clark (270508)	35,440	0.33	18.2	1.8	2.0	12.2	2.1
Cedar Creek (260428)	14,441	0.33	7.3	0.0	0.0	6.8	0.6
Middle Kalama (270114)	51,534	0.32	26.2	0.9	0.0	25.2	0.0
Lower Kalama (270113)	49,823	0.32	24.9	0.0	0.0	21.0	3.9
Upper SF Toutle (260508)	40,031	0.30	19.0	5.9	0.0	9.7	3.4
Mill Creek (260429)	26,163	0.24	9.7	0.0	0.0	9.7	0.1
Rock Creek (290415)	41,733	0.14	9.4	0.0	0.0	3.8	5.6
Spirit Lake (260507)	52,151	0.11	9.2	0.1	9.2	0.0	0.0
Lacamas (280202)	41,185	0.07	4.2	0.0	0.0	0.9	3.3
Lake Merwin (270415)	46,439	0.00	0.2	0.0	0.0	0.2	0.0
Harmony (260330)	22,546	0.00	0.0	0.0	0.0	0.0	0.0
Winston (260320)	28,321	0.00	0.0	0.0	0.0	0.0	0.0
Bremer (260331)	19,894	0.00	0.0	0.0	0.0	0.0	0.0
Swift Creek (270304)	74,150	0.00	0.0	0.0	0.0	0.0	0.0
Siouxon (270305)	39,066	0.00	0.0	0.0	0.0	0.0	0.0
Cougar (270317)	32,888	0.00	0.0	0.0	0.0	0.0	0.0
HCP Planning Unit Average		***0.32***	***18.1***	***1.9***	***1.0***	***12.7***	***2.4***
North Puget HCP Planning Unit							
Sumas River (010125)	36,444	1.05	59.5	0.0	0.0	59.0	0.5
Gilligan (030106)	18,879	0.84	24.9	1.9	0.0	19.3	3.7
Jordan (050108)	21,252	0.80	26.4	0.0	0.0	26.3	0.2
Rinker (040321)	20,481	0.72	22.9	4.9	0.6	16.1	1.4
Kenney Creek (010230)	2,791	0.71	3.1	0.0	0.0	3.1	0.0
Acme (010311)	23,518	0.70	25.9	0.0	0.0	25.6	0.3

Table E-22. Anadromous Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Anadromous Stream Density mi/sq mi	Total Anadromous Stream Miles	Miles Breakdown by Ownership			
				DNR	Federal	Private1/	Other2/
Lower Pilchuck Creek (050313)	19,364	0.69	20.9	1.0	0.0	19.4	0.6
Nookachamps (030107)	47,730	0.69	51.2	4.1	0.0	46.7	0.5
Samish River (030301)	57,397	0.64	57.0	1.9	0.0	54.1	1.0
Friday Creek (030313)	24,129	0.63	23.7	0.3	0.0	22.2	1.1
Hansen Creek (030102)	29,010	0.61	27.8	0.5	0.0	23.3	4.0
Hutchinson Creek (010310)	13,975	0.60	13.1	3.6	0.0	9.5	0.0
Stimson Hill (050215)	18,833	0.59	17.3	1.2	0.0	15.4	0.7
Hazel (050203)	24,179	0.58	22.0	2.4	4.2	15.3	0.1
Woods Creek (070223)	42,463	0.58	38.6	3.0	0.0	35.6	0.0
Alder (030103)	22,865	0.58	20.7	6.3	0.0	14.4	0.1
Warnick (010229)	25,436	0.57	22.6	4.9	0.9	16.8	0.0
Raging River (070408)	22,853	0.56	20.0	4.0	0.0	16.0	0.1
Sauk Prairie (040320)	14,137	0.54	12.0	1.5	0.3	8.2	1.9
Porter Canyon (010327)	18,550	0.54	15.7	3.3	0.0	11.0	1.3
Deming (010226)	27,527	0.54	23.0	0.6	0.0	22.3	0.1
Ebey Hill (050214)	19,812	0.53	16.3	0.7	0.0	14.9	0.7
Loretta (030104)	15,769	0.48	11.9	0.2	0.0	11.6	0.0
Jim Creek (050109)	30,690	0.47	22.7	2.6	4.3	15.8	0.0
Verlot (050107)	23,540	0.44	16.1	0.8	6.3	9.0	0.0
Olney Creek (070225)	20,655	0.43	14.0	0.9	0.0	13.2	0.0
French Boulder (050204)	45,327	0.42	29.7	11.9	4.7	12.7	0.5
Pilchuck Mtn (070226)	42,517	0.42	27.7	12.7	0.0	14.9	0.1
Grandy (040534)	18,856	0.42	12.2	0.6	0.0	11.0	0.6
Silverton (050106)	46,399	0.41	29.7	0.0	26.8	2.2	0.8
Deer Creek (050201)	41,881	0.41	26.6	7.9	7.0	11.6	0.1
Samish Bay (010414)	13,258	0.40	8.3	0.0	0.0	8.3	0.0
Youngs Creek (070219)	23,776	0.39	14.3	0.2	0.0	14.1	0.0
Cherry (070420)	38,183	0.38	22.6	4.1	0.0	16.0	2.6
Sultan River (070224)	24,388	0.36	13.9	3.0	0.0	8.9	2.0
Howard Creek (010308)	39,040	0.36	21.9	1.7	1.0	15.0	4.2
Wallace River (070217)	24,667	0.34	13.2	0.4	0.0	10.5	2.2
Corkindale (040531)	24,194	0.31	11.8	0.0	0.8	8.9	2.1
Jordan-Boulder (040224)	32,726	0.31	15.9	1.8	2.6	11.2	0.4
Hilt (040322)	12,453	0.28	5.5	0.2	0.0	5.1	0.2
Tolt (070415)	63,357	0.28	27.9	1.7	0.0	24.5	1.7
Tate (070409)	9,798	0.22	3.4	0.0	0.0	3.1	0.3
Tenas (040319)	36,688	0.21	11.8	3.1	2.7	4.7	1.3
Vedder (010131)	21,272	0.20	6.8	0.0	0.0	6.8	0.0
Skookum Creek (010309)	23,905	0.20	7.3	3.2	0.0	4.1	0.0
Canyon Creek (010232)	36,807	0.17	10.0	1.1	1.5	7.4	0.0
East Shannon (040436)	34,065	0.16	8.3	0.0	4.2	0.7	3.4
Day Creek (030105)	22,203	0.15	5.2	0.0	0.0	5.2	0.0
West Shannon (040435)	14,333	0.14	3.2	0.0	0.0	0.1	3.1
Upper NF Stilly (050202)	32,833	0.09	4.4	2.4	0.0	2.0	0.0
Jackman (040529)	16,399	0.07	1.8	0.0	0.0	1.8	0.0
Lummi Island (010617)	5,063	0.00	0.0	0.0	0.0	0.0	0.0
Cypress (030415)	4,950	0.00	0.0	0.0	0.0	0.0	0.0

Table E-22. Anadromous Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Anadromous Stream Density mi/sq mi	Total Anadromous Stream Miles	Miles Breakdown by Ownership			
				DNR	Federal	Private1/	Other2/
Lake Whatcom (010412)	35,957	0.00	0.0	0.0	0.0	0.0	0.0
Cavanaugh (050316)	29,722	0.00	0.0	0.0	0.0	0.0	0.0
Clearwater Creek (010328)	14,330	0.00	0.0	0.0	0.0	0.0	0.0
Marmot Ridge (010306)	31,794	0.00	0.0	0.0	0.0	0.0	0.0
Lower MF Snoqualmie (070307)	28,375	0.00	0.0	0.0	0.0	0.0	0.0
South Snoqualmie (070306)	57,077	0.00	0.0	0.0	0.0	0.0	0.0
North Fork Snoqualmie (070313)	66,707	0.00	0.0	0.0	0.0	0.0	0.0
Spada (070216)	44,197	0.00	0.0	0.0	0.0	0.0	0.0
HCP Planning Unit Average		***0.38***	***15.9***	***1.7***	***1.1***	***12.4***	***0.7***
Olympic Experimental State Forest							
West Dickey (200419)	28,311	1.09	48.3	6.5	0.0	39.1	2.6
Sol Duc Valley (200316)	16,585	1.09	28.2	5.2	3.4	19.4	0.2
Sol Duc Lowlands (200416)	22,368	1.02	35.8	3.0	1.8	29.8	1.1
East Dickey (200418)	26,657	0.88	36.7	12.9	0.0	23.4	0.4
Bogachiel (200412)	44,993	0.85	59.7	17.7	9.5	30.4	2.0
Pysht River (190204)	32,972	0.81	41.7	0.1	2.0	39.2	0.4
Sol Duc Valley (200201)	47,220	0.77	56.8	16.2	13.2	20.1	7.3
Lower Clearwater (210114)	45,246	0.76	53.7	17.4	0.1	34.0	2.1
Hoh Lowlands (200608)	30,244	0.76	35.9	7.1	0.3	27.8	0.7
Hoko (190302)	44,534	0.75	52.3	6.8	0.0	41.3	4.2
Clallam River (190303)	22,235	0.75	26.0	10.7	0.0	14.8	0.6
Quillayute Bottom (200417)	23,180	0.73	26.3	4.5	2.8	18.1	0.9
Cedar (200609)	12,310	0.69	13.2	2.9	2.8	7.5	0.1
Queets Corridor North (210213)	39,496	0.63	38.8	4.4	21.8	1.9	10.7
Middle Hoh (200607)	46,272	0.61	44.4	17.0	2.0	22.7	2.7
Goodman-Mosquito (200610)	33,529	0.58	30.6	13.9	4.0	12.6	0.1
Matheney-Salmon (210211)	21,630	0.56	18.9	1.8	5.1	0.4	11.6
Sekiu Coastal (190301)	27,412	0.53	22.6	1.6	0.0	21.0	0.0
Rain Forest (200505)	56,435	0.48	42.1	2.1	36.6	0.3	3.2
Queets Corridor South (210212)	29,667	0.46	21.1	5.7	15.4	0.0	0.0
Upper Clearwater (210116)	58,265	0.45	41.3	41.0	0.0	0.3	0.0
Ozette Lake (200120)	35,130	0.43	23.3	1.5	1.0	8.7	12.1
Kalaloch Ridge (210115)	11,472	0.35	6.2	0.8	1.1	4.2	0.1
HCP Planning Unit Average		***0.70***	***35.0***	***8.7***	***5.3***	***18.1***	***2.7***
South Coast HCP Planning Unit							
Nemah (240212)	40,522	0.68	42.7	12.2	0.0	29.7	0.8
Lincoln Creek (230219)	48,086	0.67	50.3	4.5	0.0	44.3	1.5
Garrard Creek (230220)	49,056	0.63	48.1	7.1	0.0	36.7	4.4
Mox Chehalis (220106)	23,315	0.63	22.8	0.9	0.0	21.9	0.0
Naselle Headwaters (240107)	48,336	0.60	45.5	1.1	0.0	44.2	0.2
South Fork Willapa (240314)	26,664	0.59	24.7	7.7	0.0	15.6	1.4
Lower Skookumchuck (230404)	44,616	0.56	39.4	0.8	0.0	37.9	0.7
Elk Creek (230117)	38,773	0.55	33.5	7.1	0.0	25.7	0.7
Cedar Creek (230521)	32,505	0.52	26.4	15.7	0.0	6.3	4.4
North River Headwaters (240402)	34,532	0.52	27.8	0.0	0.0	27.8	0.0
Willapa Headwaters (240306)	62,581	0.49	48.3	3.9	0.0	44.1	0.3
Lower Naselle (240108)	36,688	0.48	27.2	0.0	0.0	26.8	0.4

Table E-22. Anadromous Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Anadromous Stream Density mi/sq mi	Total Anadromous Stream Miles	Miles Breakdown by Ownership DNR	Federal	Private1/	Other2/
Waddel Creek (230501)	28,982	0.46	21.0	8.5	0.0	12.0	0.4
Mill Creek (240305)	15,699	0.46	11.2	4.8	0.0	6.3	0.1
Curtis (230112)	43,351	0.43	29.3	2.6	0.0	25.6	1.2
Porter Creek (230522)	32,023	0.37	18.6	10.5	0.0	7.5	0.7
Lower Willapa (240315)	32,329	0.37	18.5	0.1	0.0	18.4	0.1
Rock-Jones (230116)	22,917	0.37	13.1	0.6	0.0	12.5	0.1
Scatter Creek (230403)	31,680	0.33	16.4	0.0	0.0	15.3	1.0
Elk River (220625)	32,340	0.30	15.1	3.0	0.0	4.6	7.5
Joe-Moclips (210408)	50,805	0.28	22.4	0.4	0.0	6.0	16.0
Copalis River (210407)	40,529	0.25	15.9	0.3	0.0	12.3	3.4
Bunker Creek (230218)	22,788	0.17	6.0	0.4	0.0	5.5	0.0
Palix (240213)	35,825	0.14	7.7	0.0	0.0	7.1	0.6
HCP Planning Unit Average		***0.45***	***26.3***	***3.8***	***0.0***	***20.6***	***1.9***
South Puget HCP Planning Unit							
Tiger (080303)	40,881	0.67	42.7	4.4	0.0	34.6	3.7
Hood (150201)	145,611	0.63	143.3	35.9	0.9	100.3	6.1
Olympia (130202)	18,529	0.41	12.0	1.2	0.0	10.8	0.0
Howard Hansen (090103)	46,472	0.41	30.1	2.8	0.0	4.1	23.2
North Fork Green (090104)	18,410	0.37	10.8	0.9	0.0	8.0	1.8
Busy Wild (110204)	56,966	0.33	29.0	5.0	0.0	19.6	4.4
Summit Lake (140002)	29,140	0.24	10.9	1.0	0.0	9.9	0.0
Cumberland (090202)	26,260	0.21	8.5	0.0	0.0	1.6	6.9
Squaxin (140003)	1,066	0.00	0.0	0.0	0.0	0.0	0.0
Reese Creek (110106)	5,036	0.00	0.0	0.0	0.0	0.0	0.0
North Fork Mineral (110112)	16,072	0.00	0.0	0.0	0.0	0.0	0.0
Mineral Creek (110110)	23,047	0.00	0.0	0.0	0.0	0.0	0.0
Ashford (110104)	27,680	0.00	0.0	0.0	0.0	0.0	0.0
East Creek (110113)	14,429	0.00	0.0	0.0	0.0	0.0	0.0
Catt (110108)	13,279	0.00	0.0	0.0	0.0	0.0	0.0
HCP Planning Unit Average		***0.22***	***19.2***	***3.4***	***0.1***	***12.6***	***3.1***
Straits HCP Planning Unit							
Siebert McDonald (180202)	35,481	0.50	28.0	7.9	0.5	18.7	0.9
Chimakum (170203)	28,202	0.50	22.0	1.0	0.0	21.0	0.0
Salt (190108)	26,336	0.49	20.3	3.1	0.0	15.2	2.0
Port Angeles (180211)	24,883	0.48	18.6	1.1	0.2	16.8	0.5
Dungeness Valley (180103)	43,200	0.46	30.9	3.2	2.4	24.7	0.7
Bell Creek (180104)	5,969	0.41	3.8	0.0	0.0	3.8	0.0
Twins (190206)	20,351	0.39	12.4	6.2	1.4	4.4	0.5
Little Quil (170107)	28,536	0.36	16.1	0.7	0.9	14.4	0.0
Lyre (190107)	11,021	0.33	5.6	3.1	0.0	2.1	0.4
Dabob (170106)	16,871	0.32	8.5	1.4	0.0	6.5	0.7
Thorndike (170105)	16,587	0.31	8.1	0.9	0.0	7.2	0.0
Discovery Bay (170202)	58,871	0.28	25.8	2.5	1.1	22.1	0.1
Sequim Bay (170201)	26,752	0.27	11.1	2.8	0.6	7.5	0.1
Sutherland-Aldwell (180310)	35,109	0.18	9.6	0.0	0.6	7.1	2.0
Ludlow (170104)	22,897	0.17	6.1	0.0	0.0	6.1	0.0
Big Quil (170108)	51,823	0.17	13.7	1.0	6.9	5.7	0.1

Table E-22. Anadromous Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Anadromous Stream Density mi/sq mi	Total Anadromous Stream Miles	Miles Breakdown by Ownership			
				DNR	Federal	Private1/	Other2/
Lilliwaup (160204)	29,080	0.16	7.2	2.1	0.0	5.0	0.0
Hamma Hamma (160203)	69,941	0.05	5.8	0.0	0.0	5.8	0.0
HCP Planning Unit Average		***0.32***	***14.1***	***2.1***	***0.8***	***10.8***	***0.4***

1/ Includes privately owned industrial and non-industrial (i.e., small landowner) lands.

2/ Includes municipal, tribal, non-DNR state lands, and other lands.

Table E-23. Overall Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Stream Density mi/sq mi	Total Stream Miles	Miles Breakdown by Ownership DNR	Federal	Private1/	Other2/
Columbia HCP Planning Unit							
West Fork Grays River (250311)	10,347	12.92	208.9	36.0	0.0	172.2	0.7
Spirit Lake (260507)	52,151	12.05	981.9	77.9	868.4	27.5	8.2
North Elochoman (250203)	23,518	10.66	391.6	67.5	0.0	323.3	0.8
Grays Bay (250310)	56,613	10.41	921.2	84.2	0.0	751.4	85.5
South Fork Grays River (250302)	16,774	10.36	271.5	72.1	0.0	197.9	1.5
Skamokawa (250209)	51,687	9.94	802.5	177.9	22.9	544.2	57.5
Stillwater (260625)	28,905	9.48	428.0	24.6	0.0	402.9	0.5
Upper SF Toutle (260508)	40,031	9.38	586.9	201.0	130.5	242.9	12.6
Main Elochoman (250208)	37,009	9.30	538.0	108.2	19.7	348.3	61.7
Bremer (260331)	19,894	8.67	269.6	36.5	24.1	196.6	12.3
Middle Kalama (270114)	51,534	8.64	696.0	49.4	0.0	642.9	3.7
Delameter (260623)	37,243	8.49	493.8	22.6	0.0	470.9	0.4
Green River (260515)	46,383	8.44	611.5	26.9	0.0	554.8	29.8
Swift Creek (270304)	74,150	7.96	922.3	93.0	317.4	503.3	8.6
South Fork Toutle (260513)	42,623	7.88	524.5	131.9	0.0	387.6	5.0
Woodland (270412)	37,827	7.71	455.7	72.0	1.2	354.7	27.7
North Fork Toutle (260514)	41,051	7.71	494.4	126.4	0.0	312.1	55.9
Abernethy (250104)	40,071	7.70	482.3	300.4	1.1	147.7	33.1
Upper Washougal (280205)	31,719	7.69	381.0	272.4	45.2	59.4	4.0
Cedar Creek (260428)	14,441	7.52	169.7	9.1	0.0	153.4	7.2
Cougar (270317)	32,888	7.50	385.6	149.4	125.4	108.7	2.0
Rock Creek (290415)	41,733	7.14	465.3	213.8	77.5	147.0	26.9
Lake Merwin (270415)	46,439	7.05	511.5	213.4	0.4	296.6	1.1
Winston (260320)	28,321	7.05	311.9	74.5	0.0	227.3	10.2
Lower Kalama (270113)	49,823	6.50	506.0	27.5	0.0	444.5	34.1
Siouxon (270305)	39,066	6.21	379.1	161.8	212.6	4.4	0.3
Salmon Creek (260421)	43,837	5.92	405.2	38.2	0.0	355.1	11.9
Cedar Creek (270416)	36,416	5.50	312.8	29.0	1.5	274.6	7.6
Mill Creek (260429)	26,163	5.43	222.2	23.6	0.0	197.5	1.0
Wind River (290414)	30,669	5.28	253.2	37.9	165.3	43.5	6.5
Rock Creek Clark (270508)	35,440	5.27	291.8	42.4	68.3	174.9	6.3
Olequa (260626)	35,017	5.15	281.6	38.2	0.0	241.9	1.5
Silverstar (280204)	32,719	4.88	249.7	61.3	34.3	145.4	8.6
Harmony (260330)	22,546	4.81	169.4	9.7	0.0	150.7	9.0
Little Washougal (280203)	30,269	4.70	222.4	47.2	0.7	159.2	15.3
Hamilton Creek (280106)	32,845	4.57	234.5	47.6	64.8	67.7	54.5
Cold Creek (270509)	21,281	4.45	148.1	109.1	6.1	31.7	1.3
Lacamas (280202)	41,185	2.84	183.0	17.9	17.9	124.4	22.8
HCP Planning Unit Average		***7.45***	***425.4***	***87.7***	***58.0***	***262.9***	***16.8***
North Puget HCP Planning Unit							
Skookum Creek (010309)	23,905	8.04	300.4	81.0	27.1	191.6	0.7
Spada (070216)	44,197	7.20	497.2	290.2	126.5	11.0	69.5
Lower MF Snoqualmie (070307)	28,375	6.88	304.9	159.9	78.7	62.1	4.2
Hutchinson Creek (010310)	13,975	6.81	148.8	52.4	0.0	96.1	0.2
Warnick (010229)	25,436	6.76	268.6	165.4	4.1	98.8	0.3
Porter Canyon (010327)	18,550	6.52	188.9	56.5	0.0	107.1	25.2
Silverton (050106)	46,399	6.40	464.2	36.9	412.8	11.4	3.1
North Fork Snoqualmie (070313)	66,707	6.34	661.2	56.8	268.9	307.9	27.6
Pilchuck Mtn (070226)	42,517	6.23	414.0	289.4	1.1	113.2	10.3

Table E-23. Overall Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Stream Density mi/sq mi	Total Stream Miles	Miles Breakdown by Ownership DNR	Federal	Private1/	Other2/
Day Creek (030105)	22,203	6.17	214.2	15.3	19.3	179.4	0.2
Rinker (040321)	20,481	6.12	195.9	69.9	21.7	96.8	7.4
Deer Creek (050201)	41,881	6.11	399.9	78.1	193.0	128.3	0.5
Howard Creek (010308)	39,040	6.08	370.7	62.6	19.5	262.4	26.2
Stimson Hill (050215)	18,833	6.04	177.6	89.5	0.0	86.5	1.5
West Shannon (040435)	14,333	5.91	132.3	24.9	7.1	85.5	14.8
Tolt (070415)	63,357	5.79	572.9	35.7	57.7	384.3	95.1
Sultan River (070224)	24,388	5.79	220.5	118.4	25.9	47.2	29.0
Wallace River (070217)	24,667	5.52	212.7	41.4	106.5	46.2	18.6
Cavanaugh (050316)	29,722	5.47	254.1	149.3	0.0	104.7	0.2
Kenney Creek (010230)	2,791	5.47	23.9	0.3	0.0	23.5	0.0
South Snoqualmie (070306)	57,077	5.43	484.6	60.2	268.9	105.0	50.6
Olney Creek (070225)	20,655	5.41	174.5	63.6	0.0	108.9	2.1
Gilligan (030106)	18,879	5.34	157.4	21.8	0.0	121.1	14.5
Sauk Prairie (040320)	14,137	5.31	117.3	35.8	16.7	58.9	5.9
Verlot (050107)	23,540	5.28	194.3	14.9	107.0	69.7	2.7
Hazel (050203)	24,179	5.25	198.4	75.1	64.9	58.0	0.5
Tenas (040319)	36,688	5.24	300.1	40.2	215.0	40.5	4.4
Hansen Creek (030102)	29,010	5.19	235.3	38.5	0.0	187.2	9.6
Ebey Hill (050214)	19,812	5.19	160.6	59.8	0.0	99.1	1.7
Acme (010311)	23,518	5.18	190.3	44.8	0.0	143.6	1.8
Tate (070409)	9,798	5.13	78.5	2.5	0.0	75.4	0.7
Lake Whatcom (010412)	35,957	5.06	284.1	129.3	0.0	125.6	29.3
Clearwater Creek (010328)	14,330	5.00	112.0	70.5	31.8	8.5	1.2
Jordan (050108)	21,252	4.97	165.0	8.1	1.8	152.2	2.9
Loretta (030104)	15,769	4.96	122.3	9.1	39.2	73.0	0.9
Raging River (070408)	22,853	4.87	174.0	50.5	0.0	121.7	1.8
French Boulder (050204)	45,327	4.82	341.3	47.5	245.9	45.1	2.7
Corkindale (040531)	24,194	4.67	176.6	11.8	93.5	59.5	11.9
Woods Creek (070223)	42,463	4.55	302.1	72.3	0.0	220.3	9.4
Jordan-Boulder (040224)	32,726	4.54	232.4	61.4	57.7	110.9	2.4
Upper NF Stilly (050202)	32,833	4.54	233.1	21.3	189.5	22.1	0.1
Youngs Creek (070219)	23,776	4.54	168.5	21.9	2.8	143.3	0.5
Deming (010226)	27,527	4.48	192.8	62.8	0.0	129.2	0.8
Nookachamps (030107)	47,730	4.47	333.7	105.3	0.0	223.2	5.2
Jim Creek (050109)	30,690	4.46	213.9	35.1	39.4	130.1	9.4
Grandy (040534)	18,856	4.44	130.9	22.3	0.0	107.0	1.6
Jackman (040529)	16,399	4.27	109.4	5.4	53.5	50.4	0.1
East Shannon (040436)	34,065	4.05	215.3	28.6	103.5	64.8	18.4
Cherry (070420)	38,183	4.00	238.3	53.3	0.0	170.3	14.7
Hilt (040322)	12,453	3.92	76.2	5.1	32.4	37.7	1.0
Marmot Ridge (010306)	31,794	3.90	194.0	45.6	100.5	41.2	6.7
Lower Pilchuck Creek (050313)	19,364	3.85	116.6	7.7	0.0	108.1	0.8
Canyon Creek (010232)	36,807	3.72	213.8	37.4	47.5	122.7	6.2
Samish River (030301)	57,397	3.56	319.3	71.6	0.0	236.1	11.7
Alder (030103)	22,865	3.51	125.3	86.0	0.0	39.0	0.4
Samish Bay (010414)	13,258	3.23	66.9	16.7	0.0	41.1	9.1
Vedder (010131)	21,272	3.06	101.7	15.8	0.1	85.7	0.0
Friday Creek (030313)	24,129	2.94	110.9	14.6	0.0	90.1	6.2
Sumas River (010125)	36,444	2.69	153.1	22.5	0.0	129.5	1.2

Table E-23. Overall Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Stream Density mi/sq mi	Total Stream Miles	Miles Breakdown by Ownership: DNR	Federal	Private1/	Other2/
Cypress (030415)	4,950	2.54	19.6	15.6	0.0	3.9	0.2
Lummi Island (010617)	5,063	1.80	14.2	0.7	0.1	11.3	2.1
HCP Planning Unit Average		***5.00***	***222.5***	***57.2***	***50.5***	***105.2***	***9.6***
Olympic Experimental State Forest							
Kalaloch Ridge (210115)	11,472	9.54	171.1	101.5	8.2	60.7	0.7
Lower Clearwater (210114)	45,246	8.72	616.1	286.9	19.5	293.9	15.9
Goodman-Mosquito (200610)	33,529	8.01	419.6	141.8	34.0	241.7	2.1
Upper Clearwater (210116)	58,265	7.83	713.0	700.8	3.4	8.8	0.1
Middle Hoh (200607)	46,272	7.74	559.5	385.9	15.8	146.3	11.5
Sekiu Coastal (190301)	27,412	7.68	329.1	37.0	0.0	274.8	17.3
Bogachiel (200412)	44,993	7.21	506.7	174.8	96.7	228.2	7.0
Hoh Lowlands (200608)	30,244	6.98	330.0	84.3	7.3	228.4	10.0
Sol Duc Valley (200316)	16,585	6.83	177.0	57.0	40.0	77.5	2.5
Quillayute Bottom (200417)	23,180	6.58	238.3	66.2	32.8	121.3	18.0
Hoko (190302)	44,534	6.43	447.3	107.9	2.3	325.3	11.8
Matheney-Salmon (210211)	21,630	6.39	215.8	14.3	75.5	2.4	123.7
Cedar (200609)	12,310	6.39	122.8	56.7	18.3	47.2	0.6
Ozette Lake (200120)	35,130	6.02	330.5	44.7	78.7	164.1	43.0
West Dickey (200419)	28,311	5.91	261.3	30.2	0.0	222.9	8.3
Sol Duc Lowlands (200416)	22,368	5.82	203.5	34.6	49.9	115.0	4.1
Sol Duc Valley (200201)	47,220	5.74	423.5	111.7	164.7	119.7	27.5
East Dickey (200418)	26,657	5.62	233.9	90.3	0.0	140.4	3.2
Pysht River (190204)	32,972	5.47	282.0	20.2	52.9	206.9	2.0
Clallam River (190303)	22,235	5.40	187.5	94.4	0.1	91.0	1.9
Queets Corridor South (210212)	29,667	5.27	244.3	36.3	208.1	0.0	0.0
Queets Corridor North (210213)	39,496	5.06	312.2	60.8	135.8	23.0	92.7
Rain Forest (200505)	56,435	4.84	427.1	75.6	340.8	0.3	10.4
HCP Planning Unit Average		***6.59***	***337.1***	***122.3***	***60.2***	***136.5***	***18.0***
South Coast HCP Planning Unit							
Naselle Headwaters (240107)	48,336	11.88	897.5	91.3	0.0	803.2	2.9
Lower Willapa (240315)	32,329	11.86	599.3	28.5	0.0	569.1	1.7
Lower Naselle (240108)	36,688	11.48	658.3	85.4	2.4	565.2	5.3
South Fork Willapa (240314)	26,664	11.16	464.9	163.8	0.0	289.5	11.7
Mill Creek (240305)	15,699	10.87	266.6	170.7	0.0	94.7	1.2
Willapa Headwaters (240306)	62,581	10.76	1052.4	321.3	0.0	719.2	12.0
Nemah (240212)	40,522	10.59	670.6	170.3	0.0	489.8	10.5
Palix (240213)	35,825	10.00	559.7	62.8	0.0	477.9	19.0
Elk Creek (230117)	38,773	9.87	597.9	193.9	0.0	381.4	22.5
Curtis (230112)	43,351	9.59	649.5	112.6	0.0	523.5	13.4
Rock-Jones (230116)	22,917	9.48	339.5	104.2	0.0	230.9	4.4
Elk River (220625)	32,340	9.15	462.1	60.7	0.0	259.1	142.4
Bunker Creek (230218)	22,788	8.67	308.7	87.9	0.0	220.0	0.8
Lower Skookumchuck (230404)	44,616	7.88	549.5	114.1	0.0	431.5	3.9
North River Headwaters (240402)	34,532	7.74	417.5	40.4	0.0	376.0	1.1
Garrard Creek (230220)	49,056	7.37	564.6	233.8	0.0	317.1	13.7
Lincoln Creek (230219)	48,086	6.95	522.5	168.0	0.0	348.3	6.2
Mox Chehalis (220106)	23,315	5.67	206.6	41.0	0.0	163.2	2.5
Joe-Moclips (210408)	50,805	5.09	403.7	33.7	0.3	179.0	190.7
Copalis River (210407)	40,529	5.01	317.2	23.8	0.0	230.8	62.6
Cedar Creek (230521)	32,505	4.92	250.1	194.3	0.0	38.7	17.0

Table E-23. Overall Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Stream Density mi/sq mi	Total Stream Miles	Miles Breakdown by Ownership: DNR	Federal	Private1/	Other2/
Porter Creek (230522)	32,023	4.87	243.6	203.1	0.0	36.4	4.1
Waddel Creek (230501)	28,982	4.70	212.9	146.9	0.0	63.8	2.1
Scatter Creek (230403)	31,680	4.55	225.3	24.2	0.0	195.6	5.5
HCP Planning Unit Average		***8.34***	***476.7***	***119.9***	***0.1***	***333.5***	***23.2***
South Puget HCP Planning Unit							
North Fork Mineral (110112)	16,072	8.36	209.9	179.0	0.0	26.7	4.2
Catt (110108)	13,279	8.35	173.4	90.5	82.3	0.5	0.0
Mineral Creek (110110)	23,047	8.31	299.3	58.7	0.0	224.0	16.7
East Creek (110113)	14,429	7.89	178.0	34.7	48.9	89.4	5.0
Busy Wild (110204)	56,966	7.09	631.0	150.3	0.0	440.8	39.9
Ashford (110104)	27,680	7.07	305.9	75.8	85.0	134.0	11.1
Howard Hansen (090103)	46,472	6.80	493.5	157.1	3.3	209.5	123.6
North Fork Green (090104)	18,410	6.32	181.8	57.8	0.0	107.0	17.0
Reese Creek (110106)	5,036	5.77	45.4	43.9	0.0	1.4	0.0
Hood (150201)	145,611	4.10	932.1	207.1	15.4	621.9	87.7
Tiger (080303)	40,881	3.76	240.0	84.6	0.0	123.6	31.7
Summit Lake (140002)	29,140	3.65	166.1	49.6	0.0	113.1	3.4
Cumberland (090202)	26,260	3.52	144.3	17.0	0.0	101.9	25.3
Squaxin (140003)	1,066	3.27	5.5	1.1	0.0	0.1	4.3
Olympia (130202)	18,529	3.00	86.7	22.0	0.0	62.0	2.8
HCP Planning Unit Average		***5.82***	***272.8***	***82.0***	***15.7***	***150.4***	***24.8***
Straits HCP Planning Unit							
Twins (190206)	20,351	4.74	150.8	55.1	68.5	25.7	1.6
Dabob (170106)	16,871	4.69	123.7	32.2	0.0	88.7	2.8
Thorndike (170105)	16,587	4.68	121.3	11.4	6.7	101.1	2.1
Lilliwaup (160204)	29,080	4.59	208.5	123.8	17.2	63.2	4.2
Ludlow (170104)	22,897	4.44	158.7	10.7	0.1	144.1	3.8
Lyre (190107)	11,021	4.23	72.8	47.7	9.3	13.9	1.8
Dungeness Valley (180103)	43,200	4.05	273.5	31.2	63.9	170.0	8.3
Chimakum (170203)	28,202	3.58	157.6	10.0	7.4	135.0	5.2
Little Quil (170107)	28,536	3.54	157.8	11.4	50.5	94.9	0.9
Sequim Bay (170201)	26,752	3.48	145.6	43.9	42.1	55.0	4.6
Sutherland-Aldwell (180310)	35,109	3.43	188.2	36.2	61.5	71.0	19.5
Siebert McDonald (180202)	35,481	3.17	176.0	45.5	45.4	83.0	2.1
Hamma Hamma (160203)	69,941	3.15	343.9	73.5	214.6	53.9	1.9
Salt (190108)	26,336	3.07	126.1	51.9	0.0	66.3	8.0
Big Quil (170108)	51,823	3.00	242.8	22.0	184.8	33.6	2.4
Bell Creek (180104)	5,969	2.96	27.6	1.1	0.0	26.0	0.5
Port Angeles (180211)	24,883	2.76	107.4	26.5	9.6	67.2	4.1
Discovery Bay (170202)	58,871	2.64	242.5	35.2	48.7	147.4	11.2
HCP Planning Unit Average		***3.68***	***168.0***	***37.2***	***46.1***	***80.0***	***4.7***

1/ Includes privately owned industrial and non-industrial (i.e., small landowner) lands.

2/ Includes municipal, tribal, non-DNR state lands, and other lands.

Table E-24. Resident Fish Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Resident Fish Stream Density mi/sq mi	Total Resident Fish Stream Miles	Miles Breakdown by Ownership DNR	Federal	Private1/	Other2/
Columbia HCP Planning Unit							
Woodland (270412)	37,827	2.51	148.3	5.3	0.8	128.2	14.0
Main Elochoman (250208)	37,009	2.25	129.8	8.5	10.7	69.1	41.5
Grays Bay (250310)	56,613	2.21	195.6	8.6	0.0	139.9	47.1
Little Washougal (280203)	30,269	1.95	92.0	6.5	0.7	79.0	5.8
Harmony (260330)	22,546	1.88	66.4	2.3	0.0	58.6	5.5
Lake Merwin (270415)	46,439	1.87	136.0	18.9	0.4	116.4	0.2
Bremer (260331)	19,894	1.87	58.2	7.5	1.3	41.0	8.4
Spirit Lake (260507)	52,151	1.87	152.0	1.3	147.9	0.0	2.8
Skamokawa (250209)	51,687	1.73	140.1	14.9	13.1	73.8	38.3
Green River (260515)	46,383	1.68	121.6	2.7	0.0	112.0	6.9
Lower Kalama (270113)	49,823	1.61	125.6	2.4	0.0	107.3	15.9
South Fork Toutle (260513)	42,623	1.60	106.4	18.6	0.0	86.5	1.3
Hamilton Creek (280106)	32,845	1.53	78.6	6.4	21.9	24.7	25.7
Delameter (260623)	37,243	1.53	89.0	2.9	0.0	86.0	0.1
Abernethy (250104)	40,071	1.45	90.5	39.1	0.4	35.9	15.0
North Fork Toutle (260514)	41,051	1.40	90.1	9.6	0.0	66.0	14.6
Salmon Creek (260421)	43,837	1.39	95.5	2.5	0.0	87.8	5.3
West Fork Grays River (250311)	10,347	1.39	22.5	2.1	0.0	20.0	0.5
Rock Creek (290415)	41,733	1.39	90.8	19.4	0.0	50.0	21.4
Mill Creek (260429)	26,163	1.39	56.6	1.6	0.0	54.2	0.8
South Fork Grays River (250302)	16,774	1.37	36.0	11.0	0.0	24.9	0.1
Silverstar (280204)	32,719	1.36	69.7	9.5	7.2	49.2	3.8
Swift Creek (270304)	74,150	1.34	155.6	31.6	26.6	91.6	5.8
Stillwater (260625)	28,905	1.32	59.7	3.0	0.0	56.7	0.0
Cedar Creek (270416)	36,416	1.27	72.3	1.7	0.9	67.4	2.2
Cedar Creek (260428)	14,441	1.25	28.2	0.5	0.0	26.9	0.8
North Elochoman (250203)	23,518	1.22	44.7	9.2	0.0	35.1	0.3
Middle Kalama (270114)	51,534	1.21	97.4	2.3	0.0	95.1	0.0
Cougar (270317)	32,888	1.20	61.6	10.2	0.4	49.9	1.0
Upper Washougal (280205)	31,719	1.16	57.5	41.6	0.0	14.7	1.2
Rock Creek Clark (270508)	35,440	1.10	60.8	5.8	1.5	49.3	4.2
Upper SF Toutle (260508)	40,031	1.09	68.5	19.3	13.7	32.0	3.6
Winston (260320)	28,321	1.06	47.1	9.7	0.0	35.3	2.0
Lacamas (280202)	41,185	1.05	67.3	2.6	6.1	49.8	8.7
Olequa (260626)	35,017	1.00	54.7	2.1	0.0	52.4	0.2
Cold Creek (270509)	21,281	0.99	32.8	19.0	0.0	13.5	0.2
Wind River (290414)	30,669	0.90	43.3	1.8	11.9	26.3	3.3
Siouxon (270305)	39,066	0.56	34.3	24.3	6.6	3.2	0.2
HCP Planning Unit Average		***1.45***	***83.6***	***10.2***	***7.2***	***58.1***	***8.1***
North Puget HCP Planning Unit							
Jordan (050108)	21,252	3.11	103.3	0.5	0.0	100.5	2.2
Kenney Creek (010230)	2,791	2.82	12.3	0.0	0.0	12.3	0.0
Rinker (040321)	20,481	2.68	85.7	14.8	7.1	56.9	6.9
Tate (070409)	9,798	2.57	39.4	0.0	0.0	38.8	0.6
Hutchinson Creek (010310)	13,975	2.50	54.5	16.1	0.0	38.2	0.2
Cherry (070420)	38,183	2.42	144.7	28.4	0.0	105.3	11.1
Gilligan (030106)	18,879	2.42	71.5	3.4	0.0	57.0	11.1
Ebey Hill (050214)	19,812	2.38	73.7	14.5	0.0	57.9	1.3
Woods Creek (070223)	42,463	2.32	154.2	19.2	0.0	129.7	5.3

Table E-24. Resident Fish Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Resident Fish Stream Density mi/sq mi	Total Resident Fish Stream Miles	Miles Breakdown by Ownership DNR	Federal	Private1/	Other2/
Sultan River (070224)	24,388	2.21	84.4	29.6	7.2	31.5	16.1
Nookachamps (030107)	47,730	2.16	160.9	18.7	0.0	137.3	4.8
Pilchuck Mtn (070226)	42,517	2.14	142.0	72.1	0.2	67.4	2.3
Olney Creek (070225)	20,655	2.09	67.5	9.7	0.0	57.9	0.0
Tolt (070415)	63,357	2.09	206.4	22.3	7.4	129.9	46.8
Acme (010311)	23,518	2.08	76.5	5.2	0.0	69.7	1.6
Porter Canyon (010327)	18,550	2.08	60.2	15.3	0.0	38.1	6.8
Hansen Creek (030102)	29,010	2.00	90.6	2.4	0.0	79.8	8.5
Lower MF Snoqualmie (070307)	28,375	1.96	87.1	30.8	17.5	34.9	3.8
Sauk Prairie (040320)	14,137	1.92	42.5	9.1	0.9	26.7	5.7
Lower Pilchuck Creek (050313)	19,364	1.91	57.8	4.2	0.0	52.9	0.6
Verlot (050107)	23,540	1.90	70.0	5.7	30.5	33.0	0.8
Stimson Hill (050215)	18,833	1.87	55.1	8.5	0.0	45.4	1.2
Youngs Creek (070219)	23,776	1.82	67.5	5.1	0.0	62.4	0.0
Deming (010226)	27,527	1.81	78.0	7.2	0.0	70.2	0.6
Warnick (010229)	25,436	1.77	70.5	23.2	1.5	45.6	0.3
North Fork Snoqualmie (070313)	66,707	1.74	181.4	3.5	54.6	110.1	13.2
Lake Whatcom (010412)	35,957	1.65	92.9	6.0	0.0	58.2	28.7
Loretta (030104)	15,769	1.60	39.4	1.5	2.7	34.7	0.6
Raging River (070408)	22,853	1.59	56.6	10.0	0.0	46.2	0.4
West Shannon (040435)	14,333	1.58	35.5	3.3	0.0	17.8	14.4
Samish Bay (010414)	13,258	1.55	32.0	4.6	0.0	21.6	5.9
Wallace River (070217)	24,667	1.52	58.5	7.0	11.6	26.8	13.2
Jim Creek (050109)	30,690	1.51	72.3	7.4	16.7	46.5	1.7
Hazel (050203)	24,179	1.47	55.5	12.8	6.8	35.6	0.2
South Snoqualmie (070306)	57,077	1.46	130.3	3.8	53.2	54.2	19.0
Corkindale (040531)	24,194	1.45	55.0	1.0	10.9	33.6	9.4
Hilt (040322)	12,453	1.43	27.8	0.8	5.1	20.9	1.0
Friday Creek (030313)	24,129	1.42	53.5	1.3	0.0	46.8	5.4
Cavanaugh (050316)	29,722	1.41	65.6	21.9	0.0	43.6	0.1
Alder (030103)	22,865	1.39	49.8	19.4	0.0	30.0	0.4
Tenas (040319)	36,688	1.31	74.9	19.3	34.4	17.0	4.3
Grandy (040534)	18,856	1.30	38.3	0.7	0.0	36.4	1.2
Howard Creek (010308)	39,040	1.28	77.8	6.0	5.1	54.4	12.4
Spada (070216)	44,197	1.23	84.8	29.9	3.7	1.1	50.1
Lummi Island (010617)	5,063	1.21	9.6	0.6	0.1	7.4	1.5
Skookum Creek (010309)	23,905	1.21	45.1	14.4	0.5	30.0	0.3
Sumas River (010125)	36,444	1.19	67.8	1.5	0.0	65.1	1.2
Deer Creek (050201)	41,881	1.17	76.4	17.3	34.7	24.3	0.1
Silverton (050106)	46,399	1.14	82.9	4.0	72.3	5.4	1.2
French Boulder (050204)	45,327	1.13	80.1	25.4	24.6	28.7	1.3
Cypress (030415)	4,950	1.11	8.6	6.8	0.0	1.6	0.2
Jordan-Boulder (040224)	32,726	1.02	52.4	12.4	0.5	37.4	2.0
Samish River (030301)	57,397	0.98	88.1	2.9	0.0	84.0	1.1
East Shannon (040436)	34,065	0.87	46.1	4.4	8.6	14.9	18.2
Day Creek (030105)	22,203	0.79	27.3	0.4	1.3	25.5	0.1
Canyon Creek (010232)	36,807	0.65	37.6	5.2	0.3	26.4	5.7
Upper NF Stilly (050202)	32,833	0.64	33.0	4.8	26.3	1.9	0.0
Clearwater Creek (010328)	14,330	0.63	14.2	8.7	3.9	1.0	0.6
Vedder (010131)	21,272	0.60	19.9	4.6	0.0	15.3	0.0

Table E-24. Resident Fish Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Resident Fish Stream Density mi/sq mi	Total Resident Fish Stream Miles	Miles Breakdown by Ownership DNR	Federal	Private1/	Other2/
Marmot Ridge (010306)	31,794	0.51	25.4	11.0	0.6	7.2	6.6
Jackman (040529)	16,399	0.44	11.2	0.4	0.3	10.4	0.0
HCP Planning Unit Average		***1.61***	***68.3***	***10.7***	***7.4***	***44.3***	***5.9***
Olympic Experimental State Forest							
Hoh Lowlands (200608)	30,244	3.63	171.7	36.3	2.8	125.9	6.6
Sol Duc Lowlands (200416)	22,368	3.07	107.4	14.1	5.6	84.9	2.8
Middle Hoh (200607)	46,272	2.97	214.7	90.8	9.0	104.3	10.7
West Dickey (200419)	28,311	2.64	116.9	14.9	0.0	94.9	7.1
Sol Duc Valley (200316)	16,585	2.62	68.0	11.5	2.9	52.5	1.2
Quillayute Bottom (200417)	23,180	2.59	93.8	20.0	13.7	52.6	7.4
Queets Corridor North (210213)	39,496	2.46	151.6	24.8	66.0	5.1	55.7
Ozette Lake (200120)	35,130	2.40	131.6	9.1	31.9	49.3	41.3
Sol Duc Valley (200201)	47,220	2.28	168.4	41.6	32.5	70.4	24.0
Lower Clearwater (210114)	45,246	2.28	161.2	55.7	2.7	96.4	6.4
Bogachiel (200412)	44,993	2.25	158.4	40.7	15.9	97.2	4.6
East Dickey (200418)	26,657	2.09	87.0	30.2	0.0	55.7	1.1
Hoko (190302)	44,534	1.97	136.8	26.2	0.6	102.7	7.4
Cedar (200609)	12,310	1.81	34.8	11.5	7.0	16.2	0.2
Pysht River (190204)	32,972	1.73	89.3	1.1	4.7	82.8	0.7
Kalaloch Ridge (210115)	11,472	1.73	30.9	11.9	3.4	15.4	0.2
Rain Forest (200505)	56,435	1.66	146.6	12.4	123.7	0.3	10.3
Clallam River (190303)	22,235	1.65	57.2	28.9	0.0	26.7	1.6
Upper Clearwater (210116)	58,265	1.62	147.5	146.1	0.4	1.0	0.1
Goodman-Mosquito (200610)	33,529	1.61	84.2	32.7	15.2	35.2	1.1
Sekiu Coastal (190301)	27,412	1.59	68.2	5.0	0.0	61.0	2.2
Queets Corridor South (210212)	29,667	0.77	35.7	18.6	17.1	0.0	0.0
Matheney-Salmon (210211)	21,630	0.66	22.4	4.6	3.9	0.7	13.2
HCP Planning Unit Average		***2.09***	***108.0***	***29.9***	***15.6***	***53.5***	***9.0***
South Coast HCP Planning Unit							
Lower Willapa (240315)	32,329	2.93	147.8	1.2	0.0	145.9	0.7
Copalis River (210407)	40,529	2.88	182.2	16.9	0.0	122.8	42.5
Lower Naselle (240108)	36,688	2.40	137.5	13.0	0.7	121.7	2.1
North River Headwaters (240402)	34,532	2.38	128.6	9.1	0.0	118.8	0.6
Palix (240213)	35,825	2.30	128.7	18.4	0.0	106.0	4.2
South Fork Willapa (240314)	26,664	2.15	89.5	21.4	0.0	66.1	2.1
Naselle Headwaters (240107)	48,336	2.10	158.9	10.7	0.0	147.6	0.6
Garrard Creek (230220)	49,056	2.08	159.4	34.8	0.0	113.1	11.5
Lower Skookumchuck (230404)	44,616	2.08	144.7	12.0	0.0	130.5	2.2
Curtis (230112)	43,351	2.06	139.7	14.9	0.0	121.1	3.6
Elk Creek (230117)	38,773	2.04	123.8	31.9	0.0	87.6	4.3
Nemah (240212)	40,522	2.04	129.2	32.0	0.0	94.0	3.1
Mox Chehalis (220106)	23,315	1.96	71.5	9.1	0.0	62.1	0.3
Rock-Jones (230116)	22,917	1.91	68.3	14.0	0.0	53.5	0.8
Cedar Creek (230521)	32,505	1.89	95.9	66.1	0.0	17.1	12.7
Lincoln Creek (230219)	48,086	1.89	141.9	27.2	0.0	110.7	4.0
Porter Creek (230522)	32,023	1.85	92.5	70.7	0.0	19.1	2.8
Elk River (220625)	32,340	1.84	93.0	17.5	0.0	51.7	23.8
Waddel Creek (230501)	28,982	1.79	81.1	42.6	0.0	36.6	1.9
Joe-Moclips (210408)	50,805	1.79	142.0	8.7	0.3	70.1	62.9

Table E-24. Resident Fish Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Resident Fish Stream Density mi/sq mi	Total Resident Fish Stream Miles	Miles Breakdown by Ownership DNR	Federal	Private1/	Other2/
Mill Creek (240305)	15,699	1.73	42.4	28.5	0.0	13.7	0.2
Willapa Headwaters (240306)	62,581	1.68	164.5	35.8	0.0	124.9	3.9
Bunker Creek (230218)	22,788	1.68	59.9	12.0	0.0	47.8	0.1
Scatter Creek (230403)	31,680	1.27	62.8	4.0	0.0	55.1	3.6
HCP Planning Unit Average		***2.03***	***116.1***	***23.0***	***0.0***	***84.9***	***8.1***
South Puget HCP Planning Unit							
Ashford (110104)	27,680	2.43	105.3	21.3	9.8	67.1	7.2
Squaxin (140003)	1,066	2.36	3.9	0.6	0.0	0.1	3.3
East Creek (110113)	14,429	1.85	41.6	4.0	3.2	32.5	1.9
Hood (150201)	145,611	1.72	392.2	81.4	3.9	267.2	39.7
Olympia (130202)	18,529	1.46	42.2	8.1	0.0	32.4	1.7
Summit Lake (140002)	29,140	1.45	66.1	11.2	0.0	52.2	2.7
Howard Hansen (090103)	46,472	1.45	105.3	13.0	0.0	21.3	70.9
Busy Wild (110204)	56,966	1.42	126.4	37.5	0.0	81.2	7.8
Cumberland (090202)	26,260	1.21	49.5	1.6	0.0	25.6	22.3
Mineral Creek (110110)	23,047	1.15	41.6	3.6	0.0	36.8	1.2
North Fork Mineral (110112)	16,072	0.88	22.1	16.1	0.0	4.5	1.5
Tiger (080303)	40,881	0.87	55.5	5.5	0.0	43.5	6.5
Reese Creek (110106)	5,036	0.82	6.5	5.5	0.0	1.0	0.0
Catt (110108)	13,279	0.81	16.8	10.1	6.7	0.0	0.0
North Fork Green (090104)	18,410	0.71	20.5	1.9	0.0	13.4	5.2
HCP Planning Unit Average		***1.37***	***73.0***	***14.8***	***1.6***	***45.2***	***11.5***
Straits HCP Planning Unit							
Dungeness Valley (180103)	43,200	2.12	143.4	15.5	5.2	117.1	5.6
Dabob (170106)	16,871	1.66	43.7	15.1	0.0	26.3	2.3
Thorndike (170105)	16,587	1.49	38.6	2.6	0.5	34.6	0.8
Ludlow (170104)	22,897	1.41	50.3	1.0	0.1	46.4	2.8
Bell Creek (180104)	5,969	1.34	12.5	0.7	0.0	11.4	0.4
Lilliwaup (160204)	29,080	1.33	60.2	35.7	0.0	21.6	3.0
Sutherland-Aldwell (180310)	35,109	1.30	71.3	8.2	6.9	41.7	14.6
Little Quil (170107)	28,536	1.11	49.5	5.3	1.1	42.4	0.7
Siebert McDonald (180202)	35,481	1.10	61.0	28.3	1.7	29.8	1.3
Port Angeles (180211)	24,883	1.09	42.4	5.6	1.4	33.5	1.9
Chimakum (170203)	28,202	1.08	47.7	4.9	3.9	35.5	3.3
Salt (190108)	26,336	0.97	39.8	8.8	0.0	26.9	4.1
Sequim Bay (170201)	26,752	0.87	36.4	7.1	3.8	24.0	1.5
Lyre (190107)	11,021	0.82	14.1	8.5	0.0	4.9	0.6
Twins (190206)	20,351	0.80	25.5	12.4	7.1	5.3	0.7
Discovery Bay (170202)	58,871	0.74	67.8	11.5	3.3	49.9	3.1
Big Quil (170108)	51,823	0.46	37.1	9.2	12.9	13.4	1.6
Hamma Hamma (160203)	69,941	0.45	49.2	18.7	2.4	26.4	1.5
HCP Planning Unit Average		***1.12***	***49.5***	***11.1***	***2.8***	***32.8***	***2.8***

1/ Includes privately owned industrial and non-industrial (i.e., small landowner) lands.

2/ Includes municipal, tribal, non-DNR state lands, and other lands.

Table E-25. Bull Trout Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Bull Trout Stream Density mi/sq mi	Total Bull Trout Stream Miles	Miles Breakdown by Ownership			
				DNR	Federal	Private1/	Other2/
Columbia HCP Planning Unit							
Cougar (270317)	32,888	0.27	14.0	1.8	0.3	11.6	0.3
Woodland (270412)	37,827	0.24	14.4	0.0	0.0	14.4	0.0
Lake Merwin (270415)	46,439	0.24	17.3	0.3	0.0	17.0	0.0
Swift Creek (270304)	74,150	0.15	16.9	3.1	1.0	12.2	0.5
Rock Creek (290415)	41,733	0.07	4.6	0.0	0.0	0.0	4.6
Cedar Creek (270416)	36,416	0.02	0.9	0.0	0.0	0.9	0.0
Wind River (290414)	30,669	0.01	0.7	0.0	0.7	0.0	0.0
Lower Kalama (270113)	49,823	0.01	0.8	0.0	0.0	0.8	0.0
Siouxon (270305)	39,066	0.00	0.1	0.0	0.0	0.1	0.0
Hamilton Creek (280106)	32,845	0.00	0.0	0.0	0.0	0.0	0.0
Grays Bay (250310)	56,613	0.00	0.0	0.0	0.0	0.0	0.0
Cedar Creek (260428)	14,441	0.00	0.0	0.0	0.0	0.0	0.0
Skamokawa (250209)	51,687	0.00	0.0	0.0	0.0	0.0	0.0
South Fork Grays River (250302)	16,774	0.00	0.0	0.0	0.0	0.0	0.0
Delameter (260623)	37,243	0.00	0.0	0.0	0.0	0.0	0.0
Salmon Creek (260421)	43,837	0.00	0.0	0.0	0.0	0.0	0.0
Mill Creek (260429)	26,163	0.00	0.0	0.0	0.0	0.0	0.0
Stillwater (260625)	28,905	0.00	0.0	0.0	0.0	0.0	0.0
West Fork Grays River (250311)	10,347	0.00	0.0	0.0	0.0	0.0	0.0
Harmony (260330)	22,546	0.00	0.0	0.0	0.0	0.0	0.0
Olequa (260626)	35,017	0.00	0.0	0.0	0.0	0.0	0.0
Green River (260515)	46,383	0.00	0.0	0.0	0.0	0.0	0.0
North Fork Toutle (260514)	41,051	0.00	0.0	0.0	0.0	0.0	0.0
Winston (260320)	28,321	0.00	0.0	0.0	0.0	0.0	0.0
Main Elochoman (250208)	37,009	0.00	0.0	0.0	0.0	0.0	0.0
South Fork Toutle (260513)	42,623	0.00	0.0	0.0	0.0	0.0	0.0
Abernethy (250104)	40,071	0.00	0.0	0.0	0.0	0.0	0.0
North Elochoman (250203)	23,518	0.00	0.0	0.0	0.0	0.0	0.0
Middle Kalama (270114)	51,534	0.00	0.0	0.0	0.0	0.0	0.0
Bremer (260331)	19,894	0.00	0.0	0.0	0.0	0.0	0.0
Spirit Lake (260507)	52,151	0.00	0.0	0.0	0.0	0.0	0.0
Rock Creek Clark (270508)	35,440	0.00	0.0	0.0	0.0	0.0	0.0
Silverstar (280204)	32,719	0.00	0.0	0.0	0.0	0.0	0.0
Upper Washougal (280205)	31,719	0.00	0.0	0.0	0.0	0.0	0.0
Upper SF Toutle (260508)	40,031	0.00	0.0	0.0	0.0	0.0	0.0
Lacamas (280202)	41,185	0.00	0.0	0.0	0.0	0.0	0.0
Cold Creek (270509)	21,281	0.00	0.0	0.0	0.0	0.0	0.0
Little Washougal (280203)	30,269	0.00	0.0	0.0	0.0	0.0	0.0
HCP Planning Unit Average		***0.03***	***1.8***	***0.1***	***0.1***	***1.5***	***0.1***
North Puget HCP Planning Unit							
Jordan (050108)	21,252	0.70	23.1	0.0	0.0	23.0	0.1
Gilligan (030106)	18,879	0.56	16.4	0.1	0.0	13.5	2.9
Alder (030103)	22,865	0.50	17.9	5.4	0.0	12.4	0.1
Stimson Hill (050215)	18,833	0.50	14.7	0.4	0.0	13.6	0.7
Hansen Creek (030102)	29,010	0.49	22.3	0.0	0.0	21.7	0.7
Rinker (040321)	20,481	0.46	14.6	1.7	0.1	12.0	0.8
Porter Canyon (010327)	18,550	0.45	13.2	3.0	0.0	8.8	1.3
Loretta (030104)	15,769	0.45	11.1	0.2	0.0	10.9	0.0

Table E-25. Bull Trout Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Bull Trout Stream Density mi/sq mi	Total Bull Trout Stream Miles	Miles Breakdown by Ownership			
				DNR	Federal	Private1/	Other2/
Verlot (050107)	23,540	0.42	15.4	1.1	5.8	8.5	0.0
Deer Creek (050201)	41,881	0.42	27.3	7.4	8.2	11.6	0.1
Kenney Creek (010230)	2,791	0.41	1.8	0.0	0.0	1.8	0.0
Ebey Hill (050214)	19,812	0.41	12.7	0.1	0.0	11.9	0.7
Howard Creek (010308)	39,040	0.41	24.8	1.4	1.0	17.6	4.8
Sauk Prairie (040320)	14,137	0.36	8.0	1.2	0.0	4.9	1.9
Lower Pilchuck Creek (050313)	19,364	0.36	10.9	0.0	0.0	10.9	0.0
Silverton (050106)	46,399	0.36	26.0	0.0	23.5	1.7	0.8
Jim Creek (050109)	30,690	0.33	15.6	2.5	1.5	11.6	0.0
Warnick (010229)	25,436	0.32	12.9	1.2	0.7	11.0	0.0
Acme (010311)	23,518	0.32	11.6	0.0	0.0	11.4	0.3
Woods Creek (070223)	42,463	0.29	19.6	1.5	0.0	18.0	0.0
Hilt (040322)	12,453	0.29	5.7	0.2	0.0	5.3	0.2
Sultan River (070224)	24,388	0.29	10.9	3.0	0.0	5.9	2.1
Corkindale (040531)	24,194	0.27	10.4	0.0	0.3	8.0	2.1
Olney Creek (070225)	20,655	0.27	8.8	0.5	0.0	8.3	0.0
Hazel (050203)	24,179	0.27	10.2	1.2	0.0	9.0	0.0
Marmot Ridge (010306)	31,794	0.27	13.2	3.2	5.6	2.4	2.0
Grandy (040534)	18,856	0.26	7.6	0.0	0.0	6.9	0.6
Wallace River (070217)	24,667	0.26	9.9	0.2	0.0	7.6	2.1
Nookachamps (030107)	47,730	0.23	17.4	0.0	0.0	17.3	0.1
Jordan-Boulder (040224)	32,726	0.23	11.8	2.5	1.3	7.7	0.4
Pilchuck Mtn (070226)	42,517	0.22	14.4	6.0	0.0	8.3	0.1
French Boulder (050204)	45,327	0.21	14.6	4.4	0.7	9.2	0.2
Hutchinson Creek (010310)	13,975	0.20	4.4	0.4	0.0	4.0	0.0
Deming (010226)	27,527	0.20	8.6	0.0	0.0	8.5	0.1
Tenas (040319)	36,688	0.19	11.0	2.8	2.8	4.1	1.3
Skookum Creek (010309)	23,905	0.19	7.1	3.3	0.0	3.8	0.0
Tolt (070415)	63,357	0.19	18.5	0.0	0.0	17.7	0.8
Youngs Creek (070219)	23,776	0.18	6.8	0.0	0.0	6.8	0.0
East Shannon (040436)	34,065	0.15	7.9	0.0	3.8	0.7	3.4
Canyon Creek (010232)	36,807	0.14	8.1	1.1	0.7	6.2	0.0
West Shannon (040435)	14,333	0.14	3.2	0.0	0.0	0.1	3.1
Tate (070409)	9,798	0.11	1.6	0.0	0.0	1.4	0.2
Raging River (070408)	22,853	0.08	2.8	0.0	0.0	2.8	0.0
Day Creek (030105)	22,203	0.07	2.6	0.0	0.0	2.6	0.0
Clearwater Creek (010328)	14,330	0.06	1.3	0.8	0.0	0.2	0.3
Jackman (040529)	16,399	0.05	1.4	0.0	0.0	1.4	0.0
Cherry (070420)	38,183	0.02	1.3	0.0	0.0	1.1	0.2
Upper NF Stilly (050202)	32,833	0.02	1.1	0.5	0.0	0.7	0.0
Friday Creek (030313)	24,129	0.00	0.0	0.0	0.0	0.0	0.0
Samish Bay (010414)	13,258	0.00	0.0	0.0	0.0	0.0	0.0
Samish River (030301)	57,397	0.00	0.0	0.0	0.0	0.0	0.0
Lummi Island (010617)	5,063	0.00	0.0	0.0	0.0	0.0	0.0
Cypress (030415)	4,950	0.00	0.0	0.0	0.0	0.0	0.0
Lake Whatcom (010412)	35,957	0.00	0.0	0.0	0.0	0.0	0.0
Sumas River (010125)	36,444	0.00	0.0	0.0	0.0	0.0	0.0
Vedder (010131)	21,272	0.00	0.0	0.0	0.0	0.0	0.0
Cavanaugh (050316)	29,722	0.00	0.0	0.0	0.0	0.0	0.0

Table E-25. Bull Trout Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Bull Trout Stream Density mi/sq mi	Total Bull Trout Stream Miles	Miles Breakdown by Ownership			
				DNR	Federal	Private1/	Other2/
Lower MF Snoqualmie (070307)	28,375	0.00	0.0	0.0	0.0	0.0	0.0
South Snoqualmie (070306)	57,077	0.00	0.0	0.0	0.0	0.0	0.0
North Fork Snoqualmie (070313)	66,707	0.00	0.0	0.0	0.0	0.0	0.0
Spada (070216)	44,197	0.00	0.0	0.0	0.0	0.0	0.0
HCP Planning Unit Average		***0.22***	***8.9***	***0.9***	***0.9***	***6.5***	***0.6***
Olympic Experimental State Forest							
Queets Corridor North (210213)	39,496	0.41	25.4	0.0	16.1	0.0	9.3
Rain Forest (200505)	56,435	0.31	27.7	1.9	22.4	0.3	3.1
Hoh Lowlands (200608)	30,244	0.31	14.8	1.3	0.3	12.7	0.6
Lower Clearwater (210114)	45,246	0.26	18.5	2.1	0.1	15.1	1.1
Middle Hoh (200607)	46,272	0.22	15.6	1.5	1.4	10.3	2.5
Queets Corridor South (210212)	29,667	0.06	2.7	0.0	2.7	0.0	0.0
Matheney-Salmon (210211)	21,630	0.03	1.1	0.0	1.1	0.0	0.0
Goodman-Mosquito (200610)	33,529	0.02	1.1	0.0	1.1	0.0	0.0
Upper Clearwater (210116)	58,265	0.01	1.0	1.0	0.0	0.0	0.0
West Dickey (200419)	28,311	0.00	0.0	0.0	0.0	0.0	0.0
Sekiu Coastal (190301)	27,412	0.00	0.0	0.0	0.0	0.0	0.0
Hoko (190302)	44,534	0.00	0.0	0.0	0.0	0.0	0.0
East Dickey (200418)	26,657	0.00	0.0	0.0	0.0	0.0	0.0
Pysht River (190204)	32,972	0.00	0.0	0.0	0.0	0.0	0.0
Clallam River (190303)	22,235	0.00	0.0	0.0	0.0	0.0	0.0
Sol Duc Valley (200201)	47,220	0.00	0.0	0.0	0.0	0.0	0.0
Quillayute Bottom (200417)	23,180	0.00	0.0	0.0	0.0	0.0	0.0
Ozette Lake (200120)	35,130	0.00	0.0	0.0	0.0	0.0	0.0
Cedar (200609)	12,310	0.00	0.0	0.0	0.0	0.0	0.0
Sol Duc Lowlands (200416)	22,368	0.00	0.0	0.0	0.0	0.0	0.0
Kalaloch Ridge (210115)	11,472	0.00	0.0	0.0	0.0	0.0	0.0
Bogachiel (200412)	44,993	0.00	0.0	0.0	0.0	0.0	0.0
Sol Duc Valley (200316)	16,585	0.00	0.0	0.0	0.0	0.0	0.0
HCP Planning Unit Average		***0.07***	***4.7***	***0.3***	***2.0***	***1.7***	***0.7***
South Coast HCP Planning Unit							
Joe-Moclips (210408)	50,805	0.44	34.7	2.0	0.0	15.4	17.4
Copalis River (210407)	40,529	0.43	27.3	1.9	0.0	19.2	6.1
Garrard Creek (230220)	49,056	0.16	12.5	0.1	0.0	8.2	4.2
Mox Chehalis (220106)	23,315	0.10	3.7	0.0	0.0	3.7	0.0
Cedar Creek (230521)	32,505	0.05	2.3	0.0	0.0	1.5	0.8
Porter Creek (230522)	32,023	0.03	1.6	0.0	0.0	1.0	0.6
Lincoln Creek (230219)	48,086	0.01	0.6	0.0	0.0	0.1	0.5
Elk River (220625)	32,340	0.00	0.0	0.0	0.0	0.0	0.0
Lower Willapa (240315)	32,329	0.00	0.0	0.0	0.0	0.0	0.0
Elk Creek (230117)	38,773	0.00	0.0	0.0	0.0	0.0	0.0
Mill Creek (240305)	15,699	0.00	0.0	0.0	0.0	0.0	0.0
Rock-Jones (230116)	22,917	0.00	0.0	0.0	0.0	0.0	0.0
Nemah (240212)	40,522	0.00	0.0	0.0	0.0	0.0	0.0
Palix (240213)	35,825	0.00	0.0	0.0	0.0	0.0	0.0
North River Headwaters (240402)	34,532	0.00	0.0	0.0	0.0	0.0	0.0
South Fork Willapa (240314)	26,664	0.00	0.0	0.0	0.0	0.0	0.0

Table E-25. Bull Trout Stream Density and Length in Each Watershed

Watershed Name (and Number)	Total Acres	Bull Trout Stream Density mi/sq mi	Total Bull Trout Stream Miles	Miles Breakdown by Ownership			
				DNR	Federal	Private1/	Other2/
Willapa Headwaters (240306)	62,581	0.00	0.0	0.0	0.0	0.0	0.0
Lower Naselle (240108)	36,688	0.00	0.0	0.0	0.0	0.0	0.0
Naselle Headwaters (240107)	48,336	0.00	0.0	0.0	0.0	0.0	0.0
Lower Skookumchuck (230404)	44,616	0.00	0.0	0.0	0.0	0.0	0.0
Bunker Creek (230218)	22,788	0.00	0.0	0.0	0.0	0.0	0.0
Curtis (230112)	43,351	0.00	0.0	0.0	0.0	0.0	0.0
Waddel Creek (230501)	28,982	0.00	0.0	0.0	0.0	0.0	0.0
Scatter Creek (230403)	31,680	0.00	0.0	0.0	0.0	0.0	0.0
HCP Planning Unit Average		***0.05***	***3.4***	***0.2***	***0.0***	***2.0***	***1.2***
South Puget HCP Planning Unit							
Cumberland (090202)	26,260	0.21	8.5	0.0	0.0	1.6	6.9
Tiger (080303)	40,881	0.19	11.9	0.0	0.0	10.7	1.2
Howard Hansen (090103)	46,472	0.04	3.2	0.4	0.0	2.1	0.7
Hood (150201)	145,611	0.00	0.0	0.0	0.0	0.0	0.0
Summit Lake (140002)	29,140	0.00	0.0	0.0	0.0	0.0	0.0
Squaxin (140003)	1,066	0.00	0.0	0.0	0.0	0.0	0.0
Olympia (130202)	18,529	0.00	0.0	0.0	0.0	0.0	0.0
Busy Wild (110204)	56,966	0.00	0.0	0.0	0.0	0.0	0.0
Reese Creek (110106)	5,036	0.00	0.0	0.0	0.0	0.0	0.0
North Fork Mineral (110112)	16,072	0.00	0.0	0.0	0.0	0.0	0.0
Mineral Creek (110110)	23,047	0.00	0.0	0.0	0.0	0.0	0.0
Ashford (110104)	27,680	0.00	0.0	0.0	0.0	0.0	0.0
East Creek (110113)	14,429	0.00	0.0	0.0	0.0	0.0	0.0
Catt (110108)	13,279	0.00	0.0	0.0	0.0	0.0	0.0
North Fork Green (090104)	18,410	0.00	0.0	0.0	0.0	0.0	0.0
HCP Planning Unit Average		***0.03***	***1.6***	***0.0***	***0.0***	***1.0***	***0.6***
Straits HCP Planning Unit							
Dungeness Valley (180103)	43,200	0.39	26.6	3.3	6.9	15.6	0.8
Sutherland-Aldwell (180310)	35,109	0.17	9.1	0.0	0.6	6.6	2.0
Siebert McDonald (180202)	35,481	0.16	8.7	3.6	0.0	4.7	0.4
Bell Creek (180104)	5,969	0.06	0.6	0.0	0.0	0.6	0.0
Hamma Hamma (160203)	69,941	0.05	5.6	0.4	5.2	0.0	0.0
Big Quil (170108)	51,823	0.01	0.6	0.0	0.0	0.6	0.0
Chimakum (170203)	28,202	0.00	0.0	0.0	0.0	0.0	0.0
Dabob (170106)	16,871	0.00	0.0	0.0	0.0	0.0	0.0
Ludlow (170104)	22,897	0.00	0.0	0.0	0.0	0.0	0.0
Discovery Bay (170202)	58,871	0.00	0.0	0.0	0.0	0.0	0.0
Lyre (190107)	11,021	0.00	0.0	0.0	0.0	0.0	0.0
Twins (190206)	20,351	0.00	0.0	0.0	0.0	0.0	0.0
Salt (190108)	26,336	0.00	0.0	0.0	0.0	0.0	0.0
Little Quil (170107)	28,536	0.00	0.0	0.0	0.0	0.0	0.0
Thorndike (170105)	16,587	0.00	0.0	0.0	0.0	0.0	0.0
Sequim Bay (170201)	26,752	0.00	0.0	0.0	0.0	0.0	0.0
Port Angeles (180211)	24,883	0.00	0.0	0.0	0.0	0.0	0.0
Lilliwaup (160204)	29,080	0.00	0.0	0.0	0.0	0.0	0.0
HCP Planning Unit Average		***0.05***	***2.8***	***0.4***	***0.7***	***1.6***	***0.2***

1/ Includes privately owned industrial and non-industrial (i.e., small landowner) lands.

2/ Includes municipal, tribal, non-DNR state lands, and other lands.

Table E-26. Percent of Watershed Area in Each Land Use Category

Watershed Name (and number)	Total Acres	Percent of Watershed Area: Forested	Agricultural	Urban	Wetland Acres	Other[1/]
Columbia HCP Planning Unit						
Lacamas (280202)	41,185	50%	31%	15%	2%	1%
Olequa (260626)	35,017	63%	32%	5%	0%	0%
Harmony (260330)	22,546	56%	32%	3%	9%	0%
Woodland (270412)	37,827	61%	25%	7%	6%	1%
Little Washougal (280203)	30,269	74%	14%	8%	3%	2%
Mill Creek (260429)	26,163	78%	18%	2%	1%	1%
Salmon Creek (260421)	43,837	84%	14%	1%	1%	1%
Main Elochoman (250208)	37,009	73%	13%	2%	12%	1%
Cedar Creek (270416)	36,416	85%	12%	3%	0%	0%
Delameter (260623)	37,243	90%	6%	3%	1%	0%
Lower Kalama (270113)	49,823	88%	2%	5%	3%	1%
Skamokawa (250209)	51,687	85%	6%	0%	6%	1%
Grays Bay (250310)	56,613	78%	5%	0%	16%	1%
Stillwater (260625)	28,905	95%	4%	1%	0%	0%
Rock Creek Clark (270508)	35,440	97%	2%	1%	0%	0%
Wind River (290414)	30,669	95%	2%	1%	1%	1%
Cedar Creek (260428)	14,441	97%	2%	0%	0%	0%
Silverstar (280204)	32,719	98%	2%	0%	0%	0%
Winston (260320)	28,321	99%	1%	1%	0%	0%
Lake Merwin (270415)	46,439	87%	1%	1%	11%	1%
Abernethy (250104)	40,071	97%	0%	1%	2%	1%
Rock Creek (290415)	41,733	94%	0%	1%	5%	0%
Bremer (260331)	19,894	97%	1%	0%	1%	1%
South Fork Toutle (260513)	42,623	97%	0%	0%	1%	1%
North Fork Toutle (260514)	41,051	93%	0%	0%	4%	3%
North Elochoman (250203)	23,518	99%	0%	0%	0%	1%
Cold Creek (270509)	21,281	89%	0%	0%	0%	11%
South Fork Grays River (250302)	16,774	97%	0%	0%	1%	3%
Cougar (270317)	32,888	91%	0%	0%	7%	2%
Green River (260515)	46,383	99%	0%	0%	0%	0%
West Fork Grays River (250311)	10,347	98%	0%	0%	0%	1%
Middle Kalama (270114)	51,534	99%	0%	0%	0%	1%
Hamilton Creek (280106)	32,845	95%	0%	0%	5%	0%
Spirit Lake (260507)	52,151	67%	0%	0%	6%	27%
Upper Washougal (280205)	31,719	100%	0%	0%	0%	0%
Upper SF Toutle (260508)	40,031	95%	0%	0%	1%	4%
Swift Creek (270304)	74,150	89%	0%	0%	6%	5%
Siouxon (270305)	39,066	99%	0%	0%	1%	0%
HCP Planning Unit Average		***88%***	***6%***	***2%***	***3%***	***2%***
North Puget HCP Planning Unit						
Sumas River (010125)	36,444	38%	57%	5%	0%	0%
Samish River (030301)	57,397	59%	35%	5%	0%	1%
Hansen Creek (030102)	29,010	72%	20%	5%	1%	1%
Samish Bay (010414)	13,258	78%	18%	2%	0%	1%
Acme (010311)	23,518	80%	18%	0%	1%	1%
Ebey Hill (050214)	19,812	80%	17%	2%	1%	1%
Nookachamps (030107)	47,730	80%	13%	4%	3%	1%
Lummi Island (010617)	5,063	81%	11%	6%	1%	2%
Cherry (070420)	38,183	83%	7%	9%	1%	0%

Table E-26. Percent of Watershed Area in Each Land Use Category

		Percent of Watershed Area				
Watershed Name (and number)	Total Acres	Forested	Agricultural	Urban	Wetland Acres	Other[1/]
Vedder (010131)	21,272	84%	16%	0%	0%	0%
Tate (070409)	9,798	79%	3%	13%	2%	3%
Jordan (050108)	21,252	82%	8%	7%	3%	1%
Woods Creek (070223)	42,463	84%	10%	5%	2%	1%
Deming (010226)	27,527	86%	11%	0%	1%	2%
Lower Pilchuck Creek (050313)	19,364	88%	8%	3%	0%	0%
Alder (030103)	22,865	89%	11%	0%	0%	0%
Friday Creek (030313)	24,129	85%	5%	5%	4%	1%
Olney Creek (070225)	20,655	90%	4%	3%	1%	2%
Stimson Hill (050215)	18,833	93%	6%	0%	0%	1%
Lake Whatcom (010412)	35,957	80%	1%	5%	14%	0%
Raging River (070408)	22,853	93%	0%	5%	1%	1%
Gilligan (030106)	18,879	91%	5%	0%	3%	2%
Youngs Creek (070219)	23,776	92%	3%	1%	1%	2%
South Snoqualmie (070306)	57,077	94%	0%	4%	1%	1%
Grandy (040534)	18,856	94%	4%	0%	1%	0%
Sauk Prairie (040320)	14,137	95%	4%	0%	1%	1%
Sultan River (070224)	24,388	93%	1%	3%	3%	1%
Jim Creek (050109)	30,690	96%	3%	1%	0%	0%
Hutchinson Creek (010310)	13,975	97%	2%	0%	1%	0%
Corkindale (040531)	24,194	96%	2%	0%	2%	0%
Lower MF Snoqualmie (070307)	28,375	95%	0%	2%	1%	2%
Wallace River (070217)	24,667	94%	0%	2%	2%	2%
Kenney Creek (010230)	2,791	94%	2%	0%	2%	2%
Pilchuck Mtn (070226)	42,517	95%	0%	2%	1%	3%
Loretta (030104)	15,769	95%	1%	0%	3%	1%
Hazel (050203)	24,179	98%	1%	0%	0%	0%
Rinker (040321)	20,481	95%	1%	0%	2%	2%
French Boulder (050204)	45,327	94%	1%	0%	0%	5%
Tolt (070415)	63,357	96%	0%	0%	2%	2%
Jackman (040529)	16,399	99%	0%	0%	0%	0%
Warnick (010229)	25,436	98%	0%	0%	1%	1%
Jordan-Boulder (040224)	32,726	97%	0%	0%	1%	2%
Cypress (030415)	4,950	97%	0%	0%	1%	2%
North Fork Snoqualmie (070313)	66,707	97%	0%	0%	2%	2%
Deer Creek (050201)	41,881	99%	0%	0%	0%	0%
Verlot (050107)	23,540	93%	0%	0%	1%	6%
Silverton (050106)	46,399	94%	0%	0%	0%	5%
Spada (070216)	44,197	92%	0%	0%	4%	4%
Cavanaugh (050316)	29,722	97%	0%	0%	3%	0%
Day Creek (030105)	22,203	99%	0%	0%	1%	0%
Skookum Creek (010309)	23,905	99%	0%	0%	0%	1%
Porter Canyon (010327)	18,550	98%	0%	0%	1%	1%
Howard Creek (010308)	39,040	99%	0%	0%	0%	0%
Canyon Creek (010232)	36,807	98%	0%	0%	1%	1%
Clearwater Creek (010328)	14,330	100%	0%	0%	0%	0%
West Shannon (040435)	14,333	94%	0%	0%	6%	0%
Marmot Ridge (010306)	31,794	84%	0%	0%	0%	16%
Hilt (040322)	12,453	98%	0%	0%	1%	2%
Upper NF Stilly (050202)	32,833	100%	0%	0%	0%	0%
East Shannon (040436)	34,065	91%	0%	0%	9%	1%

Table E-26. Percent of Watershed Area in Each Land Use Category

Watershed Name (and number)	Total Acres	Percent of Watershed Area: Forested	Agricultural	Urban	Wetland Acres	Other[1/]
Tenas (040319)	36,688	97%	0%	0%	1%	2%
HCP Planning Unit Average		***90%***	***5%***	***2%***	***2%***	***2%***
Olympic Experimental State Forest						
Sol Duc Valley (200316)	16,585	87%	8%	4%	1%	0%
Sol Duc Lowlands (200416)	22,368	94%	4%	0%	1%	1%
Sol Duc Valley (200201)	47,220	95%	3%	0%	1%	0%
Clallam River (190303)	22,235	96%	3%	0%	0%	0%
Quillayute Bottom (200417)	23,180	94%	3%	0%	1%	1%
Hoko (190302)	44,534	99%	1%	0%	0%	0%
Middle Hoh (200607)	46,272	97%	0%	0%	1%	2%
Queets Corridor North (210213)	39,496	94%	0%	1%	2%	3%
Hoh Lowlands (200608)	30,244	95%	0%	0%	2%	3%
Sekiu Coastal (190301)	27,412	100%	0%	0%	0%	0%
Matheney-Salmon (210211)	21,630	99%	0%	0%	0%	1%
Bogachiel (200412)	44,993	98%	0%	0%	1%	1%
Cedar (200609)	12,310	99%	0%	0%	0%	0%
Lower Clearwater (210114)	45,246	99%	0%	0%	1%	1%
Queets Corridor South (210212)	29,667	99%	0%	0%	0%	1%
Upper Clearwater (210116)	58,265	100%	0%	0%	0%	0%
Pysht River (190204)	32,972	99%	0%	0%	0%	1%
West Dickey (200419)	28,311	98%	0%	0%	2%	0%
East Dickey (200418)	26,657	100%	0%	0%	0%	0%
Ozette Lake (200120)	35,130	99%	0%	0%	0%	0%
Goodman-Mosquito (200610)	33,529	100%	0%	0%	0%	0%
Kalaloch Ridge (210115)	11,472	99%	0%	0%	0%	1%
Rain Forest (200505)	56,435	93%	0%	0%	1%	6%
HCP Planning Unit Average		***97%***	***1%***	***0%***	***1%***	***1%***
South Coast HCP Planning Unit						
Scatter Creek (230403)	31,680	50%	41%	9%	0%	0%
Lower Willapa (240315)	32,329	71%	19%	4%	4%	1%
Lower Skookumchuck (230404)	44,616	76%	17%	6%	1%	1%
Mox Chehalis (220106)	23,315	81%	15%	4%	1%	0%
Lincoln Creek (230219)	48,086	84%	14%	1%	0%	0%
Garrard Creek (230220)	49,056	85%	13%	0%	1%	1%
Curtis (230112)	43,351	86%	12%	1%	0%	1%
Waddel Creek (230501)	28,982	88%	10%	1%	0%	0%
Rock-Jones (230116)	22,917	87%	9%	2%	0%	1%
Cedar Creek (230521)	32,505	91%	6%	2%	0%	1%
Elk River (220625)	32,340	91%	2%	6%	0%	1%
Bunker Creek (230218)	22,788	93%	7%	1%	0%	0%
Willapa Headwaters (240306)	62,581	93%	5%	0%	0%	1%
Lower Naselle (240108)	36,688	94%	2%	1%	1%	2%
Porter Creek (230522)	32,023	97%	2%	0%	0%	1%
Palix (240213)	35,825	96%	1%	1%	1%	1%
South Fork Willapa (240314)	26,664	96%	0%	2%	1%	1%
North River Headwaters (240402)	34,532	97%	2%	0%	0%	1%
Copalis River (210407)	40,529	96%	0%	1%	0%	2%
Elk Creek (230117)	38,773	98%	1%	0%	0%	1%
Nemah (240212)	40,522	98%	0%	0%	0%	1%
Naselle Headwaters (240107)	48,336	98%	0%	0%	0%	1%

Table E-26. Percent of Watershed Area in Each Land Use Category

Watershed Name (and number)	Total Acres	Percent of Watershed Area: Forested	Agricultural	Urban	Wetland Acres	Other[1/]
Joe-Moclips (210408)	50,805	98%	0%	0%	0%	1%
Mill Creek (240305)	15,699	99%	0%	0%	0%	1%
HCP Planning Unit Average		***89%***	***7%***	***2%***	***0%***	***1%***
South Puget HCP Planning Unit						
Olympia (130202)	18,529	80%	3%	16%	1%	0%
Tiger (080303)	40,881	81%	4%	12%	1%	2%
Hood (150201)	145,611	89%	1%	8%	1%	1%
Summit Lake (140002)	29,140	90%	2%	5%	2%	1%
Cumberland (090202)	26,260	93%	1%	5%	1%	0%
Busy Wild (110204)	56,966	97%	1%	1%	0%	0%
Ashford (110104)	27,680	91%	1%	1%	7%	0%
East Creek (110113)	14,429	94%	0%	0%	6%	0%
Howard Hansen (090103)	46,472	98%	0%	0%	1%	0%
North Fork Green (090104)	18,410	100%	0%	0%	0%	0%
Squaxin (140003)	1,066	98%	0%	0%	2%	0%
Reese Creek (110106)	5,036	99%	0%	0%	1%	0%
North Fork Mineral (110112)	16,072	100%	0%	0%	0%	0%
Mineral Creek (110110)	23,047	99%	0%	0%	1%	0%
Catt (110108)	13,279	100%	0%	0%	0%	0%
HCP Planning Unit Average		***94%***	***1%***	***3%***	***2%***	***0%***
Straits HCP Planning Unit						
Bell Creek (180104)	5,969	37%	55%	8%	0%	0%
Dungeness Valley (180103)	43,200	63%	33%	2%	0%	1%
Port Angeles (180211)	24,883	66%	7%	25%	0%	1%
Chimakum (170203)	28,202	80%	13%	5%	1%	2%
Siebert McDonald (180202)	35,481	84%	13%	2%	0%	0%
Salt (190108)	26,336	87%	10%	3%	0%	0%
Sequim Bay (170201)	26,752	91%	7%	1%	0%	1%
Discovery Bay (170202)	58,871	92%	1%	6%	1%	1%
Ludlow (170104)	22,897	94%	2%	3%	0%	1%
Little Quil (170107)	28,536	95%	3%	0%	1%	0%
Sutherland-Aldwell (180310)	35,109	91%	2%	1%	2%	4%
Lyre (190107)	11,021	98%	1%	1%	0%	0%
Lilliwaup (160204)	29,080	98%	0%	1%	0%	1%
Big Quil (170108)	51,823	91%	0%	0%	0%	8%
Twins (190206)	20,351	100%	0%	0%	0%	0%
Hamma Hamma (160203)	69,941	91%	0%	0%	0%	9%
Dabob (170106)	16,871	99%	0%	0%	1%	1%
Thorndike (170105)	16,587	99%	0%	0%	1%	1%
HCP Planning Unit Average		***86%***	***8%***	***3%***	***0%***	***2%***

1/ Includes areas that are barren, data noise, snow, and other areas.

Table E-27. Percent of Watershed Area Classified by DNR as Hydrologically Immature Forest in the Rain-on-Snow Zone[1/]

Watershed Name (and number)	Total Acres	Percent Classified as "Young" in the Rain-on-Snow Zone	Percentage Breakdown by Ownership DNR	Federal	Private[3/]	Other[4/]
Columbia HCP Planning Unit						
Green River (260515)	46,383	49	1	0	46	2
North Fork (260514)	41,051	48	18	0	28	2
South Fork Grays River (250302)	16,774	47	2	0	45	0
Swift Creek (270304)	74,150	44	1	15	27	0
Wind River (290414)	30,669	37	1	35	0	0
Upper South Fork (260508)	40,031	33	11	1	20	1
Siouxon (270305)	39,066	32	4	28	0	0
North Elochoman (250203)	23,518	31	0	0	30	0
Winston (260320)	28,321	29	4	0	22	3
South Fork (260513)	42,623	28	10	0	19	0
Middle Kalama (270114)	51,534	28	2	0	26	0
Main Fork (250311)	10,347	28	1	0	27	0
Silverstar (280204)	32,719	27	4	7	16	1
Hamilton Creek (280106)	32,845	27	7	8	7	5
Rock Creek Clark (270508)	35,440	26	1	13	12	0
Upper Washougal (280205)	31,719	26	6	8	12	1
Bremer (260331)	19,894	25	1	5	19	0
Spirit Lake (260507)	52,151	23	2	21	0	0
Rock Creek (290415)	41,733	20	4	12	4	0
Cougar (270317)	32,888	20	2	14	4	0
Lake Merwin (270415)	46,439	14	4	0	10	0
Headwaters (240107)	48,336	14	0	0	14	0
Cold Creek (270509)	21,281	11	7	1	3	0
Delameter (260623)	37,243	7	0	0	7	0
Skamokawa (250209)	51,687	6	0	0	5	0
Abernethy (250104)	40,071	5	2	0	3	0
Cedar Creek (270416)	36,416	4	0	0	4	0
Mill Creek (260429)	26,163	4	0	0	4	0
Catt (110108)	13,279	3	2	1	0	0
Stillwater (260625)	28,905	3	0	0	3	0
Lower Kalama (270113)	49,823	2	1	0	2	0
Little Washougal (280203)	30,269	2	1	0	2	0
Harmony (260330)	22,546	2	0	0	2	0
Main Elochoman (250208)	37,009	2	0	0	2	0
Lacamas (280202)	41,185	2	1	0	1	0
Woodland (270412)	37,827	1	1	0	0	0
Salmon Creek (260421)	43,837	1	0	0	0	0
Grays Bay (250310)	56,613	0	0	0	0	0
HCP Planning Unit Average		***19***	***3***	***4***	***11***	***0***
North Puget HCP Planning Unit						
Day Creek (030105)	22,203	42	1	3	38	0
Spada (070216)	44,197	33	25	4	0	4
Howard Creek (010308)	39,040	27	2	1	22	2
Upper Nf Stilly (050202)	32,833	27	0	24	3	0
Tolt (070415)	63,357	25	0	2	19	4
Silverton (050106)	46,399	24	0	24	0	0

Table E-27. Percent of Watershed Area Classified by DNR as Hydrologically Immature Forest in the Rain-on-Snow Zone[1/]

Watershed Name (and number)	Total Acres	Percent Classified as "Young" in the Rain-on-Snow Zone	Percentage Breakdown by Ownership DNR	Federal	Private[3/]	Other[4/]
Verlot (050107)	23,540	24	2	21	0	0
North Fork Snoqualmie (070313)	66,707	23	1	10	11	1
Deer Creek (050201)	41,881	23	1	11	11	0
Wallace River (070217)	24,667	22	10	6	4	3
Acme (010311)	23,518	22	7	0	16	0
Raging River (070408)	22,853	19	1	0	17	1
Hutchinson Creek (010310)	13,975	19	1	0	17	0
Sauk Prairie (040320)	14,137	19	5	6	8	0
South Snoqualmie (070306)	57,077	19	2	12	3	2
Jim Creek (050109)	30,690	18	1	5	11	1
Deming (010226)	27,527	18	7	0	11	0
Kenney Creek (010230)	2,791	18	0	0	18	0
French Boulder (050204)	45,327	17	0	16	1	0
Youngs Creek (070219)	23,776	17	0	0	17	0
Loretta (030104)	15,769	17	1	1	15	0
Corkindale (040531)	24,194	16	2	12	2	0
Jackman (040529)	16,399	16	1	2	13	0
Lower Middle (070307)	28,375	16	8	8	0	0
Rinker (040321)	20,481	15	2	5	8	0
E Shannon (040436)	34,065	15	0	7	7	0
Porter Canyon (010327)	18,550	14	2	0	12	1
Tenas (040319)	36,688	14	0	12	2	0
Canyon Creek (010232)	36,807	14	2	4	8	0
Hilt (040322)	12,453	13	0	10	3	0
Hazel (050203)	24,179	13	2	10	1	0
Jordan-Boulder (040224)	32,726	13	1	3	9	0
Skookum Creek (010309)	23,905	11	0	0	11	0
Olney Creek (070225)	20,655	11	6	0	3	2
Hansen Creek (030102)	29,010	10	1	0	9	0
Warnick (010229)	25,436	10	4	0	6	0
Gilligan (030106)	18,879	10	1	0	9	0
Pilchuck Mtn (070226)	42,517	9	7	0	2	0
W Shannon (040435)	14,333	9	0	1	8	0
Cavanaugh (050316)	29,722	9	1	0	8	0
Samish River (030301)	57,397	7	2	0	5	0
Grandy (040534)	18,856	6	1	0	5	0
Marmot Ridge (010306)	31,794	6	1	2	3	0
Vedder (010131)	21,272	5	3	0	3	0
Lake Whatcom (010412)	35,957	5	3	0	2	0
Stimson Hill (050215)	18,833	4	2	0	2	0
Sumas River (010125)	36,444	4	1	0	3	0
Nookachamps (030107)	47,730	3	0	0	3	0
Ebey Hill (050214)	19,812	3	0	0	3	0
Sultan River (070224)	24,388	3	1	1	0	0
Tate (070409)	9,798	2	1	0	2	0
Jordan (050108)	21,252	2	1	1	1	0
Alder (030103)	22,865	2	2	0	0	0

Table E-27. Percent of Watershed Area Classified by DNR as Hydrologically Immature Forest in the Rain-on-Snow Zone[1/]

Watershed Name (and number)	Total Acres	Percent Classified as "Young" in the Rain-on-Snow Zone	Percentage Breakdown by Ownership: DNR	Federal	Private[3/]	Other[4/]
Friday Creek (030313)	24,129	2	0	0	1	0
Clearwater Creek (010328)	14,330	1	1	0	0	0
Cherry (070420)	38,183	1	0	0	1	0
Samish Bay (010414)	13,258	0	0	0	0	0
HCP Planning Unit Average		***14***	***2***	***4***	***7***	***0***
Olympic Experimental State Forest						
Queets Corridor S (210212)	29,667	46	0	46	0	0
Rain Forest (200505)	56,435	39	4	34	0	0
Matheney-Salmon (210211)	21,630	29	0	13	0	16
Middle Hoh (200607)	46,272	26	24	1	0	0
Upper Clearwater (210116)	58,265	24	23	1	0	0
Sol Duc Valley (200201)	47,220	15	0	13	1	0
Sol Duc Lowlands (200416)	22,368	6	0	5	1	0
Queets Corridor North (210213)	39,496	5	0	5	0	0
Sol Duc Valley (200316)	16,585	5	0	5	0	0
Hoko (190302)	44,534	4	1	1	2	0
Kalaloch Ridge (210115)	11,472	3	3	0	0	0
Bogachiel (200412)	44,993	3	0	3	0	0
Pysht River (190204)	32,972	3	0	2	0	0
Clallam River (190303)	22,235	2	0	0	2	0
Lower Clearwater (210114)	45,246	2	0	0	2	0
East Dickey (200418)	26,657	2	0	0	2	0
Hoh Lowlands (200608)	30,244	1	0	0	1	0
Sekiu Coastal (190301)	27,412	1	0	0	0	1
West Dickey (200419)	28,311	0	0	0	0	0
Cedar (200609)	12,310	0	0	0	0	0
HCP Planning Unit Average		***11***	***3***	***7***	***1***	***1***
South Coast HCP Planning Unit						
Headwaters (240107)	48,336	14	0	0	14	0
Headwaters (240306)	62,581	10	0	0	10	0
Elk Creek (230117)	38,773	3	0	0	2	0
Cedar Creek (230521)	32,505	3	3	0	0	0
Rock-Jones (230116)	22,917	2	1	0	1	0
Porter Creek (230522)	32,023	2	2	0	0	0
Garrard Creek (230220)	49,056	2	0	0	2	0
Lincoln Creek (230219)	48,086	2	0	0	2	0
Lower Naselle (240108)	36,688	2	0	0	1	0
Nemah (240212)	40,522	2	0	0	1	0
Headwaters (240402)	34,532	1	0	0	1	0
South Fork Willapa (240314)	26,664	1	0	0	1	0
Lower Skookumchuck (230404)	44,616	1	0	0	1	0
Waddel Creek (230501)	28,982	0	0	0	0	0
Curtis (230112)	43,351	0	0	0	0	0
Mill Creek (240305)	15,699	0	0	0	0	0
Mox Chehalis (220106)	23,315	0	0	0	0	0
HCP Planning Unit Average		***2***	***0***	***0***	***2***	***0***

Table E-27. Percent of Watershed Area Classified by DNR as Hydrologically Immature Forest in the Rain-on-Snow Zone[1/]

Watershed Name (and number)	Total Acres	Percent Classified as "Young" in the Rain-on-Snow Zone	Percentage Breakdown by Ownership DNR	Federal	Private[3/]	Other[4/]
South Puget HCP Planning Unit						
Howard Hansen (090103)	46,472	31	7	0	24	1
North Fork Green (090104)	18,410	27	3	0	22	2
Mineral Creek (110110)	23,047	26	3	0	18	4
East Creek (110113)	14,429	23	2	10	10	1
Busy Wild (110204)	56,966	21	4	0	17	0
Ashford (110104)	27,680	18	5	4	5	3
Cumberland (090202)	26,260	13	1	0	11	0
Reese Creek (110106)	5,036	11	11	0	0	0
North Fork Mineral (110112)	16,072	8	2	0	5	1
Tiger (080303)	40,881	4	2	0	2	1
Catt (110108)	13,279	3	2	1	0	0
Summit Lake (140002)	29,140	0	0	0	0	0
Olympia (130202)	18,529	0	0	0	0	0
HCP Planning Unit Average		***14***	***3***	***1***	***9***	***1***
Straits HCP Planning Unit						
Hamma Hamma (160203)	69,941	46	1	44	0	0
Big Quil (170108)	51,823	39	0	39	0	0
Sutherland-Aldwell (180310)	35,109	27	1	25	1	0
Twins (190206)	20,351	26	0	25	1	0
Little Quil (170107)	28,536	19	0	19	0	0
Sequim Bay (170201)	26,752	15	4	9	2	0
Dungeness Valley (180103)	43,200	13	1	11	1	0
Siebert Mcdonald (180202)	35,481	12	0	12	0	0
Lyre (190107)	11,021	12	0	9	3	0
Discovery Bay (170202)	58,871	9	0	8	1	0
Lilliwaup (160204)	29,080	8	0	8	0	0
Port Angeles (180211)	24,883	7	1	6	1	0
Salt (190108)	26,336	2	2	0	0	0
Bell Creek (180104)	5,969	1	0	0	0	0
HCP Planning Unit Average		***17***	***1***	***15***	***1***	***0***

1/ Identified by DNR as "young", as opposed to "mature." Hydrologically mature is defined as a well-stocked conifer stand over the age of 25 years, with a relative density of at least 25.

2/ Watershed Analysis Units with greater than 5% ownership that have hydrologically immature forested land in the rain-on-snow zone are ranked by percent area of unit that meets these criteria.

3/ Includes privately owned industrial and non-industrial (i.e., small landowner) forest land.

4/ Includes, municipal, tribal, non-DNR state lands, and other lands.

Table E-28. Lengths of Streams in Each Watershed that Have 303(d) Listings for Temperature [1/]

Watershed Name (and Number)	Total Acres	Average Elevation of Watershed (feet)	Miles of 303(d) listed Stream	Rank[2/]	Miles Breakdown by Ownership DNR	Federal	Private[3/]	Other[4/]
Columbia HCP Planning Unit								
Lacamas (280202)	41,185	525	5.44	4		0.57	4.67	0.20
Lower Kalama (270113)	49,823	855	1.89	27			1.89	0.00
Green River (260515)	46,383	1,851	1.33	37			1.33	0.00
Abernethy (250104)	40,071	877	1.14	40	1.14		0.00	0.00
Upper SF Toutle (260508)	40,031	2,948	0.98	49	0.98		0.00	0.00
Main Elochoman (250208)	37,009	440	0.91	53	0.04		0.53	0.33
HCP Planning Unit Total			***11.69***		***2.17***	***0.57***	***8.42***	***0.53***
North Puget HCP Planning Unit								
Nookachamps (030107)	47,730	810	8.62	2	0.01		8.61	0.00
Hansen Creek (030102)	29,010	933	4.40	8			3.78	0.63
Canyon Creek (010232)	36,807	2,982	2.62	17	0.47		2.15	0.00
South Snoqualmie (070306)	57,077	2,617	2.61	18			2.61	0.00
Deer Creek (050201)	41,881	2,576	2.55	20			2.55	0.00
Howard Creek (010308)	39,040	2,393	2.50	22			2.21	0.28
Raging River (070408)	22,853	1,387	2.49	23			2.49	0.00
Tate (070409)	9,798	704	2.25	24			2.25	0.00
Warnick (010229)	25,436	2,406	1.97	26	0.02	0.17	1.77	0.00
Porter Canyon (010327)	18,550	1,983	1.64	30	0.63		0.98	0.03
Jordan (050108)	21,252	398	1.59	32			1.52	0.07
Day Creek (030105)	22,203	2,135	1.34	36			1.34	0.00
Jackman (040529)	16,399	2,854	1.16	39			1.16	0.00
Lower Pilchuck Creek (050313)	19,364	399	1.14	41			1.14	0.00
Grandy (040534)	18,856	1,351	1.12	42			1.12	0.00
Skookum Creek (010309)	23,905	2,785	1.08	44	0.90		0.18	0.00
Loretta (030104)	15,769	2,349	0.99	48			0.99	0.00
French Boulder (050204)	45,327	2,333	0.97	51	0.61		0.34	0.02
Alder (030103)	22,865	858	0.91	52			0.91	0.00
Wallace River (070217)	24,667	2,165	0.70	56			0.70	0.00
Sumas River (010125)	36,444	408	0.59	58	0.01		0.58	0.00
Acme (010311)	23,518	1,035	0.52	59			0.52	0.00
Ebey Hill (050214)	19,812	796	0.26	60	0.26		0.00	0.00
HCP Planning Unit Total			***3.95***		***2.91***	***0.17***	***39.90***	***1.02***

Table E-28. Lengths of Streams in Each Watershed that Have 303(d) Listings for Temperature [1/]

Watershed Name (and Number)	Total Acres	Average Elevation of Watershed (feet)	Miles of 303(d) listed Stream	Rank[2/]	Miles Breakdown by Ownership			
					DNR	Federal	Private[3/]	Other[4/]
Olympic Experimental State Forest								
Bogachiel (200412)	44,993	395	9.57	1	0.58	0.34	7.64	1.01
Middle Hoh (200607)	46,272	1,047	5.59	3	2.58		2.96	0.06
Sol Duc Lowlands (200416)	22,368	448	5.12	5	0.04		5.08	0.00
West Dickey (200419)	28,311	381	4.58	7	0.03		4.55	0.00
Rain Forest (200505)	56,435	2,934	3.81	10	2.13		0.00	1.69
Sekiu Coastal (190301)	27,412	271	3.70	11	0.00		3.66	0.03
Sol Duc Valley (200201)	47,220	949	3.38	12			3.02	0.35
East Dickey (200418)	26,657	504	2.74	16	0.41		2.23	0.10
Clallam River (190303)	22,235	228	2.52	21	1.18		1.20	0.14
Kalaloch Ridge (210115)	11,472	217	1.82	28		0.44	1.38	0.00
Hoh Lowlands (200608)	30,244	331	1.72	29			1.72	0.00
Quillayute Bottom (200417)	23,180	114	1.49	33	0.23		1.25	0.01
Ozette Lake (200120)	35,130	300	1.48	34	0.00		1.48	0.00
Pysht River (190204)	32,972	343	1.06	46			1.06	0.00
Sol Duc Valley (200316)	16,585	503	0.82	55			0.82	0.00
Hoko (190302)	44,534	555	0.12	63			0.01	0.11
HCP Planning Unit Total			***6.70***		***7.19***	***0.79***	***38.05***	***3.50***
South Coast HCP Planning Unit								
Garrard Creek (230220)	49,056	461	3.94	9			3.22	0.72
Lower Skookumchuck (230404)	44,616	494	2.59	19			2.59	0.00
Curtis (230112)	43,351	561	1.62	31			1.62	0.00
Scatter Creek (230403)	31,680	309	1.10	43			1.10	0.00
Lincoln Creek (230219)	48,086	439	1.05	47			1.05	0.00
Naselle Headwaters (240107)	48,336	806	0.97	50			0.97	0.00
Willapa Headwaters (240306)	62,581	785	0.87	54			0.87	0.00
Cedar Creek (230521)	32,505	839	0.60	57			0.27	0.33
Porter Creek (230522)	32,023	1,014	0.24	61			0.21	0.03
Lower Willapa (240315)	32,329	191	0.20	62			0.20	0.00
HCP Planning Unit Total			***3.94***		***0.00***	***0.00***	***12.12***	***1.08***

Table E-28. Lengths of Streams in Each Watershed that Have 303(d) Listings for Temperature [1/]

Watershed Name (and Number)	Total Acres	Average Elevation of Watershed (feet)	Miles of 303(d) listed Stream	Rank[2/]	Miles Breakdown by Ownership			
					DNR	Federal	Private[3/]	Other[4/]
South Puget HCP Planning Unit								
Hood (150201)	145,611	366	4.95	6	0.69		3.02	1.25
Howard Hansen (090103)	46,472	2,303	2.81	15	0.03		0.00	2.78
Catt (110108)	13,279	3,375	1.40	35		1.40	0.00	0.00
HCP Planning Unit Total			***13.30***		***0.72***	***1.40***	***3.02***	***4.03***
Straits HCP Planning Unit								
Chimakum (170203)	28,202	168	3.15	13			3.15	0.00
Little Quil (170107)	28,536	1,215	3.12	14			3.12	0.00
Dabob (170106)	16,871	239	2.06	25			1.47	0.59
Sutherland-Aldwell (180310)	35,109	1,528	1.27	38			0.79	0.47
Port Angeles (180211)	24,883	425	1.06	45			1.06	0.00
HCP Planning Unit Total			***10.67***		***0.00***	***0.00***	***9.61***	***1.06***

1/ Includes all streams in watershed with DNR ownership of >5%, listed for temperature.
2/ Watersheds are ranked by miles of stream listed for temperature.
3/ Includes privately owned industrial and non-industrial (i.e., small landowner) forestland.
4/ Includes, municipal, tribal, non-DNR state lands, and other lands.

Table E-29. Percent of Watershed Classified as High for Potential Slope Instability

Watershed Name (and Number)	Total Acres	Rank[1/]	Percent of Watershed Acreage Classified as High	Percentage Breakdown by Ownership			
				DNR	Federal	Private[2/]	Other[3/]
Columbia HCP Planning Unit							
Bremer (260331)	19,894	9	30.7	3.3	5.0	21.6	0.8
Grays Bay (250310)	56,613	19	25.8	3.1	0.0	22.5	0.1
Stillwater (260625)	28,905	21	25.2	0.8	0.0	24.3	0.0
North Elochoman (250203)	23,518	28	23.6	4.4	0.0	19.1	0.0
West Fork Grays River (250311)	10,347	32	22.9	4.2	0.0	18.7	0.0
Skamokawa (250209)	51,687	72	12.8	2.9	0.0	9.6	0.3
Upper Washougal (280205)	31,719	80	12.1	8.1	1.9	1.9	0.1
South Fork Grays River (250302)	16,774	97	10.1	3.1	0.0	6.9	0.1
Mill Creek (260429)	26,163	98	9.6	1.8	0.0	7.8	0.0
Siouxon (270305)	39,066	102	9.2	2.8	6.4	0.0	0.0
Main Elochoman (250208)	37,009	113	8.4	2.5	0.0	5.9	0.0
Spirit Lake (260507)	52,151	114	8.1	1.1	6.9	0.1	0.0
Upper SF Toutle (260508)	40,031	122	7.0	1.8	2.1	3.0	0.2
Delameter (260623)	37,243	123	7.0	0.0	0.0	7.0	0.0
Rock Creek (290415)	41,733	124	6.9	4.1	1.4	1.4	0.1
Cougar (270317)	32,888	129	6.1	3.2	1.7	1.2	0.0
Cedar Creek (260428)	14,441	133	5.9	0.2	0.0	5.2	0.4
Wind River (290414)	30,669	134	5.6	1.5	3.5	0.5	0.1
Hamilton Creek (280106)	32,845	135	5.6	1.3	1.6	0.8	1.9
Olequa (260626)	35,017	138	5.0	2.0	0.0	3.0	0.0
Swift Creek (270304)	74,150	146	4.6	0.7	2.0	1.8	0.0
Silverstar (280204)	32,719	153	3.3	0.6	1.4	1.3	0.1
Lake Merwin (270415)	46,439	154	3.3	1.9	0.0	1.4	0.0
Harmony (260330)	22,546	155	3.1	0.1	0.0	2.7	0.4
Rock Creek Clark (270508)	35,440	156	3.1	0.3	2.5	0.3	0.1
Salmon Creek (260421)	43,837	160	2.7	0.0	0.0	2.6	0.1
Middle Kalama (270114)	51,534	161	2.7	0.2	0.0	2.4	0.0
Winston (260320)	28,321	162	2.6	0.7	0.0	2.0	0.0
Abernethy (250104)	40,071	165	2.1	1.3	0.0	0.8	0.0
North Fork Toutle (260514)	41,051	168	1.9	0.4	0.0	1.3	0.2
Woodland (270412)	37,827	169	1.3	0.7	0.0	0.6	0.0
Green River (260515)	46,383	170	1.3	0.0	0.0	1.1	0.1

Table E-29. Percent of Watershed Classified as High for Potential Slope Instability

Watershed Name (and Number)	Total Acres	Rank[1/]	Percent of Watershed Acreage Classified as High	Percentage Breakdown by Ownership: DNR	Federal	Private[2/]	Other[3/]
Cold Creek (270509)	21,281	171	1.1	0.6	0.4	0.1	0.0
Cedar Creek (270416)	36,416	172	1.1	0.1	0.0	0.9	0.1
Lower Kalama (270113)	49,823	173	1.0	0.0	0.0	1.0	0.0
South Fork Toutle (260513)	42,623	174	1.0	0.6	0.0	0.4	0.0
Little Washougal (280203)	30,269	175	0.8	0.2	0.0	0.6	0.0
Lacamas (280202)	41,185	179	0.1	0.0	0.0	0.1	0.0
HCP Planning Unit Average			***7.5***	***1.6***	***1.0***	***4.8***	***0.1***
North Puget HCP Planning Unit							
South Snoqualmie (070306)	57,077	1	55.2	8.1	36.5	5.5	5.2
Spada (070216)	44,197	7	32.4	21.1	9.6	0.5	1.2
Silverton (050106)	46,399	8	30.9	2.2	28.2	0.5	0.1
Clearwater Creek (010328)	14,330	10	29.4	16.5	10.7	2.0	0.3
Marmot Ridge (010306)	31,794	11	28.4	3.3	23.2	1.9	0.0
North Fork Snoqualmie (070313)	66,707	12	28.2	2.5	16.1	8.9	0.6
Jordan-Boulder (040224)	32,726	13	27.7	8.0	12.4	7.3	0.1
French Boulder (050204)	45,327	14	27.3	1.5	24.7	1.0	0.1
Tenas (040319)	36,688	15	27.0	1.3	24.4	1.4	0.0
Raging River (070408)	22,853	16	26.7	10.5	0.0	15.7	0.5
Lower MF Snoqualmie (070307)	28,375	17	26.7	16.0	7.9	2.8	0.0
Jackman (040529)	16,399	23	24.6	1.6	13.9	9.1	0.0
Loretta (030104)	15,769	27	23.7	1.7	9.9	11.9	0.2
Deer Creek (050201)	41,881	29	23.5	3.6	13.9	6.0	0.0
Corkindale (040531)	24,194	30	23.4	1.8	17.6	3.4	0.5
East Shannon (040436)	34,065	31	23.0	1.9	16.0	5.1	0.0
Canyon Creek (010232)	36,807	33	22.9	2.9	13.0	6.9	0.0
Warnick (010229)	25,436	34	22.5	16.6	0.5	5.4	0.0
Porter Canyon (010327)	18,550	35	22.1	6.8	0.0	12.1	3.2
Upper NF Stilly (050202)	32,833	37	21.7	1.8	18.4	1.5	0.0
Wallace River (070217)	24,667	39	21.4	5.1	12.3	2.8	1.2
Howard Creek (010308)	39,040	40	21.0	3.2	3.1	13.5	1.2
Tolt (070415)	63,357	41	21.0	0.9	5.0	12.6	2.4
Verlot (050107)	23,540	42	20.9	0.6	16.7	2.7	0.9
Skookum Creek (010309)	23,905	43	20.7	2.9	4.6	13.1	0.0

Table E-29. Percent of Watershed Classified as High for Potential Slope Instability

Watershed Name (and Number)	Total Acres	Rank[1/]	Percent of Watershed Acreage Classified as High	Percentage Breakdown by Ownership DNR	Federal	Private[2/]	Other[3/]
Day Creek (030105)	22,203	48	19.6	2.0	1.9	15.8	0.0
Hilt (040322)	12,453	50	19.1	1.3	12.3	5.4	0.0
Hazel (050203)	24,179	52	18.4	5.4	10.9	2.0	0.0
West Shannon (040435)	14,333	53	18.1	3.1	3.1	11.9	0.1
Kenney Creek (010230)	2,791	61	15.6	2.1	0.0	13.3	0.2
Stimson Hill (050215)	18,833	62	15.5	11.5	0.0	4.0	0.0
Pilchuck Mtn (070226)	42,517	63	15.2	11.8	0.1	2.3	1.0
Vedder (010131)	21,272	65	14.7	3.0	0.1	11.5	0.0
Cavanaugh (050316)	29,722	67	14.5	9.3	0.0	5.2	0.0
Jim Creek (050109)	30,690	68	14.2	2.8	3.9	7.0	0.5
Gilligan (030106)	18,879	69	14.0	4.3	0.0	9.7	0.1
Grandy (040534)	18,856	70	13.8	2.8	0.0	11.0	0.0
Rinker (040321)	20,481	71	13.2	7.5	1.7	3.9	0.1
Sauk Prairie (040320)	14,137	73	12.7	2.9	4.9	4.9	0.0
Hutchinson Creek (010310)	13,975	75	12.6	4.8	0.0	7.8	0.0
Acme (010311)	23,518	77	12.5	3.9	0.0	8.6	0.1
Ebey Hill (050214)	19,812	84	11.7	5.6	0.0	6.0	0.0
Deming (010226)	27,527	85	11.6	5.9	0.0	5.6	0.0
Lake Whatcom (010412)	35,957	86	11.5	8.4	0.0	3.1	0.0
Olney Creek (070225)	20,655	89	11.4	8.2	0.0	2.8	0.3
Nookachamps (030107)	47,730	91	11.2	5.2	0.0	5.7	0.2
Youngs Creek (070219)	23,776	107	8.8	0.9	0.5	7.3	0.1
Hansen Creek (030102)	29,010	108	8.8	2.0	0.0	6.7	0.1
Cypress (030415)	4,950	111	8.5	7.2	0.0	1.3	0.0
Friday Creek (030313)	24,129	112	8.5	2.4	0.0	5.7	0.4
Sultan River (070224)	24,388	116	7.8	4.2	1.3	1.2	1.1
Alder (030103)	22,865	117	7.7	5.9	0.0	1.8	0.0
Jordan (050108)	21,252	120	7.4	0.8	0.1	6.2	0.4
Samish River (030301)	57,397	131	6.0	1.9	0.0	3.7	0.4
Tate (070409)	9,798	136	5.3	0.7	0.0	4.7	0.0
Sumas River (010125)	36,444	139	5.0	2.2	0.0	2.8	0.0
Cherry (070420)	38,183	144	4.7	1.6	0.0	3.1	0.0
Woods Creek (070223)	42,463	145	4.6	1.8	0.0	2.6	0.2

Table E-29. Percent of Watershed Classified as High for Potential Slope Instability

Watershed Name (and Number)	Total Acres	Rank[1/]	Percent of Watershed Acreage Classified as High	Percentage Breakdown by Ownership DNR	Federal	Private[2/]	Other[3/]
Lower Pilchuck Creek (050313)	19,364	150	3.8	0.3	0.0	3.4	0.0
Samish Bay (010414)	13,258	152	3.4	1.0	0.0	2.4	0.0
Lummi Island (010617)	5,063	178	0.4	0.0	0.0	0.4	0.0
HCP Planning Unit Average			***17.1***	***4.7***	***6.2***	***5.8***	***0.4***
Olympic Experimental State Forest							
Upper Clearwater (210116)	58,265	4	35.1	34.4	0.4	0.3	0.0
Rain Forest (200505)	56,435	5	34.9	3.4	31.5	0.0	0.0
Queets Corridor South (210212)	29,667	18	26.2	1.0	25.1	0.0	0.0
Kalaloch Ridge (210115)	11,472	24	24.5	15.7	0.8	7.8	0.1
Matheney-Salmon (210211)	21,630	26	23.7	1.1	10.2	0.1	12.3
Lower Clearwater (210114)	45,246	36	21.7	11.9	0.2	9.3	0.3
Middle Hoh (200607)	46,272	44	20.6	18.4	0.7	1.4	0.1
Clallam River (190303)	22,235	45	19.9	12.3	0.0	7.4	0.1
Sekiu Coastal (190301)	27,412	55	18.0	2.3	0.0	14.8	1.0
Hoko (190302)	44,534	56	17.9	5.4	0.2	12.0	0.3
Pysht River (190204)	32,972	57	17.5	1.4	4.8	11.3	0.1
Sol Duc Valley (200201)	47,220	58	16.9	4.8	8.7	3.2	0.2
Sol Duc Valley (200316)	16,585	66	14.6	6.2	5.3	2.9	0.2
Goodman-Mosquito (200610)	33,529	79	12.1	4.0	1.3	6.8	0.0
Bogachiel (200412)	44,993	90	11.3	4.6	4.0	2.5	0.1
Sol Duc Lowlands (200416)	22,368	96	10.1	1.7	4.8	3.6	0.1
Cedar (200609)	12,310	104	9.1	5.3	0.9	2.9	0.0
Hoh Lowlands (200608)	30,244	106	8.9	2.5	0.1	6.1	0.1
Queets Corridor North (210213)	39,496	110	8.7	2.2	5.1	0.6	0.8
East Dickey (200418)	26,657	126	6.5	2.7	0.0	3.7	0.1
West Dickey (200419)	28,311	137	5.1	0.8	0.0	4.3	0.0
Quillayute Bottom (200417)	23,180	141	4.9	2.0	0.6	2.0	0.3
Ozette Lake (200120)	35,130	142	4.8	0.8	1.7	2.2	0.1
HCP Planning Unit Average			***16.2***	***6.3***	***4.6***	***4.6***	***0.7***
South Coast HCP Planning Unit							
Lower Naselle (240108)	36,688	3	39.8	5.0	0.2	34.3	0.3
Naselle Headwaters (240107)	48,336	6	33.6	3.7	0.0	29.8	0.1
Curtis (230112)	43,351	49	19.5	3.4	0.0	15.8	0.3

Table E-29. Percent of Watershed Classified as High for Potential Slope Instability

Watershed Name (and Number)	Total Acres	Rank[1/]	Percent of Watershed Acreage Classified as High	Percentage Breakdown by Ownership: DNR	Federal	Private[2/]	Other[3/]
Mill Creek (240305)	15,699	54	18.1	11.0	0.0	7.0	0.1
North River Headwaters (240402)	34,532	59	16.8	1.9	0.0	14.9	0.0
Garrard Creek (230220)	49,056	60	16.7	9.1	0.0	7.6	0.1
Willapa Headwaters (240306)	62,581	64	14.7	5.4	0.0	9.1	0.2
Rock-Jones (230116)	22,917	83	11.8	5.1	0.0	6.5	0.1
Elk Creek (230117)	38,773	87	11.5	4.0	0.0	7.1	0.4
Elk River (220625)	32,340	92	11.0	0.9	0.0	6.1	4.0
Lincoln Creek (230219)	48,086	94	10.6	4.2	0.0	6.4	0.0
Bunker Creek (230218)	22,788	95	10.5	4.2	0.0	6.2	0.0
Lower Willapa (240315)	32,329	100	9.4	0.7	0.0	8.7	0.0
Nemah (240212)	40,522	103	9.2	1.8	0.0	7.2	0.2
Lower Skookumchuck (230404)	44,616	118	7.6	1.6	0.0	6.0	0.0
Palix (240213)	35,825	128	6.2	1.6	0.0	4.4	0.1
Mox Chehalis (220106)	23,315	132	5.9	1.8	0.0	4.1	0.0
South Fork Willapa (240314)	26,664	147	4.4	1.9	0.0	2.4	0.1
Waddel Creek (230501)	28,982	148	4.1	3.1	0.0	1.0	0.0
Porter Creek (230522)	32,023	157	3.0	2.0	0.0	0.9	0.1
Scatter Creek (230403)	31,680	164	2.2	0.3	0.0	1.8	0.0
Cedar Creek (230521)	32,505	166	1.9	1.3	0.0	0.6	0.0
Joe-Moclips (210408)	50,805	167	1.9	0.1	0.0	0.6	1.1
Copalis River (210407)	40,529	177	0.6	0.0	0.0	0.5	0.0
HCP Planning Unit Average			***11.3***	***3.1***	***0.0***	***7.9***	***0.3***
South Puget HCP Planning Unit							
Catt (110108)	13,279	22	25.0	10.3	14.5	0.1	0.0
Tiger (080303)	40,881	47	19.6	7.9	0.0	10.2	1.5
East Creek (110113)	14,429	51	18.5	3.5	7.7	7.0	0.3
Mineral Creek (110110)	23,047	74	12.6	2.0	0.0	9.7	0.9
North Fork Mineral (110112)	16,072	81	12.0	9.4	0.0	2.5	0.2
Howard Hansen (090103)	46,472	82	11.8	5.9	0.1	4.8	1.0
North Fork Green (090104)	18,410	88	11.5	5.9	0.0	4.5	1.1
Cumberland (090202)	26,260	109	8.7	1.3	0.0	6.7	0.7
Ashford (110104)	27,680	119	7.5	1.5	3.9	2.0	0.2
Hood (150201)	145,611	130	6.1	1.6	0.1	3.9	0.5

Table E-29. Percent of Watershed Classified as High for Potential Slope Instability

Watershed Name (and Number)	Total Acres	Rank[1/]	Percent of Watershed Acreage Classified as High	Percentage Breakdown by Ownership DNR	Federal	Private[2/]	Other[3/]
Busy Wild (110204)	56,966	140	4.9	1.5	0.0	3.1	0.3
Reese Creek (110106)	5,036	143	4.8	4.7	0.0	0.0	0.0
Olympia (130202)	18,529	151	3.6	0.9	0.0	2.6	0.1
Summit Lake (140002)	29,140	163	2.4	0.7	0.0	1.6	0.1
Squaxin (140003)	1,066	176	0.7	0.3	0.0	0.0	0.5
HCP Planning Unit Average			***10.0***	***3.8***	***1.7***	***3.9***	***0.5***
Straits HCP Planning Unit							
Twins (190206)	20,351	2	50.9	12.9	31.0	6.9	0.2
Hamma Hamma (160203)	69,941	20	25.7	2.1	22.5	1.1	0.0
Big Quil (170108)	51,823	25	23.9	0.9	22.2	0.7	0.0
Sutherland-Aldwell (180310)	35,109	38	21.5	3.2	14.3	3.7	0.3
Lyre (190107)	11,021	46	19.7	13.5	2.2	3.6	0.4
Little Quil (170107)	28,536	76	12.5	0.7	7.2	4.6	0.0
Salt (190108)	26,336	78	12.2	8.8	0.0	3.0	0.4
Dabob (170106)	16,871	93	10.8	3.7	0.0	6.9	0.2
Port Angeles (180211)	24,883	99	9.6	3.3	2.3	3.8	0.2
Lilliwaup (160204)	29,080	101	9.3	3.4	2.1	3.7	0.1
Siebert McDonald (180202)	35,481	105	9.0	2.4	4.5	2.0	0.0
Sequim Bay (170201)	26,752	115	8.1	2.4	3.7	1.8	0.1
Discovery Bay (170202)	58,871	121	7.3	1.3	2.8	3.0	0.2
Dungeness Valley (180103)	43,200	125	6.6	1.2	4.6	0.7	0.1
Thorndike (170105)	16,587	127	6.4	0.7	1.1	4.4	0.2
Ludlow (170104)	22,897	149	4.1	0.3	0.0	3.7	0.0
Chimakum (170203)	28,202	158	2.9	0.2	0.2	2.5	0.1
Bell Creek (180104)	5,969	159	2.7	0.7	0.0	2.0	0.0
HCP Planning Unit Average			***13.5***	***3.4***	***6.7***	***3.2***	***0.1***

1/ Watershed with greater than 5% ownership that have areas classified as high for potential slope instability are ranked by percent area of watershed that meets these criteria.

2/ Includes privately owned industrial and non-industrial (i.e., small landowner) forestland.

3/ Includes, municipal, tribal, non-DNR state lands, and other lands.

Table E-30. Percent of the Forested Area in Each Watershed Classified as Moderate for Slope Stability [1/]

Watershed Name (and Number)	Total Acres	Rank[2/]	Percent of Watershed Classified as Moderate[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Columbia HCP Planning Unit							
Swift Creek (270304)	74,150	176	20%	2%	8%	11%	0%
Middle Kalama (270114)	51,534	173	25%	2%	0%	23%	0%
Spirit Lake (260507)	52,151	168	22%	3%	18%	1%	0%
Lower Kalama (270113)	49,823	167	22%	2%	0%	20%	0%
Siouxon (270305)	39,066	165	26%	10%	16%	0%	0%
Upper SF Toutle (260508)	40,031	162	24%	8%	5%	11%	0%
North Elochoman (250203)	23,518	161	41%	8%	0%	33%	0%
Green River (260515)	46,383	159	21%	1%	0%	19%	1%
Lake Merwin (270415)	46,439	156	20%	9%	0%	10%	0%
South Fork Grays River (250302)	16,774	155	54%	16%	0%	38%	0%
Grays Bay (250310)	56,613	153	15%	2%	0%	13%	0%
North Fork Toutle (260514)	41,051	148	20%	6%	0%	13%	1%
Upper Washougal (280205)	31,719	147	26%	18%	3%	5%	0%
South Fork Toutle (260513)	42,623	145	19%	5%	0%	14%	0%
Abernethy (250104)	40,071	135	18%	11%	0%	7%	0%
Bremer (260331)	19,894	133	34%	7%	4%	22%	1%
Cougar (270317)	32,888	131	21%	9%	7%	4%	0%
Silverstar (280204)	32,719	130	20%	6%	3%	11%	1%
Rock Creek Clark (270508)	35,440	129	18%	3%	6%	8%	0%
Skamokawa (250209)	51,687	124	11%	3%	0%	8%	0%
Stillwater (260625)	28,905	123	20%	2%	0%	18%	0%
Rock Creek (290415)	41,733	112	12%	6%	5%	2%	0%
Cedar Creek (270416)	36,416	108	13%	2%	0%	10%	0%
Delameter (260623)	37,243	106	13%	1%	0%	12%	0%
Woodland (270412)	37,827	97	12%	4%	0%	8%	0%
Winston (260320)	28,321	95	15%	3%	0%	12%	1%
Cold Creek (270509)	21,281	90	19%	14%	1%	3%	0%
Main Elochoman (250208)	37,009	84	10%	3%	0%	7%	0%
Little Washougal (280203)	30,269	81	12%	5%	0%	7%	0%
Salmon Creek (260421)	43,837	79	8%	1%	0%	6%	0%
Hamilton Creek (280106)	32,845	72	10%	3%	2%	2%	2%
Wind River (290414)	30,669	71	10%	1%	8%	1%	0%
Mill Creek (260429)	26,163	56	10%	1%	0%	9%	0%
Lacamas (280202)	41,185	45	5%	1%	1%	3%	0%
West Fork Grays River (250311)	10,347	44	22%	4%	0%	18%	0%

Table E-30. Percent of the Forested Area in Each Watershed Classified as Moderate for Slope Stability [1/]

Watershed Name (and Number)	Total Acres	Rank[2/]	Percent of Watershed Classified as Moderate[3/]	Percentage Breakdown by Ownership[4/]			
				DNR	Federal	Private[5/]	Other[6/]
Olequa (260626)	35,017	42	6%	1%	0%	5%	0%
Harmony (260330)	22,546	36	9%	1%	0%	7%	0%
Cedar Creek (260428)	14,441	21	9%	0%	0%	8%	0%
HCP Planning Unit Average			***18%***	***5%***	***2%***	***11%***	***0%***
North Puget HCP Planning Unit							
South Snoqualmie (070306)	57,077	179	69%	8%	48%	7%	7%
North Fork Snoqualmie (070313)	66,707	174	21%	2%	11%	7%	0%
Spada (070216)	44,197	172	29%	19%	8%	1%	1%
Silverton (050106)	46,399	170	26%	2%	23%	0%	0%
Tolt (070415)	63,357	163	16%	1%	4%	10%	1%
French Boulder (050204)	45,327	160	21%	1%	19%	1%	0%
Jordan-Boulder (040224)	32,726	154	28%	7%	12%	9%	0%
Tenas (040319)	36,688	144	22%	2%	19%	2%	0%
East Shannon (040436)	34,065	143	23%	2%	17%	4%	0%
Deer Creek (050201)	41,881	142	19%	3%	11%	5%	0%
Marmot Ridge (010306)	31,794	141	24%	4%	18%	2%	0%
Howard Creek (010308)	39,040	140	19%	3%	2%	13%	1%
Upper NF Stilly (050202)	32,833	137	23%	2%	18%	2%	0%
Canyon Creek (010232)	36,807	136	20%	2%	10%	8%	0%
Lake Whatcom (010412)	35,957	126	17%	10%	0%	7%	0%
Lower MF Snoqualmie (070307)	28,375	122	20%	11%	6%	2%	0%
Wallace River (070217)	24,667	120	22%	7%	11%	3%	2%
Pilchuck Mtn (070226)	42,517	119	13%	9%	0%	2%	1%
Warnick (010229)	25,436	118	21%	16%	0%	5%	0%
Skookum Creek (010309)	23,905	114	22%	5%	4%	13%	0%
Raging River (070408)	22,853	113	22%	6%	0%	16%	0%
Corkindale (040531)	24,194	109	20%	1%	15%	3%	0%
Deming (010226)	27,527	102	16%	8%	0%	8%	0%
Jim Creek (050109)	30,690	101	15%	3%	4%	6%	1%
Nookachamps (030107)	47,730	96	9%	4%	0%	5%	0%
Samish River (030301)	57,397	93	7%	3%	0%	4%	0%
Jackman (040529)	16,399	92	25%	2%	14%	9%	0%
Youngs Creek (070219)	23,776	89	17%	2%	0%	14%	0%
Day Creek (030105)	22,203	87	18%	2%	2%	14%	0%
Verlot (050107)	23,540	86	17%	1%	13%	2%	1%
Hazel (050203)	24,179	85	16%	5%	8%	3%	0%

Table E-30. Percent of the Forested Area in Each Watershed Classified as Moderate for Slope Stability [1/]

Watershed Name (and Number)	Total Acres	Rank[2/]	Percent of Watershed Classified as Moderate[3/]	Percentage Breakdown by Ownership[4/]			
				DNR	Federal	Private[5/]	Other[6/]
Porter Canyon (010327)	18,550	83	20%	7%	0%	11%	2%
Acme (010311)	23,518	77	15%	6%	0%	9%	0%
Clearwater Creek (010328)	14,330	74	23%	11%	10%	2%	0%
Cherry (070420)	38,183	73	9%	2%	0%	6%	0%
Loretta (030104)	15,769	67	19%	2%	8%	10%	0%
Cavanaugh (050316)	29,722	66	10%	7%	0%	4%	0%
Olney Creek (070225)	20,655	63	14%	7%	0%	6%	0%
Rinker (040321)	20,481	62	14%	7%	2%	5%	0%
Hansen Creek (030102)	29,010	61	10%	3%	0%	7%	0%
Hilt (040322)	12,453	59	23%	2%	13%	8%	0%
Vedder (010131)	21,272	58	13%	3%	0%	10%	0%
Friday Creek (030313)	24,129	57	11%	3%	0%	8%	1%
Sauk Prairie (040320)	14,137	54	18%	6%	5%	8%	0%
Grandy (040534)	18,856	53	14%	3%	0%	10%	0%
Hutchinson Creek (010310)	13,975	52	18%	7%	0%	11%	0%
Woods Creek (070223)	42,463	49	6%	2%	0%	4%	0%
Sumas River (010125)	36,444	48	7%	2%	0%	4%	0%
Alder (030103)	22,865	43	10%	8%	0%	2%	0%
Sultan River (070224)	24,388	40	9%	6%	1%	1%	1%
West Shannon (040435)	14,333	39	14%	3%	3%	9%	0%
Gilligan (030106)	18,879	38	11%	2%	0%	8%	0%
Ebey Hill (050214)	19,812	37	10%	5%	0%	5%	0%
Jordan (050108)	21,252	32	8%	1%	0%	7%	0%
Stimson Hill (050215)	18,833	24	8%	4%	0%	3%	0%
Tate (070409)	9,798	12	9%	2%	0%	7%	0%
Lower Pilchuck Creek (050313)	19,364	8	4%	0%	0%	3%	0%
Kenney Creek (010230)	2,791	7	20%	1%	0%	19%	0%
Samish Bay (010414)	13,258	5	2%	0%	0%	2%	0%
Cypress (030415)	4,950	3	3%	2%	0%	1%	0%
Lummi Island (010617)	5,063	1	1%	0%	0%	1%	0%
HCP Planning Unit Average			***17%***	***4%***	***6%***	***6%***	***0%***
Olympic Experimental State Forest							
Rain Forest (200505)	56,435	166	19%	2%	17%	0%	0%
Upper Clearwater (210116)	58,265	138	13%	13%	0%	0%	0%
Hoko (190302)	44,534	110	11%	3%	0%	8%	0%
Middle Hoh (200607)	46,272	105	10%	9%	0%	1%	0%

Table E-30. Percent of the Forested Area in Each Watershed Classified as Moderate for Slope Stability [1/]

Watershed Name (and Number)	Total Acres	Rank [2/]	Percent of Watershed Classified as Moderate [3/]	Percentage Breakdown by Ownership [4/]			
				DNR	Federal	Private [5/]	Other [6/]
Sol Duc Valley (200201)	47,220	104	10%	2%	6%	2%	0%
Bogachiel (200412)	44,993	78	8%	3%	1%	3%	0%
Lower Clearwater (210114)	45,246	75	8%	4%	0%	4%	0%
Queets Corridor South (210212)	29,667	70	11%	1%	10%	0%	0%
Sekiu Coastal (190301)	27,412	68	11%	1%	0%	9%	0%
Goodman-Mosquito (200610)	33,529	65	9%	3%	1%	4%	0%
Pysht River (190204)	32,972	60	9%	1%	2%	7%	0%
Clallam River (190303)	22,235	47	10%	6%	0%	5%	0%
Queets Corridor North (210213)	39,496	35	5%	2%	2%	0%	0%
Matheney-Salmon (210211)	21,630	31	8%	1%	3%	0%	0%
Ozette Lake (200120)	35,130	29	5%	1%	2%	2%	0%
Hoh Lowlands (200608)	30,244	26	5%	1%	0%	3%	0%
East Dickey (200418)	26,657	23	5%	2%	0%	3%	0%
West Dickey (200419)	28,311	20	5%	0%	0%	4%	0%
Sol Duc Lowlands (200416)	22,368	16	5%	1%	1%	2%	0%
Quillayute Bottom (200417)	23,180	15	5%	2%	1%	2%	0%
Kalaloch Ridge (210115)	11,472	13	9%	5%	1%	3%	0%
Sol Duc Valley (200316)	16,585	11	5%	2%	1%	2%	0%
Cedar (200609)	12,310	9	6%	3%	1%	3%	0%
HCP Planning Unit Average			***8%***	***3%***	***2%***	***3%***	***0%***
South Coast HCP Planning Unit							
Naselle Headwaters (240107)	48,336	177	32%	2%	0%	30%	0%
Waddel Creek (230501)	28,982	164	35%	32%	0%	4%	0%
Lower Skookumchuck (230404)	44,616	157	21%	8%	0%	13%	0%
Curtis (230112)	43,351	151	20%	6%	0%	14%	0%
Lower Naselle (240108)	36,688	150	23%	4%	0%	19%	0%
Willapa Headwaters (240306)	62,581	149	13%	4%	0%	9%	0%
Porter Creek (230522)	32,023	134	22%	21%	0%	1%	0%
Nemah (240212)	40,522	128	15%	4%	0%	11%	0%
Cedar Creek (230521)	32,505	127	19%	17%	0%	1%	0%
Garrard Creek (230220)	49,056	117	11%	5%	0%	6%	0%
South Fork Willapa (240314)	26,664	115	19%	8%	0%	11%	1%
Elk Creek (230117)	38,773	111	13%	5%	0%	7%	1%
Palix (240213)	35,825	103	13%	1%	0%	11%	1%
Lincoln Creek (230219)	48,086	100	9%	4%	0%	5%	0%
North River Headwaters (240402)	34,532	82	11%	1%	0%	10%	0%

Table E-30. Percent of the Forested Area in Each Watershed Classified as Moderate for Slope Stability [1/]

Watershed Name (and Number)	Total Acres	Rank[2/]	Percent of Watershed Classified as Moderate[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Lower Willapa (240315)	32,329	69	10%	1%	0%	9%	0%
Mox Chehalis (220106)	23,315	51	11%	4%	0%	7%	0%
Rock-Jones (230116)	22,917	50	11%	3%	0%	7%	0%
Elk River (220625)	32,340	34	6%	0%	0%	3%	2%
Bunker Creek (230218)	22,788	33	8%	3%	0%	5%	0%
Mill Creek (240305)	15,699	30	11%	8%	0%	3%	0%
Joe-Moclips (210408)	50,805	27	3%	0%	0%	1%	0%
Scatter Creek (230403)	31,680	22	4%	1%	0%	3%	0%
Copalis River (210407)	40,529	6	1%	0%	0%	1%	0%
HCP Planning Unit Average			***14%***	***6%***	***0%***	***8%***	***0%***
South Puget HCP Planning Unit							
Howard Hansen (090103)	46,472	171	26%	10%	0%	13%	2%
Mineral Creek (110110)	23,047	169	49%	11%	0%	36%	3%
Busy Wild (110204)	56,966	158	17%	4%	0%	11%	1%
North Fork Mineral (110112)	16,072	152	53%	46%	0%	6%	1%
Hood (150201)	145,611	146	6%	1%	0%	3%	1%
Catt (110108)	13,279	139	56%	30%	27%	0%	0%
Tiger (080303)	40,881	121	14%	4%	0%	9%	1%
East Creek (110113)	14,429	116	37%	8%	13%	15%	1%
Summit Lake (140002)	29,140	99	15%	9%	0%	6%	0%
Ashford (110104)	27,680	98	16%	4%	7%	4%	0%
North Fork Green (090104)	18,410	94	23%	9%	0%	13%	2%
Olympia (130202)	18,529	76	19%	11%	0%	7%	0%
Cumberland (090202)	26,260	64	11%	2%	0%	8%	1%
Reese Creek (110106)	5,036	10	18%	18%	0%	0%	0%
Squaxin (140003)	1,066	2	4%	1%	0%	0%	0%
HCP Planning Unit Average			***24%***	***11%***	***3%***	***9%***	***1%***
Straits HCP Planning Unit							
Hamma Hamma (160203)	69,941	178	25%	3%	21%	1%	0%
Big Quil (170108)	51,823	175	27%	1%	25%	1%	0%
Sutherland-Aldwell (180310)	35,109	132	19%	3%	13%	3%	0%
Twins (190206)	20,351	125	29%	8%	18%	3%	0%
Discovery Bay (170202)	58,871	107	8%	1%	2%	4%	0%
Little Quil (170107)	28,536	91	14%	1%	9%	4%	0%
Lilliwaup (160204)	29,080	88	13%	8%	3%	3%	0%

Table E-30. Percent of the Forested Area in Each Watershed Classified as Moderate for Slope Stability 1/

Watershed Name (and Number)	Total Acres	Rank 2/	Percent of Watershed Classified as Moderate 3/	Percentage Breakdown by Ownership 4/ DNR	Federal	Private 5/	Other 6/
Sequim Bay (170201)	26,752	80	13%	5%	5%	3%	0%
Dungeness Valley (180103)	43,200	55	6%	1%	3%	2%	0%
Port Angeles (180211)	24,883	46	9%	3%	3%	3%	0%
Siebert McDonald (180202)	35,481	41	6%	2%	2%	2%	0%
Salt (190108)	26,336	28	6%	3%	0%	2%	0%
Ludlow (170104)	22,897	25	6%	0%	0%	6%	0%
Dabob (170106)	16,871	19	7%	2%	0%	5%	0%
Lyre (190107)	11,021	18	11%	6%	3%	2%	0%
Chimakum (170203)	28,202	17	4%	0%	0%	4%	0%
Thorndike (170105)	16,587	14	6%	1%	0%	5%	0%
Bell Creek (180104)	5,969	4	5%	1%	0%	4%	0%
HCP Planning Unit Average			***12%***	***3%***	***6%***	***3%***	***0%***

1/ Watershed with greater than 5% ownership that have soils classified as moderate potential slope instability are ranked by percent area of watershed that meets these criteria.

2/ Includes privately owned industrial and non-industrial (i.e., small landowner) forestland.

3/ Includes, municipal, tribal, non-DNR state lands, and other lands.

Table E-31. Percent of Watershed Area Classified as High for Moist Soil Compaction Potential

Watershed Name (and Number)	Total Acres	Rank[1/]	Percent Classified as High	DNR	Percentage Breakdown by Ownership: Federal	Private[2/]	Other[3/]
Columbia HCP Planning Unit							
Cedar Creek (260428)	14,441	4	99%	6%	0%	88%	5%
Olequa (260626)	35,017	5	99%	7%	0%	91%	1%
Stillwater (260625)	28,905	13	96%	7%	0%	88%	0%
Abernethy (250104)	40,071	15	95%	51%	0%	40%	3%
Delameter (260623)	37,243	16	95%	5%	0%	89%	0%
Main Elochoman (250208)	37,009	24	91%	22%	3%	64%	1%
Little Washougal (280203)	30,269	31	89%	19%	0%	69%	1%
Winston (260320)	28,321	32	89%	22%	0%	65%	2%
Mill Creek (260429)	26,163	33	89%	10%	0%	79%	0%
Lacamas (280202)	41,185	37	86%	8%	7%	68%	3%
Lower Kalama (270113)	49,823	38	86%	5%	0%	80%	1%
Salmon Creek (260421)	43,837	39	86%	6%	0%	77%	3%
Skamokawa (250209)	51,687	42	84%	20%	2%	59%	2%
South Fork Toutle (260513)	42,623	45	82%	15%	0%	65%	1%
Cedar Creek (270416)	36,416	47	82%	9%	0%	71%	1%
Harmony (260330)	22,546	48	81%	5%	0%	74%	2%
South Fork Grays River (250302)	16,774	49	81%	19%	0%	61%	0%
Woodland (270412)	37,827	54	79%	10%	0%	69%	0%
West Fork Grays River (250311)	10,347	55	79%	17%	0%	62%	0%
North Elochoman (250203)	23,518	60	78%	13%	0%	65%	0%
Grays Bay (250310)	56,613	71	73%	9%	0%	64%	1%
Middle Kalama (270114)	51,534	83	67%	5%	0%	61%	0%
Green River (260515)	46,383	85	65%	4%	0%	58%	3%
Cold Creek (270509)	21,281	95	59%	46%	1%	12%	0%
Bremer (260331)	19,894	97	57%	11%	1%	44%	1%
Rock Creek Clark (270508)	35,440	100	57%	10%	0%	45%	1%
Lake Merwin (270415)	46,439	114	48%	14%	0%	34%	0%
Silverstar (280204)	32,719	115	44%	12%	1%	31%	1%
North Fork Toutle (260514)	41,051	118	43%	16%	0%	27%	0%
Upper Washougal (280205)	31,719	124	39%	30%	0%	9%	0%
Rock Creek (290415)	41,733	132	34%	16%	0%	17%	0%
Wind River (290414)	30,669	137	31%	8%	8%	14%	2%
Hamilton Creek (280106)	32,845	138	29%	11%	8%	7%	3%

Table E-31. Percent of Watershed Area Classified as High for Moist Soil Compaction Potential

Watershed Name (and Number)	Total Acres	Rank[1/]	Percent Classified as High	DNR	Percentage Breakdown by Ownership Federal	Private[2/]	Other[3/]
Upper SF Toutle (260508)	40,031	154	16%	5%	1%	10%	0%
Siouxon (270305)	39,066	155	15%	15%	0%	0%	0%
Cougar (270317)	32,888	174	2%	1%	0%	1%	0%
Swift Creek (270304)	74,150	176	1%	0%	0%	0%	0%
Spirit Lake (260507)	52,151	177	0%	0%	0%	0%	0%
HCP Planning Unit Average			***64%***	***13%***	***1%***	***49%***	***1%***
North Puget HCP Planning Unit							
Cavanaugh (050316)	29,722	26	90%	55%	0%	35%	0%
Hansen Creek (030102)	29,010	35	86%	13%	0%	71%	3%
Tate (070409)	9,798	40	85%	6%	0%	78%	0%
Friday Creek (030313)	24,129	43	84%	15%	0%	67%	2%
Nookachamps (030107)	47,730	46	82%	27%	0%	54%	1%
Hutchinson Creek (010310)	13,975	51	80%	32%	0%	48%	0%
Day Creek (030105)	22,203	52	80%	8%	1%	70%	0%
Pilchuck Mtn (070226)	42,517	53	79%	58%	0%	20%	1%
Jim Creek (050109)	30,690	56	78%	20%	15%	39%	4%
Woods Creek (070223)	42,463	57	78%	23%	0%	53%	3%
Porter Canyon (010327)	18,550	58	78%	31%	0%	38%	10%
Warnick (010229)	25,436	59	78%	57%	1%	20%	0%
Alder (030103)	22,865	62	77%	49%	0%	29%	0%
Cherry (070420)	38,183	63	77%	14%	0%	62%	1%
Kenney Creek (010230)	2,791	64	76%	6%	0%	70%	0%
Sultan River (070224)	24,388	65	76%	47%	7%	14%	8%
Howard Creek (010308)	39,040	66	76%	15%	1%	55%	5%
Raging River (070408)	22,853	68	75%	24%	0%	50%	1%
Lower Pilchuck Creek (050313)	19,364	70	74%	6%	0%	67%	0%
Acme (010311)	23,518	72	73%	25%	0%	47%	0%
Stimson Hill (050215)	18,833	74	72%	32%	0%	40%	0%
Gilligan (030106)	18,879	75	72%	15%	0%	55%	2%
Samish River (030301)	57,397	76	71%	13%	0%	56%	2%
Deming (010226)	27,527	77	71%	33%	0%	38%	0%
Samish Bay (010414)	13,258	78	69%	22%	0%	39%	8%
Lake Whatcom (010412)	35,957	79	69%	30%	0%	39%	0%

Table E-31. Percent of Watershed Area Classified as High for Moist Soil Compaction Potential

Watershed Name (and Number)	Total Acres	Rank[1/]	Percent Classified as High	DNR	Percentage Breakdown by Ownership: Federal	Private[2/]	Other[3/]
Vedder (010131)	21,272	80	69%	10%	0%	58%	0%
Grandy (040534)	18,856	81	68%	14%	0%	54%	0%
Youngs Creek (070219)	23,776	87	65%	8%	0%	56%	0%
Skookum Creek (010309)	23,905	88	65%	21%	2%	42%	0%
Jordan (050108)	21,252	90	62%	6%	0%	56%	0%
Sumas River (010125)	36,444	92	61%	8%	0%	53%	0%
Rinker (040321)	20,481	94	59%	33%	1%	25%	0%
Olney Creek (070225)	20,655	96	58%	28%	0%	30%	1%
West Shannon (040435)	14,333	98	57%	13%	0%	43%	0%
Lummi Island (010617)	5,063	99	57%	7%	0%	45%	4%
Ebey Hill (050214)	19,812	101	55%	34%	0%	21%	0%
Clearwater Creek (010328)	14,330	106	51%	44%	1%	5%	1%
Tolt (070415)	63,357	107	50%	3%	2%	41%	5%
Loretta (030104)	15,769	109	50%	6%	2%	42%	0%
Sauk Prairie (040320)	14,137	111	49%	17%	0%	31%	0%
Hazel (050203)	24,179	116	44%	26%	4%	14%	0%
Jackman (040529)	16,399	117	44%	2%	9%	32%	0%
Canyon Creek (010232)	36,807	119	41%	12%	0%	29%	1%
Wallace River (070217)	24,667	120	41%	22%	1%	13%	5%
Lower MF Snoqualmie (070307)	28,375	122	40%	19%	9%	12%	0%
Deer Creek (050201)	41,881	125	39%	15%	1%	22%	0%
South Snoqualmie (070306)	57,077	127	37%	4%	11%	18%	5%
Corkindale (040531)	24,194	128	36%	3%	12%	19%	2%
Verlot (050107)	23,540	133	32%	4%	4%	23%	1%
North Fork Snoqualmie (070313)	66,707	135	31%	2%	6%	21%	2%
Hilt (040322)	12,453	141	27%	5%	1%	21%	0%
East Shannon (040436)	34,065	142	27%	8%	2%	17%	0%
Spada (070216)	44,197	144	25%	17%	1%	0%	7%
Jordan-Boulder (040224)	32,726	145	24%	11%	2%	11%	0%
Marmot Ridge (010306)	31,794	146	22%	13%	0%	9%	0%
French Boulder (050204)	45,327	147	22%	11%	4%	7%	0%
Upper NF Stilly (050202)	32,833	158	13%	6%	2%	6%	0%
Tenas (040319)	36,688	159	13%	7%	2%	4%	0%
Cypress (030415)	4,950	169	6%	5%	0%	0%	0%

Table E-31. Percent of Watershed Area Classified as High for Moist Soil Compaction Potential

Watershed Name (and Number)	Total Acres	Rank[1/]	Percent Classified as High	DNR	Percentage Breakdown by Ownership Federal	Private[2/]	Other[3/]
Silverton (050106)	46,399	173	3%	1%	1%	0%	0%
HCP Planning Unit Average			***57%***	***18%***	***2%***	***35%***	***1%***
Olympic Experimental State Forest							
Sekiu Coastal (190301)	27,412	21	92%	13%	0%	78%	0%
West Dickey (200419)	28,311	23	91%	11%	0%	79%	1%
Pysht River (190204)	32,972	29	89%	6%	10%	73%	0%
Hoko (190302)	44,534	30	89%	22%	1%	64%	2%
Kalaloch Ridge (210115)	11,472	34	88%	54%	0%	34%	0%
Lower Clearwater (210114)	45,246	36	86%	42%	0%	42%	2%
East Dickey (200418)	26,657	41	85%	38%	0%	46%	1%
Clallam River (190303)	22,235	61	78%	42%	0%	34%	1%
Goodman-Mosquito (200610)	33,529	73	73%	28%	0%	44%	0%
Hoh Lowlands (200608)	30,244	82	68%	22%	0%	45%	1%
Cedar (200609)	12,310	86	65%	32%	0%	33%	1%
Sol Duc Valley (200201)	47,220	89	63%	21%	24%	17%	1%
Quillayute Bottom (200417)	23,180	91	61%	22%	0%	35%	4%
Bogachiel (200412)	44,993	93	60%	27%	1%	31%	1%
Ozette Lake (200120)	35,130	102	55%	13%	2%	39%	1%
Queets Corridor North (210213)	39,496	103	52%	22%	1%	7%	22%
Sol Duc Lowlands (200416)	22,368	105	51%	12%	2%	36%	1%
Upper Clearwater (210116)	58,265	113	48%	47%	0%	1%	0%
Sol Duc Valley (200316)	16,585	121	41%	14%	0%	25%	1%
Middle Hoh (200607)	46,272	123	40%	25%	1%	13%	0%
Matheney-Salmon (210211)	21,630	148	20%	10%	0%	1%	9%
Queets Corridor South (210212)	29,667	151	20%	19%	0%	0%	0%
Rain Forest (200505)	56,435	172	3%	3%	0%	0%	0%
HCP Planning Unit Average			***62%***	***24%***	***2%***	***34%***	***2%***
South Coast HCP Planning Unit							
Bunker Creek (230218)	22,788	1	100%	29%	0%	70%	0%
North River Headwaters (240402)	34,532	2	100%	10%	0%	90%	0%
Palix (240213)	35,825	3	99%	10%	0%	86%	3%
Lower Naselle (240108)	36,688	6	98%	15%	1%	81%	1%
Lincoln Creek (230219)	48,086	7	97%	29%	0%	68%	1%

Table E-31. Percent of Watershed Area Classified as High for Moist Soil Compaction Potential

Watershed Name (and Number)	Total Acres	Rank[1/]	Percent Classified as High	DNR	Percentage Breakdown by Ownership: Federal	Private[2/]	Other[3/]
South Fork Willapa (240314)	26,664	8	97%	37%	0%	57%	3%
Nemah (240212)	40,522	9	97%	26%	0%	69%	2%
Willapa Headwaters (240306)	62,581	10	96%	29%	0%	66%	1%
Curtis (230112)	43,351	11	96%	16%	0%	79%	2%
Mill Creek (240305)	15,699	12	96%	63%	0%	32%	0%
Joe-Moclips (210408)	50,805	14	95%	7%	0%	42%	46%
Cedar Creek (230521)	32,505	17	95%	80%	0%	12%	3%
Rock-Jones (230116)	22,917	18	94%	29%	0%	63%	2%
Naselle Headwaters (240107)	48,336	19	94%	11%	0%	82%	0%
Garrard Creek (230220)	49,056	20	92%	39%	0%	52%	1%
Porter Creek (230522)	32,023	22	91%	79%	0%	11%	1%
Copalis River (210407)	40,529	25	91%	5%	0%	68%	17%
Lower Willapa (240315)	32,329	27	90%	5%	0%	84%	0%
Elk Creek (230117)	38,773	28	90%	31%	0%	56%	3%
Elk River (220625)	32,340	44	83%	11%	0%	46%	27%
Lower Skookumchuck (230404)	44,616	50	81%	16%	0%	64%	0%
Mox Chehalis (220106)	23,315	67	75%	21%	0%	54%	0%
Waddel Creek (230501)	28,982	84	65%	52%	0%	13%	0%
Scatter Creek (230403)	31,680	129	36%	5%	0%	30%	1%
HCP Planning Unit Average			***89%***	***27%***	***0%***	***57%***	***5%***
South Puget HCP Planning Unit							
Busy Wild (110204)	56,966	69	74%	21%	0%	45%	8%
North Fork Green (090104)	18,410	108	50%	17%	0%	26%	8%
East Creek (110113)	14,429	112	49%	16%	4%	27%	1%
Howard Hansen (090103)	46,472	126	37%	14%	0%	19%	4%
Ashford (110104)	27,680	134	31%	17%	0%	14%	0%
Olympia (130202)	18,529	136	31%	12%	0%	17%	2%
Squaxin (140003)	1,066	139	28%	8%	0%	0%	20%
Summit Lake (140002)	29,140	143	25%	11%	0%	14%	0%
Cumberland (090202)	26,260	149	20%	4%	0%	16%	1%
Tiger (080303)	40,881	152	18%	10%	0%	6%	1%
Reese Creek (110106)	5,036	157	14%	14%	0%	0%	0%
Mineral Creek (110110)	23,047	163	11%	2%	0%	9%	1%

Table E-31. Percent of Watershed Area Classified as High for Moist Soil Compaction Potential

Watershed Name (and Number)	Total Acres	Rank[1/]	Percent Classified as High	Percentage Breakdown by Ownership DNR	Federal	Private[2/]	Other[3/]
North Fork Mineral (110112)	16,072	168	6%	4%	0%	2%	0%
Hood (150201)	145,611	170	5%	0%	0%	3%	1%
Catt (110108)	13,279	171	4%	3%	1%	0%	0%
HCP Planning Unit Average			***27%***	***10%***	***0%***	***13%***	***3%***
Straits HCP Planning Unit							
Twins (190206)	20,351	104	51%	31%	5%	15%	0%
Lyre (190107)	11,021	110	49%	29%	1%	18%	1%
Salt (190108)	26,336	130	35%	15%	0%	18%	3%
Bell Creek (180104)	5,969	131	34%	3%	0%	31%	0%
Sequim Bay (170201)	26,752	140	28%	14%	1%	12%	1%
Dungeness Valley (180103)	43,200	150	20%	6%	1%	13%	0%
Little Quil (170107)	28,536	153	17%	2%	0%	15%	0%
Sutherland-Aldwell (180310)	35,109	156	15%	6%	2%	6%	0%
Dabob (170106)	16,871	160	13%	3%	0%	9%	0%
Discovery Bay (170202)	58,871	161	12%	2%	0%	10%	0%
Chimakum (170203)	28,202	162	11%	0%	2%	9%	0%
Port Angeles (180211)	24,883	164	11%	6%	0%	5%	0%
Ludlow (170104)	22,897	165	10%	1%	0%	9%	0%
Thorndike (170105)	16,587	166	9%	1%	1%	6%	0%
Siebert McDonald (180202)	35,481	167	8%	2%	0%	6%	0%
Big Quil (170108)	51,823	175	2%	1%	0%	1%	0%
Lilliwaup (160204)	29,080	178	0%	0%	0%	0%	0%
Hamma Hamma (160203)	69,941	179	0%	0%	0%	0%	0%
HCP Planning Unit Average			***18%***	***7%***	***1%***	***10%***	***0%***

1/ Watershed with greater than 5% ownership that have soils classified as high for moist soil compaction potential are ranked by percent area of watershed that meets these criteria.
3/ Includes privately owned industrial and non-industrial (i.e., small landowner) forestland.
3/ Includes, municipal, tribal, non-DNR state lands, and other lands.

Table E-32. Percent of the Watershed Classified as Moderate for Moist Soil Compaction Potential [1/]

Watershed Name (and Number)	Total Acres	Rank[2/]	Watershed Classified as Moderate[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Columbia HCP Planning Unit							
Swift Creek (270304)	74,150	10	60%	5%	15%	39%	0%
Hamilton Creek (280106)	32,845	16	55%	8%	16%	20%	11%
Upper SF Toutle (260508)	40,031	18	51%	17%	6%	27%	2%
Cougar (270317)	32,888	21	48%	29%	12%	7%	0%
Rock Creek (290415)	41,733	29	37%	18%	1%	16%	1%
Bremer (260331)	19,894	30	36%	4%	6%	25%	1%
Lake Merwin (270415)	46,439	31	36%	22%	0%	13%	0%
Silverstar (280204)	32,719	32	36%	12%	1%	22%	1%
Spirit Lake (260507)	52,151	36	32%	4%	28%	0%	0%
Middle Kalama (270114)	51,534	40	30%	3%	0%	27%	0%
Cold Creek (270509)	21,281	45	27%	22%	1%	4%	0%
North Elochoman (250203)	23,518	54	22%	5%	0%	17%	0%
West Fork Grays River (250311)	10,347	57	21%	1%	0%	19%	0%
Upper Washougal (280205)	31,719	59	20%	14%	0%	6%	0%
Green River (260515)	46,383	61	20%	1%	0%	17%	1%
Siouxon (270305)	39,066	62	19%	19%	0%	0%	0%
South Fork Grays River (250302)	16,774	65	18%	8%	0%	9%	0%
Cedar Creek (270416)	36,416	66	17%	2%	0%	15%	1%
North Fork Toutle (260514)	41,051	69	16%	7%	0%	8%	0%
Rock Creek Clark (270508)	35,440	82	12%	3%	0%	9%	0%
Grays Bay (250310)	56,613	84	11%	0%	0%	11%	0%
South Fork Toutle (260513)	42,623	85	11%	4%	0%	7%	0%
Winston (260320)	28,321	92	10%	2%	0%	7%	1%
Lacamas (280202)	41,185	93	10%	1%	0%	9%	0%
Skamokawa (250209)	51,687	94	10%	2%	0%	8%	0%
Salmon Creek (260421)	43,837	97	9%	2%	0%	7%	0%
Harmony (260330)	22,546	98	9%	0%	0%	8%	2%
Woodland (270412)	37,827	105	8%	5%	0%	3%	0%
Mill Creek (260429)	26,163	109	8%	0%	0%	7%	0%
Little Washougal (280203)	30,269	114	7%	4%	0%	3%	0%
Wind River (290414)	30,669	120	7%	2%	3%	2%	0%
Stillwater (260625)	28,905	142	4%	0%	0%	4%	0%
Abernethy (250104)	40,071	153	2%	2%	0%	0%	0%
Lower Kalama (270113)	49,823	158	2%	1%	0%	1%	0%

Table E-32. Percent of the Watershed Classified as Moderate for Moist Soil Compaction Potential [1/]

Watershed Name (and Number)	Total Acres	Rank[2/]	Watershed Classified as Moderate[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Olequa (260626)	35,017	165	1%	0%	0%	1%	0%
Delameter (260623)	37,243	167	1%	0%	0%	1%	0%
Cedar Creek (260428)	14,441	170	1%	0%	0%	1%	0%
Main Elochoman (250208)	37,009	173	0%	0%	0%	0%	0%
HCP Planning Unit Average			***19%***	***6%***	***2%***	***10%***	***1%***
North Puget HCP Planning Unit							
Cypress (030415)	4,950	1	93%	84%	0%	10%	0%
Tolt (070415)	63,357	34	34%	5%	5%	20%	4%
Lower MF Snoqualmie (070307)	28,375	41	29%	20%	5%	4%	0%
North Fork Snoqualmie (070313)	66,707	42	29%	3%	6%	19%	1%
Sumas River (010125)	36,444	43	28%	1%	0%	27%	0%
Jordan-Boulder (040224)	32,726	44	28%	10%	0%	17%	0%
Vedder (010131)	21,272	47	25%	4%	0%	21%	0%
South Snoqualmie (070306)	57,077	48	25%	4%	15%	2%	4%
Deming (010226)	27,527	55	21%	5%	0%	16%	0%
Raging River (070408)	22,853	56	21%	5%	0%	15%	1%
Skookum Creek (010309)	23,905	60	20%	4%	0%	16%	0%
West Shannon (040435)	14,333	68	16%	2%	0%	14%	0%
Hutchinson Creek (010310)	13,975	72	15%	5%	0%	10%	0%
Jordan (050108)	21,252	73	15%	0%	0%	15%	0%
Ebey Hill (050214)	19,812	77	14%	0%	0%	13%	0%
Warnick (010229)	25,436	81	12%	7%	1%	4%	0%
Lower Pilchuck Creek (050313)	19,364	83	11%	0%	0%	11%	0%
Acme (010311)	23,518	87	11%	0%	0%	10%	0%
Grandy (040534)	18,856	88	10%	1%	0%	9%	0%
Alder (030103)	22,865	89	10%	3%	0%	7%	0%
Howard Creek (010308)	39,040	95	10%	1%	0%	8%	0%
Cherry (070420)	38,183	96	9%	3%	0%	6%	0%
Olney Creek (070225)	20,655	101	9%	2%	0%	7%	0%
Gilligan (030106)	18,879	103	8%	1%	0%	8%	0%
Day Creek (030105)	22,203	106	8%	0%	0%	8%	0%
Rinker (040321)	20,481	108	8%	5%	0%	3%	0%
Woods Creek (070223)	42,463	110	8%	1%	0%	7%	0%
Deer Creek (050201)	41,881	112	8%	2%	0%	5%	0%
Porter Canyon (010327)	18,550	113	7%	2%	0%	5%	0%

Table E-32. Percent of the Watershed Classified as Moderate for Moist Soil Compaction Potential [1/]

Watershed Name (and Number)	Total Acres	Rank[2/]	Watershed Classified as Moderate[3/]	Percentage Breakdown by Ownership[4/]			
				DNR	Federal	Private[5/]	Other[6/]
Kenney Creek (010230)	2,791	115	7%	0%	0%	7%	0%
Tate (070409)	9,798	116	7%	1%	0%	6%	0%
Loretta (030104)	15,769	118	7%	1%	1%	4%	0%
Cavanaugh (050316)	29,722	122	7%	2%	0%	5%	0%
Canyon Creek (010232)	36,807	126	6%	2%	0%	4%	0%
East Shannon (040436)	34,065	127	6%	2%	0%	4%	0%
Hazel (050203)	24,179	128	5%	3%	0%	1%	0%
Upper NF Stilly (050202)	32,833	130	5%	2%	1%	2%	0%
Wallace River (070217)	24,667	132	5%	0%	0%	4%	0%
Tenas (040319)	36,688	133	4%	2%	1%	2%	0%
Clearwater Creek (010328)	14,330	134	4%	4%	0%	0%	0%
Jim Creek (050109)	30,690	135	4%	0%	0%	4%	0%
Corkindale (040531)	24,194	136	4%	1%	2%	1%	0%
Samish River (030301)	57,397	137	4%	0%	0%	4%	0%
Stimson Hill (050215)	18,833	138	4%	0%	0%	4%	0%
Marmot Ridge (010306)	31,794	141	4%	2%	0%	2%	0%
Hilt (040322)	12,453	145	3%	0%	0%	3%	0%
Sultan River (070224)	24,388	146	3%	0%	0%	2%	0%
Hansen Creek (030102)	29,010	148	3%	0%	0%	3%	0%
Nookachamps (030107)	47,730	149	3%	1%	0%	2%	0%
Jackman (040529)	16,399	150	3%	0%	0%	2%	0%
Verlot (050107)	23,540	151	3%	0%	1%	1%	0%
Sauk Prairie (040320)	14,137	152	2%	1%	0%	2%	0%
Youngs Creek (070219)	23,776	155	2%	0%	0%	2%	0%
Pilchuck Mtn (070226)	42,517	157	2%	1%	0%	2%	0%
French Boulder (050204)	45,327	160	2%	1%	0%	1%	0%
Lummi Island (010617)	5,063	163	1%	0%	0%	1%	0%
Samish Bay (010414)	13,258	164	1%	0%	0%	1%	0%
Friday Creek (030313)	24,129	169	1%	0%	0%	1%	0%
Spada (070216)	44,197	171	1%	1%	0%	0%	0%
Lake Whatcom (010412)	35,957	176	0%	0%	0%	0%	0%
Silverton (050106)	46,399	178	0%	0%	0%	0%	0%
HCP Planning Unit Average			***11%***	***3%***	***1%***	***7%***	***0%***

Table E-32. Percent of the Watershed Classified as Moderate for Moist Soil Compaction Potential [1/]

Watershed Name (and Number)	Total Acres	Rank[2/]	Watershed Classified as Moderate[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Olympic Experimental State Forest							
Middle Hoh (200607)	46,272	12	56%	45%	1%	11%	0%
Sol Duc Lowlands (200416)	22,368	19	48%	7%	13%	27%	1%
Upper Clearwater (210116)	58,265	23	44%	44%	0%	0%	0%
Sol Duc Valley (200316)	16,585	25	42%	11%	0%	30%	1%
Sol Duc Valley (200201)	47,220	38	31%	10%	11%	9%	1%
Hoh Lowlands (200608)	30,244	50	23%	4%	0%	19%	0%
Bogachiel (200412)	44,993	51	23%	10%	1%	12%	0%
Clallam River (190303)	22,235	53	22%	8%	0%	14%	0%
Quillayute Bottom (200417)	23,180	63	19%	6%	0%	11%	1%
Queets Corridor North (210213)	39,496	67	17%	6%	7%	1%	2%
East Dickey (200418)	26,657	70	15%	7%	0%	8%	0%
Goodman-Mosquito (200610)	33,529	71	15%	8%	0%	7%	0%
Matheney-Salmon (210211)	21,630	74	14%	7%	0%	1%	7%
Cedar (200609)	12,310	78	13%	5%	0%	8%	0%
Hoko (190302)	44,534	86	11%	2%	0%	8%	0%
Lower Clearwater (210114)	45,246	99	9%	3%	0%	6%	0%
Ozette Lake (200120)	35,130	104	8%	1%	0%	7%	0%
Rain Forest (200505)	56,435	107	8%	8%	0%	0%	0%
Pysht River (190204)	32,972	111	8%	0%	3%	5%	0%
West Dickey (200419)	28,311	119	7%	1%	0%	6%	0%
Queets Corridor South (210212)	29,667	125	6%	5%	1%	0%	0%
Sekiu Coastal (190301)	27,412	147	3%	0%	0%	3%	0%
Kalaloch Ridge (210115)	11,472	154	2%	2%	0%	0%	0%
HCP Planning Unit Average			***19%***	***9%***	***2%***	***8%***	***1%***
South Coast HCP Planning Unit							
Scatter Creek (230403)	31,680	28	39%	0%	0%	38%	1%
Mox Chehalis (220106)	23,315	52	22%	1%	0%	21%	0%
Lower Skookumchuck (230404)	44,616	79	13%	2%	0%	11%	0%
Elk Creek (230117)	38,773	91	10%	2%	0%	6%	1%
Waddel Creek (230501)	28,982	100	9%	5%	0%	3%	0%
Porter Creek (230522)	32,023	102	8%	8%	0%	0%	0%
Garrard Creek (230220)	49,056	121	7%	1%	0%	6%	0%
Naselle Headwaters (240107)	48,336	124	6%	0%	0%	6%	0%
Rock-Jones (230116)	22,917	129	5%	2%	0%	3%	0%

Table E-32. Percent of the Watershed Classified as Moderate for Moist Soil Compaction Potential [1/]

Watershed Name (and Number)	Total Acres	Rank[2/]	Watershed Classified as Moderate[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Cedar Creek (230521)	32,505	131	5%	1%	0%	2%	2%
Mill Creek (240305)	15,699	139	4%	4%	0%	0%	0%
Nemah (240212)	40,522	143	3%	1%	0%	3%	0%
Willapa Headwaters (240306)	62,581	144	3%	1%	0%	3%	0%
Curtis (230112)	43,351	156	2%	1%	0%	1%	0%
Lower Naselle (240108)	36,688	159	2%	1%	0%	1%	0%
Joe-Moclips (210408)	50,805	161	2%	0%	0%	0%	2%
Lincoln Creek (230219)	48,086	162	2%	1%	0%	1%	0%
South Fork Willapa (240314)	26,664	166	1%	0%	0%	1%	0%
Copalis River (210407)	40,529	168	1%	0%	0%	0%	1%
Lower Willapa (240315)	32,329	172	1%	0%	0%	1%	0%
North River Headwaters (240402)	34,532	174	0%	0%	0%	0%	0%
Palix (240213)	35,825	175	0%	0%	0%	0%	0%
Bunker Creek (230218)	22,788	177	0%	0%	0%	0%	0%
Elk River (220625)	32,340	179	0%	0%	0%	0%	0%
HCP Planning Unit Average			***6%***	***1%***	***0%***	***5%***	***0%***
South Puget HCP Planning Unit							
Squaxin (140003)	1,066	5	71%	13%	0%	0%	58%
Hood (150201)	145,611	7	68%	18%	0%	43%	7%
Summit Lake (140002)	29,140	8	64%	18%	0%	45%	1%
Howard Hansen (090103)	46,472	13	56%	21%	0%	27%	8%
Olympia (130202)	18,529	15	56%	6%	0%	46%	4%
North Fork Green (090104)	18,410	20	48%	19%	0%	23%	6%
Tiger (080303)	40,881	26	41%	13%	0%	20%	8%
Cumberland (090202)	26,260	37	32%	3%	0%	27%	2%
East Creek (110113)	14,429	39	31%	4%	14%	11%	1%
Mineral Creek (110110)	23,047	46	26%	5%	0%	19%	3%
Busy Wild (110204)	56,966	75	14%	4%	0%	9%	1%
North Fork Mineral (110112)	16,072	80	12%	8%	0%	3%	1%
Reese Creek (110106)	5,036	90	10%	10%	0%	0%	0%
Ashford (110104)	27,680	117	7%	2%	3%	1%	0%
Catt (110108)	13,279	140	4%	4%	0%	0%	0%
HCP Planning Unit Average			***36%***	***10%***	***1%***	***18%***	***7%***

Table E-32. Percent of the Watershed Classified as Moderate for Moist Soil Compaction Potential [1/]

Watershed Name (and Number)	Total Acres	Rank[2/]	Watershed Classified as Moderate[3/]	Percentage Breakdown by Ownership[4/]			
				DNR	Federal	Private[5/]	Other[6/]
Straits HCP Planning Unit							
Thorndike (170105)	16,587	2	81%	7%	2%	72%	1%
Ludlow (170104)	22,897	3	77%	7%	0%	70%	0%
Dabob (170106)	16,871	4	76%	23%	0%	53%	1%
Chimakum (170203)	28,202	6	68%	5%	5%	55%	3%
Lilliwaup (160204)	29,080	9	61%	39%	0%	23%	0%
Port Angeles (180211)	24,883	11	57%	11%	1%	44%	1%
Salt (190108)	26,336	14	56%	25%	0%	30%	1%
Discovery Bay (170202)	58,871	17	53%	8%	0%	40%	5%
Siebert McDonald (180202)	35,481	22	46%	12%	0%	33%	0%
Little Quil (170107)	28,536	24	43%	8%	0%	35%	0%
Bell Creek (180104)	5,969	27	40%	2%	0%	37%	1%
Sequim Bay (170201)	26,752	33	35%	13%	0%	20%	2%
Lyre (190107)	11,021	35	33%	21%	1%	10%	1%
Dungeness Valley (180103)	43,200	49	23%	6%	0%	16%	0%
Sutherland-Aldwell (180310)	35,109	58	21%	9%	0%	11%	1%
Hamma Hamma (160203)	69,941	64	18%	10%	0%	7%	0%
Big Quil (170108)	51,823	76	14%	6%	1%	7%	0%
Twins (190206)	20,351	123	6%	4%	1%	2%	0%
HCP Planning Unit Average			***45%***	***12%***	***1%***	***31%***	***1%***

1/ Watershed with greater than 5% ownership that have soils classified as moderate for moist soil compaction potential are ranked by percent area of watershed that meets these criteria.

2/ Includes privately owned industrial and non-industrial (i.e., small landowner) forestland.

3/ Includes, municipal, tribal, non-DNR state lands, and other lands.

Appendix F

Preferred Alternative Policies

F. PREFERRED ALTERNATIVE POLICIES

F.1 BOARD OF NATURAL RESOURCES RESOLUTION NO. 1110

This Resolution was approved and adopted by the Washington State Board of Natural Resources on March 2, 2004.

STATE OF WASHINGTON

DEPARTMENT OF NATURAL RESOURCES

BOARD OF NATURAL RESOURCES

RESOLUTION NO. 1110

A **RESOLUTION** authorizing the Department of Natural Resources to prepare the Final Environmental Impact Statement for Sustainable Forest Management of State Trust Lands in Western Washington.

BE IT RESOLVED BY THE BOARD OF NATURAL RESOURCES, DEPARTMENT OF NATURAL RESOURCES, STATE OF WASHINGTON, THAT THE FOLLOWING PRINCIPLES SHALL BE INCORPORATED INTO THE PREFERRED ALTERNATIVE:

SECTION 1. State law (formerly RCW 79.68, recodified at Laws of 2003, Ch. 334, sec. 555(3)) directs the DNR to apply "sustained yield" management to state trust forestlands. The law requires the DNR to periodically adjust acreages designated for inclusion in the sustained yield management program, and calculate a sustainable forestry harvest level.

SECTION 2. The "sustainable harvest level" means the volume of timber to be scheduled for sale from state-owned lands during a planning decade. This is part of DNR's strategic plan for sustainable forest management. It provides for sustainable harvesting on a continuing basis without major prolonged curtailment or cessation of harvest, as required by state law.

SECTION 3. A draft environmental impact statement (DEIS) was issued, November 2003. The DEIS identified six alternatives without identifying a preferred alternative. Scoping comments, multiple public meetings, extensive written comments on the DEIS, direct public comments to the Board of Natural Resources, special Board Sustainable Forestry Workshops, comments from the Sustainable Forestry Technical Committee, outputs from the ***Options*** policy simulation model, and the DEIS itself, all have provided important information that has led to the development of the preferred alternative.

SECTION 4. The Preferred Alternative shall be analyzed in the Final Environmental Impact Statement (FEIS). The DNR shall publish the FEIS and present its findings to the Board of Natural Resources and the public during May 2004. The Preferred Alternative shall be based upon the following statements and the documents referenced in Section 6:

A. Inter-decadal sales variability shall be limited to +/- 25%, based on volume.

B. The model calculation will be based on value. Operational management will also use volume to make stand-level decisions to capture forest value growth while managing the total inventory.

C. Sustainable harvest calculation groups shall be twenty (17 Forest Board Counties, Capital Forest, Olympic Experimental Forest (OESF) and all federal grants and Forest Board Purchased as a single group).

D. Actively manage the land base consistent with our fiduciary and Habitat Conservation Plan responsibilities.

E. Maturity criteria that reflect forest health and value-based considerations will be used by the DNR to provide professional management of the forested trust assets.

F. Bio-diversity pathways will be used to simultaneously increase the production of trust revenue and complex forest habitat with a priority for habitat areas, and across the landscape as appropriate.

G. Old Growth Research Areas continue to be deferred. Over time, target 10-15% of each westside HCP planning units for the development of older forests as defined by structural characteristics provided that existing old growth (as defined by the HCP) and older stands will be a priority focus in developing HCP planning unit targets.

H. The "50/25" strategy is removed and cumulative effects will be addressed through other SEPA processes.

I. The HCP directions shall replace the current legacy & reserve tree requirements.

J. For northern spotted owls:

a. Nesting/roosting/foraging and Dispersal Management: implement the HCP strategy for 50% habitat targets.

b. Prior to 2007, protect circles identified in Owl Memo #1.

c. Prior to 2007, protect Stat 1-R circles outside of the OESF.

d. Prior to 2006, protect SW owl circles other than those above.

e. Prior to 2005, protect owl circles in the OESF.

K. Riparian management shall be consistent with the HCP requirements and agreement with the federal services.

L. The Department shall annually report to the Board of Natural Resources its assessment of the environmental and economic results of implementing the Preferred Alternative. The Department shall employ a structured monitoring and reporting program.

SECTION 5. The Department shall present an analysis to the Board of Natural Resources during the May 2004 meeting that identifies hiring, implementation timelines and cash flow necessary to transition to the Preferred Alternative management practices and associated harvest levels. The Department is directed to prepare a Preferred Alternative that shall meet an average annual harvest target of 636mmbf as soon as possible.

SECTION 6. The FEIS shall take guidance from the following documents in the preparation of the FEIS and its Preferred Alternative: Document One (Management Principles and Objectives, February 3, 2004 as amended by the Board February 17, 2004). Document Two (The description of the Preferred Alternative as presented and amended by the Board on February 17, 2004).

APPROVED AND ADOPTED by the Board of Natural Resources, Department of Natural Resources, State of Washington, this second day of March, 2004.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the Commissioner of Public Lands.

DOUG SUTHERLAND
Commissioner of Public Lands

Approved as to form,
March 2, 2004

Phil Ferester, AAG

F.2 SUSTAINABLE HARVEST CALCULATION MANAGEMENT PRINCIPLES AND OBJECTIVES

The following document is the Board of Natural Resources Resolution 1110, Document 1.

Washington State
Board of Natural Resources

Resolution 1110 – Document 1. **February 17, 2004**

Sustainable Harvest Calculation Management Principles and Objectives

These principles and objectives were first introduced in a memo to the Board of Natural Resources (Board) by Board member Terry Bergeson, Superintendent of Public Instruction, at the January 2004 Board meeting. The memo was discussed and amended January 8th, February 3rd, and February 17th.

The objectives below provide a broad level of direction by the Board of Natural Resources to the Department of Natural Resources in modeling the sustainable harvest calculation and subsequent implementation of the preferred alternative, focusing on:

- Our fiduciary responsibilities;
- A flexible framework for DNR staff to work within;
- Phasing in management strategies to maximize net revenue within reasonable expenditures;
- Utilizing innovative forestry techniques to maintain a diverse, healthy forest system and to protect sensitive areas and habitats, and;
- Requiring monitoring and, at a minimum, annual reporting by DNR to the Board of efforts and results in an outcome-based format so that the Board can respond in a timely manner to policy and implementation issues.

The Board must ensure all decisions meet our fiduciary responsibilities and legal obligations. From the court ruling in *Skamania:* "The state's fiduciary duty of undivided loyalty prevents it from using state trust lands to accomplish public purposes other than those which benefit the trust beneficiaries." Each decision needs to be weighed in terms of:

- Being prudent;
- Assuring intergenerational equity; and
- Maintaining asset productivity in perpetuity.

With these principles in mind, the following objectives reflect the discussion of the Board members for the Sustainable Harvest Calculation and DNR management to meet:

1. The first objective is to have financial performance measured by net present value, a valuable tool to help assure optimum returns to all generations.
2. The second objective is to align all department-created policies, procedures and tasks with Board approved policies to ensure flexibility, optimize the net present value, and achieve other asset management objectives in support of our fiduciary responsibilities.
3. A third objective is to direct the DNR to provide professional management of the assets through active stewardship of as much of the landscape as allowable by law (including the HCP), opening up the landscape to on-base activities.
4. A fourth objective is for the Sustainable Harvest Calculation to reflect a flexible framework within which DNR may, year to year and stand by stand, use professional judgment, best

available science and sound field forestry to achieve excellence in our public stewardship. Timber sales should be regulated through a combined value and volume approach. Decadal target volumes should be managed to effectively market timber so as to increase the value of each timber sale, allowing for intra-decadal variability.

5. A fifth objective is to phase in innovative and more intensive silviculture activities such as improvements to planting stock, site preparation, fertilization, and thinnings that are appropriate for local stand conditions as cash flow is available, e.g., from improved timber sales marketing and reductions in regulatory or administrative constraints, living within present expenditure limits (referring to the 25 percent management fee) in the near-term.
6. A sixth objective is to actively manage the land base in such a manner as to complement our fiduciary responsibilities and still achieve a mosaic that includes a diverse forest structure and provides for broader economic, conservation, aesthetic, recreational and other public benefits. To this end, such innovative activities might include different types of variable density harvests, contract harvesting in sensitive areas, intentionally managing for snags and woody debris, rotating harvest ages, and the development of biological pathways – all in appropriately designated areas.
7. A seventh objective is to employ a structured monitoring and reporting program, providing, at a minimum, annual reporting by DNR to the Board on efforts and results. The report shall include short- and long-term costs and benefits and foreseeable changes needed in statutes, Board approved policies, management fees, or departmental practices.
8. An eighth objective is to identify those trust lands that are inefficient or unsuitable for meeting the trust mandate or fiduciary responsibility but appear to provide ecosystem and/or public benefits. Partnering with communities and other interest groups, DNR should identify and prioritize parcels no longer suited for trust land management and look at creative ways to remove those lands from the trust inventory, such that the trusts are fully compensated. (One example that might receive priority for communities is old natural forests, areas of old growth that have never been harvested or managed for harvest (estimated at 2,000 to 2,500 acres in total).)

F.3 DECISION MATRIX USED BY THE BOARD OF NATURAL RESOURCES TO AID IN THE SELECTION OF A PREFERRED ALTERNATIVE

The attached matrix was developed at December 2, 2003, and January 8, and February 3, 2004, Board of Natural Resources meetings.

Matrix that illustrates the likely outcomes of various policy choices

Compared to current conditions and Alternative 1 future projections

		a	b	c	d	e	f	g	h	i	j
		Outcomes									
	Policy Issues	Alternative	Revenue		Income variability	Amount of Structurally Complex forest beyond that required by the HCP	Implementation		Long-term standing inventory increases under Alt. 1	Likely environmental risks and social benefits of land managed in the urban-rural interface	
			Near-term	Long-term			Costs	Timing		Environmental	Socio-economic
	Volume & Value										
1	Volume	1,2,3,4	same	same	neutral	neutral	same	same	neutral	same	same
2	Value	5,6	positive	positive	neutral	neutral	increase	delay	neutral	increase	increase
	Silviculture										
3	DNR current Silviculture	1, 2, 3	same	same	neutral	same	same	same	same	same	same
4	Minimum Silviculture	4	negative	same	neutral	increase	decrease	immediate	increase	decrease	decrease
5	Intensive Silviculture	5, 6	positive	positive	neutral	same	increase	delay	same	increase	increase
6	Bio Diversity	6	positive	positive	neutral	increase	increase	delay	same	decrease	increase
	Timber Harvest Flow										
7	Even-flow	1,4	same	same	same	neutral	neutral	neutral	neutral	same	same
8	Relative Non-declining	2	Slight "+"	same	same	neutral	neutral	neutral	neutral	same	same
9	Relatively Unconstrained	3	Big "+"	same	Big "+"	neutral	neutral	neutral	neutral	increase	increase
10	Modulating	5,6	Big "+"	same	Slight "+"	neutral	neutral	neutral	neutral	increase	increase
	Ownership Groups										
11	24	1,2,4	same	same	same	neutral	neutral	neutral	neutral	same	same
12	20	3,5,6	Slight "+"	same	Slight "+"	neutral	neutral	neutral	neutral	same	same
13	1	3	Big "+"	same	Big "+"	neutral	neutral	neutral	neutral	increase	increase
	Available "On-base" land										
14	Maintain procedures & deferrals	1	negative	negative	neutral	Slight "+"	decrease	immediate	increase	same	same
15	Change procedures & deferrals	3,4,5,6	Slight "-"	positive	neutral	neutral	decrease	immediate	neutral	increase	increase
16	Change procedures	2	positive	positive	neutral	neutral	increase	immediate	neutral	increase	increase
	Older Forests										
17	Basic Protection Only	1,2,3	neutral	neutral	neutral	neutral	neutral	neutral	neutral	neutral	neutral
18	Specific site Protection	4	neutral	neutral	neutral	neutral	neutral	neutral	neutral	neutral	neutral
19	Landscape Targets	5,6	neutral	neutral	neutral	neutral	neutral	neutral	neutral	neutral	neutral
	Riparian Management										
20	No management	1,4	neutral	neutral	neutral	neutral	neutral	neutral	increase	same	same
21	Moderate Management	2,3,5	Slight "+"	Slight "+"	neutral	neutral	neutral	delay	neutral	same	same
22	Intensive Management	6	positive	positive	neutral	increase	increase	delay	neutral	increase	increase

Legend

positive	Dark shading represents a positive or increase response in an outcome or an immediately ability to apply the change compared to the present
negative	Light shading represents a negative or reduced response in an outcome or a delayed in the application
neutral	White represents a neutral response in the outcome to the proposed change

F.4 POLICIES AND PROCEDURES PROPOSED FOR ADOPTION TO IMPLEMENT THE PREFERRED ALTERNATIVE

Attached is the Policy Manual developed by DNR regarding circumstances triggering the need for a recalculation of the sustainable harvest level.

POXX-XXX CIRCUMSTANCES TRIGGERING THE NEED FOR A RECALCULATION OF THE SUSTAINABLE HARVEST LEVEL

DISCUSSION

State law requires that the Department shall manage the state-owned lands under its jurisdiction, which are primarily valuable for the purpose of growing forest crops on a sustained yield basis. "To this end, the Department shall periodically adjust the acreages designated for inclusion in the sustained yield management program and calculate a sustainable harvest level." (RCW 79.10.320). State law also defines sustainable harvest level as, "Sustainable harvest level means the volume of timber scheduled for sale from state-owned lands during a planning decade as calculated by the department and approved by the board."(RCW 79.10.300(5)).

The legislature envisioned that the sustainable harvest level is likely to need adjustment from time to time, based on the quantity, quality, growth, and availability of the timber resource on state lands. At the time the statute was enacted, the suitable time period was thought to be one decade, with the average annual sustainable harvest level remaining constant during the decade.

Currently, the factors affecting a stable long-term sustainable harvest calculation remain dynamic. Regulatory requirements are in flux, and information about the resource base continues to improve. In addition, new more powerful and flexible computer models have emerged, making it feasible to adjust the harvest level as circumstance changes. At the same time, the fundamental trust obligations and statutory requirements continue to be the foundation of policy.

POLICY

The department, with board approval, will recalculate the statewide sustainable harvest level, for board adoption no less frequently than every ten years.

The department will adjust the calculation and recommend adoption by the board when the department determines changing circumstances suggest that an adjusted harvest level in the near term would be prudent. Such circumstances may include major changes in legal requirements, significant new policy direction from the board, new information about the resource base available for harvest, or changes in technology.

POXX-XXX **CIRCUMSTANCES TRIGGERING THE NEED FOR A RECALCULATION OF THE SUSTAINABLE HARVEST LEVEL**

SEE ALSO

RCW 79.10.300, Land Management Authorities and Policies – Definitions
RCW 77.10.320, Land Management Authorities and Policies – Sustainable Harvest Program

Cancels: PO14-004 Sustainable Even-Flow Timber Harvest, Dated: July 1992
PO14-005 Harvest Levels Based on Volume, Dated: July 1992
PO14-006 Western Washington Ownership Groups, Dated: July 1992

PO0X-XXX DEFINITION OF SUSTAINABILITY FOR THE SUSTAINABLE HARVEST CALCULATION

DISCUSSION

State law defines "sustained yield" as "management of the forest to provide harvesting on a continuing basis without major prolonged curtailment or cessation of harvest." (RCW 79.10.310). A common law duty of the state as trustee is to not favor either present or future trust beneficiaries over each other. Sustained yield management helps accomplish this duty.

Within that broad statutory direction, various interpretations of sustained yield management are possible. Differences in interpretation may relate to the size of areas subject to separate calculations of sustainable yield of timber, for example, either the state trust ownership as a whole or smaller areas; the degree of variability of timber harvest over time; and the aspect of forest management to be the primary focus of sustainability, such as area or volume of timber harvested or retained, or revenue earned.

In the past, the department has divided the forest land base into separate sustainable harvest units based on county boundaries, the department's administrative regions, and several separately treated areas. In addition, the department has set the variability of harvest over time based on a non-declining even-flow objective. The department has calculated sustainable yield based on timber volume. The Board of Natural Resources has expressed a desire for a more flexible system as the basis for the sustainable harvest calculation.

(Lands formerly know as Forest Board Transfer and Forest Board Purchase are now defined in RCW 79.02.010(10) as "State Forest Lands." For purposes of this policy, former Forest Board Transfer lands will be called "State Forest Trust Lands," and former Forest Board Purchase Lands will be called "State Forest Purchase Lands.")

POLICY

For Western Washington the department will calculate a separate long-term decadal sustainable harvest level, expressed as timber volume, for twenty distinct sustainable harvest units, as follows: Each of the seventeen county beneficiaries of

Cancels: PO14-004 Sustainable Even-Flow Timber Harvest, Dated: July 1992
PO14-005 Harvest Levels Based on Volume, Dated: July 1992
PO14-006 Western Washington Ownership Groups, Dated: July 1992

PO0X-XXX DEFINITION OF SUSTAINABILITY FOR THE SUSTAINABLE HARVEST CALCULATION

State Forest Trust lands separately, and all of the federally granted trusts and State Forest Purchase lands in Western Washington together, with the exception that the Olympic Experimental State Forest and the Capitol State Forest shall each have a separate calculation regardless of trust.

In order to ensure intergenerational equity among beneficiaries, within each sustainable harvest unit, the calculated decadal harvest volume level for any decade may vary up or down, no more than approximately 25% from the level of the preceding decade. In order to take advantage of shorter term operational or market opportunities, the harvest level for any year within a decade may also fluctuate up to 25% plus or minus from the decadal average, as long as the decadal average is met over the decade.

Subject to all applicable legal and policy direction, the department will analyze the financial characteristics of forest stands in order to optimize the economic value of forest stands and timber production over time, in planning and scheduling timber harvests, in making investments in forest growth, and in searching for the least-cost methods of achieving other forest management objectives.

SEE ALSO

RCW 79.02.010(10), Public Lands Management - Definitions
RCW.79.10.310, Land Management Authorities and Policies, Sustained Yield Plans - Defined

Cancels: PO14-011 Managing "On Base" Lands, Dated: July, 1992
PO14-030 Silviculture Activities, Dated: July, 1992

PO0X-XXX GENERAL SILVICULTURAL STRATEGY APPLIED TO THE TIMBER RESOURCE BASE AVAILABLE FOR SUSTAINABLE HARVEST IN WESTERN WASHINGTON

The department defines silviculture as the art and science of cultivating forests to achieve objectives. The department uses a flexible, site-by-site approach for evaluating and implementing silvicultural treatments, based on site specific, rotational or long term analysis incorporating return on investment, variable biological conditions, and physical limitations. Site-specific silvicultural prescriptions include intensive activities such as refined planting stock, site preparation, fertilization, and thinning, as budgets allow at the time prescribed activities come due. Innovative silvicultural treatments can also be used to create, develop, enhance, or maintain forest biodiversity and health. For example, the objective of the "biodiversity pathways" approach to silviculture, presented by Carey et al (1996) is for simultaneous increases in production of both habitat and income. This approach creates complex, multi-aged stand structure that sustains key forest stand elements to replicate vital ecological functions over stands and landscapes.

All silviculture strategies are applied within a context of specific stand-level or larger area objectives to achieve long-term sustainable flow of forest products, services and other relevant values. Stands whose progress toward objectives is below potential are generally chosen for management intervention. Stands selected for regeneration harvests include those that have a low possibility for a positive response to partial harvest regimes.

POLICY

The department will follow legal requirements in maintaining the greatest possible portion of the trust forest lands as on-base.

The department will provide professional management of forestland through active stewardship of on-base lands. The active management of the land base will be carried out as an integral part of the department's fiduciary responsibilities and to achieve on a landscape basis a combination of forest structures that provide for broader economic, conservation, aesthetic recreational and other public benefits. 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

Cancels: PO14-011 Managing "On Base" Lands, Dated: July, 1992
PO14-030 Silviculture Activities, Dated: July, 1992

PO0X-XXX GENERAL SILVICULTURAL STRATEGY APPLIED TO THE TIMBER RESOURCE BASE AVAILABLE FOR SUSTAINABLE HARVEST IN WESTERN WASHINGTON

The department will target over time 10 to15 percent of each western Washington HCP Planning Unit for older forest conditions. The department will use retention of existing old growth stands (as defined in the HCP) as a priority in achieving these targets. Retained areas may include Old Growth Research Areas described in Policy PO14-014

SEE ALSO

PO14-014, Old Growth Research Area Deferrals
PO14-031, Harvest and Reforestation methods

Cancels: PR 14-001-010 Determining Harvest Levels And Completing The Five-Year Action And Development Plan for Westside Regions and TK 14-001-020 Developing The Draft Five-Year Action And Development Plan

PR-14-001-010 **SUSTAINABLE HARVEST IMPLEMENTATION PLANNING**

APPLICATION All State forested trust lands west of the Cascades managed under the direction of the Land Management Division, except for recreation sites, Natural Area Preserves, and Natural Resources Conservation Areas.

DISCUSSION

This planning procedure describes the process the Department will utilize to implement the Sustainable Harvest Calculation. The procedure will provide direction and guidance for implementing the Board of Natural Resources policies and Department procedures and standard practice memorandums related to the sustainable harvest calculation. The primary purpose of sustainable harvest implementation planning is to describe how field operations within a HCP planning unit and over a 10-year period are likely to meet the Department's strategic policy goals.

Action

Implementation plans will be developed for each of the HCP planning units in western Washington after the sustainable harvest is completed. These plans will be developed over a period of time; the preparation will be based on available resources and budget. The purpose of the plans is to develop strategies that will be used to implement the Sustainable Harvest Calculation consistent with policies approved by the Board of Natural Resources at the HCP planning unit level over a 10-year period. These plans are tactical, not operational, and thus will not incorporate harvest schedules. Operational harvest scheduling is a dynamic process and will be negotiated between the regions and divisions.

All implementation plans should describe the measurable outcomes that are expected in specified areas of the HCP planning units. The measurable outcomes can encompass aspects of the ecological, economic and social-cultural environment. Examples include desired stand structures, volume targets and visual management requirements. Many of the outcomes are already established as a result of strategic policy direction set by the Department in documents such as the HCP and the sustainable harvest calculation. Other outcomes might be specified by local knowledge. Each implementation plan should then specify the types of forest management strategies that will accomplish the measurable outcomes. For example, a strategy to meet target Nesting, Roosting and Foraging landscape thresholds might include an array of potential silviculture prescriptions based on stand condition and type.

Implementation plans will be amended to reflect policy changes made by the Board (such as an update to the sustainable harvest level or the Forest Resource Plan). Plans will be also be updated as needed due to a changing environment. All implementation plans, at a minimum will specify strategies describing how policy objectives and harvest levels will be met within each HCP planning unit over the next decade. The implementation planning proposals will be subject to environmental analysis and public participation under the State Environmental Protection Act (SEPA) and shall be approved by the Department's Land Steward.

APPROVED BY: ______________________________

Gretchen Nicholas, Manager
Land Management Division

Definitions

Expected Outcomes: These are measurable objectives that assist in describing the planning goals and for monitoring the plan's performance overtime. Examples include: forest conditions described in terms of stand structure; harvest products or revenue projections; miles of trials to be construction/maintained.

Desired future/forest conditions: Narrative descriptions of the expected outcomes and expectations but are not measurable or mandatory in nature. Provided more as communication bridge between lay and scientific or technical terms than as an objective. Examples could include: development of older forest conditions; aesthetically intact forest, formation of community relations through local monitoring programs with schools; etc.

Management Strategies: These are the methods or the "sequence of activities" that will be used to achieve the expected outcomes. These management strategies may universal applied to all areas within the HCP unit or specifically to a watershed or land classification. Examples include: silvicultural prescriptions used to meet target conditions, management activities to direct public through strategic trail building, sign and gate placement, or scheduling the sequence of harvest in a given area to manage visual impacts.

Operational schedules: in the department refers to planning exercises that develop specific activity schedules for a specific area over a short time frame. Examples include timber harvest schedules (the distribution spreadsheet, information held in Planning and Tracking database) for one or more years for a district or administrative unit level, resource assessment schedules at the watershed or landscape scale within a biennium, HCP monitoring activities.

Policy objectives: These are the Department's strategic policy goals as provided in the HCP, FRP, ASP, Board of Natural Resources approved sustainable harvest level and Executive Management direction outlined in Department procedures and standard practice memorandums. The policy objectives for the plan are scaled and adjusted for the specific HCP unit. Examples include: the Sustainable Harvest Unit target levels for the HCP unit; HCP riparian conservation objectives.

Strategic forest management planning: in the department refers to Board of Natural Resources, Executive Management planning processes that develop statewide or regional wide plans and direction for the management of State forested trust lands. Time frames are typically long-term, 10 years or multiple decades. Examples include the Forest Resource Plan, the Habitat Conservation Plan (HCP), the Asset Stewardship Plan (ASP), and sustainable harvest.

Tactical forest management planning: in the department refers to planning exercises that develop forest management strategies to meet and fulfill the department's strategic policy goals, objectives and direction over more specific smaller geographic scales and/or timeframes. Examples include 10-year Implementation plans at the HCP planning unit scale, Klickitat HCP amendment, landscape plans at the watershed scale (Loomis, OESF and Lake Whatcom), and region Road Management and Abandonment Plans (RMAPS).

Cancels: **PR 14-004-120 Management Activities Within Spotted Owl Nest Patches, Circles, Designated Nesting, Roosting, and Foraging and Dispersal Management Areas, August 2004**

PR14-004-120 **MANAGEMENT ACTIVITIES WITHIN SPOTTED OWL CIRCLES AND DESIGNATED NESTING, ROOSTING, FORAGING (NRF) AND DISPERSAL MANAGEMENT AREAS**

APPLICATION

All forested ecosystems in the west-side planning units covered by the Habitat Conservation Plan (HCP).

DISCUSSION

DNR's conservation objective for the northern spotted owl is to provide habitat that makes a significant contribution to demographic support, maintenance of species distribution, and facilitation of dispersal. The strategy is intended to provide nesting, roosting, and foraging (NRF) habitat and dispersal habitat in strategic areas in order to achieve the conservation objective. The strategy is also intended to create a landscape in which active forest management plays a role in the development and maintenance of the structural characteristics that constitute such habitat.

ACTION

1. **Northern Spotted Owl Circles**

   Determine if the proposed activity is located within any known spotted owl circles that are listed in Owl Implementation Memorandum #1, dated January 1998:

   a. **Do not harvest within the following circles prior to January 2007:**

Pacific Cascade Region	Rock Creek/Chehalis
Olympic Region	Lower Stequaleho, Willoughby Ridge, Kunamakst Creek, Kalaloch, Solecks River, Kloochman, Queets Campground, Owl Creek, Shale Creek, Upper Stequaleho, Upper Clearwater River, Minter Creek, Tacoma Creek East Fork

b. **Harvest only within non-habitat areas within the following circles prior to January 2007.**

Pacific Cascade Region	Blue Mountain
Olympic Region	Anderson Ridge, Lake Creek/Soleduck, Lower Bear Creek, Reade Hill, Whiskey Creek, Salt Creek

c. **Do not harvest or construct roads between March 1st and August 31st within the best 70 acres of a site center if the circle is outside of designated NRF and Dispersal Management Areas, or within 0.7 miles of the site center if the circle is within a designated NRF or Dispersal Management Area.**

d. **The following WDFW Status 1R (reproductive) owl circles will be protected:**

   a. **Inside the Olympic Experimental State Forest (OESF), Status 1R owl circles will be protected as follows until January 2005:**
   b. **All other Status 1R owl circles will be protected as follows until January 2007:**
      1) Do not harvest areas considered Type A or B[1] habitat.
      2) Conduct habitat enhancement activities in areas that are considered Type C[1] habitat.
      3) Areas considered non-habitat are unrestricted.

   Request permission, in writing, for variations to this direction from the Land Management Division Manager.

e. **Per Standard Practice Memorandum SPM03-07, *Management of Northern Spotted Owl Circles and The Identification of Northern Spotted Owl Habitat in Southwest Washington*, inside the following Southwest Washington owl circles prior to FY2006:**

Site #880	**Elochoman River**
Site #877	**Upper Mill Creek – Willapa**
Site #1042	**Seven Creek – Elk Creek**
Site #1008	**Shields Creek – Chehalis**

[1] Contact Division HCP Implementation staff for more information and descriptions of Type A, B, and C northern spotted owl habitat.

1) Pacific Cascade Region will defer harvests that will degrade what is termed the Best Available Habitat defined as:
   a) Stands meeting the HCP definition of dispersal habitat, and
   b) Containing at least 1 snag per acre, **and**
   c) Containing at least 2,300 cubic feet of down woody debris per acre.

2) Pacific Cascade Region will apply habitat enhancement activities in stands that are termed Possible Habitat defined as:
   a) Stands meeting the HCP definition of dispersal habitat, and
   b) Containing at least 1 snag per acre, **or**
   c) Containing at least 2,300 cubic feet of down woody debris per acre.

2. NRF and Dispersal Management Areas

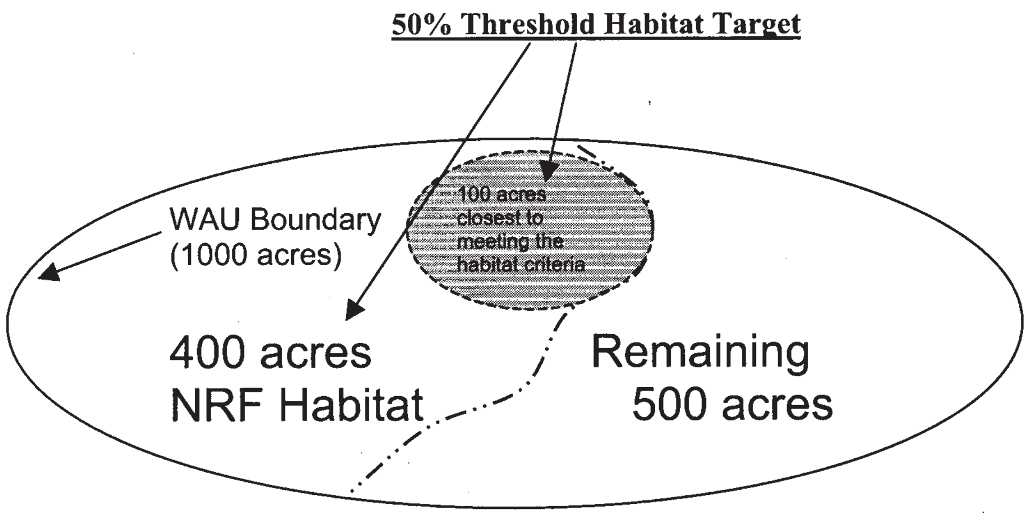
Westside DNR regions shall identify and classify forest stands within WAUs located in the NRF or Dispersal Management Areas.

For each WAU in the designated NRF or Dispersal Management Area, regions shall identify at least 50% of the DNR managed forestland area as the "threshold habitat target" within the WAU. This threshold habitat target will be prioritized by biological significance (i.e., presence and abundance of habitat components, adjacency to other habitat, adjacency to federal lands, etc.) and will be classified as follows, in priority:

1) Nest patch core and buffer areas in NRF Management Areas;
2) Forest stands that are considered Sub-mature/Dispersal or higher quality habitat. A portion of this habitat classification has been completed using the Forest Resource Inventory System (FRIS) HCP items database and maps and threshold percentages for each WAU are available to region staff. Field assessments and verification by Region or Division wildlife biologists will most likely be necessary to confirm the FRIS habitat designations. This field verification and documentation will be required as additional information and corrections for updating the FRIS HCP items NRF and Dispersal habitat delineations.
3) Forest stands that are non-habitat but are considered closest to meeting the specific habitat criteria. Further information and guidance on identifying stands considered closest to meeting specific habitat criteria will be provided to each region by staff from the HCP Implementation Section.

Identifying 50% of the DNR managed forestland area as the "threshold habitat target" within the WAU
(Simplified Example)

In this scenario, the WAU contains 1,000 acres. It will be necessary to identify the acres that are considered habitat using the FRIS HCP habitat database and to use field assessments conducted by a wildlife biologist (in this case 400 acres are considered NRF habitat). The next step is to identify areas closest to meeting the habitat criteria (in this case 100 acres is needed to be identified to reach the 50% threshold habitat target). Management activities can take place in the remaining 50% that do not count toward the threshold habitat target (in this case it is 500 acres).



Management activities can take place in areas considered suitable habitat as long as NRF habitat remains after the management activities are complete. Management activities may be conducted in the areas closest to meeting the habitat criteria only if the management activities do not increase the amount of time required for the target amount of NRF goal to be attained (50% threshold habitat target) if all the stands in that WAU were left unmanaged.

In the remaining 50% of the WAU that does not count toward the threshold habitat target, regions shall describe and specify the silviculture management prescriptions, strategies and other allowable forest management activities (e.g. road management, recreation, etc.) for stands within NRF and Dispersal Management Areas. This management strategy shall consider:

1) The northern spotted owl and other conservation strategies outlined in the HCP;
2) The Implementation Agreements between the DNR and the Federal Services or other state agencies;
3) The application of harvest methods using the biodiversity pathways approach; and
4) Other local agreements.

The Division that is responsible for the management and implementation of the HCP shall review and provide recommendations on the approval of the management strategies in NRF or Dispersal Management Areas.

The Region Manager shall also approve the management strategies inside NRF and Dispersal Management Areas.

3. Nest Patches

Determine if the proposed activity is located within a designated spotted owl nest patch. Do not conduct management activities within nest patches.

Do not trade or transfer land within a nest patch unless the nest patch buffer has been located in non-habitat and an area of equal or better habitat quality and potential is available for replacement within the appropriate area.

Approval Date: ________________ Approved By: ______________________________

Gretchen Nicholas
Land Management Division Manager

Cancels: **Replaces PR 14-005-020 (May 2000). Effective immediately.**

PR 14-005-020 **SELECTING STANDS FOR REGENERATION HARVEST**

APPLICATION All forest trust uplands subject to timber harvest

Discussion. The Trust Mandate is the fundamental reason why the Department manages trust lands. Under the Trust Mandate, the Department has a fiduciary requirement to generate revenue for the Trusts. In addition, the Department's Habitat Conservation Plan (HCP) requires the Department to manage for ecological habitat objectives, and the State Environmental Policy Act (SEPA) requires public interaction to discern additional objectives and assess environmental effects. This results in silvicultural prescriptions based on social, environmental/ecological, and economic landscape and FMU objectives that drive development of distinct management strategies. Regeneration harvests are an appropriate management strategy that is applied within the context of a stands progress towards FMU and landscape objectives.

Thus, the purpose of this procedure is to specify steps for selecting stands for regeneration harvest in order to best achieve the sustained harvest level. The sustainable harvest levels are based in part on the assumption that management strategies will assure optimum growth towards specified outcomes. It also assumes that the most financially efficient methods possible will be chosen to meet social, environmental and economic objectives. To that end, it is assumed that units that are progressing at the slowest rate towards FMU objectives will be chosen for management intervention. Units targeted for regeneration harvest will include those that have the lowest possibility for a positive response to partial harvest regimes. The Divisions will collaborate with the regions to develop methods to ensure correct implementation of this procedure.

Action. The following are the steps of major supporting actions for scheduling harvests:

Step 1—Information Inventory

- Review GIS or other information base to support landscape management for habitat and/or other pertinent landscape objectives
- Review GIS or other information base to generate transportation system information
- Review available FRIS, P&T, and/or site-specific stand information to support a determination of stand suitability for regeneration harvest of commercial cohort(s)
- Review relevant social, environmental/ecological, and economic issues applicable to the areas of consideration
- Conduct information-gathering site visits as necessary

Step 2—Mid-Term Harvest Schedule

- Use information in Step 1, above, to identify stands with commercial cohorts suitable for regeneration harvest within the next several—approximately five—years.
- Determine probable landscape and FMU objectives for these stands
- Reschedule, beyond the mid-term, stands that appear likely to fail to meet one or more landscape or FMU objectives—ecological and social objectives in particular
- Prioritize for first removal stands with urgent characteristics (such characteristics may be trust revenue and/or volume, stand development and growth rate trends, landscape forest structure and age class distribution, forest and ecological health, fire hazard, etc.)

Step 3—Execution

- Select a sufficient number of high priority stands to meet the yearly sustained harvest level
- Conduct remaining field work, SEPA analysis, timber sale appraisal, contract preparation, required review, contract award, and contract execution

APPROVED BY: ______________________________

Gretchen Nicholas, Manager
Land Management Division

Cancels: **PR 14-006-090 (May 2000) for west-side, only; the May 2000 procedure remains in effect for east-side. Effective immediately.**

PR 14-006-090 **MANAGEMENT OF FOREST STAND COHORTS, WEST-SIDE**

APPLICATION All regeneration harvest FMUs on forested trust uplands, west-side

Discussion

Forest stand "cohorts" are forest stand components whose management imperatives make them statistically distinct. For example, *cohorts* such as live wildlife reserve trees, snags, and down dead logs, are statistically distinct because statutes, regulations, and the Department's HCP require their management and retention beyond a single rotation. These multi-rotational, or legacy, *cohorts* co-exist with one or more rotational, commercial *cohorts* within the same FMU. While legacy *cohorts* are managed to achieve environmental FMU objectives (such as wildlife and mycorrhizal habitats), one or more commercial *cohorts* within the same FMU are managed to achieve the economic FMU objective to generate revenue for the Trusts.

The purpose of this procedure is to provide unified direction for management of forest stand cohorts in a single document. To this end, the procedure specifies mandatory cohorts and their minimum requirements. The result is a structured silvicultural approach that reaches beyond uniformly applied classical even-aged—clearcut, seed tree, and shelterwood—and uneven-aged silvicultural systems. This approach, cohort management, synchronizes with site-specific silvicultural prescriptions that simultaneously manage distinct cohorts to achieve rotational social, environmental, and economic FMU objectives. The Department will provide periodic training to implement this procedure.

Action

Safety Regulations pre-empt all other requirements. Check current SPMs for up-dated additional guidance.

Cohort management shall integrate relevant social, environmental, and economic FMU objectives into site-specific, rotational silvicultural prescriptions that are optimal bio-diversity pathways for each particular situation. Cohorts may serve multiple FMU objectives. Silvicultural prescriptions provide the means to realize landscape objectives.

At least one commercial cohort shall be managed, generally on a rotational basis, for maximum benefit to trust beneficiaries, consistent with other FMU and landscape objectives.

Multi-rotational (legacy) cohorts shall be managed to levels directed in the table below.

All West-Side State Forest Uplands *

Legacy Cohort	Average /Acre	Dimensions	Proximity
Large, Structurally Unique Green Trees Suited for Wildlife *	$\geq$ 2 trees	-- $\geq$ 1 tree, from largest diameter class -- $\geq$ 1 tree, from dominant crown class	At least 1 clump per 5 acres, or generally 400 feet or less from any point in the FMU to a green leave tree; leave trees should be toward FMU interior, except as needed for ecological objectives
Snag Recruits *	$\geq$ 3 trees	-- Intermediate to dominant crown class -- $\geq$ 10 inches DBH, $\geq$ 30 feet in height, and $\geq$ 33 percent live crown ratio -- Select largest diameter trees first, preferably those with structural deformities and cavities	
Snags (standing dead trees suitable for wildlife)	$\geq$ 3 snags (safety requirements shall be met)	-- $\geq$ 15 inches DBH, $\geq$ 30 feet tall, if available -- Select largest diameter cavity trees first -- If snags cannot be left safely, replace with suitable live trees	Leave snags as consistent with safety requirements
Down dead wood	$\geq$ 2 logs	-- Small end diameter $\geq$ 12 inches, length $\geq$ 20 feet -- Select largest diameter logs first	None

*--Note: Table parameters represent average minimums. Acre-by-acre densities are variable—to include clumping—so long as proximity criteria are followed and FMU averages meet or exceed minimum requirements. FMU-specific objectives may dictate higher—but not lower—retention levels, particularly when managing for habitat objectives and combined effects of social, environmental, and economic landscape and FMU objectives.

--Any unstable and hazardous wildlife reserve tree or snag that could pose a threat to humans shall be felled and substituted by a suitable and safe snag or tree.

--Leave tree refugia may be created of sufficient size to safely accommodate hazardous wildlife trees or snags.

--Leave trees, snags, and clumps may be arranged to accommodate logging and vegetation management.

--Priority for retention will be given to tree species with propensity to develop cavities; legacy tree species in the stand after harvest should be generally representative of the legacy species diversity prior to harvest.

--Land Management division manager may approve alternate minimums provided that legal, regulatory, and HCP requirements remain inviolate.

APPROVED BY: ______________________________

Gretchen Nicholas, Manager
Land Management Division

Cancels: **TK 14-001-010 Maintaining Mature Forest Components, Dated August 1999**

TK 14-001-010 **MAINTAINING MATURE FOREST COMPONENTS**

APPLICATION All even-aged forest lands that are managed under the direction of the Forest Resources Division, except for recreation sites, Natural Area Preserves, and Natural Resources Conservation Areas.

DISCUSSION

This task defines how the department will maintain forest cover diversity on DNR-managed lands as part of the Five-year Action and Development Plan planning process (see procedure PR 14-001-010 and task TK 14-001-020). The desired outcome of this task is to design timber sales that result in a wide range of habitat conditions at both a local and landscape level.

At the local level, the proximity of adjacent stands will be considered when planning management activities so that a desired amount of forest cover and structure can be maintained. A single regeneration harvest area may be made-up of several harvest units. However, the total size of a single harvest area may not exceed 100 acres without separation. The purpose of the separation is to provide diverse habitat conditions. Areas designated as riparian management zones (RMZs) or leave tree areas may not be included as part of the separation requirement. This local level strategy applies to all regeneration harvest activities on both the eastside and westside.

Exceptions will be considered when there are special needs (i.e., salvage cutting, forest health issues, land purchases and sales, or land exchange agreements).

The following definitions apply to this task:

Regeneration harvest activity – any harvest activity that results in a residual stand that has a stocking level that is less than 20 mature trees per acre (mature trees are 10 inches diameter at breast height (dbh) or greater). This includes, shelterwood and seed tree type silvicultural systems.

Regeneration harvest unit –a single area to be harvested that is designated by roads and/or boundary tags.

Regeneration harvest area – an area consisting of one or more regeneration harvest units. This area includes all units to be harvested as well as those that have been harvested and are stocked with trees that are less than four feet tall. The Land Management Division has developed a program to identify these areas.

Action

1. Request Geographic Information System (GIS) data for location and ownership of forested land within the WAU with the proposed management activity.

2. Determine the size of the proposed regeneration harvest area.

    a. Total the number of acres of the regeneration harvest area by combining all unit acres that are not separated by at least one logical harvest unit (an area that must be at least 300-feet-wide and well stocked with trees that are at least four feet tall). Do not include RMZs, wetland buffers, or leave tree areas as part of the separation. If the total harvest area is:

        - less than 100 acres, include the sale in the Five-year Action and Development Plan. End this task and return to procedure PR 14-001-010.

        - greater than 100, not separated by a logical harvest unit, and the majority of timber is sold for salvage, forest health, land sale or purchase, or land exchange reasons obtain region manager approval before including the sale in the Five-year Action and Development Plan. End this task, and return to procedure PR 14-001-010.

            - If the sale is disapproved, reduce the size of the proposed harvest unit so that the combined acreage of all the units does not exceed 100 acres. End this task and return to procedure PR 14-001-010.

3. Construct roads as necessary to access management areas.

    Note: Forest Practices require that clear-cut units on islands be no larger than 40 acres. See WAC 222-30-110, Timber Harvesting on Islands.

APPROVED BY: ____________________________

Gretchen Nicholas, Manager
Land Management Division

SEE ALSO:

PO14-016 LANDSCAPE PLANNING

PO14-019	WATERSHED ANALYSIS
PO14-020	RIPARIAN MANAGEMENT ZONES
PO14-021	WETLANDS
PO14-031	HARVEST AND REFORESTATION METHODS
PO14-032	GREEN-UP OF HARVEST UNITS
PR 14-001-010	DETERMINING HARVEST LEVELS AND COMPLETING THE FIVE-YEAR ACTION AND DEVELOPMENT PLAN
TK 14-001-020	DEVELOPING THE DRAFT FIVE-YEAR ACTON AND DEVELOPMENT PLAN
WAC 222-30-110	TIMBER HARVESTING ON ISLANDS.

Appendix G

Response to Comments

Appendix G

G. RESPONSE TO COMMENTS

TABLES

Appendix G

G.1 INTRODUCTION

In November 2003, the *Draft Environmental Impact Statement on Alternatives for Sustainable Forest Management of State Trust Lands in Western Washington* was released for public comment. During the comment period, more than 4,500 individual comments were received from over 740 separate letters, e-mails, web comments, and oral testimonies. A listing of the names of the commenters for each letter, e-mail, web comment, or oral testimony received is provided in Table G-1.

Each comment received by the Washington Department of Natural Resources (DNR) was provided to each of the members on Board of Natural Resources in its original, unedited form on January 12, 2004.

Following an initial review of the comments and a general analysis of the issues, the comments were categorized into 23 subject areas and 108 issues. Responses were then prepared for each of these areas and issues, and appropriate changes were incorporated into the Final Environmental Impact Statement (EIS). The subject areas and issues by which comments were summarized and responded to and page numbers for each subject area can be found in Table G-2.

DNR approached the responses to comments as an opportunity to achieve two goals: 1) to address public concerns about the accuracy and extent of the analysis, and 2) to explain the analysis and its meaning, which is in places very technical. In this sense, the responses serve as a guide for the reader that will answer their questions and direct them to where their questions and concerns are addressed in the State Environmental Policy Act documents.

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS

Comment No.	Name of Commenter	Organization	Format
1	Cathy Wickwire	N/A	E-mail
2	Marcus Morgan	Chewelah SD Board of Directors	E-mail
3	Brian Sullivan	N/A	E-mail
4	John Stewart	N/A	E-mail
5	Suzanne Griffith	N/A	E-mail
6	Rachel Brombaugh	N/A	E-mail
7	Dan Gonsor	N/A	E-mail
8	Deirdre Wilcox	N/A	E-mail
9	Perry Parsons	N/A	E-mail
10	Gian Morresi	N/A	E-mail
11	Paul Rogland	N/A	E-mail
12	Jacqueline Bricker	N/A	E-mail
13	Kristin deLancey	N/A	E-mail
14	Joe Talbert	N/A	E-mail
15	Stephen Kingsford-Smith	N/A	E-mail
16	Jeffrey Belt	N/A	E-mail
17	Noreen Wedman	N/A	E-mail
18	Carol Bernthal	N/A	E-mail
19	Jim Comrada	Habitat Systems Northwest Inc.	E-mail

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
20	Benedict Anderson	N/A	E-mail
21	John Clapp	N/A	E-mail
22	Stephen de Blois	N/A	E-mail
23	M Richardson	N/A	E-mail
24	Torsten Griem	N/A	E-mail
25	Vanessa Collier	N/A	E-mail
26	Andreas Niesen	N/A	E-mail
27	Erik Hagstrom	N/A	E-mail
28	Kathi Jackson	N/A	E-mail
29	Bill Swann	N/A	E-mail
30	Len Gardner	N/A	E-mail
31	JoAnn Hunter	N/A	E-mail
32	Chris Reynolds	N/A	E-mail
33	Kevin Farrell	N/A	E-mail
34	Stonewall Bird	N/A	E-mail
35	Darren Kavanagh	N/A	E-mail
36	Ron Smith	Buse Timber & Sales	E-mail
37	Chuck Pettis	N/A	E-mail
38	Adam Berger	N/A	E-mail
39	Amy Souers	N/A	E-mail
40	Marian Wineman	N/A	E-mail
41	Robert Dalton	N/A	E-mail
42	Marilyn Heiman	N/A	E-mail
43	Leah Hausman	N/A	E-mail
44	Maureen Maloney	N/A	E-mail
45	Ronald Ramey	N/A	E-mail
46	Timothy Ferguson	N/A	E-mail
47	Bryan Burke	N/A	E-mail
48	Thomas Cox	N/A	E-mail
49	Mark Wahl	N/A	E-mail
50	Pat Rasmussen	N/A	E-mail
51	James McRoberts	N/A	E-mail
52	Susan Alter	N/A	E-mail
53	Vanessa Kirn	N/A	E-mail
54	Arland Swanson	N/A	E-mail
55	Helen Reddout	N/A	E-mail
56	Burt Culver	N/A	E-mail
57	Tracy Swenson	N/A	E-mail
58	Maureen Sullivan	N/A	E-mail
59	Katherine Dixon	N/A	E-mail
60	Keith Johnson	N/A	E-mail
61	Cecile and Alex Urquhart	N/A	E-mail
62	Jennifer Tice	N/A	E-mail
63	Jenna McDonald	N/A	E-mail
64	Margot Fetz	N/A	E-mail
65	Jesse Putnam	N/A	E-mail
66	Peter Roth	N/A	E-mail
67	Scott Dungan	N/A	E-mail
68	Edward McAninch	N/A	E-mail
69	Catherine Muller	N/A	E-mail

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
70	Bruce Reed	N/A	E-mail
71	Ed Gallo	N/A	E-mail
72	Dale Koetke	N/A	E-mail
73	Holly O'Neil	N/A	E-mail
74	Pat Collier	N/A	E-mail
75	Joe Dryden	N/A	E-mail
76	Jennifer Winters	N/A	E-mail
77	Patricia Coffey	N/A	E-mail
78	Laura Koetke	N/A	E-mail
79	Mark Harrison	N/A	E-mail
80	Julie Baker	N/A	E-mail
81	Brad Wellman	N/A	E-mail
82	Corwin Allred	N/A	E-mail
83	Timothy Coleman	N/A	E-mail
84	Sean Pender	N/A	E-mail
85	Chad Nancarrow	N/A	E-mail
86	Christine Gallagher	N/A	E-mail
87	Laurinda Johnsen	N/A	E-mail
88	Jeremy Brown	N/A	E-mail
89	Richard Smith	N/A	E-mail
90	Edward Mills	N/A	E-mail
91	Mark Longtine	N/A	E-mail
92	Alma Cardenas	N/A	E-mail
93	Michael Coday	N/A	E-mail
94	David Averill	N/A	E-mail
95	Margo Wyckoff	N/A	E-mail
96	Harriet Winkelman	N/A	E-mail
97	Louis Richard	N/A	E-mail
98	Jeanie Murphy	N/A	E-mail
99	Rosemary Harrell	N/A	E-mail
100	Paul Waner	N/A	E-mail
101	Jonathan Seagrave	N/A	E-mail
102	Melissa McLure	N/A	E-mail
103	Byron Rot	N/A	E-mail
104	Ted Hart	N/A	E-mail
105	Jessica Renner	N/A	E-mail
106	Claudia & Randy DeWees	N/A	E-mail
107	Samya Clumpner	N/A	E-mail
108	Rev. Maria Hoaglund	N/A	E-mail
109	Tana Beus	N/A	E-mail
110	Ann Gibson	N/A	E-mail
111	Bruce Lippke	University of Washington	E-mail
112	Julie Foster	N/A	E-mail
113	Keleigh Muzaffar	N/A	E-mail
114	Tim McNulty	Olympic Park Associates	E-mail
115	Roger Chapanis	N/A	E-mail
116	Geoff Praeger	N/A	E-mail

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
117	Gerry Milliken	N/A	E-mail
118	Shari Tallarico	N/A	E-mail
119	Beth Doglio	N/A	E-mail
120	Suzanne Dolberg	N/A	E-mail
121	Dave Ivanoff	Hampton Affiliates	Oral
122	Peggy Burton	League of Women Voters of Thurston County	Oral
123	Bill Sloane	Mason County South Side School Board	Oral
124	N. Roger Scott	N/A	Oral
125	Nina Carter	Washington Audubon Society	Oral
126	Jean Shaffer	Forest Stewards Guild	Oral
127	Carol Johnson	North Olympic Timber Action Committee	Oral
128	Bob Dick	American Forest Resource Council	Oral
129	Kurt Kingman	Mason County Mary M. Knight School Board	Oral
130	Don Montgomery	N/A	Oral
131	Peter Goldman	Washington Forest Law Center	Oral
132	Angela Emery	Washington Forest Law Center	Oral
133	Eric Harlow	Washington Forest Law Center	Oral
134	Dan Cothren	Wahkiakum County	Oral
135	Dennis Creel	Hampton Resources	Oral
136	Flora Leisenring	N/A	Oral
137	Gary Haynes	Tumwater Lumber Company	Oral
138	Ron Erickson	Olympic Ministries	Oral
139	Sue Chickman	Olympic Peninsula Audubon Society	Oral
140	Pat MacRobbie	League of Women Voters of Clallam County	Oral
141	Nedra Reed	City of Forks	Oral
142	Chuck Lockhart	Washington Hardwoods Commission	Oral
143	Cherie Kidd	N/A	Oral
144	Jill Silver	N/A	Oral
145	Richard Terril	N/A	Oral
146	Rod Fleck	City of Forks	Oral
147	Dean Throop	N/A	Oral
148	Dave Dickson	N/A	Oral
149	Nash Huber	N/A	Oral
150	Jim Conomos	N/A	Oral
151	Peter von Christierson	Olympic Forest Coalition	Oral
152	Jerry Hendricks	N/A	Oral
153	Carol Johnson	North Olympic Timber Action Committee	Oral
154	Timothy Smith	City of Port Angeles	Oral
155	Frank Walter	Quillayute Valley School District	Oral
156	Pat Milliren	N/A	Oral
157	Steve Tharinger	Clallam County	Oral
158	Paul Kitchel	Olympic Resources Co.	Oral
159	Tim McNulty	Olympic Park Associates	Oral
160	Martin Hutten	N/A	Oral
161	John Sherrett	Forks Community Hospital	Oral
162	Larry Leonard	N/A	Oral
163	Jim Scarborough	Olympia Forest Coalition	Oral

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
164	Norm Schaaf	N/A	Oral
165	Steve Vogel	Clallam Fire District 3	Oral
166	Lorraine Ross	N/A	Oral
167	Robert Hemsley	Association of Western Pulp and Paper Workers	Oral
168	Sara Lee O'Connor	N/A	Oral
169	Steve Gloor	N/A	Oral
170	Chris Burns	Washington Department of Fish and Wildlife	Oral
171	Jim Haguewood	Clallam County Economic Development Council	Oral
172	Mike Doherty	Clallam County	Oral
173	Dave Chamberlain	N/A	Oral
174	Gena DiLabio	N/A	Oral
175	Dave Sweitzer	Washington Hardwoods Commission	Oral
176	Ted W. Anderson	Skagit County	Oral
177	Larry Maechler	N/A	Oral
178	Steve Aslanian	N/A	Oral
179	Russ Pfeiffer-Hoyt	Mt. Baker School Board	Oral
180	Lisa McShane	Northwest Ecosystem Alliance	Oral
181	Teresa Dix	N/A	Oral
182	Henry Lagergren	N/A	Oral
183	Randy Walcott	Sierra Club Mt. Baker Group	Oral
184	Mark Baugh	Hampton Tree Farms	Oral
185	Tom Pratum	North Cascades Audubon Society	Oral
186	Kris McCall	Hampton Tree Farms	Oral
187	Lorna Frey	N/A	Oral
188	Paul Kreigel	N/A	Oral
189	David MacFarlane	N/A	Oral
190	Katherine Johnson	Pilchuck Audubon Society	Oral
191	Steve Higgins	N/A	Oral
192	Rob Janicki	N/A	Oral
193	Gretchen Starke	Vancouver Audubon Society	Oral
194	Dave Ivanoff	Hampton Affiliates	Oral
195	John Hadaller	N/A	Oral
196	Tony Waldal	N/A	Oral
197	Darrell Alvord	Hampton Tree Farms	Oral
198	Thom McConathy	N/A	Oral
199	Genny Kortes	Vancouver for Peace	Oral
200	John Hudson	N/A	Oral
201	Al McKee	Skamania County	Oral
202	Emily Platt	Gifford Pinchot Task Force	Oral
203	Jim Mickel	American Forest Industry Council	Oral
204	Jim Comrada	N/A	Oral
205	Fred Johnson	Wahkiakum County	Oral
206	Jason Spadaro	SDS Lumber Company	Oral
207	Tom Gordon	WTA	Oral
208	Jordan Wells	N/A	Oral
209	Peggy Bryan	Skamania Co. Economic Development Council	Oral
210	Douglas Princehouse	Washington Hardwoods Commission	Oral

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
211	Janet Strong	Chehalis River Council	Oral
212	Jim Dickison	Simpson Timber	Oral
213	Dan Boeholt	N/A	Oral
214	Mike Davis	Hampton Tree Farms	Oral
215	Jim Bennett	Quinault Lake School District	Oral
216	Mike Warren	Hampton Tree Farms	Oral
217	Bill Pickell	Washington Contract Loggers Association	Oral
218	Bob Dick	American Forest Resource Council	Oral
219	Nancy Peckman	Washington State Society of American Foresters	Oral
220	Rod Fleck	City of Forks	Oral
221	Bill Little	Western Council of Industrial Workers	Oral
222	Martharose Laffey	Washington State School District Association	Oral
223	Jim Carlson	Premier Forest Products	Oral
224	Bob Meier	Rayonier	Oral
225	Jack Smith	WA Department of Fish and Wildlife	Oral
226	James Stewart	N/A	Oral
227	Bill Bickar	N/A	Oral
228	Dean Schwickelath	Grays Harbor Audubon Society	Oral
229	Judy Turpin	N/A	Oral
230	Roger Gresky	N/A	Oral
231	Ron Gelbrich	Washington Hardwoods Commission	Oral
232	Charlie Raines	Sierra Club	Oral
233	Becky Cox	League of Women Voters of Washington	Oral
234	Mark Kemp	Hampton Tree Farms	Oral
235	Michael Marsh	Washington Native Plant Society	Oral
236	Randy Robinson	Seattle Audubon Society	Oral
237	Chris Peterson	Seattle Audubon Society	Oral
238	Marilyn Sandall	Seattle Audubon Society	Oral
239	G. Parameswaran	N/A	Oral
240	Gene L Chase	C&C Contracting	Oral
241	Gordon Iverson	N/A	Oral
242	D. Eric Harlow	Washington Forest Law Center	Oral
243	Alex Morgan	Seattle Audubon Society	Oral
244	Morgan Ahouse	Seattle Audubon	Oral
245	Angela Emery	Washington Forest Law Center	Oral
246	Becky Kelley	Washington Environmental Council	Oral
247	Marcy Golde	Washington Environmental Council	Oral
248	Jennifer Harris	N/A	Oral
249	Peter Goldman	Washington Forest Law Center	Oral
250	Greg Pulley	Pulley Logging	Oral
251	Larry Machler	Machler Forestry	Oral
252	Vince Houmes	N/A	Oral
253	Susan Sanders	N/A	Oral
254	David Adam Edelstein	N/A	Oral
255	Jack Severns	N/A	Oral
256	Muriel Severns	N/A	Oral
257	Dennis Creel	Hampton Resources	Oral

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
258	Robert Stagman	N/A	Oral
259	Jed Dunkerley	N/A	Oral
260	Bob Dick	American Forest Resource Council	Oral
261	Gabe Tucker	N/A	Oral
262	Brenda Buchanan	Sierra Club	Oral
263	Betty Ringlee	Peninsula School District	Oral
264	Nevin Wood	Nova High School	Oral
265	Martharose Laffey	Washington State School Directors Association	Oral
266	Austin Shepherd	N/A	E-mail
267	Bernhard Kreutz	N/A	E-mail
268	Dolores Geer	N/A	E-mail
269	Bill Yake	N/A	E-mail
270	Steve B.	N/A	E-mail
271	Robert Bickel	N/A	E-mail
272	Kirie Pedersen	N/A	E-mail
273	William Null	N/A	E-mail
274	Jessica McNamara	N/A	E-mail
275	Bob Howard	N/A	E-mail
276	Arland Swanson	N/A	E-mail
277	Paul Wittrock	N/A	E-mail
278	Dawn Gauthier	N/A	E-mail
279	James Davis	N/A	E-mail
280	Greg McCann	N/A	E-mail
281	Gordon Wood	N/A	E-mail
282	Terradan Sagewynd	N/A	E-mail
283	June Otow	N/A	E-mail
284	H. Fogg	N/A	E-mail
285	Marianne Webster	N/A	E-mail
286	Tom Reeve	N/A	E-mail
287	Jerry Liebermann	N/A	E-mail
288	Barbara Geiger	N/A	E-mail
289	Gail Glass	N/A	E-mail
290	Larry Maechler	N/A	E-mail
291	Kate Ritley	N/A	E-mail
292	Bill Yake	N/A	E-mail
293	David Colwell	N/A	E-mail
294	Julia Allen	N/A	E-mail
295	Jon Leland	N/A	E-mail
296	Eric Baicy	N/A	E-mail
297	Richard Bergner	N/A	E-mail
298	Daniel Henling	N/A	E-mail
299	Margaret Larson	N/A	E-mail
300	Emily Carter	N/A	E-mail
301	Holly Lin	N/A	E-mail
302	Jospeh Losi	N/A	E-mail
303	Steven Short	N/A	E-mail
304	Eric Wilborn	N/A	E-mail

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
305	Becky Brown	N/A	E-mail
306	Jeff Strong	N/A	E-mail
307	Kirk Francis	N/A	E-mail
308	Christian Fulghum	N/A	E-mail
309	William Ferren	N/A	E-mail
310	Paul Zimmerman	N/A	E-mail
311	Greg Martin	N/A	E-mail
312	Peter Belov	N/A	E-mail
313	Cindi Handloff	N/A	E-mail
314	Katherine Moulton	N/A	E-mail
315	Jordan Norris	N/A	E-mail
316	Christian Martin	N/A	E-mail
317	Peter Rimbos	N/A	E-mail
318	Anne Dulfer	N/A	E-mail
319	Mike O'Shea	N/A	E-mail
320	Ed Gallo	N/A	E-mail
321	Michele Coad	N/A	E-mail
322	Tom Blumer	N/A	E-mail
323	Dorothy Sager	N/A	E-mail
324	Nancy Gross	N/A	E-mail
325	Ann Gibson	N/A	E-mail
326	Jodi Broughton	N/A	E-mail
327	Joe Chasse	N/A	E-mail
328	Julie Lockhart	N/A	E-mail
329	Dave Scott	N/A	E-mail
330	Fred Neil	N/A	E-mail
331	Ingrid Dahl	N/A	E-mail
332	M. Anne Sweet	N/A	E-mail
333	Jennifer Tice	N/A	E-mail
334	D. Hanig	N/A	E-mail
335	John Butler	N/A	E-mail
336	Wayne Katon	N/A	E-mail
337	Jack Stewart	Vashon Forest Stewards	E-mail
338	Steven Cividanes	N/A	E-mail
339	Joan Weisenbloom	N/A	E-mail
340	Bruce Turcott	N/A	E-mail
341	Cheryl Robinson	N/A	E-mail
342	Ingrid Rasch	Corporate Action Now, LLC	E-mail
343	Sylvia Burges	N/A	E-mail
344	Chris Johnson	N/A	E-mail
345	Mark Johnson	N/A	E-mail
346	Anne Fox	N/A	E-mail
347	Glen Mangiantini	N/A	E-mail
348	Robert Scott	N/A	E-mail
349	Tracy Ouellette	N/A	E-mail
350	Trisha Towanda	N/A	E-mail
351	Greg Hoffenbacker	N/A	E-mail

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
352	Judith Gustafson	N/A	E-mail
353	Gretchen Chambers	N/A	E-mail
354	Ignacio Silva	N/A	E-mail
355	Pat Collier	N/A	E-mail
356	Annalee Cobbett, JD	N/A	E-mail
357	Jessica Klinkert	N/A	E-mail
358	Jamie Moore	N/A	E-mail
359	Paul Mocker	N/A	E-mail
360	Warren Northrop	N/A	E-mail
361	Corina Logan	N/A	E-mail
362	Don Marsh	N/A	E-mail
363	Kendra Donelson	N/A	E-mail
364	Paul Osebold	N/A	E-mail
365	Susan Graham	N/A	E-mail
366	Vern Rutter	N/A	E-mail
367	Dee Knapp	N/A	E-mail
368	Sharon McClellan	N/A	E-mail
369	Barbara Rosenkotter	N/A	E-mail
370	Halee Love	N/A	E-mail
371	Matthew Keifer	N/A	E-mail
372	Halee Love	N/A	E-mail
373	Darlene Schanfald	Friends of Miller Peninsula State Park	Letter
374	Stonewall Bird	N/A	E-mail
375	Marcia Ponto	N/A	E-mail
376	Derek Dexheimer	N/A	E-mail
377	Hellmut Golde	N/A	E-mail
378	Joe Ryan	N/A	E-mail
379	Mike Blankenship	N/A	E-mail
380	S. Jon King	N/A	E-mail
381	Stan Kemble	N/A	E-mail
382	Scott Royer	N/A	E-mail
383	Gayle Rothrock	N/A	E-mail
384	Edward Chadd	N/A	E-mail
385	Eldon Ball	N/A	E-mail
386	Bob Burkholder	N/A	E-mail
387	Robert Burns	N/A	E-mail
388	Janis Burger	N/A	E-mail
389	Scott Bergen	N/A	E-mail
390	Abraham Ringel	N/A	E-mail
391	Michael O'Brien	N/A	E-mail
392	Jon Stahl	N/A	E-mail
393	David Cline	N/A	E-mail
394	Jim Davis	Conservation Partnership Center	E-mail
395	Joseph Couples	N/A	E-mail
396	Gideon Rosenblatt	N/A	E-mail
397	Kevin Ceurter	Intel Corporation	E-mail
398	Antonia Jindrich	N/A	E-mail

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
399	Sharon Rowe	N/A	E-mail
400	Devon Westerholm	N/A	E-mail
401	Paul Osebold	N/A	E-mail
402	Kathleen Nolan	N/A	E-mail
403	David Laws	N/A	E-mail
404	Roger Hudson	Earth Ministry	E-mail
405	Michael Hagen	N/A	E-mail
406	Steve Tornblom	N/A	E-mail
407	Christina Bemis	N/A	E-mail
408	Noreen Wedman	N/A	E-mail
409	L. Vogeley	N/A	E-mail
410	Marjorie Leone	N/A	E-mail
411	Kate Nichols	N/A	E-mail
412	Tom Edwards	N/A	E-mail
413	R McKinnon	N/A	E-mail
414	Carla Carroll	N/A	E-mail
415	Robert Haverfield	N/A	E-mail
416	Pamela Zipp	N/A	E-mail
417	Craig Zora	N/A	E-mail
418	David Dickson	Quillayute Valley School District	E-mail
419	William Hermann	N/A	E-mail
420	Sonya Remington	N/A	E-mail
421	Dan Kostrzewski	N/A	E-mail
422	Daniel Hoaas	N/A	E-mail
423	Daniel Bell	N/A	E-mail
424	Eric Place	Northwest Environment Watch	E-mail
425	Joan Espana	N/A	E-mail
426	Jonelle Kemmerling	N/A	E-mail
427	James Chapman	N/A	E-mail
428	Eycke Strickland	N/A	E-mail
429	Andrew Carey	N/A	E-mail
430	Hudson Brad	N/A	E-mail
431	Rosemary McCracken	N/A	E-mail
432	Deborah Livingstone	N/A	E-mail
433	Richard Pierson	N/A	E-mail
434	Ruth Mulligan	St. Mark's Episcopal Cathedral	E-mail
435	Kathleen Ryan	N/A	E-mail
436	Larry Phillips	N/A	E-mail
437	Dave Shreffler	N/A	E-mail
438	Thomas Hammond	N/A	E-mail
439	Sean Bevington	N/A	E-mail
440	Rick Gantman	Mount Baker School District	E-mail
441	Steven Harper	Concerned Neighbors of Lake Samish	E-mail
442	Mary Bertrand	N/A	E-mail
443	Michael McCool	N/A	E-mail
444	Kerry McCool	N/A	E-mail
445	Christopher Howard	N/A	E-mail

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
446	Patrick Mus	N/A	E-mail
447	Joes Kuperberg	N/A	E-mail
448	Mauricio Austin	N/A	E-mail
449	Crystal Oswald-Herold	N/A	E-mail
450	Suzanne Estey	Office of King County Executive Ron Sims	E-mail
451	John Mazzariello	N/A	E-mail
452	Mark Skatrud	N/A	E-mail
453	Seth Cool	N/A	E-mail
454	Paul Butler	The Evergreen State College	E-mail
455	Dan Boeholt	N/A	E-mail
456	Sue Fogle	Colville School District No. 115	E-mail
457	Lehman Holder	N/A	E-mail
458	Dave Kertis	N/A	E-mail
459	Daniel Hall	American Lands	E-mail
460	David Dicks	N/A	E-mail
461	Stephanie Field	Friends of the San Juans	E-mail
462	Hilton Turnbull	Jamestown S'Klallam Tribe	E-mail
463	Tom Johnson	N/A	E-mail
464	Erick McWayne	N/A	E-mail
465	Ira Coen	N/A	E-mail
466	Leigh McKeirnans	N/A	E-mail
467	Alicia Beck	N/A	E-mail
468	Dan Cothren	Washington State Association of Counties	E-mail
469	Andrew Stone	N/A	E-mail
470	Mindy Newby	N/A	E-mail
471	Jennifer Harris	N/A	E-mail
472	Steve Erickson	Whidbey Environmental Action Network	E-mail
473	Jeff Reifman	N/A	E-mail
474	Nina Carter	Audubon Washington	E-mail
475	Stacy Green	N/A	E-mail
476	Tom Gohlke	N/A	E-mail
477	Scott Burns	N/A	E-mail
478	Janice Roberts	N/A	E-mail
479	Tom Westergreen	Great Western Lumber Company	E-mail
480	Craig Cooper	N/A	E-mail
481	Jean Westgate	Friends of Sumas Mountain	E-mail
482	David Jaffe	N/A	E-mail
483	Henry Mansfield	N/A	E-mail
484	Phil Rogers	N/A	E-mail
485	Mike McHenry	Lower Elwha Klallam Tribe	E-mail
486	Tina Schulstad	Sierra Club-Cascade Chapter	E-mail
487	Jim Hutchison	N/A	E-mail
488	Claudia Self	Grays Harbor County	E-mail
489	Chris Dillard	N/A	E-mail
490	Sara Fleet	N/A	E-mail
491	Anna Hochhalter	N/A	E-mail
492	Patti Stone	N/A	E-mail

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
493	Sandra Ciske	N/A	E-mail
494	Chris Stone	N/A	E-mail
495	Tim Paxton	N/A	E-mail
496	Mystique Grobe	N/A	E-mail
497	Ginger Oppenheimer	N/A	E-mail
498	Jo Morgan	N/A	E-mail
499	Jayme Curley	N/A	E-mail
500	Kurt Wieland	N/A	E-mail
501	Dinda Evans	N/A	E-mail
502	David Kerlick	N/A	E-mail
503	Megan Groshuesch	Ozark Natural Science Center	E-mail
504	Kurt Baumgarten	N/A	E-mail
505	Michael Savatgy	N/A	Letter
506	Aubrey Taylor	N/A	Letter
507	Chuck Parker	Buse Timber & Sales	Letter
508	Bob Wilson	N/A	Letter
509	Ken Norris	N/A	Letter
510	Glen Westlund	N/A	Letter
511	Mark Arnold	N/A	Letter
512	Pat Schuche	N/A	Letter
513	Jim Hogan	Blue Ribbon Coalition	Letter
514	Fred Yancey	Mary M. Knight School District 331	Letter
515	Aloma Blaylock	N/A	Letter
516	Teresa Dix	N/A	Letter
517	Todd Miller	N/A	Letter
518	Chuck Lockhart	K Ply Inc	Letter
519	Katherine Humphrey	N/A	Letter
520	Teresa Dix	N/A	Letter
521	David Sweitzer	Washington Hardwoods Commission	Letter
522	Gena DiLabio	N/A	Letter
523	Ted Anderson	Skagit County Board of Commissioners	Letter
524	Lorna Frey	N/A	Letter
525	Jeanne King	N/A	Letter
526	Lyn Bishop	N/A	Letter
527	Tom Pratum	North Cascade Audubon Society	Letter
528	Katherine Johnson	Pilchuck Audubon Society	Letter
529	Paul Kriegel	N/A	Letter
530	Glenn Wiggins	N/A	Letter
531	Lorraine Ross	N/A	Letter
532	Phillip Kitchel	N/A	Letter
533	Glenn Beckman	N/A	Letter
534	Don Hansen	N/A	Letter
535	Carol Johnson	North Olympic Timber Action Committee	Letter
536	Chuck Lockhart	Washington Hardwood Commission	Letter
537	Sue Chickman	Olympic Peninsula Audubon Society	Letter
538	Nedra Reed	City of Forks	Letter
539	Wes Short	Clallam County Fire District 3	Letter

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
540	Ruth Gerdon	Clallam County Treasurer's Office	Letter
541	Don Montgomery	N/A	Letter
542	Don Montgomery	N/A	Letter
543	(unknown)	N/A	Letter
544	Angela Emery	Washington Forest Law Center	Letter
545	Peggy Burton	League of Women Voters of Thurston County	Letter
546	Garry Schueley	N/A	Letter
547	Ron Fox	N/A	Letter
548	Patrick Ehrenheim	N/A	Letter
549	Dahrl Norris	N/A	Letter
550	Carl Gay	N/A	Letter
551	G M Dilabio	N/A	Letter
552	Josey Paul	WRIA 19 Board Members	Letter
553	Joyce Jensen	N/A	Letter
554	Peggy Printz	N/A	Letter
555	Carol Volk DVM	N/A	Letter
556	Ron Erickson	N/A	Letter
557	Gretchen Starke	Vancouver Audubon Society	Letter
558	Gretchen Starke	N/A	Letter
559	Robert Talent	Skamania County Board of Commissioners	Letter
560	James Dickison	Simpson Timber Company	Letter
561	Doug Princehouse	Washington Hardwoods Commission	Letter
562	Janet Strong	Chehalis River Council	Letter
563	Nancy Peckman	Washington State Society of American Foresters	Letter
564	Bill Pickell	Washington Contract Logger's Association	Letter
565	Francis Walter	Quillayute Valley School District No 402	Letter
566	Phillip Sharpe	N/A	Letter
567	Robert Stagman MD	N/A	Letter
568	Fayette Krause	N/A	Letter
569	Ronald Strabbing	Grays Harbor County	Letter
570	Todd Clements	N/A	Letter
571	Gerry Lane	Allen Logging Company	Letter
572	S. Brooke Taylor	N/A	Letter
573	Jim Stewart	N/A	Letter
574	Melissa Pratt	N/A	Letter
575	Ron Gelbrich	Washington Hardwoods Commission	Letter
576	Ray Thayer	Klickitat County Commissioners	Letter
577	Dan Frymirg	N/A	Letter
578	Robert Goldard	N/A	Letter
579	John Barston	N/A	Letter
580	Daniel Warner	N/A	Letter
581	John Carlson	N/A	Letter
582	K. Norris	N/A	Letter
583	Tim Locke	N/A	Letter
584	Grant Munro	N/A	Letter
585	Tera McDonald	N/A	Letter
586	Laura Emerson	N/A	Letter

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
587	Jonathan Clemens	N/A	Letter
588	Wayne Stewart	East Valley School District No 361	Letter
589	Ron Schuler	N/A	Letter
590	Tracy Kiein	N/A	Letter
591	Patricia MacRobbie	League of Woman Voters of Clallam County	Letter
592	Jim Mason	N/A	Letter
593	Stanley Fouts	N/A	Letter
594	Paul Burke	N/A	Letter
595	Jeff Camson	N/A	Letter
596	First Name Watson	N/A	Letter
597	E. Arondl	N/A	Letter
598	Jesse Barstow	N/A	Letter
599		N/A	Letter
600	Bryan Merril	N/A	Letter
601	Gary Cohn	Port Angeles School District No 121	Letter
602	William Miller	N/A	Letter
603	R.C. Parker	Western Wood Products Association	Letter
604	Ken Berg	U.S. Fish & Wildlife Service	Letter
605	Gerald Eller	N/A	Letter
606	Helen Elwood	N/A	Letter
607	Bob Jacobs	N/A	Letter
608	Gary Hanes	Tree Source Industries	Letter
609	Gerald Steel	Citizens for Sustainable Forestry	Letter
610	CW Rennie	N/A	Letter
611	J.D. Noe	N/A	Letter
612	Steve Aslanian	Skagit Audubon Society	Letter
613	Charles Direbiss	N/A	Letter
614	Roger Cole	N/A	Letter
615	John Rhodes	Association of Western Pulp and Paper Works	Letter
616	Diana Gordon	N/A	Letter
617	Rev. Rodger Hudson	Earth Ministry	Letter
618	Michael Luzzo	N/A	Letter
619	Dan Boeholt	Southwest Washington County Farm Bureau	Letter
620	Jonathan Green	N/A	Letter
621	Brad Holt	Boise Cascade Corporation	Letter
622	Tom Gordon	N/A	Letter
623	(none)	Port Angeles Chamber of Commerce	Letter
624	Jewell Woodward	N/A	Letter
625	Ron Schillinger	N/A	Letter
626	Richard Pierson	Society of American Foresters	Letter
627	Alan Yen, Ph.D.	N/A	Letter
628	Gene Myers	N/A	Letter
629	Tomas Sergel	Bethel Public Schools	Letter
630	Bruce McComas	Port Townsend Paper Corporation	Letter
631	Ross Marquarell	N/A	Letter
632	Alice Alexander	N/A	Letter
633	John Hendrickson	N/A	Letter

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
634	RB Brackbill	N/A	Letter
635	Mardel Chowen	N/A	Letter
636	Brando Blore	N/A	Letter
637	Jim Scarborough	Olympic Forest Coalition	Letter
638	Rob McNair	Tacoma Audubon Society	E-mail
639	Sue Parrott	Commission Against Domestic Violence	E-mail
640	Mike Jackson	Professional Forestry Services, Inc	E-mail
641	June Kite	N/A	E-mail
642	Keith Wyman	N/A	E-mail
643	Andrea Imler	Cascadia Consulting Group	E-mail
644	Ingrid Gourley	Washington State School Directors Association	E-mail
645	Andy Mendenhall	N/A	E-mail
646	Fred Johnson	Board of Wahkiakum County Commissioners	E-mail
647	Gordon Smith, Ph.D.	EcoFor	E-mail
648	Jack Scharbach	N/A	E-mail
649	Drew Coe	Nooksack Indian Tribe Natural Resources Dept.	E-mail
650	Kris Nelson	N/A	E-mail
651	Ann Musche	Willapa Hills Audubon Society	E-mail
652	Carol Johnson	N/A	E-mail
653	Richard Tipps	N/A	E-mail
654	Lisa McShane	Northwest Ecosystem Alliance	E-mail
655	Elizabeth Davis	League of Women Voters	E-mail
656	Pat Willits	N/A	E-mail
657	Brian Heinrich	N/A	E-mail
658	Ken Zirinsky	N/A	E-mail
659	Frank Hammond	N/A	E-mail
660	Lynn Bahrych	N/A	E-mail
661	Gabriel Tucker, Ph.D.	N/A	E-mail
662	Jean Shaffer	Tree Shepherd Woods/Nisqually Tree Art Furn.	E-mail
663	Bill Thurston	Freeman School District	E-mail
664	Mike Marsh	Washington Native Plant Society	E-mail
665	Peter Revesz	N/A	E-mail
666	Richard Wallace	WA Department of Ecology	E-mail
667	Bruce Davies	Northwest Indian Fisheries Commission	E-mail
668	David Moskowitz	The Wild Salmon Center	E-mail
669	Jessica Klinkert	N/A	E-mail
670	Harrison Grathwohl	N/A	E-mail
671	Rose Oliver	N/A	E-mail
672	Joseph Losi	N/A	E-mail
673	Andrew Fox	N/A	E-mail
674	Larry Rymon, Ph.D.	N/A	E-mail
675	Harley Oien	N/A	E-mail
676	David Heflick	Kettle Range Conservation Group	E-mail
677	Polly Dyer	N/A	E-mail
678	Donald Parks	N/A	E-mail
679	Alvin Penn	Hoh Tribe	E-mail
680	Linda Marsh	N/A	E-mail

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
681	Alex Morgan	Seattle Audubon Society	E-mail
682	Eric Harlow	Washington Forest Law Center	E-mail
683	Tim Cullinan	N/A	E-mail
684	Jan McMillan	Grays Harbor Audubon	E-mail
685	Becky Kelley	Washington Environmental Council	E-mail
686	Erin Moore	N/A	E-mail
687	Jill Silver	Hoh Tribe	E-mail
688	Michael Lang	Friends of the Columbia Gorge	E-mail
689	Alan Soicher	N/A	E-mail
690	Victoria Olson	N/A	E-mail
691	Kathryn Ketcham	N/A	E-mail
692	Malcolm Dick	American Forest Resource Council	Letter
693	Paula Swedeen	Washington Department of Fish & Wildlife	Letter
694	Nedra Reed	City of Forks	Letter
695	Robert Collard	Lake Washington School District No 414	Letter
696	Dennis Morrisette	County Commissioners, Grays Harbor County	Letter
697	Betty Ringlee	Peninsula School District	Letter
698	Robert Lee	N/A	Web
699	Gordon Pogorelc	North Fork Timber Co.	Web
700	Margaret M. Bell	North Olympic Library System	Web
701	Bruce Fischer	N/A	Web
702	William Little	N/A	Web
703	Linda Gresky	N/A	Web
704	Teresa Dobson	N/A	Web
705	Eric Jacoby	N/A	Web
706	Don Wallace	N/A	Web
707	Ted Matts	N/A	Web
708	Scott Species	N/A	Web
709	Patricia Walker	N/A	Web
710	Sharon Florakis	N/A	Web
711	C. Backman	N/A	Web
712	Ken Estes	N/A	Web
713	John R Reid	N/A	Web
714	Dennis Hummitzsch	Koochiching County, Minnesota	Web
715	Fred Allen	N/A	Web
716	Jack Peasley	Quincy High School Principal	Web
717	John Phillips	N/A	Web
718	Adam Bachman	N/A	Web
719	Earl Emerson	N/A	Web
720	Lisa Egtvedt	N/A	Web
721	Hal Enerson	N/A	Web
722	Rick Liebel	Washington State Bowhunters	Web
723	Jim Bouma	N/A	Web
725	Alan Yen	N/A	Web
726	JohnPaul F. McGee	N/A	Web
727	Susan Sanders	N/A	Web
728	Ted Matts	N/A	Web

Table G-1. Listing of Commenters Who Submitted Comments on the Draft EIS (continued)

Comment No.	Name of Commenter	Organization	Format
729	Janet Burcham	N/A	Web
730	Sue Cohn	No. Olympic Library System Board of Trustees	Web
731	John Schmidt	N/A	Web
732	Wayne Zipse	Clarkston School District Board	Web
733	David Schuchardt	N/A	Web
734	Chelsey Pipasquate-Hunton	N/A	Letter
735	Rebecca Gilbert	N/A	Letter
736	Cindy Colton	N/A	Letter
737	Steve Koehler	Protect the Peninsula's Future	Letter
738	Jack Markley	N/A	Letter
739	Thomas Kelly	North Mason School District	Letter
740	Joan Miller	N/A	Letter
741	Jean Kyle	N/A	Letter
742	Sue Fogle	Colville School District Board of Directors	Letter
743	Grace Yuan	Preston Gates Ellis LLP	E-mail
744	Dennis Morrisette	Grays Harbor Board of County Commissioners	Letter
745	James Bennett	Quinault Lake School District #97	Letter
746	Eric Johnson	Lewis County Board of County Commissioners	Letter
747	Sue Nattinger	N/A	Letter
748	Coleman Byrnes	N/A	Letter

Table G-2. List of Subject Areas and Issues

Starting Page	Subject Area	Issue
G-20	Forest Structure and Vegetation	Benefits of Managing for Structure
		Habitat – Plants, Wildlife and Ecosystems
		Thinning
		Clearcutting
		Forest Health
		Rotation Length
		Old Forest
		Hardwoods Management
		Salvage Logging
		Active/Passive Management
		Biodiversity Pathways
		Model Assumptions
		Analysis of Forest Structure
		Projections of Stand Structural Development
G-32	Riparian	General Riparian and Wetland Function
		Benefits of Structure in Riparian Areas
		Structure and Riparian Impacts
		Active/Passive Management
		Stream Buffers
		Hardwoods Management
		Riparian Procedure/Habitat Conservation Plan Compliance
		Level of Risk versus Level of Impact
		High Levels of Harvest/Model Outputs
		Riparian and Wetland Model Assumptions
		Accuracy of Riparian Modeling Results and Implementation
G-42	Wildlife	General Concerns
		Habitat Structure
		Biodiversity Pathways
		Deer and Elk Habitat
		Marbled Murrelet Habitat
		Marbled Murrelet/Northern Spotted Owl – Habitat Conservation Plan Compliance
		Northern Spotted Owl – Habitat
		Northern Spotted Owl – New Research
		Northern Spotted Owl – Owl Circles
G-53	Air Quality	Carbon Sequestration and Global Warming
G-53	Geomorphology, Soils, and Sediment	General Concerns
		Model Assumptions
		Soil Productivity
		Unstable Slopes
G-58	Hydrology	Peak Flows and Flooding

Table G-2. List of Subject Areas and Issues (continued)

Starting Page	Subject Area	Issue
G-59	Fish	Salmon and Fish Habitat
G-61	Public Utilities and Services	Impacts to Revenue Stream
G-62	Cultural Resources	Harvesting Impacts
G-62	Recreation and Scenic Resources	Harvesting Impacts
G-63	Cumulative Effects	General Approach Land Ownerships Watersheds
G-66	Impacts Analysis	General Concern Baseline for Analysis Deferral to Habitat Conservation Plan and Forest Resource Plan Components Not Yet Implemented Illustration of Alternatives and Impacts Impacts Proportionate to Harvest Levels Inadequate Referencing of Analysis to Habitat Conservation Plan and Forest Resource Plan Model Assumptions Need for a Supplemental Draft EIS Public Input Process Range of Alternatives Scale and Resolution of Impact Analysis
G-77	Alternatives	Alternative 1 Alternative 2 Alternative 3 Alternative 4 Alternative 5 Alternative 6 Components of a Preferred Alternative
G-83	Forested Trust Land Revenue	Alternative Revenues Economic/Financial Analysis Management Costs Maximum Harvest and Revenue Value of Timberlands as Intact Forests
G-87	Social/Economic Concerns	General Concerns Economic Viability Educational Opportunities of a Managed Landscape Full Cost Accounting Global Markets Impacts to Local Communities / Social and Economic Impact Analysis

Table G-2. List of Subject Areas and Issues (continued)

Starting Page	Subject Area	Issue
G-90	Roads	General Concerns
		Inadequate Analysis
		Road Planning and Building
G-92	Certification	Importance of Certification
		Economics of Certification
G-93	Implementation	Field Verification/Region Review
		Implementation Planning
		Monitoring
G-97	Policies and Procedures	Deferrals
		Environmental Protections
		Even Flow
		Arrearage
		Harvest Regulation (Value versus Volume)
		Old Forest
		Ownership Groups
		Policy Changes
		Northern Spotted Owl Procedure
G-102	Olympic Experimental State Forest	Planning and Management
		Harvest Levels
		Riparian Management
G-106	Trust Mandate	Alternatives Violating/Fulfilling Trust Mandate
		Fiduciary Responsibility
		Intergenerational Equity
		Non-Financial Benefits of Forested Trust Lands
		Prudent Person Doctrine
		Purpose of Forested State Trust Lands
		Trust Beneficiaries
		Undivided Loyalty
G-110	Sustainability	Balance Between Social, Ecological, and Revenue Issues
		Managing for the Long Term versus the Short Term
G-112	Other	Within DNR’s Responsibility but Outside the Purview of the Draft EIS
		Not Within DNR’s Responsibilities

G.2 SUBJECT AREAS, ISSUES, AND RESPONSES

Subject Area: Forest Structure and Vegetation
Issue: Benefits of Managing for Structure

Comment Summary:
Benefits of managing forests for older stand structures include reduced environmental impacts, diversity of habitats, and protection of riparian systems and aquatic species, such as salmon. Comments expressed concern for the spatial distribution of forest structure, including the importance of a stepped series of stand ages adjacent to each other to allow for species migration and dispersal, and the pattern and impacts of legacy trees.

Response:
DNR and the Board of Natural Resources (Board) share the public's interest in managing forests for structure. That interest is reflected in the Preferred Alternative selected by the Board. The assessment of environmental effects in the Final EIS details the benefits and the short-term environmental risks of creating structurally complex forests.

Ultimately, it is DNR's goal to create a mosaic of forest structures across the landscape that provides habitat for wildlife and plant species. In many cases, it is possible to provide a spatial distribution of forest structure that supports migration and dispersal for species such as the northern spotted owl, marbled murrelet, and species that use riparian corridors and streams. In other areas, the spatial distribution of forest structures is frequently initially determined by the history of activity on the landscape. Stands become suitable for harvest based on the timing of the last stand regeneration and the history of silvicultural treatments (such as planting and thinnings). In some cases, a "stepped series" of adjacent stand ages is harder to achieve than others. Basic standards of harvest unit size limits, stand adjacency (green-up procedure), riparian protection, unstable slope protection, and legacy tree retention, however, are applied to all stands, thus naturally promoting diversity among adjacent stands and across the landscape. Patterns of legacy and leave tree retention are determined by field foresters and depend on stand conditions and site-specific management goals. Legacy tree placement is engineered to benefit wildlife and reduce environmental impacts to the greatest extent possible.

Subject Area: Forest Structure and Vegetation
Issue: Habitat – Plants, Wildlife, and Ecosystems

Comment Summary:
DNR should manage forested trust lands to produce habitat and create wildlife and plant diversity through habitat restoration and rehabilitation and selective removal of small-diameter trees. Plant species, especially those on the Natural Heritage Program plant list, should be protected in all habitats.

Response:
DNR's Habitat Conservation Plan aims to protect and enhance habitat that will support wildlife diversity. The focus is on providing habitat at the landscape

level. The Habitat Conservation Plan is a multi-species plan that addresses compliance with the federal Endangered Species Act on forested trust lands, mostly in western Washington. The Habitat Conservation Plan is a long-term land management plan that conserves and provides protection for threatened and endangered species and their habitat, while allowing timber harvesting and other management activities to continue.

The Preferred Alternative includes components of the biodiversity pathways approach to habitat creation. A major feature of biodiversity pathways is variable density thinning with underplanting. Variable density thinning creates a mosaic of different stand densities on a small scale (approximately .25 to 1.0 acre). The trees may be thinned heavily in one area and not thinned at all in another area. The tree removal pattern may include all diameter classes to encourage development of a multi-story canopy. Selective removal of small-diameter trees, traditionally known as thinning from below, will also occur under the Preferred Alternative. This practice is commonly used to increase commercial timber value by concentrating growth on the larger, more valuable trees, and creating a more uniform stand. The technique of thinning from below is less likely to be used to create certain types of habitat, however, because it encourages uniformity.

Federally listed and proposed endangered and threatened plant species described in the Habitat Conservation Plan (DNR 1997) have very limited ranges and narrow habitat requirements and are restricted to small areas. Because of these factors, it is anticipated that they can be effectively managed while meeting other land management objectives. Each of the Alternatives are expected to create fewer disturbances to potential habitats but create more structurally complex forests that will provide greater benefit for endangered and threatened plant species (Final EIS Chapter 4, Section 4.2.8). The Preferred Alternative strives to achieve this balance between creation of habitat and creating revenue for the trusts.

DNR maintains a database on these species, including both site-specific and species-specific information that will be useful in locating and protecting known sites and potential habitat (DNR 1997). For additional information regarding threatened, endangered, and sensitive plant data, refer to Appendix Section D.2 in the Final EIS.

Subject Area: Forest Structure and Vegetation
Issue: Thinning

Comment Summary:

Thinnings both improve forest health and provide the opportunity to restore structural and species diversity with lower environmental impacts than clearcutting. Thinning has costs in terms of economic efficiency but has the benefit of helping to produce a steady income of revenue, timber, and jobs. Various recommendations were made for how to best conduct thinnings to meet financial and forest structure goals, including the following: thinning competitive exclusion stage stands to create diversity of plant species and habitat structures, using selective thinning combined with longer rotations to increase revenue, tailoring thinning to stand conditions and adjacent riparian habitat conditions, and starting with thinning dense stands near human communities to reduce risks of fire.

Response:
Stand thinning can improve forest health, reduce risk of wildfire, create habitat, and create revenue. In addition, thinning can result in a number of other benefits for local communities. All of the Alternatives analyzed in the Draft EIS and the Final EIS employ thinnings to meet both habitat and revenue goals. Each of the Alternatives applies different types of thinnings with varying intensities to achieve the goals of this management approach. Different types of thinnings can result in varied outcomes, depending on stand goals and objectives. Within the context of the Preferred Alternative selected by the Board of Natural Resources, variable density thinnings will be favored; however, traditional thinnings and selective harvest will be applied according to individual stand objectives. The policy decision to thin a particular stand will be based on site conditions and desired strategic policy outcomes. As specified in the Board of Natural Resources Resolution 1110, DNR will prioritize investment of staff time and funding on thinning investments to simultaneously meet both financial and conservation objectives. For additional information on thinning, see Chapter 4, Appendix B and D in the Final EIS.

Subject Area: Forest Structure and Vegetation
Issue: Clearcutting

Comment Summary:
Commenters expressed widely varying opinions about clearcuts and their environmental effects. Clearcuts have negative impacts on a variety of resources, including wildlife habitat, forest health and diversity, legacy habitat elements, areas of visual concern, unstable slopes, and peak flooding events. Interests ranged from phasing out clearcuts as a silvicultural method, doing no clearcuts at all, or using selective cutting as an alternative to clearcuts. Other comments suggested that clearcuts provide benefits to wildlife species, particularly “big game,” such as deer and elk.

Response:
DNR recognizes the impacts of clearcutting on forested trust lands and therefore no longer practices clearcutting in the historical sense. Instead DNR conducts regeneration harvests. A number of procedures and policy directives are in place to mitigate harvest impacts, such as the size and configuration of individual harvested areas and leaving legacy trees and stream buffers. Regeneration harvests will most likely be applied only in areas where DNR is not managing for specific sensitive resources. Examples of these sensitive resource areas include riparian areas, northern spotted owl and marbled murrelet areas that contribute to habitat threshold targets, and unstable slopes. The Preferred Alternative will enhance habitat areas and continue to protect specific sensitive resources while creating revenue for the trust beneficiaries. For more information regarding the

impacts of regeneration harvest, refer to Sections 4.2 (Forest Structure and Vegetation), 4.4 (Wildlife), 4.6 (Geomorphology, Soils, and Sediment), 4.7 (Hydrology), 4.14 (Scenic Resources), and 4.15 (Cumulative Effects) in the Final EIS.

Subject Area: Forest Structure and Vegetation
Issue: Forest Health

Comment Summary:
Comments expressed concern for forest health as a result of both passive and active management. Some cited forest health issues associated with a heavily managed landscape, and therefore advocated limiting impacts associated with active management, such as limiting clearcut operations and the number of stand entries.

Others detailed the possible negative impacts of not actively managing a forested landscape, including fire, disease, and pest infestations and dense overstocked stands. Techniques such as aggressive replanting, thinning management, intensive salvage operations, keeping stand ages young, and maintaining fire access were detailed as recommendations.

Response:
The Forest Resource Plan Policy No. 9- Forest Health and Guideline 14-004-030-Assessing and Maintaining Forest Ecosystem Health, both incorporate forest health practices into forest management, stressing prevention through early detection and management such as the maintenance of appropriate species and tree density in forested trust lands. During the past decade, DNR has learned more about specific activities that can assist the long-term health of forest ecosystems. Decreasing forest density and increasing diversity can help prevent disease. Active management that includes regeneration harvest and intensive thinning strategies under Alternatives 5 and the Preferred Alternative are expected to result in the greatest reduction of overstocked forests by 2067 (Final EIS, Table 4.2-11) Passive management results in slight increases in the acres of forest stands with a high relative density, thus resulting in a slightly higher percentage of stands in the competitive exclusion stage (Final EIS, Table 4.2-11). In addition, the Preferred Alternative will minimize the number of thinning entries by conducting heavier thinnings per entry that can withstand this type of activity. For more information regarding forest health, refer to Chapter 4, Section 4.2.6 in the Final EIS.

Subject Area: Forest Structure and Vegetation
Issue: Rotation Length

Comment Summary:
Comments centered on the ecological, financial, and economic benefits and disadvantages of short and long rotation lengths. Commenters thought that rotation lengths under some of the Alternatives were not optimum to achieve the stated objectives for those Alternatives. One comment asserted that Culmination of Mean Annual Increment should be reached to optimize timber production and revenue generation and to reduce environmental impacts from shorter rotations.

Others suggested that shorter rotations, as suggested in Alternative 5 and the Preferred Alternative, would not be consistent with DNR's wildlife policy (Forest Resources Plan Policy No. 22). There was a request to illustrate maturity criteria between biological productivity and economic potential.

Response:
Many factors affect the rate at which a stand develops, including site conditions, tree genetics, the tree species planted after harvest, density of the new trees, natural disturbance, and management activities (Franklin et al. 2002; Oliver and Larson 1996). While stand development stages roughly can be tied to the age of a stand, there are too many variables to expect a forest to develop along a predictable timeline. DNR does not have a set rotation age and harvesting? is not uniform across a landscape but varies based on on-site conditions. Under current policy, to meet specified objectives (such as diversity), DNR will implement a variety of rotation lengths. This means that some stands could be harvested as early as 45 years and other stands could be harvested when the trees reach 100 years old (DNR 1992).

Each Alternative meets all federal and state statutes; the trust mandate; the Habitat Conservation Plan, and the Forest Resource Plan policies. No changes to the wildlife policy are expected during this process, and DNR believes Alternative 5 and the Preferred Alternative are consistent with the wildlife policy**.**

Biological productivity of a forest stand can be expressed in more than one way. One common method is to define the point where a stand's growth begins to slow, which is referred to as the culmination of mean annual increment . This means that the growth of the forest stand at this point has reach its maximum stage. Beyond this culmination of mean annual increment age, the rate of growth begins to decline.

The economic potential of the stand is typically the measure of the monetary return that the forest stand can make over a period of time. Typically this is used to compare various stands or policies to assess performance. Performance is usually measured using discounted revenues and discounted costs over a specified period of time. In forestry settings, the time is usually one or more rotations. The metric most commonly used is net present value, which is the value of the net revenue (discounted gross revenue minus discounted gross costs) today from a managed rotation of a forest stand. Net present value is sensitive to time and the interest (discount and compound) rate chosen. (DNR uses a real rate of 5 percent). Time is important for two reasons: 1) because time influences (to a certain degree) the forest products and therefore the potential revenue, and 2) because the greater the length of the time period between costs and revenue, the less value the future revenues have today. The interest rate chosen reflects an organizational preference of revenues today versus tomorrow: the lower the interest rate, the less the preference for the current revenue over future revenues. For a Douglas-fir, site III stand, a rotation length of approximately 55 years will maximize the net present value at a 5 percent interest rate. The same stand will likely reach the CMAI between 80-100 years (Curtis 1995).

Subject Area: Forest Structure and Vegetation
Issue: Old Forest

Comment Summary:
Comments expressed concern over the impacts associated with the cutting of old forests (frequently referred to as "old growth"). Old forests are highly valued for their function as wildlife habitat (particularly for imperiled and old growth-related species), as a source of biodiversity, as a benefit to the hydrologic system, as a source of carbon sequestration, for their resistance to fire, and as a genetic and scientific resource. Old forests also provide and protect tribal hunting, fishing, and gathering rights; social and ecological heritage; and tourism. Questions were asked about the current location of old forests and how they are managed. There were also concerns about whether it is possible to recreate the benefits of "old growth" with old forests.

Response:
DNR's Habitat Conservation Plan is designed to create and maintain habitat for threatened and endangered species through the development of structurally complex forests. Under the Habitat Conservation Plan riparian conservation strategy, riparian forests are managed for structurally complex forest conditions through restoration. Other Habitat Conservation Plan strategies involve the management of forestlands for northern spotted owls by creating structural components (i.e., thinnings and patch cuts) of old forests through silvicultural practices. Though DNR management is guided by strategies to create complex forest habitats, there currently are few formal mechanisms for protecting old forests. The definition of "old growth" in the Habitat Conservation Plan is based on both age and structure (DNR 1997). For the purposes of this Final EIS, old forests are analyzed based on the following criteria: 1) those forests older than 150 years of age, or 2) those forests that have various old forest characteristics, (labeled as "structurally complex forests") that include the stand development stages of botanically diverse, niche diversification, and fully functional forests.

The Alternatives described and analyzed in the Draft EIS and Final EIS look at various ways to create and protect old forests. To address public concern about old forests, the Preferred Alternative selected by the Board of Natural Resources targets 10 to 15 percent of each Westside HCP Planning Unit for the development of old forests based on structural characteristics. The Board directed that existing old forests be a priority for achieving these targets. When the Board selects a sustainable harvest level, the identification and deferral of old forest stands will take place through a planning process.

Subject Area: Forest Structure and Vegetation
Issue: Hardwoods Management

Comment Summary:
Hardwoods are a resource that should be included in the sustainable harvest calculation. Hardwoods provide ecological and financial benefits. Hardwoods

need to be included in the harvest model for short 30-year rotations and for the harvest of all alder stands more than 50 years old.

Response:
DNR understands the important role hardwoods play in generating revenue for the trust beneficiaries. Each Alternative provides a range of management opportunities that include hardwoods, and the Preferred Alternative will create an opportunity to manage hardwoods for the future. In addition, DNR most likely will continue to develop timber sales that will examine and create marketing opportunities for hardwoods.

Subject Area: Forest Structure and Vegetation
Issue: Salvage Logging

Comment Summary:
DNR is not taking full advantage of the financial resource found in salvage logging, or the removal of dead, downed, and diseased timber on forested trust lands. Comments requested that the specific salvage industries (such as shake and shingle) be addressed in the Draft EIS and Final EIS.

Response:
DNR continues to consider various timber harvest methods as a normal business practice. Maintaining the health and productivity of forested trust lands is essential to DNR in its responsibilities as trust manger. However, prediction of the amount of salvage timber that will result from fire and pest damage is speculative, and thus it is a variable not used in the sustainable harvest calculation. Salvage logging will be assessed at the operational scale to optimize potential marketing opportunities.

Subject Area: Forest Structure and Vegetation
Issue: Active/Passive Management

Comment Summary:
Active management approaches improve forest productivity and health, increase revenue generation, and allow for greater management flexibility. Apply active management either to all forested trust lands or to older stands.

Passive management approaches result in lower disturbance levels and risk to natural resources. The use of fertilizers under active management approaches will have impacts on lichens, native species, salmon, and streams.

Response:
Active management under Alternatives 5 and the Preferred Alternative could result in higher rates of tree growth, forests less susceptible to insect and disease damage, and greater gains in structurally complex forests in the near future than the other Alternatives. However, these Alternatives could entail more relative risk of adversely affecting threatened, endangered, and sensitive plants resulting from more harvest-related disturbance and more area harvested (Final EIS, Section 4.2).

Passive management under Alternatives 1 or 4 could entail less relative risk of adversely affecting sensitive resources than the other Alternatives. However, Alternatives 1 and 4 would result in less healthy, dense forest stands, with lower tree growth rates. These less structurally complex forests could be more susceptible to damage from insects and disease (Final EIS, Section 4.2).

The balance between active and passive forest management strategies is one of the key issues examined among the Alternatives. The Board of Natural Resources selection of a Preferred Alternative attempts to strike a balance between innovative active management techniques that will have greater long-term benefits to forest health and habitat, and management strategies that minimize harvest-related disturbance. This balance emphasizes short-term risk aversion (such as temporarily retaining deferrals of important owl circles and targeting old forest conditions on a percentage of the landscape). DNR believes the Preferred Alternative effectively strikes this balance.

Subject Area: Forest Structure and Vegetation
Issue: Biodiversity Pathways

Comment Summary:
The application of biodiversity pathways on forested trust lands meets silvicultural and habitat goals. However, there is some concern expressed over the extent, timing, and location of biodiversity pathways management as proposed in the Alternatives and there is some interest in seeing it phased in on a trial basis or in particular land classes. The theoretical nature of the concept on a landscape scale raises questions about unforeseen impacts associated with its application and the accuracy of modeled outcomes of this silvicultural approach. One comment asked for management under a similar silvicultural strategy known as Natural Selection Ecosystem Centered Forestry.

Response:
The objectives of biodiversity pathways are to create more complex forest structure, composition, and diversity. The Preferred Alternative will strive to apply these objectives to DNR forested trust lands with an emphasis on habitat areas, such as riparian areas, nesting, roosting, foraging, and dispersal habitat. The stand development classification system developed for the Final EIS (refer to Appendix B, Section B.2) shows that the Preferred Alternative creates a greater proportion of complex stands; which is due to less frequent but appropriately heavier thinnings in habitat areas. For more information on biodiversity pathways, refer to Section 4.2 of the Final EIS.

The DNR sustainable harvest calculation is a programmatic analysis rather than a project-level action. Specific and localized management decisions, such as where and when biodiversity pathways will be applied to a given landscape, are not addressed at this programmatic level. In addition, the extent, timing, and location of the application of biodiversity pathways approach will most likely be determined at the operational scale, based on existing conditions and site-specific stand goals. The success at a site will be assessed over time, based on its effectiveness for meeting the goals of the stand, and adaptive management will allow modifications that improve the effectiveness of the approach.

DNR is not intimately familiar with the forest management philosophy known as Natural Selection Ecosystem Centered Forestry. However, many of the principles of “Ecoforestry” are embodied in biodiversity pathways, a likely similar philosophy of forest management. Both paradigms incorporate principles of sustainability by mimicking natural forest processes and developing complex forest structures. DNR strives to meet many of those same principles and would continue to do so with the implementation of biodiversity pathways management of forested trust lands embodied in the Preferred Alternative.

Subject Area: Forest Structure and Vegetation
Issue: Model Assumptions

Comment Summary:
The public had comments about a number of issues associated with the modeling assumptions and process related to forest structure. Comments included inquiries as to the growth and yield of the Westside land base by land class and over time, including historic levels. In addition, concerns expressed a lack of confidence in the results relating to structurally complex forests. The modeling was completed based on stand inventories developed for silvicultural goals but should have been developed for a number of ecological conditions.

Response:
“Forest growth and yield” refers to the change in standing tree volume and structure over time. DNR used a commercially available software package to project the growth and yield of the forested trust land base through time. Changes in forest conditions, such as in the distribution of stand development stages or species composition, can reflect changes in potential growth and yield. The Final EIS displays changes in standing inventory and harvest levels, by Alternative over time, in Table 4.2-7 and Figure 4.2-1, respectively. Changes in standing inventory allow an examination of the relationship between yields and growth. Each Alternative would result in increases in standing volume over the analysis period, with the Preferred Alternative increasing by about 50 percent by 2067. Changes will differ for each Alternative by land class, as each represents a different management approach, thus resulting in different harvest levels in different resource areas.

DNR used OPTIONS, a forest simulation (computer) model, to examine various sustainable forestry management scenarios. The model uses forest inventory variables to report estimated future forest structures and timber yields. To evaluate ecological implications of different sustainable forest management Alternatives, a forest stand classification was developed; the classification system describes forest conditions in terms of structure, which is a classification that helps users understand key ecological functions, including wildlife habitat. The classification criterion uses forest inventory data for several attributes of stand structure to distinguish stand conditions associated with wildlife habitat and stages of forest development.

DNR's internal literature reviews, expert consultation, and data from a published compendium on wildlife habitat associations and ecological functions (Johnson and O'Neil 2001), were used to build a structural classification referred to as the Forest Structure Classes. An additional forest classification (Stand Development Stages) was developed to evaluate effects of alternative silvicultural regimes used in all the Alternatives, as well as the Preferred Alternative, based on the biodiversity pathway approach developed for the Washington Landscape Management Project by Carey et al. (1996). The assumptions on which the outcomes were based were reviewed by a technical review committee composed of academic, public agency, and industry experts in the fields of forest science and management. The technical review committee made numerous suggestions that helped DNR improve the modeling process. For further discussion on stand development stages and a complete list of the members of the technical review committee refer to Appendix B in the Final EIS.

DNR made changes to improve estimates of projected stand structural development in the Final EIS. In addition, to improve modeled volume estimates, stand yields used for the Final EIS were re-examined and adjusted for the Final EIS Alternatives. See Section 2.3 of Chapter 2 in the Final EIS for a description of those changes and Chapter 4 for the results of those changes.

Subject Area: Forest Structure and Vegetation
Issue: Analysis of Forest Structure

Comment Summary:
The Final EIS and modeling defined the structural stages too broadly to understand forest condition, which made them inconsistent with other classifications. The Final EIS inappropriately used concepts of structurally complex forest to focus the analysis on narrow comparisons between Alternatives instead of examining impacts on the environment common to all Alternatives. The document contained no analysis of the impact of harvest types on stand structure or how different harvest types will ensure that structure is maintained or achieved over time.

Response:
To evaluate ecological implications of different sustainable forest management Alternatives, forest stand classifications were developed that describe forest conditions in terms of habitat for wildlife species and their key ecological functions. The classification criteria use forest inventory data for several attributes of stand structure to distinguish stand conditions associated with wildlife habitat and stages of forest development. These classifications are based on research conducted in independent scientific efforts and are consistent with those efforts. Other classification schemes developed for other purposes may not be consistent in approach or result, and may not be appropriate for application to this effort. For information concerning the forest development stages refer to Appendix B in the Final EIS and the comment response on "Projections for Structural Development."

The analysis examines likely impacts at an appropriate scale, detailing relative landscape level changes as a result of these programmatic changes. These changes are measured in two primary ways in this analysis: 1) the area of activities over the landscape over time, and 2) the changes in forest structural composition. Impacts are examined for each Alternative for all identified impacted resources. Impacts occurring on a site-specific basis such as timber sales, however, are appropriately analyzed by project-level proposals.

The Draft EIS and Final EIS examine changes to forest structure over time as a result of the management approach taken for each Alternative. Inherent in those changes in structure are the effects of the silvicultural applications (i.e., a type of harvest) that created them. This relationship between silvicultural applications and structural development is well demonstrated in the analysis. An analysis of the change in distribution of forest development stages can be found in the Final EIS (Table 4.2-8 in Section 4.2). In addition, an analysis of the effects of harvest intensity by harvest type can be found in Appendix D in the Final EIS.

Subject Area: Forest Structure and Vegetation
Issue: Projections of Stand Structural Development

Comment Summary:
For stand development over the life of the Habitat Conservation Plan, none of the Alternatives shows significant increases in fully functioning forests; Alternatives showing both passive management and commercial management overestimate the likely increases in structurally complex forest. Structurally complex forests might better be restored while creating timber revenue by phasing in longer alternating rotations under biodiversity pathways management.

Response:
In response to concerns about projected stand development under the different Alternatives, DNR has made changes for the Final EIS. A description of the changes to the stand development stages can be found in Chapter 2, Section 2.3, of the Final EIS, and changes to estimations of stand development can be found throughout Chapter 4. Projected changes in structure, stand development, and volume were extensively reviewed with the technical review committee. Subsequently, DNR made changes to certain Draft EIS analyses. In short, DNR agrees that estimations in the Draft EIS for both passive and commercial management approaches overestimated the likely increases of structurally complex forests.

However, the assessment that none of the Alternatives shows significant increases in fully functioning forests is not accurate, particularly in light of projected stand structural development in the Final EIS. Each of the Alternatives, with the exception of Alternative 5, shows an increase in both niche diversification and fully functional forests. Alternatives 1, 2, 3, and 4 each show increases from 1 percent in each class to 2 and 3 percent, respectively. The Preferred Alternative shows a significant increase of 5 percent of the land base in both niche diversification and fully functional forests by 2067. DNR believes these to be significant increases in the most complex forests. Though it will take time to develop stand structure on forested trust lands, changes to management today will steadily increase complex forests into the future.

Current science suggests that biodiversity pathways management will result in complex structures more quickly than conventional forest management techniques. For this reason, the Board of Natural Resources incorporated these innovative silvicultural practices for a large portion of DNR-managed lands in the Preferred Alternative.

Subject Area: Riparian
Issue: General Riparian and Wetland Function

Comment Summary:
Many comments expressed general concern about riparian and wetland function and the impacts of harvest in those areas. DNR is asked to manage riparian and wetland areas for water quality, fish and wildlife habitat, threatened and endangered species, and biodiversity. The importance of functioning wetlands was highlighted with concerns about flood control, fish habitat, essential wildlife and plant habitat, toxin and sediment storage, impacts due to flooding, and impacts to salmon populations. Comments asserted that, contrary to DNR policy, there *is* a net loss of wetlands because there are no significant data taken before harvest.

Response:
None of the Alternatives propose any changes in the policies and procedures for management of harvest or harvest activities in wetlands or wetland buffers. A Draft Riparian Forest Restoration Strategies has been written and is currently being reviewed by the public and Native American tribes and is collaboratively being amended by the Federal Services (this includes U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration Fisheries Service). When this document is approved, it will go through the State Environmental Protection Act process.

The amount of activity in Riparian Management Zones was estimated in the Habitat Conservation Plan (DNR 1997). Environmental impacts to the near-term riparian functions associated with low-intensity timber management should not result in the potential for significant adverse environmental impacts. In addition, the range of activities proposed for the six Alternatives in the Final EIS are consistent with the projected activity levels in the Habitat Conservation Plan. Active management can change tree species composition and accelerate the development of larger trees within riparian areas over the long-term. The analyses show that there are demonstrated long-term benefits associated with such management.

Shade levels would generally improve under all the Alternatives. Shade helps maintain cool water by preventing the warming effects of direct sun. Mass wasting is not expected to increase as a result of implementation of any of the Alternatives; however, increased harvest would increase the risk of surface erosion from harvest-related activities. The potential of adding more large woody debris is expected to improve under all the Alternatives. Protection of floodplains and off-channel habitat is not expected to differ among the Alternatives. For additional information regarding the impacts to fish habitat by Alternative, refer to Chapter 4, Section 4.10.4 (on Fish)

DNR shares concerns about wetland protection, and for that reason has policies and procedures in place to protect wetlands. The 1992 Forest Resource Plan, the Habitat Conservation Plan, and the Washington Forest Practices Rules contain provisions for protecting wetlands. For further information on these protections, please refer to Section C.7 of Appendix C in the Final EIS. DNR foresters consult wetlands maps when designing a timber sale. Because data sources are not consistently comprehensive, foresters walk their sales on multiple occasions. On these walks, they frequently identify previously unidentified sensitive resources, such as unmapped wetlands, where appropriate protection measures are then applied.

Subject Area: Riparian
Issue: Benefits of Structure in Riparian Areas

Comment Summary:
Comments centered on the types of silvicultural prescriptions that should be allowed to create forest structure in riparian areas. Proposals included the application of treatments to create old forest characteristics through understory removal; promote restoration with revenue generation as a secondary consideration; provide the strongest protection of riparian areas possible; and accelerate old forest structural development in even-aged, densely overstocked, and structurally uniform stands. Concern was also expressed about whether stand development treatments would decrease the frequency of large woody debris recruitment to stream channels.

Response:
The Draft EIS and Final EIS include a range of Alternatives examining the types of silvicultural prescriptions that would create forest structure in riparian areas. Each Alternative, including the Preferred Alternative, models potential strategies to approximate the volume and conservation benefits that might ultimately come from riparian management activities when the Federal Services have approved a riparian procedure under the Habitat Conservation Plan. Refer to Chapter 4, Section 4.3 (Riparian Areas), and Table 4.3-2 in the Final EIS for more information on the estimated acres of forest management in riparian areas under each Alternative, including the Preferred Alternative.

DNR believes that restoration of riparian zones should be tailored to site-specific conditions. DNR also recognizes that restoration activities to promote fully functioning riparian stands can include some commercial thinning that can provide timber revenue and help to offset restoration costs; however, these revenues are a side-benefit and not an objective of restoration. Commercial harvest is allowable when it meets the riparian conservation strategy objectives of the Habitat Conservation Plan.

The rate of riparian forest improvement varies with each Alternative. Active management under the Preferred Alternative is expected to achieve more fully functioning stands within 80 to 90 years, rather than approximately 220 years for passive management (Carey et al. 1996). Larger and taller trees in the riparian zone have a greater likelihood of providing streams with more functional large woody debris, more shade, more leaf and needle litter, and improved microclimate conditions. For additional information refer to Chapter 4, Section 4.3.4 (on riparian resources), in the Final EIS.

Subject Area: Riparian
Issue: Structure and Riparian Impacts

Comment Summary:
Some comments faulted aspects of the Draft EIS analysis around riparian forest structural development. Concerns around gauging long-term riparian health by the metric of "fully functioning" forest without due examination of change in numbers of large trees as set out in the Habitat Conservation Plan were expressed. Others felt that the Draft EIS should have better linked how harvest applications would move forest structures to fully functioning conditions and where on the landscape those improvements would occur. They assert that future desired riparian conditions are not tied in any quantitative way to the proposed treatments or to the expected volumes that will be removed.

Response:
The Draft EIS used two stand structural classes to describe the effects of the Alternatives on riparian and fish resources. These include the "very large tree" stages and the "fully functional" stages. The very large tree stages include the botanically diverse, niche diversification, fully functional, and old natural stand development stages; the fully functioning stages are only the last two (fully functional and old natural). In the Final EIS, the analysis of riparian and fish resources uses a slightly different stand structural class nomenclature: "large trees" for those in the large tree exclusion and understory development stages, and "very large trees" for those in the botanically diverse, niche diversification, and fully functional stand development stages.

DNR agrees that there are differences among the Alternatives when comparing the two classes of stages in the Final EIS. Each of these stand development classifications provides a measure of changes in riparian forests containing large trees over time. DNR believes the Alternatives place stands on particular structural pathways that will likely continue beyond the life of the Habitat Conservation Plan. As implementation of the Habitat Conservation Plan progresses, DNR will continue to improve its understanding of changes in stand structure. It should be noted that this project uses different criteria for measuring changes in forest structure than specified in the Habitat Conservation Plan. It is anticipated that stand structure will be increasingly used to measure DNR's success in achieving the objectives in the Habitat Conservation Plan.

The change in stand development classification made for the Final EIS improves upon the estimates of riparian stand structural changes presented in the Draft EIS.

The Preferred Alternative demonstrates improvements over time in the development of structurally complex forest, and hence very large trees in riparian areas, from about 26 percent in 2004 to 33 percent in 2067. While all the Alternatives improve to between 29 percent and 33 percent in structurally complex forests by 2067, only the Preferred Alternative creates more than 13 percent of riparian forests in the two most complex stages—niche diversification and fully functional forest.

It should be understood that while the Alternatives in the Draft EIS and Final EIS demonstrate the effects and impacts of different approaches to achieving the Habitat Conservation Plan riparian conservation strategies, none of these "modeling techniques" constitute a specific policy or procedural change. The sustainable harvest process will not define the Habitat Conservation Plan riparian procedure. The range of riparian modeling techniques presented in the Alternatives provided the Board of Natural Resources an opportunity to hear the public's concerns about riparian management. It also gave the Board the opportunity to discuss with DNR the potential relative advantages and disadvantages of different riparian management approaches in terms of habitat development, revenue generation, and environmental impacts. A Draft Riparian Forest Restoration Strategies document was developed by DNR staff and will be submitted for approval by the Federal Services.

Appendix D in the Final EIS illustrates the expected percent of harvest activities in riparian areas under each Alternative by HCP Planning Unit. Table D-10 displays the expected percentages of area harvested under each of the Alternatives by harvest type, HCP Planning Unit, and decade. These harvest types are described in Appendix B in the Final EIS. The Draft EIS and Final EIS illustrate restoration activities in riparian areas at the HCP Planning Unit level instead of a site-specific level. While an estimation of area impacted by harvest type is analyzed in the Draft EIS and Final EIS, specific locations of silvicultural prescriptions and structural development are not provided because of the programmatic nature of the analysis. The determination of appropriate silvicultural pathways to achieve desired future conditions in riparian stands is not determined for western Washington at a programmatic level but at the operational level on a stand-by-stand basis. As foresters examine riparian stands on the ground, they will decide what treatments are necessary, based on stand structure, topography, site-specific management constraints, social issues, operational feasibility, marketability of the stand, and other factors. There is a body of literature that identifies how silvicultural treatments move forest stands to fully functioning conditions, including research by Carey et al. (1996).

Subject Area: Riparian
Issue: Active/Passive Management

Comment Summary:

Comments stated that DNR should manage riparian and wetland areas using either a passive or active land management approach. Those advocating active management cited the large portion of the land base with highly productive forests and the ability to create complex stand structures desirable for wildlife species and to maintain forest health and vigor.

Those proposing passive management discussed the ecological importance of properly functioning riparian systems and the increased potential for disturbance and negative impacts to soils, water quality, standing trees, and fish and wildlife habitat. Some comments proposed specific conditions for riparian harvest—including thinning only on a limited experimental basis with monitoring—only when riparian stands are overstocked or only for restoration purposes.

Response:
One of the benefits of examining a range of Alternatives is that it allows an exploration of the outcomes and environmental effects of active and passive management approaches. Alternatives with more passive management, such as Alternatives 1 through 4, are expected to have a higher proportion of riparian area with large and very large trees in competitive exclusion stages. The Preferred Alternative includes active management at a moderate level to enhance and restore riparian areas by using a range of treatments, including infrequent heavy thinnings, patch cuts, snag creation, and downed woody debris treatments.

Each of the Alternatives meets the objectives of the Habitat Conservation Plan for conserving and enhancing Endangered Species Act-listed species. Each of the Alternatives attempts in a different way to balance the short-term risks of potential adverse impacts with long-term gains in stand structural development that create riparian habitat. Alternatives 1 and 4 take a passive approach, and minimize short-term risks. Though they continue over the analysis period (through 2067) to move stands into the complex forest stages, they result in only moderate gains of only 4 percent in the two most complex stages of niche diversification or fully functional forests. Alternative 5 and the Preferred Alternative take commercial and active approaches, respectively, with potentially higher short-term risks. Like Alternatives 1 and 4, Alternative 5 also creates structurally complex forests in riparian areas but shows only minor improvements (1 percent) in the two most complex stages. On the other hand, the Preferred Alternative shows substantial gains, with a combined total of more than 13 percent of the riparian land base (an improvement of more than 10 percent over current conditions) in niche diversification and fully functional forests. These approaches typify the range of preferences offered by the public and a wide range of resulting future conditions. Harvest activities in riparian areas will only be completed for restoration purposes and will be consistent with the Final Riparian Forest Restoration Strategies, when adopted.

DNR's Habitat Conservation Plan monitoring section is conducting a long-term riparian forest management study in the Olympic Experimental State Forest. These experimental commercial thinnings of riparian forests will increase DNR's ability to integrate riparian thinnings into the timber sale program across Westside HCP Planning Units.

Subject Area: Riparian
Issue: Stream Buffers

Comment Summary:
Specific suggestions for stream buffer sizes and buffer size rules were offered, such as no harvesting within 300 feet of fish-bearing streams and within 100 feet of non-fish bearing streams. There needs to be protective buffers around streams and wetlands. There was some confusion about whether Forest Practices Rules for stream buffers applied to DNR forested trust lands, and specifically why the Draft EIS talked about a 25-foot no-cut zone rather than 30 or 50 feet.

Response:
Stream buffer widths are specified in the Habitat Conservation Plan in the Riparian Conservation Strategy for the five Westside HCP Planning Units and the Olympic Experimental State Forest.

The Habitat Conservation Plan Riparian Strategy defines the size of riparian buffers required for Type 1 through 5 streams. For Type 1through 3 streams, which are fish-bearing, the width of the riparian buffer should be equal to the site potential height of trees in a mature conifer stand or 100 feet, whichever is greater. For non-fish bearing streams, a riparian buffer of 100 feet is required for all Type 4 streams; for Type 5 streams, a buffer is required only "when necessary for water quality, fisheries habitat, stream banks, wildlife and other important elements of the aquatic systems" (DNR 1997). In addition, all wetlands that are bigger than 0.25 acre are protected with a buffer. Wetlands that are larger than 1.0 acre have a buffer width equal to the site potential height of trees in a mature conifer stand or 100 feet, whichever is greater. Wetlands that are between 0.25 and 1.0 acre have a buffer of 100 feet. Seeps and wetlands that are smaller than 0.25 acre are protected the same as Type 5 streams (DNR 1997).

The Habitat Conservation Plan (DNR 1997) describes the type of allowable activities in a riparian management zone for Type 1 through 4 streams. This includes the following: the first 25 feet will be a no timber harvest area, the next 75 feet will be a minimal-harvest area, and the remaining portion of the riparian buffer will be a low harvest area. However, there will be no activity within the riparian management zone until there is an approved Riparian Forest Restoration Strategies document and resulting riparian procedure by the Federal Services .

Due to the existence of the Habitat Conservation Plan, DNR is subject to a different set of regulatory requirements (than the Forest Practices Rules) for aquatic resources and critical habitats for state threatened and endangered species. For a more complete understanding of the interaction, refer to the rules found in WAC 222-12-041.

Subject Area: Riparian
Issue: Hardwoods Management

Comment Summary:
Hardwoods in riparian areas hold high financial value; up to 50 percent of hardwood-dominated forests are in high-value wood. Use the alternate plan

process under the Forest Practices Rules to allow the harvest of hardwoods in riparian areas.

Response:
Forest management activities that maintain or restore the quality of salmon habitat are allowed within the riparian management zone under the Habitat Conservation Plan, Riparian Strategy. It is likely that under some Alternatives, some riparian areas that are hardwood-dominated riparian stands would be harvested to promote ecosystem restoration within the riparian areas (DNR 1997). Site-specific decisions regarding the removal of hardwoods will be made based on individual stand conditions and objectives consistent with the Habitat Conservation Plan.

Regarding the alternate plan process for riparian areas under the Forest Practices rules, whether DNR has an alternate plan or not, DNR must meet its obligations under the Habitat Conservation Plan. Therefore, DNR believes that the alternate plan process does not appear to offer any advantages in hardwood management, either economic or environmental. For additional information refer to WAC 222-12-041, *Use of approved state and federal conservation agreements for aquatic resources*..

Subject Area: Riparian
Issue: Riparian Procedure/Habitat Conservation Plan Compliance
Comment Summary:
Questions were raised about how activities would be carried out in the Riparian Management Zone in any of the proposed Alternatives, such as what is the scale of a riparian management area and how relative density levels will maintain or achieve the "fully functioning structure" objective that underlies a given silvicultural strategy. In addition, there were questions about how riparian activities could be modeled or implemented without an approved riparian procedure with the Federal Services, and what provisions in the Habitat Conservation Plan might need to be changed in order to implement a given Alternative. DNR should get a riparian procedure approved by the Federal Services before calculating the sustainable harvest.

Response:
All policy and operational actions will be consistent with the Habitat Conservation Plan. A Draft Riparian Forest Restoration Strategies document has been written and is currently being reviewed by the public and Native American tribes and is collaboratively being amended by the Federal Services. When it is approved, it will go through the State Environmental Protection Act process. When finalized, the Riparian Forest Restoration Strategies will provide direction and guidance to foresters to determine how best to manage and/or restore riparian management zones to fully functioning structure.

DNR will not conduct any harvest activity in the riparian management zones, with the exception of light access development and maintenance (road and yarding corridors), until the Riparian Forest Restoration Strategies are approved by the Federal Services. Until then, DNR will continue to defer all timber harvest activities from all Riparian Management Zones on forested trust lands. The assumptions used to simulate harvest activity in riparian areas for each of the Alternatives are based on what might be allowable under the Habitat Conservation Plan Riparian Conservation Strategy. If the future approved Riparian Forest Restoration Strategies result in substantial changes from that portrayed in the selected Alternative chosen by the Board of Natural Resources, DNR would re-examine the riparian outcomes and make any necessary adjustments needed.

After the Riparian Forest Restoration Strategies are finalized, DNR will most likely enter a riparian management zone on a stand-by-stand basis. Riparian management will most likely be done in conjunction with an upland management area, thus making entries operationally feasible.

Subject Area: Riparian
Issue: Level of Risk versus Level of Impact

Comment Summary:
Concern was raised that although the Draft EIS does acknowledge that the Preferred Alternative poses a higher risk for most riparian-related resources, it does not adequately quantify or justify the claim that there would be "no significant adverse impact from any Alternative, when compared to current conditions, beyond those anticipated in the Habitat Conservation Plan EIS." One commenter found the proposed mitigation of "intensive monitoring" insufficient to allay concerns regarding the risk and uncertainty of increasing riparian area harvesting as proposed in some of the Alternatives. Another disagreed with the assertion that because none of the Alternatives proposed activities other than yarding corridors, roads, and restoration activities within the 25-foot no-harvest buffer, there would be no substantial adverse effects to stream bank stability and sediment filtering capacity from surface erosion. With significant differences among Alternatives in those activities, the commenter believes that this conclusion is unsubstantiated.

Response:
The Draft EIS and Final EIS acknowledge that potential adverse effects may occur from all Alternatives as a result of timber harvest practices. It is impossible to have commercial timber harvest practices without some level of adverse effects. The policies of the Board of Natural Resources (Board) and DNR procedures are designed to avoid or minimize these adverse effects to the extent practicable, while continuing to fulfill our trust responsibilities. DNR's Habitat Conservation Plan and Incidental Take Permit provide sideboards on what level of activities are acceptable relative to the Endangered Species Act. The Final EIS analysis concludes that if the planning processes, procedures, and mitigation measures designed to protect riparian and fish resources are implemented and are effective, the amount of adverse effects of Alternatives 2 through 5 and the Preferred Alternative should not be significantly different than under Alternative 1 or beyond those anticipated in the Habitat Conservation Plan EIS (DNR 1996)

and Forest Practices EIS (Washington Forest Practices Board 2001). However, because the levels of harvest activity are substantially higher under Alternative 5 for the Olympic Experimental State Forest, the risk of increased adverse effects from implementation or effectiveness failures is higher in the short term.

In authorizing the preparation of the Final EIS and the Preferred Alternative, the Board also directed DNR to use the "Sustainable Harvest Calculation Management Principles and Objectives." This guidance requires monitoring and annual reports "so that the Board can respond in a timely manner to policy and implementation issues." These Principles and Objectives, coupled with the various provisions of the Habitat Conservation Plan's Implementation Agreement, provide a dynamic framework to respond to new information, either from peer-reviewed science or operational implementation.

Subject Area: Riparian
Issue: High Levels of Harvest/Model Outputs

Comment Summary:
Substantial concerns were expressed about the high levels of riparian harvest reported in the Draft EIS under Alternative 5 and the Preferred Alternative in some decades and in some planning units. Comments suggested a wide variety of potential and unanticipated impacts associated with these harvest levels, including impacts to soils, standing trees (windthrow), canopy closure, and water quality, and commenters criticized some of the nomenclature used to characterize activities and impacts. It was questioned whether harvest levels under some of the Alternatives were in conflict with the Habitat Conservation Plan, the Federal Services, or the Biological Opinion written prior to its signing, particularly as harvest levels relate to the function of activities and number of thinning entries in riparian areas. Comments also questioned the source of the modeling errors discussed in the Draft EIS.

Response:
The Alternatives in the Final EIS analyzed a range of possible riparian activities designed to be consistent with DNR's commitments under the Habitat Conservation Plan, federal and state laws, and the trust mandate. All the Alternatives model forest management with parameters that are believed to be reasonable estimates of what might be allowed under the riparian procedure when DNR and the Federal Services reach an agreement on the riparian procedure's contents. Compared to Alternatives 1 and 4, Alternative 5 may push the upper boundary of what levels of activities might be allowable under the Habitat Conservation Plan in the riparian management zone. The Preferred Alternative, however, appears to be clearly within the boundaries of the riparian conservation strategy that is identified in the Habitat Conservation Plan and the Draft Riparian Forest Restoration Strategies. For a specific discussion of riparian impacts, see Chapter 4, Section 4.3, in the Final EIS.

As clarified in Chapter 2, Section 2.4, of the Final EIS, assumptions used to build the Preferred Alternative did not restrict the acreage of activities in riparian areas. Though there were no modeling errors, some of the Alternatives showed high estimated levels of activity—higher than what might be operationally feasible. However, the result provided a useful illustration to the Board of Natural Resources and DNR of the environmental effects of such a management course. As stated in the Final EIS, modeling assumptions for the Preferred Alternative were reviewed, and additional modeling efforts were conducted. The Preferred Alternative reflects changes in technique to restrict activities in the Riparian Management Zone to smaller areas, as would be more feasible operationally. The Preferred Alternative, both in intent and in outcome, represents an approach that can be implemented within what is anticipated under a Habitat Conservation Plan and is consistent with the direction of the Draft Riparian Forest Restoration Strategies

Harvest effects on soils, windthrow, canopy closure (stream shade), and water quality can be found in the Draft EIS and Final EIS in Sections 4.6 (Geomorphology, Soils, and Sediment), 4.2 (Forest Structure and Vegetation), 4.3 (Riparian Areas), and 4.8 (Water Quality), respectively.

The Riparian Conservation Strategy in the Habitat Conservation Plan does not specify a number of allowed entries into a riparian stand over a single harvest rotation, through the life of the Habitat Conservation Plan, or any other time period. However, harvest within Riparian Management Zones must be based on the following objectives: 1) to maintain or restore salmonid freshwater habitat on forested trust lands and 2) to contribute to the conservation of other aquatic and riparian obligate species (DNR 1997) for the five Westside HCP Planning Units. Some riparian areas are expected to benefit from multiple thinning activities. Under the biodiversity pathways approach, variable density thinning can occur at a 10- to 20-year interval and at 0.5 to 1.0 acre scales (Carey et al. 1996).

Multiple entries are likely under some of the Alternatives, which may include both precommercial and commercial thinnings. The number and type of entries into a riparian area will most likely be dependent on the Draft Riparian Forest Restoration Strategies.

It is unlikely that entries into riparian areas will occur independently of activities in the adjacent upland portion of the stand and will therefore not happen with any greater regularity than planned upland entries.

Subject Area: Riparian
Issue: Riparian and Wetland Model Assumptions

Comment Summary:

As in other sections of the Draft EIS, comments asserted that the lack of modeling details in the analysis was an important oversight. There were questions related to data accuracy, how riparian buffers were modeled, and how harvest activities were modeled. There was also a question about what models were used to assess riparian impacts as they relate to water quality. Another comment expressed that the model overestimates structurally complex forests resulting from passive management regimes.

Response:
While the models used to calculate the sustainable harvest level are not explicitly designed as a primary tool for conducting an EIS analysis, they can be used in conjunction with the Best Available Science (working with reasonably available data) to help understand the likely environmental effects resulting from policy and procedure alternatives. However, the assumptions that went into the models are complex and highly technical and do not help one gain a meaningful understanding of the policy and procedure components of the Alternatives. The policy and procedural modifications that were used for the development of the Alternatives are disclosed in the Draft EIS and Final EIS.

The assumptions on which the outcomes were based were reviewed by a technical review committee composed of academic, public agency, and industry experts in the fields of forest science and management. The outcomes and the associated environmental impacts are addressed in Chapter 4 in the Final EIS. DNR understands the concern over the nature of assumptions made in the calculation of the harvest Alternatives. The analysis contained in the EIS, however, is focused on the likely impacts of the proposed action, which provides a qualitative assessment of the relative risks for different policy and procedure decisions. The analysis is further supported by the modeling outcomes.

Models were not used to assess water quality impacts to riparian areas because such impacts are site-specific and are not suitable for this programmatic, non-project analysis.

Adjustments were made to the estimates of structurally complex forest development for each of the Alternatives in the Final EIS. An explanation of the adjustments and specific changes to structural development projections in riparian areas can be found in Chapter 2 (Section 2.3) and Chapter 4 (Section 4.3), respectively.

Subject Area: Riparian
Issue: Accuracy of Riparian Modeling Results and Implementation

Comment Summary:
The inaccuracies in the Draft EIS related to harvest levels in riparian areas call into question the assumptions for the model. DNR should release all modeling details so that others can validate the outputs. There is concern about the relationship between modeling results on which the sustainable harvest level will be set, their accuracy, and the expectations these results will create for obtaining harvest volume during implementation of the Preferred Alternative.

Response:
For more information regarding the model assumptions and outputs, refer to the comment response, “Riparian and Wetland Model Assumptions.”

Modeling outcomes have been reviewed at the operational level to determine their accuracy and operational feasibility. The sustainable harvest calculation is a broad landscape target; when implementing harvest targets, field foresters will follow the Habitat Conservation Plan, Forest Practices Rules, and other policies and procedures guiding management on a stand-by-stand basis.

The sustainable harvest calculation modeling results will form the basis for recommendations to the Board of Natural Resources (Board). Based on the recommendations, the Board will set a sustainable harvest level. The sustainable harvest level will become a target, to be met by DNR, of a volume of timber scheduled for sale per Revised Code of Washington (RCW) 79.10.300. DNR believes harvest volume estimates for each of the Alternatives, including the Preferred Alternative, to have a reasonable level of accuracy given the best available scientific knowledge and data possessed by DNR. If that information is found to be substantially incorrect or outdated in the future through implementation or other inquiry, an assessment of the potential effects to volume estimates may be required. The sustainable harvest calculation is, by nature, an iterative process that must be periodically reexamined (RCW 79.10.320). In addition, this issue is the subject of one of the new policies proposed under the Preferred Alternative (titled “Circumstances triggering the need for a recalculation of the sustainable harvest level;” see Appendix F), which is proposed for adoption by the Board concurrent with their adoption of the Preferred Alternative. It should be understood, however, that harvest volume targets would never supersede the observance of DNR policies and procedures or federal and state statutes. Achieved harvest levels will be the product of stand-by-stand management and will be determined by operational feasibility, rather than model outcomes.

Subject Area: Wildlife
Issue: General Concerns

Comment Summary:
Harvest activities raise risks to sensitive species and habitats, particularly those dependent on older forests. The potential harvest activity impacts, especially to species covered by the Habitat Conservation Plan, were not adequately addressed in the Draft EIS. Wildlife is a public resource and should be preserved for future generations. In view of potential risks to wildlife, DNR should apply the “precautionary principle” and err on the side of conservation in selecting a harvest level.

Response:
All Alternatives are consistent with the Habitat Conservation Plan strategies and commitments. The Habitat Conservation Plan is a multi-species plan that is authorized under the Endangered Species Act to conserve threatened and endangered species, while allowing a wide range of management activities on forested trust lands. Under the Habitat Conservation Plan, DNR uses a habitat-based landscape-level approach for federally listed species. For example, the Habitat Conservation Plan provides for long-term conservation strategies for the northern spotted owl and marbled murrelet, both of which are dependent on structurally complex forests (Final EIS, Appendix D, Table D-11). In addition, the Habitat Conservation Plan provides habitat for unlisted species that: 1) helps

maintain the geographic distribution of unlisted species that have small annual or breeding-season home range areas, 2) contributes to demographic support of populations of unlisted species with large home ranges on federal forest reserves, and 3) facilitates the dispersal of these wide-ranging species among federal forest reserves (DNR 1997).

None of the Alternatives propose changes to the policies or procedures that directly address species covered in the Habitat Conservation Plan, other than changes to the northern spotted owl and legacy and reserve tree procedures. Some species covered in the Habitat Conservation Plan are associated with unique habitats other than forest habitat (see Table D-1 in the Final EIS). The availability of such habitats is not expected to change in response to timber harvest activities, but habitat quality can be affected by harvest of adjacent stands. Table 4.4-5 in the Final EIS lists the criteria by which effects of the Alternatives were evaluated for each species and ranks the Alternatives with respect to these criteria. DNR believes that continued implementation of the Habitat Conservation Plan, as proposed in all of the Alternatives, will likely result in the protective management of forested trust lands using conservation strategies specifically designed to protect wildlife habitat and populations. This is the appropriate level of precaution for a forest serving multiple objectives.

Subject Area: Wildlife
Issue: Habitat Structure

Comment Summary:
Expand discussions about wildlife associated with specific stand structural stages, including the response of different wildlife communities to different forest structural stages and the spatial aspects of habitat creation across the landscape. There will be simplification of structure and function resulting from intensive forest management. Additionally, the estimates for structurally complex forest development under Alternatives implementing passive and commercial forest management are too great relative to those under biodiversity pathways management. A commenter also argued that structurally complex forest cannot be used as a measure of DNR's success in meeting its obligations under the Habitat Conservation Plan but only serve as a relative indicator of change to habitats of management concern under the Alternatives in the Draft EIS.

Response:
Section 4.4 (Wildlife) in the Final EIS identifies the five wildlife habitat types and the species that are dependent on these forest structures that are addressed in the analysis: ecosystem initiation forest, competitive exclusion forest, structurally complex forest, riparian and wetland habitats, and uncommon habitats. Because program does not schedule individual timber harvests across the landscape, it is inappropriate to assess the spatial pattern of habitat creation and maintenance. It is assumed that creating and protecting habitats for critical species under the Habitat Conservation Plan also will help create a mosaic of habitats for other native species communities.

Some changes have been made in the Final EIS to address the concerns about habitat development The results regarding the development of complex forest structures under all silvicultural management regimes, including active, passive, and innovative approaches, have been corrected in the Final EIS. For additional information about these changes, refer to the Section 4.2 (Forest Structure) in the Final EIS.

When the Habitat Conservation Plan was signed in 1997, forest structure class was identified by the age of the stand, which was considered a surrogate for habitat structure. However, as new data and science have become available, stand age has become a less important measure of structural development; the primary problem is that age does not incorporate physical attributes or structural components important for characterizing habitat, including snags, understory development, and down woody debris components. The sustainable harvest calculation analysis uses forest structure instead of age to more accurately represent structural diversity and habitat values. The Federal Services that implement the Endangered Species Act are supportive of the DNR’s use of better metrics for forest structure. DNR will work with them to continue to better implement the Habitat Conservation Plan as understanding of forest structure improves.

Forest structure may prove to be more effective than other measures, such as age, in monitoring conservation benefits provided under the Habitat Conservation Plan.

Subject Area: Wildlife
Issue: Biodiversity Pathways

Comment Summary:
Differing opinions were expressed on the biodiversity pathways management approach and its benefits to wildlife habitat. While some questioned its appropriateness for protecting all species listed under the federal Endangered Species Act, others held that biodiversity pathways management benefited the species protected under DNR’s Habitat Conservation Plan. Specifically, the Draft EIS was criticized for not considering the effect of biodiversity thinning on northern spotted owl habitat. However, other comments suggest that such management can enhance the owl’s habitat, particularly in dispersal areas.

Response:
One of the goals of biodiversity pathways management is to create habitat to maintain and/or recover threatened and endangered species. DNR believes that the biodiversity pathways approach over time will provide additional habitat for Endangered Species Act-listed species found in western Washington forested state trust lands **,** especially those dependent upon structurally complex forests (refer to Appendix D, Table D-11, in the Final EIS). The principles and recommendations for conservation of biodiversity that stemmed from the Carey et al. (1996) research were focused on intensive management of second-growth forests to: 1) provide wood products, 2) restore ecological function as habitat for wildlife associated with late-serial stages of forest development, and 3) provide

late-successional biodiversity reserves to enhance riparian ecosystem function and landscape function.

For more information regarding the allowable management activities in northern spotted owl habitat refer to Chapter 2 in the Final EIS. Table 4.4-3 in the Final EIS illustrates the projected acres of structurally complex forests in designated Nesting, Roosting, Foraging, and Dispersal Management Areas in 2067 relative to current conditions for all the Alternatives. In addition, Table 4.4-4 in the Final EIS examines the type of harvest activity (by harvest volume removal) that could potentially occur under each Alternative for designated Nesting, Roosting, and Foraging Management Areas.

Subject Area: Wildlife
Issue: Deer and Elk Habitat

Comment Summary:
The availability of deer and elk foraging habitat is important to the viability of deer and elk populations, particularly on the Olympic Peninsula. The lack of logging on the Olympic Peninsula is sending deer and elk herds into lower pastures, and therefore having effects on human populations. One commenter thinks the Draft EIS analysis of deer and elk contrasts with findings in the Washington Forest Landscape Management Project (DNR 1996).

Response:
The discussion on effects to deer and elk is clarified in Section 4.4.4 of the Final EIS. The analysis in the EIS assumes ecosystem initiation, structurally complex forest, and open-canopy forest in the understory re-initiation stages of forest development to provide forage habitat for deer and elk. While these forest stand development stages all provide forage, there are nutritional quality and quantity differences between ecosystem initiation and more structurally complex forest stages. For the purposes of the analysis in the Draft EIS and Final EIS, these stand development stages are assumed to provide equal forage habitat value. The Washington Forest Landscape Management Project (Carey et al.1996) examined two harvest scenarios for a block of state land in the Clallam River watershed, one in which timber production is maximized and another where 30 percent of the forest is maintained as fully functional forest. Modeling for the project showed that estimated carrying capacities for deer were roughly comparable under the two scenarios, with elk populations performing almost 50 percent better when achieving 30 percent fully functional forest.

The update in the stand development classifications for the Final EIS led to revised estimates of available deer and elk forage habitat displayed in Table 4.4-6 (Chapter 4, Section 4.4). The Final EIS analysis shows that, in contrast with the results in the Draft EIS, by 2067 the Preferred Alternative will result in greater increases in the number of watersheds providing foraging habitat than Alternative 5. This is the same trend detailed above that was shown by Carey et al. (1996).

Subject Area: Wildlife
Issue: Marbled Murrelet Habitat

Comment Summary:
Protecting marbled murrelet habitat is critically important. The analysis of impacts to the marbled murrelet and its habitat in the Draft EIS—including that in riparian areas—was deficient. Substituting structurally complex forests for murrelet habitat is not a scientifically credible approach and should not be a substitute for the completion of the survey and research steps outlined in the Habitat Conservation Plan. Further, the marbled murrelet assumptions used by DNR were not consistent with Washington Department of Fish and Wildlife's understanding or position.

Response:
Based on comments by the Washington State Department of Fish and Wildlife and the U.S. Fish and Wildlife Services on the Draft EIS, DNR made adjustments to assumptions in the Preferred Alternative for marbled murrelet management. In the absence of more specific information, to estimate and simulate a long-term conservation strategy in the Preferred Alternative, all marbled murrelet-occupied sites, occupied reclassified stands, and DNR deferred sites will be maintained in a long-term deferred status. The remainder of habitat will be changed from a deferred status to an undeferred status. The net effect of this modeling will be that 55 percent (approximately 81,000 acres) of identified marbled murrelet reclassified habitat will be maintained in a long-term deferred status, and the remainder placed into "Riparian and Wetland" or "Upland Areas with Specific Objectives" land classes, depending on the proximity to riparian areas. None of the marbled murrelet habitat will be placed in Upland Areas with General Objectives, as this land class has the fewest harvest restrictions. As with all of the Alternatives, it is assumed for the purposes of modeling that all marbled murrelet reclassified habitat will be deferred until 2007 while a long-term strategy is developed.

The modeling of management activities in marbled murrelet habitat is only an estimate of what may be allowed under DNR's Habitat Conservation Plan when a long-term strategy is implemented. It does not represent a policy choice to remove any protections for marbled murrelets. The Draft EIS and the Final EIS do not attempt to examine site-specific land management; rather, the analysis is designed to support broad policy level decision-making. DNR believes the use of structurally complex forest types is similar enough for the purposes of this analysis and would be consistent with the levels that are expected under the Habitat Conservation Plan. The assumptions used were the same as the analysis conducted for the Habitat Conservation Plan. The assumptions were designed based on the principle that the long-term conservation strategy would take a combined landscape approach with the protection of specific sites; the protection of current habitat areas; and a level of management to recruit, restore, and enhance other forest stands as suitable habitat.

Marbled murrelet habitat management will be determined through a long-term conservation strategy developed by DNR's scientific staff working in collaboration with the Federal Services, Washington Department of Fish and Wildlife, and other scientific specialists. When the long-term strategy is developed and approved by the Board of Natural Resources, its implementation and possible effects on the sustainable harvest level will be examined.

For more information on the potential effects of each of the Alternatives on the marbled murrelet, refer to Chapter 4, Section 4.4, in the Final EIS.

Subject Area: Wildlife
Issue: Marbled Murrelet/ Northern Spotted Owl – Habitat Conservation Plan Compliance

Comment Summary:
There are concerns over the relationship between the sustainable harvest level and implementation of the marbled murrelet and northern spotted owl conservation strategies in the Habitat Conservation Plan. In particular, DNR should not complete the sustainable harvest calculation until the current marbled murrelet and northern spotted owl population status assessments being conducted by the Federal Services and a marbled murrelet strategy for forested trust lands are complete. In addition, the release of the northern spotted owl and marbled murrelet habitat in some Alternatives are inconsistent with the Habitat Conservation Plan and its assumptions around "take" detailed in the Federal Services' Biological Opinions. There are also concerns regarding future changes in the Habitat Conservation Plan, species status, and DNR management.

Response:
Neither the U.S. Fish and Wildlife Services nor the Washington Department of Fish and Wildlife shared concerns about Habitat Conservation Plan compliance or consistency associated with the proposed action. None of the Alternatives, including the Preferred Alternative, propose changes to the northern spotted owl conservation strategy, as outlined in the Habitat Conservation Plan (DNR 1997). Active management in young stands is a primary approach to recruit northern spotted owl habitat on forested trust lands. DNR will continue to work with the Federal Services and the Washington Department of Fish and Wildlife to manage northern spotted owl habitat across the landscape.

Table B.2.6-1 in Appendix B lists the land deferrals for marbled murrelets; however, it does not intend to state a policy position for marbled murrelet management. Rather, the table indicating deferral until 2007 was meant as a summary of the assumptions related to these deferrals. Under the Habitat Conservation Plan, DNR committed to the development of a long-term conservation strategy for marbled murrelet habitat on forested trust lands in western Washington. DNR currently is developing this long-term conservation strategy as part of a five-step process (DNR 1997). In the interim, until the inventory surveys are completed, DNR defers timber harvest activities in all occupied and reclassified marbled murrelet habitat on forested trust lands. Despite schedules for deferral and release of marbled murrelet habitat for the purposes of assumptions for the Alternatives, it is presumed that all habitat provisions will remain until a long-term strategy is in place (whether that is before 2007 or after 2007, in accordance with the Alternative assumptions). DNR and the technical review committee have reviewed the modeling assumptions for marbled murrelets and continue to believe that the assumptions are reasonable in light of present information.

Table B.2.6-1 in Appendix B lists the modeling assumptions for the marbled murrelet and the northern spotted owl for each Alternative, including the Preferred Alternative. The potential release of the administrative owl circles under the Preferred Alternative, and the release of the HCP Implementation Agreement Memorandum #1 (Memorandum #1) owl circles in 2007, were in the "take" estimates that were stated in the Biological Opinion (DNR 1997). The Habitat Conservation Plan, on which the Biological Opinion was based, assumed that all owl circles would be harvested in the first decade. However, because of recommendations from the U.S. Fish and Wildlife Services (DNR 1997), DNR agreed to protect 56 of the 66 critical owl circles that the Interagency Technical Group recommended (DNR 1997, Owl Site Prioritization Schedule). These additional protections exceeded the expectations of the Habitat Conservation Plan and have resulted in substantially lower levels of take than assumed in the Biological Opinion. DNR is currently well below the level of take for the first decade of the Habitat Conservation Plan because of the additional protections DNR put into place with the Habitat Conservation Plan Implementation Memorandum #1 owl circles.

In authorizing the development of the Final EIS and its Preferred Alternative, the Board of Natural Resources also directed DNR to use the Sustainable Harvest Calculation Management Principles and Objectives. It requires monitoring and annual reports "so that the Board can respond in a timely manner to policy and implementation issues." The analyses for the Draft EIS and the Final EIS do not attempt to assess site-specific management but instead are designed to support broad policy level decision-making for western Washington by HCP Planning Unit. If significant changes to management occur (such as the approval of a long-term strategy for the marbled murrelet), implementation of that change and possible effects on the sustainable harvest level will be examined.

Subject Area: Wildlife
Issue: Northern Spotted Owl – Habitat

Comment Summary:
A number of strategies were advocated for creating and protecting northern spotted owl habitat, including both active and passive habitat management, management for complex habitat structures in appropriate spatial configurations, maintaining all current habitat areas, and maintaining biological legacies beyond eight trees per acre. Additionally, the Draft EIS did not demonstrate that the aggressive riparian management under some Alternatives would not have an adverse impact on northern spotted owls. Lastly, there was no comparison in the analysis between the acres of projected harvest in northern spotted owl habitat

and the estimates of acreages for take in the U.S. Fish and Wildlife Service's Biological Opinion completed for the Habitat Conservation Plan.

Response:
One of the objectives of all the Alternatives is to create structurally complex forests across the landscape, while providing for sustainable forestry management. In the Preferred Alternative, biodiversity pathways are used to simultaneously increase complex forest habitat with a priority for habitat areas and the production of trust revenue across the landscape (Board of Natural Resources Resolution 1110).

For all the Alternatives except the No Action Alternative, 50 percent of forested trust lands in each watershed in designated Nesting, Roosting, Foraging, or Dispersal Management Areas will be managed as the "threshold habitat target" within the watershed. This threshold habitat target will be prioritized by biological significance (i.e., presence and abundance of habitat components, adjacency to other habitat, adjacency to federal lands, etc.). In the remaining 50 percent of the watershed that does not count toward the threshold habitat target, silviculture management prescriptions and other allowable forest management activities may be conducted.

DNR believes that leaving legacy trees is an important function for maintaining structural characteristics for stands in the future. The Habitat Conservation Plan discusses the habitat value of structurally unique trees for seed regeneration, as a retention source for large snags, and as an essential habitat for the bald eagle and several bird species of concern (including the Vaux's swift, the pileated woodpecker, as well as a number of bat species) (DNR 1997).

None of the Alternatives, including the Preferred Alternative, proposes riparian area management that is inconsistent with the objectives of the riparian conservation strategy in the Habitat Conservation Plan. Cutting of trees in riparian areas will only be conducted for riparian restoration activities. Harvests in northern spotted owl nesting, roosting, foraging, and dispersal habitats existing in riparian management zones will maintain habitat at levels specified by procedures for both the northern spotted owl and riparian habitat management. For more detailed information regarding the type of management in the riparian areas or the northern spotted owl management areas for all the Alternatives refer to Chapter 2, Section 2.6.3, in the Final EIS.

All of the Alternatives, including the Preferred Alternative, comply with DNR's Habitat Conservation Plan in all regards, including habitat management for the northern spotted owl. The graduated release of the administrative owl circles under the Preferred Alternative and the release of the Memorandum #1 owl circles in 2007 are assumed in the take estimates that were stated in the Biological Opinion, **(** i.e., it was assumed that the habitat in those circles would be available for harvest immediately, and that harvest of those circles was included in estimations of take. For more information regarding the level of take identified in the U.S. Fish and Wildlife Service's Biological Opinion refer to the comment response for *Marbled Murrelet/NSO – Habitat Conservation Plan Compliance*.

Subject Area: Wildlife
Issue: Northern Spotted Owl – New Research

Comment Summary:
Concern was raised over the status of northern spotted owl populations in Washington, and the integration of new research conducted since the development of the Habitat Conservation Plan into the Draft EIS analysis. New research on northern spotted owls shows population declines, and the Best Available Science should be provided to the decision-makers to assist in their examination of the Alternatives. In addition, habitat provisions must be revisited now and over time as new information about northern spotted owl population status becomes available to avoid cessation of future harvest on DNR lands due to owl population changes.

Response:
There are many possible explanations for the decline of northern spotted owl populations in Washington. They include the following: 1) the high density of barred owls, 2) the loss of habitat due to wildfire, 3) logging of northern spotted owl habitat of state and private lands, 4) forest defoliation caused by insect infestations, and 5) advancing forest succession toward climax forest communities (e.g., *Abies spp*.) in the absence of wildfires. For more information of northern spotted owl demographic studies, refer to the Section 4.4.3 (Wildlife) in the Final EIS. The Final EIS expands the discussion of new information relating to declining northern spotted owl populations in Washington in Section 4.4 (Wildlife) for additional information. This analysis contains the Best Available Science known to exist at the time of publication of this document.

The latest data on northern spotted owl population rate of change (1999-2003) were discussed in the demography workshop that took place in January 2004. The preliminary report was released in May 2004, and the U.S. Fish and Wildlife Service's 5-year status report is anticipated to be released in late October 2004. The results of northern spotted owl demographic studies presented at the workshop provide an indication of currently known changes in northern spotted owl demography in Washington, while the 5-year status report will address possible causes of these changes. For more information regarding the results of the study, refer to Section 4.4.4 in the Final EIS.

DNR’s role in supporting northern spotted owl populations, however, is well defined in the Habitat Conservation Plan. The Washington Department of Fish and Wildlife and the U.S. Fish and Wildlife Service both agree that DNR’s Habitat Conservation Plan remains an appropriate conservation strategy for forested trust lands affecting the northern spotted owls in Washington.

Appendix G

Subject Area: Wildlife
Issue: Northern Spotted Owl – Owl Circles

Comment Summary:

There are concerns with the implications of maintaining or releasing the northern spotted owl circles, citing "takings" under the Endangered Species Act and violations of the trust mandate. Clarification was requested on the differences between the owl circles and the history of their origins, especially the difference between Memorandum #1 circles and those created without Board of Natural Resources discussion or approval. Clarification is also needed on the Draft EIS assertion that many owl circles are currently unoccupied.

Response:

Because the Memorandum #1 owl circles arose out of the Habitat Conservation Plan commitments, DNR interprets these circles as part of its Habitat Conservation Plan. Northern spotted owl circles identified in the Memorandum #1 will be released in 2007 for possible timber harvest consistent with the objectives and strategies of the Habitat Conservation Plan (page 4-61, Draft EIS). In approving DNR's Habitat Conservation Plan, the U.S. Fish and Wildlife Service asked DNR to protect certain specific northern spotted owl circles for the first decade of the Habitat Conservation Plan (i.e., until 2007) in addition to the other northern spotted owl commitments in the Habitat Conservation Plan. Risks associated with the loss of reproductive owls outside identified circle areas were considered acceptable in light of gains in long-term habitat availability. The Habitat Conservation Plan has a landscape-level focus on population dynamics rather than relying on the protection of individual northern spotted owls.

In 1997, both U.S. Fish and Wildlife Service and the Washington Department of Fish and Wildlife recommended that DNR minimize or defer harvest in specific northern spotted owl sites status 1-3 (66 sites total). In 1998, DNR agreed to consider the recommendations of the Interagency Technical Group (DNR 1997, Owl Site Prioritization Schedule) for the owl circles status 1-3 for 10 years (resulting in the protection of 56 circles). These recommendations were instituted as management guidance in the January 1998 Memorandum #1 owl circles

In August 1999, DNR developed additional procedures to further avoid potential northern spotted owl takes in circles not protected by Memorandum #1. The basis for this decision was a concern that harvests might occur at a more rapid pace than originally envisioned; however, this did not occur. The Preferred Alternative proposes to revise this procedure for the northern spotted owl management to reflect the release of these administrative owl circles (Status 1 Reproductive) in 2007, with the exception of Status 1 Reproductive circles in the Olympic Experimental State Forest, which will be released in 2004, and the Southwest Washington owl circles, which will not be released prior to 2006. For additional information regarding owl circles refer to Chapter 2, Section 2.6.3, in the Final EIS. In addition, for a discussion of the trust mandate, see comment responses for "Trust Mandate."

Subject Area: Air Quality
Issue: Carbon Sequestration and Global Warming

Comment Summary:
There needs to be more analysis done on carbon sequestration on state lands. The impacts from each Alternative on global warming were unclear, and it was also unclear why air quality was equal among the Alternatives. Shorter rotations and increased rates of harvesting, combined with a tendency toward wetter winters and drier summers, could increase flooding and result in reduced carbon storage capacity on a watershed level.

Response:
Washington and other western states are participating in a federal grant to examine how the 2.1 million acres of forested trust lands and 8.5 million acres of private forestland could be used to reduce greenhouse gas that comes from vehicles, electric power generated by fossil fuels, and other CO^2 sources.

This project is part of the Global Climate Change Initiative studying "carbon sequestration," where trees remove carbon from the air as part of their natural respiration and store the carbon in the wood as standing trees or in structural lumber. Greenhouse gas emitters would then purchase "carbon credits" from forestland owners. The carbon balance for current management of forested state trust lands is thought to be positive considering carbon in the forest and in structural wood products produced from the forest. This is especially true when accounting for the reduction of structural materials with more carbon-intensive production, such as steel or concrete.

Carbon credits are just one part of DNR's effort to reduce greenhouse gasses. Wind power leases on non-forested trust land were signed in 2003 that are now generating power for 45,000 homes near Ellensburg.

Besides greenhouse gas effects, other impacts related to air quality are considered minor under all Alternatives because the use of prescribed burning to prepare a site for planting is projected to be similar to current levels under all of the Alternatives. Any burning is regulated by the Washington State Smoke Management Plan. Few or no additional adverse effects on air quality are anticipated to result from prescribed burning on the westside due to cool and wet weather patterns that generally prevail (see page 4-97 of Draft EIS).

For additional information on carbon storage refer to Chapter 4, Section 4.5, of the Final EIS and also the comment response in "Harvest Rotation" in Forest Structure and Vegetation.

Subject Area: Geomorphology, Soils, and Sediment
Issue: General Concerns

Comment Summary:
Logging and road-building cause the most landslides, especially on unstable slopes, which impacts water quality and cultural and public resources. What is the reasoning and scientific basis for the assertion in the Draft EIS that none of the Alternatives cause or increase landslide activity?

Response:
DNR recognizes that landslides are a risk to a variety of resources, including infrastructure and public safety. No Alternative changes any policy regarding slope stability. Implementation of any Alternative would require full compliance with the current set of policies and Forest Practices Rules. DNR also recognizes that harvest activities—especially road-building—may increase landslide risk and that greater levels of activity could potentially increase landslide risk in landslide prone areas, even as DNR follows existing protective policies. Given the conservative nature of the policies and Forest Practices Rules, none of the Alternatives would result in any probable significant adverse impacts to any of the resource areas, relative to current conditions, beyond those anticipated in the Habitat Conservation Plan and Forest Practices Rules.

In addition, DNR states in the Habitat Conservation Plan that, “Unstable Slopes will be identified through field reconnaissance or identified with slope geomorphology models and verified through field reconnaissance with qualified staff. If, in the future, timber harvests and related activities can be accomplished without increasing the frequency or severity of slope failure and without severely altering the natural input of large woody debris, sediment, and nutrients to the stream network, then such activity shall be allowed” (DNR 1997). However, it should be noted that DNR does not harvest on unstable slopes in the riparian management zone.

The Washington Forest Practices Rules set forth detailed requirements for harvest proposals involving potentially unstable slopes and landforms (WAC 222-10-030 (1)). This rule requires analyses of slope stability to be performed by persons who are qualified experts in geology or geomorphology (WAC 222-10-030(5)).

The sustainable harvest analysis is a programmatic EIS, which does not schedule particular harvests. The specific details of where a timber harvest will occur will be determined during implementation. As noted in the Draft EIS and Final EIS, the sustainable forestry calculation is a “non-project action” under the State Environmental Policy Act—that is, there is no specific proposed activity for a specific site, meaning that DNR has not specified or analyzed activity on specific locations.

Regeneration harvest activities and road-building, in particular, have been shown to increase the frequency and severity of landslides on potentially unstable slopes beyond background levels, as discussed in the Final EIS and Habitat Conservation Plan Final EIS. Numerous root strength studies (e.g., Wu et al. 1979; Wu and Swanston 1980; Ziemer 1981; Schmidt et al. 2001) have led to a more thorough understanding of the impact of decreasing root strength on slope stability. Relatively recent modeling results (Dhakal and Sidle 2003) indicate that thinning and retaining vigorous understory vegetation should reduce landslide volumes and frequencies significantly as compared to historical use of clearcutting. Additionally, the Final EIS discussion in Chapter 4, Section 4.6, contains additional information regarding road density, road-related sedimentation, and other factors.

Road-building practices have also contributed to landslides in forested trust lands. As discussed in the Final EIS, road-building, maintenance, and abandonment procedures also are regulated by the Forest Practices Rules to minimize risk of landslides and erosion.

DNR identifies potentially unstable areas prior to layout of timber sales or roads at the project level, as required by the Forest Practices Rules. The use of modeling data alone may misidentify potentially unstable slopes and will not provide adequate data to evaluate and respond appropriately to actual landslide risk. For areas identified as potentially unstable, a licensed geologist will determine which, if any, operations may take place and what mitigation may be needed. For example, depending on the actual site conditions, field evaluation could result in increased or decreased levels of harvest for a particular location, the abandonment or redesign of a road, selection of an alternative yarding technique such as by helicopter, or the relocation of a proposed road.

Subject Area: Geomorphology, Soils, and Sediment
Issue: Model Assumptions

Comment Summary:
Modeling for Alternatives 2 and 3 assumes that between 10 and 30 percent of forested areas identified as having the potential for shallow rapid landslides could be harvested. The modeling assumptions should be disclosed, along with an analysis of risk and uncertainty of meeting those assumptions. The OPTIONS model should be run again specifically to study the potential increase of landslides with increased harvest levels on unstable slopes.

Response:
DNR recognizes that landslides are a risk to a variety of resources, including infrastructure and public safety. DNR also recognizes that harvest activities may increase landslide risk. Additionally, refer to the comment response under Geomorphology, Soils, and Sediment for “General Concerns.”

DNR has reviewed its assumptions in this area and still believes that the assumptions made in modeling the various Alternatives were reasonable for the purposes of estimating the potential future harvest levels. The actual amount of unstable area across the landscape may be different than current data indicate. If a significantly greater amount of land is identified as actually unstable and therefore less (or not) harvestable, then actual harvest levels would be less than the model predicts. Current uncertainties in the total area of unstable and potentially unstable slopes across the landscape will be addressed through increased identification and monitoring efforts described in Section 4.6.3.5 under “Mass Wasting” in the Final EIS. Also see the discussion of the OPTIONS model in Appendix B in the Draft EIS and Final EIS.

As discussed in the Draft EIS and Final EIS, for increased harvest levels, the risk of mass wasting events will require identification of potentially unstable slopes prior to harvest. For areas identified as potentially unstable, a qualified expert makes a determination of the appropriate types of operations allowed to take place, as well as necessary mitigation. DNR has not specified the percentage of tree removal, if any, on specific locations that are or may be identified as potentially unstable. That determination is made based on site conditions at the project level.

For additional information regarding the modeling assumptions, see the comment response for “Riparian and Wetland Model Assumption.”

Subject Area: Geomorphology, Soils, and Sediment
Issue: Soil Productivity

Comment Summary:
Current scientific literature was not used in the discussion for soil productivity, especially in the discussion for Alternative 5 and the Preferred Alternative, which have the greatest environmental impacts. Neither the Habitat Conservation Plan nor Forest Resource Plan EIS documents discuss this problem.

Response:
DNR believes that current scientific literature was used in the discussion on soil productivity (see Chapter 4, Section 4.6.3, of the Final EIS). The analysis in the Final EIS refers to Section 4.6 of the 1996 Final EIS for the Habitat Conservation Plan and Section 3.2.2.2 of the 2001 Final EIS on Alternatives for Forest Practices Rules. However, the subject of soil productivity was not addressed in the Forest Resource Plan. The Preferred Alternative will have fewer entries over the life of the stand; therefore, there is less degradation to soil productivity under the Preferred Alternative.

For additional information on soil productivity, refer to Chapter 4, Section 4.6, in the Final EIS.

Subject Area: Geomorphology, Soils, and Sediment
Issue: Unstable Slopes

Comment Summary:
Increased harvest activities would increase the rate of slope failure, especially on potentially unstable slopes in the North Puget HCP Planning Unit and Olympic Experimental State Forest. Alternatives 2, 3, and 5 and the Preferred Alternative assume that 70 percent of the areas initially identified as potentially unstable can be thinned, but there were no documented studies provided to back up this assumption. The Draft EIS incorrectly states that areas with potential slope instability are limited to light access only within riparian areas, and harvest can occur in areas that have been field-verified to be of high mass wasting potential. The Habitat Conservation Plan explicitly states that such activities cannot take place until research has been conducted that demonstrates harvesting these areas will not cause an increase in the severity or frequency of landslides above natural rates.

Response:
As discussed in the response for "Model Assumptions," potentially unstable slopes are field-verified and decisions are based on site conditions at the project level.

DNR has reviewed its assumptions in this area and still believes that the assumptions made in modeling the various Alternatives were reasonable for the purposes of estimating the potential future harvest levels. At the project level, potentially unstable slopes are initially identified by DNR using topographic map-based modeling (SMORPH model). Prior to harvest design, potentially unstable slopes are field-verified by a geologist. However, mapping and tracking of landslides has not been systematic or comprehensive. Modeling and small-scale mapping may underestimate slope gradients or fail to identify certain types of features as potentially unstable and therefore may underestimate or overestimate the potential for failure where unstable slopes are identified. Field verification prior to project layout is required by Forest Practices Rules and is conducted by DNR prior to harvest layout (WAC 222-10-030 (1)). The level of operations and harvest in any particular area, and any required mitigation measures, will depend on site conditions.

Recent studies indicate the importance of root strength on slope stability, as discussed in Section 4.6.3.5 of the Final EIS under Mass Wasting. Modeling results (Dhakal and Sidle 2003) indicate that thinning and retaining vigorous understory vegetation should reduce landslide volumes and frequencies significantly as compared to regeneration harvest activities.

Refer to the discussion in Section 4.6 on Mass Wasting in the Final EIS regarding monitoring and improved identification of unstable and potentially unstable slopes. Scientific understanding of landslide processes will continue to inform operational decisions to minimize risk and meet the requirements of the Habitat Conservation Plan. The Habitat Conservation Plan does not allow any management activity in the Riparian Management Zone where areas of high mass wasting potential occur, with the exception of road crossings and yarding corridors.

The Habitat Conservation Plan states on page IV.62, "If, in the future, timber harvest and related activities can be accomplished without increasing the frequency or severity of slope failure and without severely altering the natural input of large woody debris, sediment and nutrients to the stream network, then such activity shall be allowed." That is to say that DNR will have to be able to demonstrate that the above criteria will be met if the DNR are to operate in those areas.

DNR will continue to rely upon current scientific understanding of landslide processes when making operational decisions to minimize risk and meet the goals, letter, and intent of the Habitat Conservation Plan. Sustainable forestry operations will continue to be planned to minimize landslide risk and not increase the frequency or severity of landslides.

Implementation monitoring of Habitat Conservation Plan-managed land is ongoing. A pilot project has been completed examining the evaluation of slope stability in timber sale planning and to test the effectiveness of associated mitigation recommendations. A report is submitted annually to the Federal Services that has included levels of compliance with Habitat Conservation Plan strategies that address unstable slopes.

Long-term effectiveness monitoring will be implemented on a sub-basin scale to measure above-background sediment delivery from roads and harvest activities. Selection of sub-basins for monitoring will be based on percent of Habitat Conservation Plan-managed land, aquatic resources with listed species at risk, and other factors such as domestic water use. Six initial priority Water Resource Inventory Areas have been identified for long-term effectiveness monitoring. Also, as part of the strategy, Best Management Practices will be evaluated using paired studies at the road segment scale to measure impacts on the aquatic ecosystem in the Olympic Experimental State Forest.

Subject Area: Hydrology
Issue: Peak Flows and Flooding

Comment Summary:
Higher harvesting rates will increase flooding by reducing the soil's ability to absorb heavy precipitation from storm events. Increased runoff rates could lead to increased streambed scour and alter the balance between sediment storage, transport, and off-channel habitat, which adversely affects salmon habitat. Watershed-by-watershed analyses need to be conducted to examine the impacts of the proposed Alternatives.

Response:
The Final EIS describes the potential beneficial and adverse effects of the different Alternatives to the affected environment and to endangered species populations at a level of detail appropriate to a programmatic EIS. DNR has used the best available scientific information and an in-depth understanding of the intent and practical application of the policies and procedures in the Forest Resource Plan and Habitat Conservation Plan.

The Draft EIS and Final EIS describe (Chapter 4, Section 4.7) that Procedure 14-004-060 would be followed under any Alternative. This procedure prohibits harvest of hydrologically mature forests in rain-on-snow and snow zones where the mature forest type makes up less than 66 percent of these zones. It is applied in a watershed-by-watershed basis before any potential harvest activities may occur. Avoiding harvest in areas that are below the policy threshold values should significantly reduce the likelihood of increased peak flows.

The Draft EIS and Final EIS does not claim that there will be absolutely no adverse effects to endangered fish populations from proposed harvest levels under the different Alternatives. Instead, it states that the levels of potential adverse effects are consistent with the levels expected under the Habitat Conservation Plan, which acknowledged resource impacts and provides for specified levels of "incidental take" of listed species. The Draft EIS and Final EIS analyses conclude the amount of the adverse effects of any of the Alternatives should not be significantly different than under Alternative 1.

Refer to Chapter 2, Section 2.6, in the Final EIS for further information concerning the Preferred Alternative.

Subject Area: Fish
Issue: Salmon and Fish Habitat

Comment Summary:
Alternative 5 and the Preferred Alternative would result in a decrease of future large woody debris recruitment and an increase in stream sedimentation. Additionally, the Federal Services have not approved a riparian procedure that meets the intent of the Habitat Conservation Plan. Harvesting activities in the floodplains under Alternatives 2, 3, and 5 and the Preferred Alternative, which is not allowed under the Habitat Conservation Plan, causes more environmental impacts than benefits. The potential economic benefits of each Alternative must be weighed against the potential impacts to salmon populations. The Draft EIS is weak in specificity and completeness of its plans for protecting streams and endangered fish populations, especially on the Olympic Peninsula, and is based on weak or no science.

Response:
The Draft EIS and Final EIS indicates that in the long term, overall conditions for endangered fish populations are likely to improve under all Alternatives relative to current conditions as a result of continued implementation of the Riparian Conservation Strategy. The Alternatives are designed to implement the Riparian Conservation Strategy with different levels of active or passive management, which is hypothesized to affect the time required to achieve complex stand characteristics and higher levels of riparian function. The fish analysis relies on discussions in other sections of this EIS to document potential effects on sediment load and hydrology. Consequently, the discussion in the fish section is brief. As stated in the Draft EIS and Final EIS, floodplain and off-channel habitat protection is similar under all Alternatives. Consequently, no differences in adverse effects are expected.

The task of the Final EIS is not to formulate a specific riparian strategy; rather, it is to inform high-level policy choice about the overall approach to the riparian areas. The Board Resolution 1110, Section 4(K) indicates that riparian management will be consistent with the Habitat Conservation Plan and have the agreement of the Federal Services. The final riparian strategy has been written and reviewed by the Federal Services and is currently being reviewed by a number of stakeholders. It will go through a State Environmental Policy Act analysis, which is independent of the Final EIS process.

Although the modeling assumptions in the Final EIS were informed by the draft riparian forest restoration strategies, the modeling assumptions and outputs of the Final EIS do not determine site-specific riparian harvest. The type of harvest in riparian areas will be guided by the final approved riparian procedure and its site-specific application. As field foresters examine riparian stands on the ground, they will decide what treatments are necessary, based on stand structure, topography, site-specific management constraints, social issues, operational feasibility, marketability of the stand, and other factors. There is a body of literature that identifies how silvicultural treatments move forest stands to fully functioning conditions, including research by Carey et al. (1996)

Overall, large woody debris levels are expected to increase over current conditions under all Alternatives in the long term. Some differences among the Alternatives are expected. The area of riparian land class dominated by large and very large trees is expected to increase and exceed current levels over the life of the Habitat Conservation Plan for all Alternatives. However, relative to Alternative 1, some long-term reduction in large woody debris potential may occur from the removal of riparian trees, predominantly under Alternatives 2, 3, and 5 and the Preferred Alternative. Under the Preferred Alternative, these adverse effects are expected to transition into long-term beneficial effects in the form of more structurally diverse riparian forest.

The Preferred Alternative is expected to mitigate localized reductions in large woody debris potential by active development of down woody debris and instream large woody debris through the felling of large trees toward the stream and through leaving them in place. This active management technique would provide immediate improvements in the availability of these features at places where treatments are implemented. In contrast, Alternatives 1 through 5 rely on relatively infrequently occurring natural disturbances (e.g., windthrow, fire, disease, decadence, etc.) to increase downed wood and large woody debris levels.

Riparian buffers can significantly reduce the amount of coarse sediment that reaches a stream by filtering it through the vegetation. Similarly, buffers can limit the amount of fine sediment that reaches a stream from surface erosion by physically obstructing or inhibiting the movement of the sediment into the water. Ground-based and cable yarding methods can further decrease levels of soil compaction and/or rutting and surface erosion along skid trails in the riparian zone. Given the nature of the requirements of the Forest Practices Rules and the Habitat Conservation Plan, no Alternative is likely to cause substantial adverse effects on streambank stability or sediment filtering capacity. For more information on effects to riparian resources, please refer to Chapter 4, Section 4.3, in the Final EIS.

Activities to be carried out in riparian areas are primarily for riparian restoration. None of the Alternatives would result in harvesting activities within the flood plains as stated in the Habitat Conservation Plan.

The Habitat Conservation Plan riparian conservation strategy for the Olympic Experimental State Forest is designed to allow a level of forest management activity that protects riparian and aquatic resources while generating revenue to trust beneficiaries. The conservation strategy for the Olympic Experimental State

Forest also is designed to be more flexible than the five other Westside HCP Planning Units. Research activities are underway to better understand and manage forested trust lands. The levels of harvest under Alternatives 5 and the Preferred Alternative include substantial amounts of thinning activities in riparian zones to reduce the level of competitive exclusion and to accelerate tree growth and stand complexity.

For information regarding Riparian Management Zones and endangered fish species, refer to the comment response in “Riparian Management” under the subject area “Olympic Experimental State Forest,” and “Stream Buffers” under the subject area “Riparian” in this summary. Additionally, refer to Chapter 4, Section 4.10, of the Final EIS for a discussion on the Preferred Alternative and its expected effects on fish and their habitat.

Subject Area: Public Utilities and Services
Issue: Impacts to Revenue Stream

Comment Summary:
Funds supplied to the state forest (formerly known as “Forest Board”) counties and their junior taxing districts are inadequate, which causes significant adverse impacts on a county’s ability to provide essential services. DNR needs to carry out a more thorough analysis on diminishing trust revenues on public services than is included in Section 4.11 of the Draft EIS. The information provided in Section 4.11 does not depict accurately the adverse impacts from reduced forested trust land revenues to timber-dependent counties. The Draft EIS should provide additional analysis of the Preferred Alternative on the top six junior taxing districts whose budgets had a significant contribution of timber sales revenue in 2001.

Response:
As noted in the Final EIS, DNR provided to the Board of Natural Resources an analysis that addresses the potential impacts to trust revenues in financial terms. A State Environmental Policy Act EIS is not required to evaluate potential socioeconomic impacts, such as impacts to local and regional employment (WAC 197-11-448). As a result, this type of analysis is not included in the Final EIS. DNR did, however, commission a separate study that assessed the potential long-term effects of changing DNR management operations by evaluating the socioeconomic resiliency of Washington counties. This report is available on the DNR Web site at http://www.dnr.wa.gov/htdocs/fr/sales/sustainharvest/socioeconpaper.pdf.

DNR and the Board understand the importance of the revenues generated by forested trust lands (State Forest transfer and purchase lands) to county governments that are less populated. DNR has attempted to portray this information as clearly as possible, both in the EIS and in the socioeconomic report mentioned above. For additional information regarding public utilities, refer to Chapter 4, Section 4.11, of the Final EIS.

Subject Area: Cultural Resources
Issue: Harvesting Impacts

Comment Summary:
Concerns were expressed regarding DNR's policies for the identification and protection of cultural resources.

Response:
None of the Alternatives changes any policies or practices related to cultural resources.

DNR follows specific policies and procedures in identifying, evaluating, and protecting archaeological, historic, and cultural sites. When probable archaeological, cultural, or historic properties are identified through consultation, TRAX review (computer tracking system), or during an on-site inspection, a DNR archaeologist visits the site and develops a recommended course of action. DNR continually works with the Office of Archaeological Historic Preservation.

Special consideration is also given to the historical and cultural concerns of Native American tribes. DNR conducts ongoing relations with Washington's tribes as one government to another, consistent with the Centennial Accord and Washington's governance by separate independent state officials, DNR recognizes the sovereign status that has been accorded Washington's federally recognized Native American tribes. DNR recognizes it is in the best interest of all parties to identify and resolve issues and concerns.

Subject Area: Recreation and Scenic Resources
Issue: Harvesting Impacts

Comment Summary:
Maintain the ability to enjoy popular recreational opportunities like hiking, hunting, and fishing on forested trust lands. What is the economic benefit of unlogged recreational areas? Where is the analysis that justifies the claim that increased harvesting activities identified under Alternative 5 and the Preferred Alternative will not impact scenic values? Standing timber does have an economic value, while recreational opportunities have environmental impacts.

Response:
As noted in the Draft EIS and Final EIS, the sustainable forestry calculation is a non-project action under the State Environmental Policy Act. As such, the analyses presented in the Draft EIS and Final EIS are programmatic in nature rather than site-specific. Additionally, other mitigation measures may be applied as appropriate. In the absence of site-specific data, it is assumed that DNR procedures, coupled with site-specific mitigation, would prevent significant impacts to scenic resources in areas where timber harvest could take place. Forested trust lands are dispersed throughout western Washington and represent about 9 percent of forestlands in western Washington.

Specific forest management activities may be seen as aesthetically displeasing to some, even though DNR only conducts these activities on a small percentage of forested trust lands each year. DNR's fiduciary obligations to the trusts may require that aesthetic management issues take a secondary priority to other considerations.

DNR follows specific policies outlined in the 1992 Forest Resource Plan with regard to recreation on forested state trust lands. Forested trust lands have historically been open to the public under the “Multiple Use Act,” which allows public use of forested trust lands when compatible with management responsibilities. DNR is currently reviewing its policies regarding recreational use and scenic resources in the Forest Resource Plan update process.

Subject Area: Cumulative Effects
Issue: General Approach

Comment Summary:
The Draft EIS cumulative effects analysis does not disclose potential impacts on the environment by Alternative, including the proposed changes to current procedures, and fails to incorporate modeling results. The Draft EIS inappropriately defers cumulative effects analysis to the Habitat Conservation Plan and Forest Resources Plan, neither of which analyzed cut levels. The increase in the distribution of more desirable forest structures over time and space does not fulfill the requirement to assess the cumulative effects of the Alternatives on the environment and is contrary to studies and research that show increased downstream effects from increased levels of timber harvest and management in watersheds. The screening in the Draft EIS may help identify some watersheds at risk, but it does not identify the impacts of the proposed harvest levels. The cumulative effects of riparian harvesting on aquatic resources are not disclosed, especially in regard to sediment delivery. There is an increased concern over the substantial increase of harvest proposed in riparian areas in the North Puget Planning Unit, which was identified in the Draft EIS as having a relatively high risk for cumulative effects to fish resources compared to other Westside HCP Planning Units. The cumulative effects analysis is no longer being done at any level of planning.

Response:
A comparative analysis of the relative risk for cumulative effects for each Alternative is illustrated in the Draft EIS and Final EIS. This risk is evaluated as it relates to different forest stand structure characteristics that evolve over time. (Chapter 4, Section 4.15). A range of short-term (less than 10 years) impacts and long-term (greater than 60 years) impacts are compared by using varying harvest intensities for several land classifications related to the stand structures that are anticipated to develop under a variety of silvicultural practices over time. The basic premise of the analysis is that the potential for cumulative effects across western Washington forested state trust lands can be anticipated, illustrated, and analyzed. This can be done largely by displaying the distribution of forest structures evolving over time. Additionally, no activity levels are being proposed that exceed those analyzed in the 2001 Forest Practices rules Final EIS and DNR Habitat Conservation Plan Final EIS.

In the Final EIS, DNR limited its conclusions regarding cumulative impacts to the 1.4 million acres of western Washington forested state trust lands taken as a whole. The DNR concluded that at this scale there is no significant adverse impact. It was not within the scope of this analysis to review the potential cumulative impact for any specific watershed at this broad scale of setting a sustainable harvest level. The Draft EIS and Final EIS analysis and conclusions regarding the potential for cumulative effects are indicated by forest stand structure characteristics that are anticipated to evolve over time for a range of potential policy and procedural changes. These potential changes are analyzed over an area spanning 179 watersheds, where DNR forested trust lands make up at least 5 percent of the watershed (see Chapter 4, Section 4.15, of the Final EIS). Reasonably available information considered for these watersheds was used as a screening tool to discern the potential for the Alternatives to produce adverse cumulative effects. The Final EIS analyzes and compares the likely outcomes of six management Alternatives. This includes the No Action Alternative and the Preferred Alternative at the scale of DNR's HCP Planning Units (of which there are five in western Washington plus the Olympic Experimental State Forest). This approach is designed to work in conjunction with project-level planning and analysis during implementation of the sustainable harvest policies and procedures.

In addition to this broad scale analysis of cumulative effects on western Washington forested state trust lands, DNR has considered the contribution of both the additional statewide and site-specific efforts at mitigating the cumulative effects of forest practices.

Current Forest Practices Rules address cumulative effects and pertinent elements of the environment protected by the Forest Practices Act. The rules have been designed and frequently amended in accordance with adaptive management and programmatic State Environmental Policy Act processes to address the cumulative impacts of individual forest practices. The environmental impacts of the Forest Practices Rules are described in related programmatic EISs. DNR's Habitat Conservation Plan also has been analyzed in terms of the cumulative impacts resulting from forest management activities, including timber harvest. The analyses conclude that managing according to these standards substantially mitigates for potentially significant adverse cumulative effects, which is consistent with the current effort to set a decadal harvest level for forested trust lands in western Washington.

In addition to the federal and state laws listed above, most DNR forest practices activities are subject to the State Environmental Policy Act. Building on the Department of Ecology's standard State Environmental Policy Act Environmental Checklist, the *State Forest Land Environmental Checklist* was developed to help DNR disclose and understand landscape level interactions. The *State Forest Land Environmental Checklist* is currently used on every major timber sale. Adjacency and landscape/watershed-administrative-unit (watershed) maps for the proposals are available on the Internet at http://www.dnr.wa.gov under "SEPA Center." Such maps aid our understanding and analyses of landscape level considerations. In addition, DNR has appended the standard State Environmental Policy Act environmental checklist with approximately 100 additional questions that review overall Watershed Administrative Unit (WAU) conditions and potential future activities in the watershed.

For additional information, refer to the responses for Field Verification/Region Review and Habitat Conservation Plan/Forest Resource Plan Implementation, and also refer to Procedure PR 14-001-010 Forest Management Implementation Planning in Appendix F of the Final EIS for more information.

For a more detailed discussion of the cumulative effects analysis, refer to Chapter 4, Section 4.15, of Final EIS.

Subject Area: Cumulative Effects
Issue: Land Ownerships

Comment Summary:
The Draft EIS does not justify the statement that all Alternatives create a new balance of forest structure at the landscape level. The possible exception might be the case where DNR is the sole owner within a watershed. A cumulative effects analysis must consider the current and past harvest activities on private, state, and federal lands.

Response:
Conclusions in the Draft EIS and Final EIS regarding the increase in complex forest structures over time, and potential impacts to the resource areas of concern, are based on analysis of likely changes to forest cover and structure where DNR manages forested trust lands making up at least 5 percent of the watershed. The data sets used in this analysis cover DNR, Tribal, and other public and private ownerships for each of the 179 separate watersheds. Although DNR has no jurisdiction over how other landowners might choose to manage their lands, some assumptions have been made based on several data sets, including satellite imagery, maps, photos and other tools, and the influences of other state and federal policies. The proposed Alternatives, in conjunction with other recent changes in forest management (the new Forest Practices Rules, the Northwest Forest Plan, and habitat conservation plans on state and private lands), are expected to create a new balance of forest structure across the landscape. However, this analysis cannot speculate regarding what forest management activities other forested landowners may perform in the coming years, or the timing of those activities. Cumulative impacts for private lands and DNR forested trust lands are regulated by Forest Practices, and cumulative impacts for federal lands are regulated by the Northwest Forest Plan.

For a more detailed discussion of the cumulative effects analysis in terms of including all ownerships represented in the analysis area, refer to Chapter 4, Section 4.15, of the Final EIS.

Subject Area: Cumulative Effects
Issue: Watersheds

Comment Summary:
Harvest levels must specify the geographic source of the timber, consider and respond to cumulative effects by watershed in order to guide site-specific State Environmental Policy Act analysis, and not continue to piecemeal by timber sale. A planning region scale of analysis must reflect the watershed level impacts to fish. Sediment amounts of multiple river systems cannot be aggregated and averaged to support a conclusion that, for a larger planning unit, sediment is not a problem.

Response:
The Draft EIS and Final EIS analysis of the potential risks associated with cumulative effects consider the total land affected where DNR manages forested trust lands that make up at least 5 percent of the watershed. A range of potential policy and procedure changes are presented for each Alternative considered in the Draft EIS and Final EIS. The relative number of watersheds affected, and the intensity of those effects in terms of relative risks to resource areas of concern, are provided in Chapter 4, Section 4.15 (on Cumulative Effects), of the Final EIS. The analysis shows a relative range of impacts anticipated within each specific HCP Planning Unit's watersheds. This analysis avoids speculative conclusions. It is supported by a semi-quantitative approach that ranks watersheds for several key resource areas based on the best reasonably available information for this programmatic proposal.

While the analysis does not provide precise conclusions about the current or future existence of cumulative effects at the watershed level, current broad-based data, by watershed, are used as a screening tool. This provides information on what types of cumulative effects might occur and where these effects might be most likely to occur.

Although the analysis in the Draft EIS and Final EIS do not directly assess the cumulative effects of the Alternatives by watershed, the Draft EIS and Final EIS use extensive watershed data to assess the cumulative effects of setting a decadal harvest level for the 1.4 million acres of western Washington forested state trust lands.

For a more detailed discussion of the cumulative effects analysis, refer to Chapter 4, Section 4.15, of the Final EIS.

Subject Area: Impacts Analysis
Issue: General Concern

Comment Summary:
General concerns are recorded about the overall potential for greater impacts to the environment under increased harvest levels of the proposed Alternatives and that the Draft EIS did not adequately analyze or describe the impacts. There is a general bias towards more cutting. The analysis is misdirected from riparian

impacts to theoretical models of future forest structures. A systems approach should be used that includes all environmental, legal, and marketing factors.

Response:
To assume that increasing the harvest level will automatically increase the environmental impacts is a legitimate concern. However, within a certain range of activity, increasing the harvest will not automatically increase significant adverse environmental impacts. The impacts depend on the type of harvest and the condition of the forest. None of the Alternatives would result in any probable significant adverse impacts to any of the resource areas, relative to current conditions, beyond those anticipated in the Habitat Conservation Plan Final EIS and the 2001 Forest Practices Rules Final EIS. The impacts have been illustrated in terms of varying risks to the environment among the Alternatives, including the Board of Natural Resources' (the Board's) consideration and identification of a Preferred Alternative.

The Final EIS shows the Preferred Alternative's potential risks of impacts within this same context of relative risk. The Draft EIS and Final EIS are structured to analyze a reasonable range of options and mitigation measures that could achieve the objectives, purpose, and need set out by the Board. The Alternatives considered represent the limits of the Board 's flexibility for achieving stated objectives. The one Alternative that is not required to meet the objectives is the No Action Alternative.

The Draft EIS and Final EIS show a range in the increased level of harvest possible under each of the other Alternatives, from a relatively small increase in Alternative 4 to a relatively large increase in Alternatives 5 and the Preferred Alternative. This increased potential is constrained by a set of assumptions that interpret environmental protection and other policy strategies defined by the objectives across the five Westside HCP Planning Units and the Olympic Experimental State Forest. These assumptions include limitations **[on]** harvest from riparian areas as well as other areas of resource sensitivity and other basic tenets of DNR's Habitat Conservation Plan, the Forest Practice Rules, the Forest Resource Plan, and other federal and state statutes. These broad management constraints serve to mitigate the environmental impacts from increasing harvest on less sensitive lands.

The analysis of impacts is a programmatic analysis targeted at 1.4 million acres of western Washington forested state trust lands. As such, it provides for a decision informed by analyses of the environmental impacts reasonably anticipated at this scale versus a more site-specific action at some smaller scale. These impacts are illustrated by the likely changes in forest structure for each of the Alternatives. The harvest level for a particular HCP Planning Unit will be refined during implementation based on an understanding of the potential impacts to specific resources and other local factors. For a discussion of the modeling process, refer to Chapter 2, Section 2.3, of the Final EIS.

Subject Area: Impacts Analysis
Issue: Baseline for Analysis

Comment Summary:
The existing conditions of the affected environment are not a good baseline for evaluating the impacts of the Alternatives or a good standard for preserving the public trust. The No Action Alternative should be the baseline.

Response:
The State Environmental Policy Act requires that the impacts of the Alternatives, including the Preferred and the No Action Alternatives, be evaluated on their likelihood to affect the environment by causing a significant adverse impact to the environment. The current condition of the environment establishes a fundamental basis for assessing the impacts of the Alternatives. The potentially significant impacts of the No Action Alternative must also be assessed. The existing condition of the environment provides a consistent standard for measuring the potential impacts of all the Alternatives and for comparing the Alternatives, including No Action and Preferred Alternatives, with one another.

Subject Area: Impacts Analysis
Issue: Deferral to Habitat Conservation Plan and Forest Resource Plan Components Not Yet Implemented

Comment Summary:
DNR is relying on the analysis of the implementation of previous documents and State Environmental Policy Act EISs, specifically the Habitat Conservation Plan and Forest Resources Plan. DNR needs to fully implement policies required under those documents, such as landscape planning, watershed analysis, road maintenance plans, a long-term marbled murrelet strategy, and riparian procedures before completing the Final EIS.

The Forest Resources Plan should be updated prior to setting the sustainable harvest level. The Alternatives do not reflect constraints of—and may not be in compliance with—the Habitat Conservation Plan.

Response:
DNR's Forest Resource Plan and Habitat Conservation Plan Draft EIS and Final EIS provided analysis of several key resource issues regarding the adoption of several policies and strategies. For many issues that are being addressed in the sustainable harvest calculation Draft EIS and Final EIS, that analysis has been determined to be relevant and applicable. Implementation of the policies is ongoing and addresses new challenges along the way ranging from cost to DNR's capacity to manage an ever-increasing number of projects important to the beneficiaries, DNR, and the citizens of the state of Washington. Some examples include marbled murrelet survey efforts and progress on developing strategies; Road Maintenance and Abandonment Plans efforts and strategies; Riparian Procedures; and the Lake Whatcom planning and State Environmental Policy Act process.

The Draft EIS and Final EIS of the Habitat Conservation Plan and the Forest Resource Plan, as well as the Final EIS, analyze and disclose the environmental effects of fully implementing the provisions of those documents that either cause or constrain impacts. Full implementation over a period of time is presumed in all cases.

Ongoing discussions with the Federal Services to ensure that the Habitat Conservation Plan remains a valid agreement under any of the Alternatives.

The portion of the Forest Resource Plan policies that most directly affect the sustainable harvest calculation are being reviewed through this calculation process and are included in the Final EIS. The completion of the Final EIS will provide the environmental review necessary for the Board of Natural Resources to adopt revisions to this subset of Forest Resources Plan policies immediately relevant to the periodic recalculation of the sustainable harvest levels required by state law. DNR issued a determination of significance and scoping notice (State Environmental Policy Act File No. 04-031501) to begin a comprehensive review and update of the Forest Resource Plan policies through the State Environmental Policy Act. If the Board makes different policy choices in the future, either in its review of the Forest Resource Plan or in other areas not covered by the Forest Resource Plan, the Board may amend the harvest level as needed.

Road maintenance is a requirement under Washington State Forest Practices Rules (WAC 222-24-051); DNR is on schedule with these requirements.

For additional information review the response for “Field Verification/Region Review” under “Implementation.”

Subject Area: Impacts Analysis
Issue: Illustration of Alternatives and Impacts

Comment Summary:
The Alternatives need to be laid out in an easily understood presentation that allows reviewers to quickly note the differences in terms of impacts to all the resources together, and not simply ranking against one another. A clear summary should be included of the policy, procedure, and task changes for each Alternative. Modify Table ES-2 to separate risks of impacts from risks of not achieving desired outcomes. Show harvest volumes by type of harvest and decade plus more factual evaluation of harvest costs versus income expectation. Criteria should be added that constrain Alternatives for removing a portion of volume or leaving a relative density, not just high, medium, or low volume per acre.

Response:
The Executive Summary is an attempt to provide a more concise summary of relationships and information found in the body of the Final EIS. However, the issues and interactions are not simple. A complete reading of the EIS is the most reliable basis to reach an understanding of the complexities without undue simplification that can occur in summaries.

Table 2.6-1 in Chapter 2 of the Final EIS contains a summary of the policy, procedure, and task changes for each Alternative considered in the Final EIS.

Table ES-2 in the Draft EIS has not been included in the Final EIS. The table was an attempt to portray the relative effects of the Alternatives in a simple visual manner. Many commenters, however, did not understand the table or the information it contained. Many sections of the environmental analysis contained in the Draft EIS and Final EIS discuss the impacts associated with the risk of not achieving desired outcomes for each of the Alternatives. The risks associated with each Alternative relate directly to an analysis of the effectiveness of proposed policies and procedures at meeting the Board of Natural Resources' objectives in addition to that of the environmental effects.

Average annual harvest volumes for the first decade are shown both by ownership group and by trust in Tables 2.6-2 and 2.6-3 (respectively) in both the Draft EIS and Final EIS. Area harvested, by harvest type, is used throughout most of the environmental analysis to evaluate environmental effects, rather than harvest volume, as it is a better estimator of impacts. An analysis of harvest volumes and their resulting gross and net income projections have been provided to the Board on an ongoing basis to aid in their decision-making process (for more information, see each of the responses contained within the subject area "Trust Land Revenue").

Though projected harvest areas are categorized by volume removed per acre for the purposes of the environmental analysis, this measure should not be confused with retention of minimum stand relative density. DNR procedures often define minimum relative density levels to be retained as a result of management of sensitive resources (such as nesting, roosting, foraging, and dispersal habitat). This serves as a criterion for harvest activities but is not necessarily an effective way to measure environmental effects. For more details on how relative density helps determine individual activities at a stand level, see the descriptions of the Alternatives in Chapter 2, Section 2.6, of the Final EIS.

Separate from the EIS, the Board directed DNR to provide additional information that "identifies hiring, implementation timelines, and cash flow necessary to transition to the Preferred Alternative…"(see Section 5, Board Resolution 1110, March 2004). Additional information is being developed that will be presented to the Board prior to policy action on the Sustainable Forest Management Preferred Alternative.

Subject Area: Impacts Analysis
Issue: Impacts Proportionate to Harvest Levels

Comment Summary:

Increased harvest activities equate to greater impacts resulting from a variety of factors, including loss of soil productivity, shortened rotations, increased harvest on unstable slopes, and riparian areas. Current harvest levels lack adequate environmental controls, and the Draft EIS lacks analysis of the relative impacts of increasingly greater harvest levels by Alternative. Higher harvest levels and more protection are incompatible.

To the contrary, DNR needs to harvest the maximum amount within current laws; the annual yield should be much higher than shown. Increased management enhances the value of the resource to the beneficiaries, and no environmental harm will result if current rules are followed.

Response:
To assume that increasing the harvest level will automatically increase the environmental impact is a legitimate concern. However, within a certain range of activity, increasing the harvest will not automatically increase significant adverse environmental impacts. The impacts depend on the type of harvest and the condition of the forest. The Preferred Alternative incorporates a management approach that is thought to improve forest health and habitat quality in competitive exclusion forests. The different impacts have been illustrated in terms of varying risks to the resource areas among the Alternatives, including the Preferred Alternative. None of the Alternatives would result in any probable significant adverse impacts to any of the resource areas, relative to current conditions, beyond those anticipated in the Habitat Conservation Plan Final EIS and the 2001 Forest Practices Rules Final EIS. Also, as discussed under Chapter 4, Section 4.6, in the Final EIS, road-related impacts are not proportionate to harvest levels.

The Draft EIS and Final EIS are structured to analyze a reasonable range of options and mitigation measures that could achieve the objectives, purpose, and need set out by the Board of Natural Resources. The Alternatives considered represent the range of the Board’s flexibility for achieving stated objectives. The one Alternative that is not required to meet the objectives is the No Action Alternative.

The Draft EIS and Final EIS show a range in the increased level of harvest possible under each of the other Alternatives from a relatively small increase in Alternative 4 to a relatively large increase in Alternatives 5 and the Preferred Alternative. This increased potential is constrained by a set of assumptions that interpret environmental protection and other policy strategies defined by the objectives across the five Westside HCP Planning Units and the Olympic Experimental State Forest. These assumptions include limitations to harvest from riparian areas as well as other areas of resource sensitivity and other basic tenets of DNR’s Habitat Conservation Plan, the Forest Practices Rules, the Forest Resource Plan, and other federal and state statutes. These broad management constraints serve to mitigate the environmental impacts from increasing harvest on less sensitive lands. For additional information, refer to the comment response on “General Concerns” under “Cumulative Effects.”

Appendix G

Subject Area: Impacts Analysis
Issue: Inadequate Referencing of Analysis to Habitat Conservation Plan and Forest Resource Plan

Comment Summary:

The Draft EIS relies too much on the analysis of previous documents and State Environmental Policy Act EISs, specifically the Habitat Conservation Plan and Forest Resource Plan. The range of concerns include the relevancy of the analysis in the older documents; the changing circumstances regarding Endangered Species Act-listed species and stream typing classifications; the lack of the Habitat Conservation Plan or Forest Resource Plan to evaluate the impacts of setting or substantially increasing harvest levels; the impacts of those increased harvest levels on habitat; the incompatibility of criteria for analysis, i.e., structurally complex forests; the pinning down of the point of reference for determining no significant adverse impacts; and the acknowledgement that specific habitat, i.e., marbled murrelet and riparian components, are already analyzed.

Response:

Three sources of environmental analysis have assisted us in this work: DNR's Forest Resources Plan EIS, the Habitat Conservation Plan EIS, and the 2001 Forest Practices Rules EIS. These documents provide the most relevant analysis available for assessing the broad impacts of timber harvesting in the state of Washington. Through those EIS analyses, various impact intensities were evaluated and management standards were established, ranging from green-up requirements (the required age of adjacent forest stands where harvest is proposed to occur) to harvesting in riparian areas or adjacent to unstable slopes. As the Department of Ecology's State Environmental Policy Act (SEPA) Handbook notes, "SEPA documents do not have expiration dates" (Section 2.7). State Environmental Policy Act language encourages the use of pre-existing, relevant environmental documents to reduce duplication and paperwork and improve decision-making (WAC 197-11-640).

Consistent with State Environmental Policy Act requirements, the Draft EIS and Final EIS do not attempt to duplicate this analysis. It integrated the standards established from the outcomes of the analysis, such as Forest Practices Rules and other DNR policies and procedures, into the Alternatives. Other objectives specified by the Board of Natural Resources defined specific outcomes for western Washington forested state trust lands. All together, this set of rules, policies, and objectives provide the framework for evaluating reasonable alternatives that may currently achieve the Board's goals.

This approach allowed the Board to look at a range of alternatives that would not be reasonably expected to exceed the significant adverse impacts analyzed in these other documents. It allowed the Board to focus their attention on the likely outcomes for achieving results and any additional variation in the potential impacts related to the current Alternatives. This approach involved the consideration of impacts that could be important to the relative level of risk that the Board is willing to accept when selecting a Preferred Alternative.

Where some environmental objectives or strategies were not finalized—such as with DNR's long-term marbled murrelet strategy or riparian conservation strategy—the Alternatives incorporate the most likely outcomes based on current knowledge and compliance with state and federal laws. The policies in the Final EIS incorporate the mitigation analyzed in the Draft EIS and Final EIS.

For additional information on northern spotted owls and marbled murrelet, refer to Chapter 2 and Chapter 4 in the Final EIS.

Subject Area: Impacts Analysis
Issue: Model Assumptions

Comment Summary:
Information about the model, its calibration, validation, and sensitivities was not disclosed. The make-up, utilization, interpretation, and application of the modeling results in the Draft EIS analysis of impacts and a clear set of assumptions also were not disclosed. There are inconsistencies between DNR's and other agencies' data. Comments questioned the validity of model results and the sensitivity of the model to varying inputs and whether potential modeling errors referred to in the Draft EIS for the Preferred Alternative might also be present in other Alternatives. Other comments stated that the conservative modeling approach should be highlighted, and that an optimization model would "improve" results.

Response:
The purpose of modeling was to illustrate a range of alternatives for forested trust lands that would represent an array of policy decisions under consideration by the Board of Natural Resources. DNR employed a rigorous process in the development of the models and the best available knowledge, expertise, and data were incorporated from both within and outside DNR. The model is used in conjunction with accepted science to help understand likely environmental effects resulting from policy and procedure alternatives. However, the assumptions that went into the model are complex and highly technical and do not help one to gain a meaningful understanding of the policy and procedure components of the Alternatives. The policy and procedural assumptions going into the development of the Alternatives are disclosed in the Draft EIS and Final EIS. For additional information refer to Chapter 2 of the Final EIS.

Consistent data inputs were used for each of the Alternatives, including those defining areas that are deferred or limited for harvest, the forested trust land inventory, and resources on the land base. DNR expects that data from different sources and created for different purposes will frequently not agree. In instances where DNR had incomplete data for forested trust lands, data were sought from other sources.

A technical review committee made up of industry, government, and academic experts reviewed the entire process, including modeling software, data, and assumptions, in detail. For a list of the technical committee and modeling participants, refer to Appendix B, Section B.2, in the Final EIS. DNR regional staff reviewed the outcomes of the modeling to help verify the information, and comments were incorporated to help calibrate the models for future runs. This was a technically robust and rigorous process that was carefully scrutinized throughout the development and operation of the model. The technical advisory committee's review of the process indicated that they believed the modeling approach used to be reasonable, and that while an optimization model approach has some advantages, the simulation approach chosen to model outcomes also has compelling advantages. Those advantages outweighed the advantages of another modeling approach in light of the goals of this program.

The modeling outcomes presented for riparian areas in Alternative 6 in the Draft EIS were the result of specific modeling strategies for this Alternative that were not employed in the other Alternatives. Therefore, the errors identified as concerns in the Preferred Alternative would not be expected to occur or affect the other Alternatives. Alternative 6 was modified and replaced with the Preferred Alternative in the Final EIS. The Final EIS analyzes Alternatives 1 through 5 and the Preferred Alternative (see Final EIS, Chapter 2). For further explanation of outcomes of individual Alternatives, refer to the analysis of impacts to resources in Chapter 4 of the Final EIS.

Subject Area: Impacts Analysis
Issue: Need for a Supplemental Draft EIS

Comment Summary:
Recalculations, the identifying of a Preferred Alternative that mixes or matches policy interactions in a new set of modeling outputs, and recent information that supplements the Habitat Conservation Plan analysis will require a supplemental draft environmental impact statement and opportunity for public comment.

Response:
An analysis of the Preferred Alternative has not revealed any new impacts that are outside the range of analysis in the Final EIS. Under these circumstances, DNR believes the formulation of a Preferred Alternative from the components of Alternatives previously studied in the Draft EIS and the provision of additional analysis in response to public comments on the Draft EIS, are among the appropriate functions of the Final EIS (WAC 197-11-560). A discussion of the impacts specific to the Board of Natural Resources' identification of a Preferred Alternative, including a discussion of northern spotted owls, are disclosed in Chapters 2 and 4 of the Final EIS.

Subject Area: Impacts Analysis
Issue: Public Input Process

Comment Summary:
The openness, inclusiveness, and thoroughness of the process (e.g., technical advisory committee, linking stand structure to habitat suitability, and spatially

explicit modeling) were all acknowledged. Other comments stated the need for more hearings, longer hearings, hearings located in more locations, and a longer comment period. Some felt that DNR was responsive to inquiries, while others felt ignored and that more DNR employee participation and coordination with Washington Department of Fish and Wildlife is needed.

Response:
DNR and Board of Natural Resources are committed to an open process. In addition to open houses and public meetings, the open process is ensured through the requirements of the State Environmental Policy Act. For some proposals, including this work on the sustainable harvest calculation, DNR chose to exceed the minimum requirements to ensure the intent of the State Environmental Policy Act is accomplished when soliciting public input. The opportunities to comment both during the formal State Environmental Policy Act process and the Board's regularly scheduled meetings helped provide for an exchange of information that exceeds the State Environmental Policy Act requirements and meets the Board's intent to inform their decisions with public concerns regarding this sustainable forestry proposal. A total of 17 meetings, including public hearings specifically related to sustainable forest management, were conducted in addition to the regularly conducted Board meetings over the last 2.5 years. Additionally, DNR extensively consulted with the Washington Department of Fish and Wildlife, which also had a staff member on the technical advisory committee.

Subject Area: Impacts Analysis
Issue: Range of Alternatives

Comment Summary:
Comments ranged from a belief that the Alternatives were too broad and outside of the objectives stated for the sustainable harvest calculation proposal to being too narrow and not considering options that would reduce harvest levels. The range of Alternatives is inadequate because it does not include any that decrease harvest and emphasize trees and wildlife. There is a lack of increased environmental protection caused by increasing harvest levels over current levels.

The Alternatives may not be feasible to implement. There is a disregard for science and history and opportunities for change. There should be a locally tailored alternative. DNR may be underestimating the potential harvest yield, inappropriately limiting alternatives to relative minor reductions in overstocked stands, and going beyond the scope of the Habitat Conservation Plan by exceeding a standard of minimizing and mitigating adverse impacts.

Response:
The range of Alternatives considered represents the Board of Natural Resources' decision-making parameters as forested trust land manager for achieving the stated objectives, purpose, and need of the proposal (see Chapter 2 of the Final EIS). All of the Alternatives, with the exception of the No Action Alternative were considered feasible and reasonable to consider in that they would meet these stated goals. The one Alternative that is not required to meet the Board's objectives, purpose, and need is the No Action Alternative. The Draft EIS and

Final EIS show a range in the increased level of harvest possible under each of the other Alternatives. However, none of the Alternatives reach the maximum historical levels of timber harvest from forested trust lands in western Washington.

Consistent with meeting the conservation objectives of the Habitat Conservation Plan, one of the objectives is to provide the highest quality habitat possible while providing as much revenue as possible to the trust's beneficiaries over time. Higher quality habitat can be created through specific harvesting designs. The Board's identification of the Preferred Alternative reflects adequate habitat retention and creation through increasing the percentage of complex forest structures over time, implementation feasibility, consideration of the Best Available Science, and an acceptable level of risk to resources and trust beneficiaries. Implementation will be guided by a number of processes that are in place to monitor and adjust activities. DNR performs several types of monitoring as a part of the Habitat Conservation Plan agreement. The monitoring includes annual reports to the Federal Services that review the results of field audits and progress towards habitat goals. DNR also employs adaptive management—which means that it will change its strategy if scientific evidence shows that change is needed. For example, recently the Klickitat northern spotted owl amendment to the Habitat Conservation Plan reconfigured the targeted habitat to include higher quality habitat than was originally designated by the Habitat Conservation Plan. The Board has also requested annual reports on progress towards habitat and volume goals (see Board Resolution 1110 in Appendix F of the Final EIS).

For additional information and analysis of the Preferred Alternative, refer to Chapters 2 and 4 of the Final EIS and the proposed procedure for Implementation Planning in Appendix F of the Final EIS.

Subject Area: Impacts Analysis
Issue: Scale and Resolution of Impact Analysis

Comment Summary:
Comments stressed that the model outputs need to be analyzed in terms of impacts by Alternative, resource, and watershed. Others suggested that watershed analysis at this level of planning is unnecessary. Others expressed that some random analysis of landscapes or Watershed Administrative Units (WAUs) would help. Concerns were raised that the policy and procedure changes must be spelled out in order for their impacts to be analyzed and that the harvest levels should be based on field information rather than a top-down approach.

Response:
The modeling is carried out to inform the Board of Natural Resources' decision of likely outcomes at the scale of DNR's HCP Planning Unit (of which there are five Westside HCP Planning Units and the Olympic Experimental State Forest in western Washington). DNR has been modeling various strategies that would implement a range of policy positions for achieving the Board's objectives for sustainable forest management on forested trust lands in western Washington. The Alternatives show what is theoretically possible based on existing and

anticipated constraints and other management assumptions, including the use of a much more accurate inventory of forested trust lands than when the last calculation was carried out in 1996.

Concerning the potential environmental impacts associated with each Alternative, the Draft EIS and Final EIS illustrate that each Alternative has the ability to achieve a common objective of increasing the percentage of state forested trust lands that contain more structurally complex forests. Although the analysis does not specifically identify individual landscapes or watersheds smaller than the HCP Planning Unit, it does consider a range of harvest intensities across WAUs within the land classifications used in the Draft EIS and Final EIS analyses. The impacts relative to the land classifications have been considered in the Board's identification of a Preferred Alternative.

For information regarding the impacts of the Preferred Alternative, refer to Chapter 4 of the Final EIS, including the discussion of Cumulative Effects in Section 4.15. For information regarding the policies needed to implement the Preferred Alternative, refer to Appendix F in the Final EIS. For information regarding land classifications used in the analysis refer, to Appendix B-2 in the Final EIS.

Subject Area: Alternatives
General Response for all the Alternatives

All comments were sent to the Board of Natural Resources for their consideration in developing a Preferred Alternative, and the Board has extended its appreciation for comments received about all of the Alternatives. The Preferred Alternative combines certain features from all six Alternatives analyzed in the Final EIS.

Concerns raised in each Alternative about different policy, procedural, or operational components are responded to in the appropriate issue areas in the following responses.

For additional information or comparison information regarding the Preferred Alternative, refer to Section 2.6 of the Final EIS.

Subject Area: Alternatives
Issue: Alternative 1

Comment Summary:

Comments in support of Alternative 1 expressed a range of suggestions that include the following: protect remaining old forest, obtain Forest Stewardship Council Certification, and keep the 50/25 rule in place. Others did not support this Alternative because it did not provide an adequate revenue stream to trust beneficiaries and it maintained the administrative owl circles.

Comments also questioned the harvest level of 396 million because it is far less than the 560 million calculated at the time of the Habitat Conservation Plan, and commenters wanted clarification based on this discrepancy. Comments said that the conservation benefits in the Habitat Conservation Plan could be modified for higher harvest levels while still maintaining the agreed-upon level of habitat.

Response:
Concerns are responded to in the appropriate issue areas of this response summary (i.e., Forest Stewardship Council certification is addressed under its own category; for responses regarding Forest Stewardship Council certification, refer to comment response on "Certification").

Alternative 1 represents the Board of Natural Resources' existing policies and DNR's forest management strategies as indicated by DNR Forest Resource Plan Habitat Conservation Plan, DNR procedures and tasks, current DNR operations, and all current federal and state statutes.

The discrepancy between the 396 million board feet anticipated from Alternative 1 and the 575 million board feet is due to the added current northern spotted owl management strategy, lack of a riparian procedure, and updated inventory. New constraints were added following the calculation but not considered in the determination of the harvest level. The new constraints include reserving additional owl circles; a more restrictive approach to nesting, roosting, foraging, and dispersal habitat; the 50/25 rule; and changed assumptions about decadal flow.

Subject Area: Alternatives
Issue: Alternative 2

Comment Summary:
Alternative 2 is what DNR should have been doing since the Habitat Conservation Plan was adopted. It represents the Habitat Conservation Plan intent as negotiated with the Federal Services and adopts a modified non-declining even flow constraint. This harvest level is lower than what was initially anticipated when the Habitat Conservation Plan was signed. Some comments did not support this Alternative because it offered too much compromise and not enough timber.

Response:
Alternative 2 models the *intent* of the Habitat Conservation Plan and represents existing Board-approved policies and forest management strategies as defined by the 1992 Forest Resource Plan, 1997 Habitat Conservation Plan, and current federal and state statutes, including Forest Practices Rules. However, it does not include all current DNR administrative procedures in DNR's Forestry Handbook.

Subject Area: Alternatives
Issue: Alternative 3

Comment Summary:
Comments supporting Alternative 3 thought it would offer a variety of advantages, such as providing savings in management costs and an increase in harvest levels over Alternative 1, while providing the necessary revenue to counties. Comments that did not support Alternative 3 said it would result in a disadvantage to individual trusts, wouldn't provide sufficient revenue, and would

benefit the Forest Board lands at the expense of the county trusts, which could call into question DNR's duty of undivided loyalty. An explanation is needed for the Draft EIS claim that consolidating the trusts would result in doubling harvest volumes.

Response:
Alternative 3 is modeled with the intent of combined ownership groups while still representing existing Board of Natural Resources-approved policies and forest management strategies as defined by the Forest Resource Plan, Habitat Conservation Plan, and current federal and state statutes.

Combining ownerships, and therefore eliminating the restrictions caused by age classes and boundary lines, as proposed in Alternative 3, provides the opportunity for more variations of potential harvest strategies. In addition, the harvest level increase during the first decade of about 300,000 acres is due to long-term deferral areas being released, which results in about 15 percent of the forestland base in long-term deferral instead of 37 percent taken out of long-term deferral.

The Preferred Alternative outlined in the Final EIS uses 20 ownership groups (17 Forest Board Counties, Capitol Forest, Olympic Experimental State Forest with all federally granted trust lands, and Forest Board-purchased lands as a single group (Board Resolution 1110, Section 4 (c)). The combined ownership in the Preferred Alternative results in more acres available for management activities by the end of the first decade.

DNR believes that the common law requirement of undivided loyalty to trust beneficiaries is fundamental. This principle requires that trust land and its assets not be diverted to benefit others at the expense of the trust beneficiaries without compensation. There is, however, no requirement to avoid providing others with collateral benefits. The trustee simply must make all decisions with the beneficiaries' interest first and foremost in mind (DNR 1992).

Subject Area: Alternatives
Issue: Alternative 4

Comment Summary:
Alternative 4 is best because it includes no environmental "rollbacks," allows the possibility for forest certification, longer rotation ages, and minimized recreation impacts. This Alternative would protect salmon and create a higher percentage of botanically diverse and fully functional forestlands. Revenues would be higher because of the premium paid for higher quality saw logs. However, other comments expressed the idea that it did not provide sufficient revenue to trust beneficiaries, would create forest health issues, and create logs too large for local mills to process.

Response:
Alternative 4 is modeled with a passive management approach while still representing existing Board of Natural Resources-approved policies and forest management strategies as defined by the Forest Resource Plan, Habitat

Conservation Plan, and current federal and state statutes. Passive management refers to a land management approach that allows forest growth and structural development processes to occur with little silvicultural (cultivation of forest species and stand care) activity.

The wood products market and DNR's role in the market has been studied to some degree. A market analysis of the Alternatives was presented to the Board prior to their decision on the components of a Preferred Alternative. As the manager of state trust lands, it is DNR's responsibility to protect the trusts and to provide options for current and future trust beneficiaries, including appropriate levels of revenue production. DNR cannot predict with confidence what will happen to log markets or the future ability of mills to process large-diameter logs; however, DNR will continue to monitor market dynamics and trends, particularly for large-diameter logs. DNR has an interest in future markets and will continue to monitor those markets to ensure that DNR's wood products continue to play an important role.

Recreational impacts from harvesting activities vary based on the harvest activity and are addressed at the operational level. For further information on the current DNR policy for Recreation on State Forest Lands, refer to the Forest Resource Plan Policy No. 29.

Subject Area: Alternatives
Issue: Alternative 5

Comment Summary:
Alternative 5 is best for a variety of reasons, such as the following: it creates both direct and indirect jobs; it complies with the Habitat Conservation Plan requirements and state and federal laws; it meets fiduciary responsibilities; and it increases revenue to the junior taxing districts. Additionally, it strikes a balance between revenue generation, employment creation, and habitat production while providing more money for schools. Those in opposition to Alternative 5 have concerns about the credibility of the science and believe it would create shorter rotations and more clearcuts, which are not in the best interests for forests, fish, wildlife, or for recreational opportunities.

Response:
Alternative 5 is modeled with an intensive management approach while still representing existing Board of Natural Resources-approved policies and forest management strategies as defined by the Forest Resource Plan, Habitat Conservation Plan, and current federal and state statutes. Intensive management or active management refers to a land management approach that accelerates forest growth and structural development processes through greater use of silvicultural activities.

A technical advisory committee made up of industry, government, and academic experts reviewed the entire process, including modeling software, data, and assumptions in detail. For a list of the technical committee and modeling participants, refer to Appendix B in the Final EIS.

For additional information, refer to comment responses in issue “Impact Analysis,” subject area “Range of Alternatives.”

Subject Area: Alternatives
Issue: Alternative 6

Comment Summary:
Those in support of Alternative 6 favored it for a variety of reasons, such as the following: it produces the highest yields while focusing on habitat needs, it focuses on riparian restoration, it combines biodiversity pathways with conventional intensive management, and it is based on credible science. Those in opposition of this Alternative believed it is the wrong approach for state forests because of increased clearcutting and shorter rotation ages. Concerns were also expressed about increased management along streams, which will result in additional emphasis being placed on stand structure over revenue. Still others wanted a realistic economic analysis because of the heavy reliance on experimental forestry with this Alternative, which could increase windthrow, while others have concerns about the lack of federal approval regarding the riparian procedure. There were requests for more information concerning the modeling errors that were stated in the Draft EIS for this Alternative, which then led to questions regarding modeling errors on other Alternatives.

Response:
Alternative 6 is modeled with an innovative silvicultural management approach while still representing existing Board of Natural Resources-approved policies and forest management strategies as defined by the Forest Resource Plan, Habitat Conservation Plan, and current federal and state statutes.

As clarified in Section 4.3 of the Final EIS, the model assumptions used to build Alternative 6 did not adequately restrict the acreage of activities in riparian areas. The result was a model that did not effectively represent the policy objective of Alternative 6. Therefore, this Alternative showed high estimated levels of activity—higher than might be either operationally feasible or achievable under a long-term riparian conservation strategy. However, the result provided a useful illustration of the environmental effects of such a management course.

Harvesting activities in the riparian areas are low-volume removals, mostly thinnings, with some patch cuts (removing a small stand of trees to create openings to allow light and for other desired vegetation to thrive). These activities are necessary to produce the increase in the amount of more “fully functional” complex forests in riparian zones.

Intensive timber management in the form of patch cuts and upland clearcuts can also affect the risk of windthrow in riparian buffers. Data for windthrow within riparian buffers from seven studies reported in Grizzel and Wolf (1998) had a mean windthrow rate of about 15 percent for 344 sites in western Washington and Oregon, with maximum windthrow rates ranging from 17 to 100 percent in the different studies. Pollock and Kennard (1998) re-analyzed several windthrow data sets by looking at the relationship between buffer width and likelihood of windthrow. They reached the conclusion that buffers of less than 75 feet have a higher probability of suffering appreciable mortality from windthrow than forests with wider buffers. In general, vulnerability to windthrow tends to return to normal a few years after logging (Moore 1977; Steinblums 1978; Andrus and Froelich 1986).

The Preferred Alternative reflects changes in modeling technique that benefited from the Alternative 6 lessons, resulting in an Alternative with greater restrictions on activities in the riparian management zone; the Preferred Alternative models smaller areas treated and fewer entries. This combination is more feasible operationally. DNR believes that the Preferred Alternative, both in intent and in outcome, represents an approach that can be implemented within what is anticipated under a current draft of the riparian conservation strategy.

The goal of harvesting in the riparian areas is to achieve better and more diverse habitat. Except as expressly permitted by the Habitat Conservation Plan, there are no harvests within the core Riparian Management Zones. For additional information regarding DNR approval on the Riparian Conservation Strategy, refer to comment response for “Riparian Procedure/Habitat Conservation Plan Compliance.”

Subject Area: Alternatives
Issue: Components of a Preferred Alternative

Comment Summary:
Many combinations of different alternatives were suggested as a way to maximize revenues and provide continued environmental protections while not foreclosing on options for forest certification. Some were interested in selecting certain components for a Preferred Alternative, which include maximizing revenue while providing a steady timber supply, complying with the Habitat Conservation Plan, increasing environmental protections, and attaining certification for state forests. Suggestions also were provided for developing different alternatives for specific geographical areas by working with a coalition of industry, Native American tribes, and environmental groups to develop new alternatives. Some also suggested a “true” no impact alternative or one that maintains the viability of the environment rather than “short-term profits.” This suggested alternative would “truly” analyze the environmental impacts, encourage native species, protect old growth, and reflect a wider range of management options to benefit future generations with respect to protecting environmental features.

Response:
DNR believes the Board of Natural Resources Preferred Alternative does maintain the viability of the environment and benefits future generations. The Preferred Alternative aims not at “short-term profits” but at sustainable long-term revenue for schools and other public institutions, along with long-term Habitat Conservation Plan compliance.

For information regarding the process for selecting a Preferred Alternative, refer to Chapter 2 of the Final EIS

Subject Area: Trust Land Revenue
Issue: Alternative Revenues

Comment Summary:
Funds for school construction should be acquired with less reliance on timber harvesting, but when harvest does occur, it should be focused on specific age classes and species to maximize its revenue generation. Comments recommended many ecological, economic, and social alternatives for revenue generation, ranging from the need to manage the trust portfolio differently to acquiring additional urban and forestland, or to charge permit fees for forest products such as floral greens and recreational activities.

Response:
DNR has specific statutory or constitutional authorities that largely focus on land management for the specific and direct financial benefit of the trust beneficiaries. DNR continuously examines the distribution and productivity of trust assets to best serve the interest of beneficiaries. The revenue generated through DNR's management of trust lands comes from a variety of sources, the largest of which is the sale of timber. Although the primary economically productive use of the 2.1 million acres of forested trust lands across the state is timber production, DNR continues to find other creative ways to earn revenue on forested trust lands. However, alternative sources of revenue are not the focus of the sustainable harvest calculation, nor are they within the scope of the environmental analysis contained in the Draft EIS or Final EIS. Alternative sources of revenue will be reviewed during the Forest Resource Plan update.

DNR selects stands of trees for harvest based on a number of criteria, such as stand maturity, value, location, age of adjacent stands in the landscape, sensitive resources, and social concerns. The Preferred Alternative focuses management on selecting stands that optimize the economic value of forest stands and timber production over time within the context of meeting forest health and habitat goals. For a detailed description of how lands are selected for harvest under each of the Alternatives, including the Preferred Alternative, see Chapter 2, Section 2.6.

Subject Area: Trust Land Revenue
Issue: Economic/Financial Analysis

Comment Summary:
An economic and financial analysis is needed for each of the Alternatives concerning past and current management decisions and the costs associated with the Habitat Conservation Plan. The Final EIS needs to show how riparian harvests contribute to revenue production. The Draft EIS failed to explain why current harvest levels failed to meet volume targets and what DNR will do to ensure that future harvest volumes will meet the desired projections. Negative discount rates should be used to recognize the increasing importance of forest

resources over time and DNR needs to explain the costs and the benefits of the proposed Alternatives.

Response:
Economic and financial analyses have been presented to the Board of Natural Resources on an ongoing basis since the release of the Draft EIS, including how portions of the riparian management zone that contribute to functioning riparian areas also contribute to revenue production under each of the Alternatives. This economic analysis, however, is not the purpose of an environmental impact statement and is not contained in the Draft EIS or Final EIS. The purpose of this calculation, however, is to set management direction for the future rather than to examine past management decisions.

Despite this, the reasonable Alternatives, including the No Action Alternative and Preferred Alternative, help provide an understanding of the impacts of past management decisions on harvest levels. The No Action Alternative depicts current management and provides an estimate of the sustainable harvest level into the future under current management practices. Likewise, Alternative 2 depicts a sustainable harvest level under management practices that implement only the Habitat Conservation Plan without current additional management constraints. These two Alternatives offer a picture of the differences in harvest levels between a “strict” Habitat Conservation Plan implementation approach and the current approach, and some clues as to why harvest levels, set as a result of the 1996 harvest calculation, has not been achieved.

DNR has taken great care to undertake a calculation that incorporates a review by its regional staff to ensure that activity levels and harvest volumes are realistic. The goal of this process is to set an achievable harvest level for the future. In addition, as implementation of the Board-selected harvest Alternative is undertaken, new information is gathered, and currently undeveloped conservation strategies are approved by the Federal Services, adjustments to the calculation may be required.

DNR applies a positive discount rate of 5 percent when calculating the value of timber resources into the future, in accordance with Forest Resource Plan (DNR 1992) Policy No. 12. This is one of the underlying assumptions of all revenue projections presented to the Board and the public through this process. In addition, the costs and financial returns of each of the reasonable Alternatives have been presented to the Board and the public on a regular and ongoing basis as estimates have been refined and improved. This information is not contained in the Draft EIS or Final EIS. The Board meeting minutes, which contain information presented to the Board, are available on DNR’s Web site at http://www.dnr.wa.gov/

Subject Area: Trust Land Revenue
Issue: Management Costs

Comment Summary:
DNR's management costs are high, and DNR needs to be more efficient. The current management fee is not sufficient to manage forests in perpetuity, and DNR needs more flexibility to be more responsive to markets.

Response:
DNR consistently manages the costs of business given variable timber prices, which results in changes in budgets and improved understanding of operating efficiencies, market opportunities, and advances in silvicultural research. DNR staff is examining issues of operating efficiency and costs associated with management under today's practices versus possible future management scenarios (depending upon the result of the sustainable harvest calculation), and the relationship between those costs and the money retained for reinvestment. This money is placed in the Resource Management Cost Account and the Forest Development Account for the ongoing management of forested trust lands. Discussions continue with the Board of Natural Resources on this subject.

DNR endeavors to remain flexible and responsive to timber markets. The Preferred Alternative shifts management to prioritize stands for harvest based on value rather than volume, which will better reflect the market at that time. In addition, staff continues to explore ways to expand the range of timber products offered on forested trust lands. Pole, hardwood, and contract logging sales, among others, will continue to be pursued as sources of revenue.

DNR is committed to increase net returns to the beneficiaries while meeting all conservation objectives. DNR will evaluate additional opportunities to further increase effectiveness and efficiency; this will take the form of a report by the trust manager (DNR) to the Board and the trustees. Publication of this report is anticipated by the end of the 2004 calendar year.

Subject Area: Trust Land Revenue
Issue: Maximum Harvest and Revenue

Comment Summary:
The maximum harvest and revenue are needed to provide a more stable source of revenue for schools, junior taxing districts, counties, and timber-dependent communities and provide relief for the taxpayer. Keep state land revenue generation high to discourage sale of forested trust lands and conversion to non-forest uses. Active management can create more jobs for local communities. Accelerated logging will result in minimal short-term funding gains for schools.

Response:
DNR has explored the linked issues of optimizing revenue over time and providing revenue stream stability to the beneficiaries, both in the Final EIS (Chapter 4, Section 4.2) and directly with the Board of Natural Resources. In short, there is a trade-off between increasing near-term revenue and providing revenue stability. To absolutely maximize revenue, beneficiaries must accept at

times wide fluctuations in the revenue stream. Constraining revenue production during some time periods, in order to assure enough revenue at other times, can reduce that variability. This constraint, however, can result in inefficiencies and lost opportunities in long-term revenue production. This assumes a closed system in which the land base, age class distribution, etc., do not change over time. In reality, a forest is not a closed system.

Trust land managers oversee its assets to better modulate revenue fluctuation over time through decisions about silviculture, asset management (land sales and replacement purchases), and other revenue sources. For further analysis of this relationship, please see the discussion of environmental effects in Section 4.2 of the Final EIS.

DNR recognizes the great asset that forested trust lands provide to the beneficiaries and all the people of the state of Washington. Forested trust lands serve many functions, including helping to fund public institutions; providing wildlife habitat and other conservation benefits; and protecting sensitive resources, recreation areas, and visual areas. Ultimately, however, as trust manager, DNR must manage the trust assets in the best near- and long-term interest of the beneficiaries within all current legal directions. As such, DNR must maintain forested trust lands in a productive capacity.

DNR will continue to manage trust lands for long-term revenue production and conservation objectives. DNR will manage those lands in a manner that best fulfills these goals within the existing statutory, contractual, and regulatory framework. Forest management has secondary benefits to local communities, which will continue under the Preferred Alternative.

Subject Area: Trust Land Revenue
Issue: Value of Timberlands as Intact Forests

Comment Summary:
Healthy intact forest ecosystems have “values” that are beyond measure, that are not subject to economic fluctuations. The public depends on state lands for recreation, habitat for wildlife, and critical watershed functions. When state forests are managed too intensively, management flexibility is decreased over the long-term.

Response:
Forested trust lands fulfill many functions, some measurable (revenue, acres of habitat) and some immeasurable (recreation, value of intact ecosystems, spiritual value). Forested trust lands will continue to serve in those capacities and will be managed in a manner that does not interfere with DNR’s primary fiduciary responsibilities.

There are a variety of silvicultural and management tools available to maintain management flexibility over the long term. Each of the Alternatives implements strategies that affect future management options. There are advantages to each approach—overly intensive management reduces flexibility over time, as does overly passive management. The choice of the best strategy depends on the management goals for a given landscape, not a one-size-fits-all approach across the state. The Preferred Alternative attempts to blend approaches to provide some flexibility by managing for today and tomorrow to provide both habitat and revenue, in addition to less measurable values.

Subject Area: Social/Economic Concerns
Issue: General Concerns

Comment Summary:
DNR needs to be more aware of societal pressures, from the need to recycle to reduce natural resource consumption to how environmental degradation has contributed to the mental health problems of today's youth. Working forests have historically—and are today—an important component of a diverse economic base and help protect against low-density urban sprawl.

Response:
DNR forested trust lands provide economic, ecological, and social benefits to all the people of Washington. Most forested trust lands in western Washington are within 20 minutes of urban centers. These lands continue to provide extensive benefits to those populations, including a steady stream of public benefits and services that doesn't come from taxes, forests that protect water quality and quantity, habitat for diverse native fish and wildlife, jobs in natural resource-based communities, and opportunities for millions of people to visit and enjoy the solitude of nature, to name a few. DNR takes into account the social, environmental, and economic aspects of being a trust land manager. While the fiduciary responsibilities of trust management define many goals, many other desirable outcomes are achieved with these broad forested, mostly lower-elevation landscapes.

Subject Area: Social/Economic Concerns
Issue: Economic Viability

Comment Summary:
Harvesting younger trees at shorter rotations is economically advantageous for local mills. The management of forested trust lands has a direct impact on the economic vitality of the local communities, counties, and junior taxing districts.

There is already an oversupply of small wood on the market and longer rotations and higher quality timber is more within the long-term interest of DNR. Forests should be managed for income, jobs, habitat, and recreation.

Response:
DNR's responsibility as a prudent trust manager is to produce both short- and long-term income for the trust beneficiaries. The Board of Natural Resources specified that each of the Alternatives and components of the Alternatives must meet DNR's legal and policy mandates, including federal and state laws, the trust mandate, and the Habitat Conservation Plan. Analyses examined primary financial impacts to the trusts and the socioeconomic resiliency of western Washington counties (Daniels 2004). Secondary or indirect benefits to local

communities as a result of state timber harvest may be desirable but are not a stated objective of management.

The Preferred Alternative will likely improve forest structure in the upcoming decades; these improvements will result in more structurally complex and diverse forests, thus enhancing and creating habitat and recreational opportunities.

Subject Area: Social/Economic Concerns
Issue: Educational Opportunities of a Managed Landscape

Comment Summary:
State forests offer educational opportunities for DNR and the classroom. DNR and research institutions should collaborate to increase statewide environmental education to create more learning opportunities and discussions around forestry. Create a DNR program that promotes scientific coordination at the university and K-12 levels, especially those educational institutions that are trust revenue recipients.

Response:
DNR is aware that many levels of understanding exist regarding forest management activities on forested trust lands. DNR is working collaboratively on research, monitoring studies, and educational programs and will continue to work with the public through various forms of public outreach and education. One example of the type of collaborative research that DNR is currently working on is the Small Stream Buffer Experiment. This study is examining the possible impacts and consequences of different management approaches along first order streams. This is a cooperative study with the U.S. Forest Service Pacific Northwest Station and the University of Washington. This research will be used for the development of a long-term conservation strategy for Type 5 streams.

DNR is also actively involved with a variety of educational programs such as the Students in the Watershed program. This program gives North Mason High School students a year-long opportunity to work and learn about the Tahuya State Forest. Students work with DNR mentors to monitor and record the health of water and stream life in the Tahuya State Forest, set up timber sales, and conduct biological assessments. DNR just celebrated its tenth year working with the students in the Watershed program

Subject Area: Social/Economic Concerns
Issue: Full Cost Accounting

Comment Summary:
DNR and the Board of Natural Resources need to examine the analysis and the reports done on Full Cost Accounting and look at such risks as flooding, landslides, and loss of wildlife. Without understanding the full extent of the externalities that may befall the trust beneficiaries, the Board of Natural Resources is not fulfilling its fiduciary responsibilities.

Response:
In general, DNR agrees that decision-makers should evaluate the potential relevant future benefits, costs, and risks of proposed decisions. DNR believes it

carries out its obligations to act prudently and with foresight in pursuing with undivided loyalty the interests of the trust beneficiaries through management of forested trust lands. DNR employs economists and other specialists whose primary duties are to assess the risks and benefits of department decisions, whether those risks relate to market, ecological, or legal circumstances, and to recommend strategies to minimize risk and to maintain future options. The trust duty of "intergenerational equity"—fairness to this generation and to future generations equally—guides DNR to preserve the corpus of the trust, which is the trust lands themselves and their ecological functions and services, especially for the benefit of future generations of trust beneficiaries. Prudent trust management also avoids speculative enterprises, including overemphasis on highly speculative benefits, costs, or risks.

The state of Washington's Forest Practices Rules are intended to avoid many of the risks mentioned in the comments regarding "public resources." Full and proactive regulatory compliance is a foundation of forested trust land management.

Subject Area: Social/Economic Concerns
Issue: Global Markets

Comment summary:
DNR needs to examine its role in marketing within the global marketplace and examine how it could maximize future global wood markets, while maintaining responsible forest management. Other countries may have less productive capacity and more environmental problems.

Response:
DNR is not able to assess effects of DNR actions on global markets, impacts, or trends, nor does it guide its actions based on those factors. One of the reasons for this is that raw logs from forested trust lands cannot be exported under current federal law. However, the opportunity to harvest timber from Washington's forested trust lands in an environmentally sound manner provides revenue to schools, stimulates economic growth, and may lessen the demand for timber from forests in other parts of the world that do not have strong environmental stewardship.

Subject Area: Social/Economic Concerns
Issue: Impacts to Local Communities / Social and Economic Impact Analysis

Comment Summary:
The Final EIS needs to include an evaluation of the indirect impacts that forest management has on local communities in terms of taxes, revenues, jobs, and other industries. DNR needs to keep forested trust lands as working forests but needs to also consider the social impacts. DNR needs to pursue active management that will produce jobs, restore habitat, and generate revenue based on long-term stability and predictability.

Keep environmental protections without putting public resources at risk. Protect the rivers, which help sustain fishing-dependent communities. It is not DNR's responsibility to create jobs, and higher cut rates contribute to the boom and bust cycle that plagues timber-dependent communities. An economic and social impact study should have been included in the Draft EIS that looks at the impacts to rural communities, as well as, a realistic range of biological sustainability and market and financial conditions.

Response:
DNR and the Board of Natural Resources' duty is the long-term interest of the trusts, which benefit all local communities of the state in many ways through funding of public schools and universities, and helping to pay for public services in most Westside counties.

Under the State Environmental Policy Act, the purpose of an EIS is to evaluate the environmental impacts of a proposal, with specific reference to elements of the natural and built environment (RCW 43.21C.110 [1][f]). An EIS is not required to evaluate potential socioeconomic impacts, such as impacts to local and regional employment (WAC 197-11-448). As a result, this type of analysis is not included in the Final EIS. DNR did, however, commission a separate study that assessed the potential long-term effects of changing DNR management operations by evaluating the socioeconomic resiliency of Washington counties (Daniels 2004).

Under the State Environmental Policy Act there is no requirement for the inclusion of financial or economic analyses in an EIS. The State Environmental Policy Act notes that if a cost-benefit analysis is being considered by an agency for the proposal, it may be referenced in or appended to the EIS (WAC 197-11-450). With these points in mind, the EIS does not provide a cost-benefit analysis or directly address the financial and economic costs and benefits of the proposed Alternatives. However, DNR has and will continue to report to the Board the financial implications of the Board's decisions and the potential financial and other impacts to the trusts. This information is also available on DNR's Web site at http://www.wadnr.gov/.

Subject Area: Roads
Issue: General Concerns

Comment Summary:
Build no new roads, and reduce the number of roads using decommissioning projects to prevent problems with water quality and quantity. Budget constraints have resulted in road and culvert maintenance issues. What happened to the implementation of the road management strategy identified in the Habitat Conservation Plan (IV.62)?

Response:
None of the Alternatives changes the strategies for management of the road network or our compliance with the Habitat Conservation Plan and Washington Forest Practices Rules. Following the latest Forest Practices rules, the current road maintenance planning and repair requirements must be completed within the

next 12 years, a much shorter timeline than the multi-decadal analysis of the sustainable harvest calculation.

Acres treated under the sustainable harvest calculation in Alternative 1 (No Action) and the Preferred Alternative are less than harvest scenarios anticipated with the Habitat Conservation Plan.

For additional information concerning Roads refer to Chapter 4, Section 4.6, of the Final EIS.

Subject Area: Roads
Issue: Inadequate Analysis

Comment Summary:
Fully evaluate the impacts and effects of building roads on slope stability, erosion, soil compaction, habitat fragmentation, and water quality. An analysis of roads, by Alternative, is needed since increased harvest levels would require additional road building. A worst-case analysis is required (WAC 197-11-080(3)) and should be part of the Final EIS.

Response:
The existing road network already accesses more than 70 percent of DNR-managed “on-base” landscape; meaning that the various proposed sustainable harvest options would have little impact on future new road construction. A road density analysis for DNR forested trust lands shows a nearly equal road network density between “on-base” acreage and “short-term deferral” acreage.

Current DNR road management is subject to the Habitat Conservation Plan and Washington Forest Practices Rules. Environmental impact statements for these two directives analyzed road-related sediment and mitigation measures for environmental effects. None of the Alternatives are believed to exceed effects detailed in those documents. DNR road management strategies will be maintained under each of the Alternatives to mitigate potential adverse environmental effects.

The Forest Practice Act provides rules aimed at protection for potential environment impacts associated with timber harvestingThe “Forest and Fish” report, which resulted in the revision the Forest Practices Rules in 2001, were passed into law after DNR’s Habitat Conservation Plan and have significantly raised the level of environmental protection with respect to road management, unstable slopes, and fish blockage repair. Additionally, each road that is constructed is further evaluated under the State Environmental Policy Act as a part of DNR’s review of timber sale projects occurring on state lands.

For additional information concerning Roads, refer to Chapter 4, Section 4.6, of the Final EIS.

Subject Area: Roads
Issue: Road Planning and Building

Comment Summary:
Temporary roads cause environmental harm, and additional funding is needed to adequately address maintenance issues associated with roads and culvert replacement projects that block fish passage.

Response:
DNR road management is subject to the Habitat Conservation Plan and Washington Forest Practices Rules. Environmental impact statements for these two directives analyzed road-related sediment and mitigation measures for environmental effects. As described in Chapter 2 of the Draft EIS, the road network on forested trust lands is expected to be similar under all Alternatives due to the existing road network that already accesses over 70 percent of DNR's "on-base" landscape. However, road use is expected to be higher under Alternatives with higher harvest levels.

Funding for maintenance on DNR's roads is accomplished in conjunction with each timber sale and with Access Road Revolving Funds. Current projections are that the Preferred Alternative will generate enough funds for the Access Road Revolving Funds to adequately cover the costs of repairs under Road Maintenance and Abandonment Plans. The Preferred Alternative provides sufficient revenues to fully fund all Forest Practices road maintenance and abandonment responsibilities.

For additional information concerning Roads, refer to Chapter 4, Section 4.6, of the Final EIS.

Subject Area: Certification
Issue: Importance of Certification

Comment Summary:
Comments on certification ranged from conducting certification prior to setting the sustainable harvest level to having certification done after the Preferred Alternative is chosen. There was concern that many Alternatives under consideration would preclude certification. Certification would build public trust and ensure economic, social, and environmental standards. A variety of certification programs were recommended for DNR to pursue, such as Forest Stewardship Council, Sustainable Forestry Initiative, or self-certification. Other comments suggest that certification is not needed because the Habitat Conservation Plan and Forest Practices Rules provided the necessary environmental protections.

Response:
Certification is being considered in a parallel process to the sustainable harvest calculation. If DNR and the Board of Natural Resources decide to pursue certification, impacts to harvest levels will be evaluated at that time. This approach does not foreclose the Board option to pursue certification in the future. The Board is interested in information regarding a third party certification

system—Forest Stewardship Council and Sustainable Forestry Initiative, specifically. DNR is currently assessing the potential benefits and costs. DNR believes that the Habitat Conservation Plan and the Washington Forest Practices Rules, under which DNR manages its lands, are based on credible science and represent a high standard that could be certified.

Subject Area: Certification
Issue: Economics of Certification

Comment Summary:
There are a variety of economic advantages to certification, such as a competitive edge in the marketplace, added market value for timber, and an increase in revenue. Some disadvantages to certification are that it's not economically beneficial and will increase costs for DNR. In addition, comments expressed advantages for certification because it would meet the full extent of the trust mandate in maximizing revenue, while others expressed the view that certification violated the trust mandate and undivided loyalty to the trust beneficiaries.

Response:
DNR is examining the potential benefits of certification—specifically, Forest Stewardship Council and Sustainable Forestry Initiative. Currently there is no price incentive for a forest landowner to sell certified timber. According to a recent Oregon State University study, when both Forest Stewardship Council timber and non-certified timber were priced the same, the certified timber was chosen by roughly 2 to 1. However, when the price of certified timber was increased by 2 percent, the non-certified lumber was chosen roughly by 2 to 1 (Anderson and Hansen 2003). Because the economic benefits of certification for the trust beneficiaries, as yet, are nonexistent or speculative, and the costs of Forest Stewardship Council certification appear to be substantial, the Board of Natural Resources as trust manager is proceeding very cautiously. The Board is committed to its trust obligation of having a dual duty of prudently producing income for present and future trust beneficiaries and avoiding speculative enterprises. The Board and DNR remain interested in forest certification and fully intend to pursue additional information in the future.

For additional details on certification, see the January 2004 Board of Natural Resources meeting minutes.

Subject Area: Implementation
Issue: Field Verification / Region Review

Comment Summary:
There are concerns about DNR's ability to implement any of the Alternatives because they were based on a model without ground-truthing. Rural communities need to be able to count on a predictable and stable income and timber volume. Planning should have driven the sustainable harvest calculation instead of the sustainable harvest calculation driving the planning. Landscape plans and road plans required by the Habitat Conservation Plan have not been implemented.

Response:
Ground truthing has occurred to the extent that it is reasonable for a policy-setting exercise on 1.4 million acres of DNR western Washington forested state trust lands. The forest inventory program has gathered information on the ground with a sampling intensity of a plot for every 5 acres on two-thirds of DNR forested trust lands in western Washington. The plot information gathered by contractors is quality control-checked by DNR inventory foresters. The information is then processed to predict forest structure and timber volume. The timber volume is checked against historical records from past harvests in the same vicinity. Early in the process of the sustainable harvest calculation, timber volumes were distributed to the region field offices for review, and based on their review, some of the timber volumes were adjusted.

The question of whether to do local planning first is interesting because ideally strategic planning should provide a foundation for tactical or local planning. An example of strategic planning is the Habitat Conservation Plan that did not allow each individual watershed to set up a northern spotted owl protection strategy. Rather, the strategy was based on allocated statewide objectives for owl protection in certain areas. The allocation of these statewide objectives then becomes a part of the landscape objectives, along with other policy objectives that are set by other high level planning exercises, such as the Forest Resource Plan.

DNR believes the commitments of the Habitat Conservation Plan and the Forest Resource Plan to conduct landscape planning are being met. The Habitat Conservation Plan (DNR 1997) states “landscapes assessments utilizing the concepts of landscape planning can be useful and successful at many levels. For example, a plan based on a landscape assessment can be as simple as a computerized geographic information system (GIS) report that displays resource information that indicates forest stands available for various silvicultural activities.”

Refer to the comment response for “Implementation Planning,” which describes the systems that DNR has invested in over the past decade to accomplish planning, and also refer to draft Procedure PR 14-001-010 Forest Management Implementation Planning in Appendix F of the Final EIS.

Subject Area: Implementation
Issue: Implementation Planning

Comment Summary:
Demonstrate desired outcomes and analyze the risks from increased logging on watersheds. Additionally, without planning, how does the Board of Natural Resources know the true effects of their harvest calculation decisions? Concerns were raised about the methodology to calculate and assess the cumulative effects of timber harvest on each watershed as required by the Habitat Conservation Plan and Forest Resource Plan. There also are concerns with the lack of environmental review at the regional level associated with the implementation of a Preferred

Alternative or with producing the anticipated volume of harvest. Restricting harvest on some lands would result in a greater impact to other lands.

Response:
Planning has many elements and occurs at a number of scales. DNR has made major investments in the critical elements of planning.

Successful planning cannot take place without three elements:

(1) Data or information about the resource,

(2) Correct information about how management will occur, and

(3) A method to process or use the information in (1) and (2) above.

Forested state trust lands management programs have developed Geographic Information Systems databases for planning and tracking forest management activities. One such system is the forest inventory system, which provides a picture of timber growth and volume on a strategic level. The collection of data for the inventory system over the past decade has cost over $10 million. The inventory consists of temporary forest plots measuring trees, vegetation, snags, and down woody debris. The information is field-verified by foresters after it is collected. Historic information about timber sales volume is recorded and the timber volumes calculated for the sustainable harvest model (OPTIONS) are reviewed by region foresters.

Management of individual forest stands is tracked through DNR's Planning and Tracking system. Field and office staff use DNR's Planning and Tracking System to plan future management activities; to record information about management activities that have occurred on forested trust lands; and to track and monitor progress towards achieving desired objectives described in the Habitat Conservation Plan, Forest Resource Plan, and DNR procedures and tasks at the stand and landscape scales.

The Planning and Tracking System relies heavily on DNR's Geographic Information System-based data layers, which integrate trust ownership, forest inventory, Species and Habitats of Concern, Watershed Administrative Units, aerial photos, topographic features, roads, streams, archeological sites, and endangered species. The large data collection allows an assessment of volume and forest conditions at multiple scales, which provides foresters with a plethora of information about a forest stand that can be tracked through the Planning and Tracking Database system.

As a part of the Habitat Conservation Plan effort, DNR has spent over $21 million in the past 8 years on research and monitoring to understand appropriate management strategies to achieve the objectives outlined in the Habitat Conservation Plan. The GIS information provides a solid base for both strategic level planning, such as the sustainable harvest, as well as tactical and operational planning, which occur in the framework of a series of state laws that regulate forest activities to prevent or mitigate potential cumulative impacts.

DNR has published some landscape planning documents (Elochoman, Siouxon, Clallam River, Tiger Mountain, Tahuya) and continues to implement Forest Resource Policy No. 16 (with plans currently under development for Lake Whatcom and the Loomis State Forest). However, as the Forest Resource Plan is updated, DNR could see changes to the existing planning policy. Please refer to draft Procedure PR 14-001-010 Forest Management Implementation Planning in Appendix F of the Final EIS and refer to the response for "Road Planning and Building" and "General Approach" in the "Cumulative Effects" section for additional information.

Subject Area: Implementation
Issue: Monitoring

Comment Summary:
Monitoring is needed to ensure that the desired conditions are being met. Concerns were expressed that unless there is a system to monitor and evaluate predicted outcomes, these alternatives could be unsustainable and thereby violate intergenerational equity.

Some question whether thinnings are effective for enhancing wildlife activities and recommend that a cautious approach be taken regarding silvicultural prescriptions for riparian areas. In addition, some question whether DNR has the staff to monitor effectively, while others would like to have an independent third party monitor DNR's practices.

Response:
DNR is actively conducting implementation effectiveness and validation monitoring to assess implementation of our Habitat Conservation Plan. Implementation monitoring (also known as compliance monitoring) simply determines whether or not a management plan (e.g., a habitat conservation plan) is implemented properly on the ground. Effectiveness monitoring is done to determine whether or not the management plan is producing the desired habitat conditions. Validation monitoring is done to determine whether or not certain species respond to the desired habitat conditions as anticipated. Under the Board of Natural Resources Resolution 1110 Section 4(L), DNR is required to provide an annual report to the Board of its assessment of the environmental and economic results of implementing the Preferred Alternative. It also requires DNR to employ a structured monitoring and reporting program (see Appendix F in the Final EIS).

Adaptive management provides for ongoing modifications of management practices to respond to new information and scientific developments. The monitoring and research provisions of the Habitat Conservation Plan are in part designed to identify modifications to existing management practices. The Habitat Conservation Plan Implementation Agreement also details a process to respond to significant new information.

Subject Area: Policies and Procedures
Issue: Deferrals

Comment Summary:
Why is so much trust land currently off-base without the Board of Natural Resource's approval? Why are Natural Area Preserves, Natural Resource Conservation Areas, parks, and wilderness areas not used to satisfy habitat requirements? Discuss and analyze further the existing 35 percent of the land base, or 486,000 acres, in the off-base status and account for the number of acres that are off-base under each Alternative.

Response:
In the past, as DNR procedures were developed, it was difficult to predict the off-base designations that would occur as a result of implementation. Under Alternative 1, the amount of on-base lands is estimated at 654,100 acres, while the Preferred Alternative has 1,177,600 acres on-base by year 2014. The percentage of land in on-base and off-base status is provided in the Final EIS in Appendix B beginning on page B-7 for each of the Alternatives, including the Preferred Alternative.

Natural Area Preserves and Natural Resource Conservation Areas provide habitat in areas identified as important for achieving conservation objectives of the Habitat Conservation Plan, and DNR is given credit for the habitat contributions provided by these lands (DNR 1997). In addition, when developing the northern spotted owl strategy, one of the criteria for selecting Nesting, Roosting, and Foraging Management Areas was based on availability of DNR forested trust lands within 2 miles of federal reserves. DNR forested trust lands will be providing habitat across a wider elevation gradient than would be present if habitat were maintained only on federal reserves (DNR 1997).

Subject Area: Policies and Procedures
Issue: Environmental Protections

Comment Summary:
Do not increase harvest levels if it results in "rolling back" environmental protections for riparian buffers, critical wildlife habitat, leave tree requirements, unstable slopes, the 50/25 procedure, shorter rotations, or policies that eliminate certain mature forest components. New policies should enhance diversity in second growth forests for many uses. However, some believe enough concessions have already been made on forested trust lands through the development of the Habitat Conservation Plan.

Response:
One of the important outcomes of this recalculation and analysis is an assessment of alternate methods of both achieving the conservation benefits desired as a result of the Habitat Conservation Plan and meeting DNR's fiduciary responsibility as trust manager.

All of the suggested policy and procedure changes are consistent with all current federal and state statutes, the other policies of the Forest Resource Plan, Habitat

Conservation Plan, and Forest Practices Rules that may exceed certain requirements of the Habitat Conservation Plan. Therefore, there is no “rollback” of legally based environmental protections associated with state or federal law, Board of Natural Resources responsibilities, or Habitat Conservation Plan contractual requirements.

The Draft EIS analyzed the range of Alternatives and their associated environmental impacts with changes to certain polices and procedures. The environmental analysis is based on a review of proposed changes to policy and procedures under which DNR operates. The environmental impacts were analyzed in the Draft EIS and Final EIS for specific concerns regarding riparian areas, wildlife habitat, forest structure, geomorphology, soils and sediment, and cumulative effects.

The Preferred Alternative uses silvicultural practices designed to create, develop, enhance, and/or maintain forest biodiversity and health in specified locations. The Preferred Alternative is expected to result in the development of 10 to 15 percent of each of the five Westside HCP Planning Units and the Olympic Experimental State Forest as old forest based on structural characteristics.

For additional information or comparison information regarding the Preferred Alternative, refer to Chapter 2, Section 2.6, of the Final EIS.

Subject Area: Policies and Procedures
Issue: Even Flow

Comment Summary:
Some comments expressed confusion about the benefits of the even-flow policy. Some were not sure how harvest levels could be projected when management is based on revenue, and believed the even-flow policy would result in over-harvesting when prices are low. Some believe the current 25 percent (plus or minus) variation was sufficient to capture market fluctuations.

Response:
Timber harvest even-flow ensures that about the same amount of timber is available now and will continue to be available for future generations in perpetuity. The current policy for sustainable even-flow timber harvest is defined in Forest Resource Plan Policy No. 4. The policy states, “DNR will manage state (trust) forest lands to produce a sustainable even flow harvest of timber, subject to economic, environmental and regulatory considerations.”

In application, the term “even-flow” means that roughly the same amount of timber is offered for sale by DNR on an ongoing basis. It refers to the amount of variability from the sustainable forestry level that will be entered into the computer model. Different interpretations of sustainable even-flow will result in different harvest levels.

The definition for sustained yield contained in RCW 79.10.310 requires “management of the forest to provide harvesting on a continuing basis without major prolonged curtailment or cessation of harvest." This concept of sustained or sustainable even flow can be characterized in several ways.

Under current policy, even flow is managed as a narrow band of variation allowing the harvest level to vary by as much as 25 percent above and below the long-term harvest level.

The Preferred Alternative proposes a policy objective of allowing timber harvest flows, measured by volume, to not vary from a previous decade by more than +/- 25 percent.

Subject Area: Policies and Procedures
Issue: Arrearage

Comment Summary:
If an arrearage in timber volume exists, how would DNR address the impacts of the lost timber volume after the 2004 calculation? The assumption is made that any potential arrearage is not being folded into the Alternatives and included in calculations of the current volume.

Response:
The arrearage question is related to, but separate from, the calculation of the sustainable harvest level. RCW 79.10.330 directs DNR to conduct analysis of alternatives to determine a course of action regarding arrearage to provide the greatest return to the trusts based on economic conditions then existing or forecasted to exist, as well as the impacts on the environment of harvesting the additional timber.

The concept of arrearage is more simply stated as follows: if some forested trust land timber sales are not sold, or purchaser's default on sales, it results in the sustainable harvest level not being harvested. DNR will conduct an analysis to determine if an arrearage exists, and if so, it will further assess the timing, economics, and potential environmental impacts of adding arrearage sales on top of the sustainable harvest level.

Arrearage analysis would need to be performed after the sustainable harvest calculation has been set for the next decade because, until the updated sustainable harvest volume is established, it is unknown if there is any arrearage volume available that meets the statutory tests. After the sustainable harvest calculation is completed, DNR will review management options related to any arrearage.

Assessing the environmental impacts associated with any arrearage is beyond the scope of the State Environmental Policy Act analysis for calculating the sustainable harvest level for the coming decade.

Subject Area: Policies and Procedures
Issue: Harvest regulation (value vs. volume)

Comment Summary:
A value-based harvesting plan would favor hardwood removal because of the low volumes associated with hardwoods. Timber counties believe this type of regulation could provide high net returns. Other comments question whether a

value-based harvest plan would comply with RCW 79.10.300(5) that defines the state harvest level as being the "volume of timber scheduled for sale from state-owned lands during a planning decade as calculated by DNR and approved by the board." Comments reflected concern with the inability to predict future economic value and questioned the lack of analysis associated with a change based on value versus volume, not only to revenue but also to projected habitat values.

Response:
The method of calculating the sustainable forestry levels is central to the management of forested trust lands. Sustainable harvest can be regulated by several means, including volume, acreage, and economic value. Current Board of Natural Resource policy uses timber volume.

When harvest is calculated by volume, as current policy dictates in Forest Resource Plan Policy No. 5, the objective is to determine the maximum volume that can be sustained over a planning period, subject to a large number of legal and policy constraints. Timber volume is expressed in terms of millions of board feet.

The Preferred Alternative would change the calculation method from maximization of volume to maximization of value subject to policy objectives and resource constraints.

For further discussion on value versus volume, refer to "Maximum Harvest and Revenue" under the issue "Trustland Revenue" in these comment summaries. Also see the Board of Natural Resources Resolution 1110 and all its attachments in Appendix F for additional policy considerations regarding financial considerations.

Subject Area: Policies and Procedures
Issue: Old Forest

Comment Summary:
As a policy, protect old forest and climax ecosystems within the reasonable Alternatives. Keep a percentage of each HCP Planning Unit in old growth and buffer the stands. Others commented that because there is old growth on federal lands, it is not necessary to protect old growth forests on forested state trust lands. In addition to offering support and criticism to the proposed Alternatives, comments proposed new variations, including protecting no old forests and protecting all trees older than 80 years. Some stipulated that differences exist between "old growth" and "old forests," based on structural characteristics, and wanted both "old growth trees" and "old growth stands" clearly defined.

Response:
The Alternatives described and analyzed in the Draft EIS and Final EIS look at various ways to create and protect old forests. To address public concern about old forests, the Preferred Alternative selected by the Board of Natural Resources shows a significant increase of 5 percent of the land base each in niche diversification and fully functional forests by 2067.

The definition of “old growth” in the Preferred Alternative and in the Habitat Conservation Plan is based on both age and structure (DNR 1997). In addition, Forest Stand Development Stage Classifications can be found in Appendix B, Section B-2, of the Draft EIS and Final EISs. Additionally, definitions of old forest and structurally complex forests can be found in the glossary.

Subject Area: Policies and Procedures
Issue: Ownership Groups

Comment Summary:
Don’t combine ownership groups; it would diminish accountability to beneficiaries; more information is needed to understand how these assets would be distributed. Some comments favored combining ownership groups because it would provide equity among the stakeholders when a Preferred Alternative is selected.

Response:
Currently, the sustainable forestry calculation is based on “ownership groups.” In all, there are 24 ownership groups with two other variations (1 ownership group, 20 ownership groups) considered in the Final EIS. However, when all of the ownership groups are combined into one group as in Alternative 3, long-term harvest levels fluctuate more than in the other Alternatives. The Preferred Alternative will calculate the sustainable harvest level using 20 ownership groups (17 Forest Board Counties, Capitol Forest, Olympic Experimental Forest, and all federal grants and Forest Board Purchased as a single group).

Subject Area: Policies and Procedures
Issue: Policy Changes

Comment Summary:
The Draft EIS did not describe or analyze the changes that were going to be made to the policies and procedures; instead it defers this information to the Final EIS, thus eliminating the opportunity for public comment prior to adoption. For instance, what policy changes will be made regarding leave and snag trees, legacy trees on unstable slopes, amendments to policy #5, and identification of unstable slopes? Concerns were raised regarding the role of the Federal Services in approving any new procedures or policies.

Changes to the Revised Forest Resources Plan in 2005 would affect harvest levels, thus requiring another calculation. Why are these two processes not being done jointly?

Response:
The Preferred Alternative combines elements of the Alternatives that were disclosed and analyzed in the Draft EIS. The Draft EIS illustrated the expected outcomes and the range of environmental effects that would result from different policy changes necessary to implement each of the Alternatives. The specific policy language is included in the Final EIS and will be consistent with the Preferred Alternative. All policies or procedures that require the approval of the Federal Services will only be implemented after DNR receives such approval

from the Federal Services, and when appropriate, have been approved by the Board of Natural Resources.

For additional information, refer to "Deferral to Habitat Conservation Plan and Forest Resource Plan components not yet Implemented."

Subject Area: Policies and Procedures
Issue: Northern Spotted Owl Procedure

Comment Summary:
Specific preferences were offered for changes to DNR procedure on northern spotted owl habitat management, including how to manage nesting, roosting, foraging, and dispersal habitat and when to release habitat circles. Comments included managing nesting, roosting, foraging, and dispersal habitat as the procedure currently states, conducting only enhancement activities in habitat, and maintaining up to 20% of non-habitat for legacy elements. Interest was expressed in the entire spectrum of owl circle management, from maintaining all circles indefinitely to releasing them all immediately.

Response:
A clarification to procedure PR 14-004-120 on conducting management activities within northern spotted owl nest patches; circles; and designated Nesting, Roosting, and Foraging Management Areas and Dispersal Management Areas within Watershed Administrative Units below the threshold level referred to in the Habitat Conservation Plan will be included in the Final EIS.

For additional information regarding the changes proposed to procedure PR 14-004-120 under the Preferred Alternative, refer to Appendix F of the Final EIS.

Subject Area: Olympic Experimental State Forest
Issue: Planning and Management

Comment Summary:
Concerns were raised about only one landscape plan being completed and no 12-step watershed assessment work completed since the Habitat Conservation Plan was approved in 1997. The 11 landscapes within Olympic Experimental State Forest have been grouped into four analysis units that Federal Services have not discussed or agreed to yet. Concerns were also received on how the 20/40 habitat minimums would be applied to the analysis units. Other comments suggested a restoration alternative for Olympic Experimental State Forest or to separate the Olympic Experimental State Forest from the Alternatives because the Habitat Conservation Plan requires minimum standards for each landscape in the Olympic Experimental State Forest. Others favored harvest levels being more comparable to the other five Westside HCP Planning Units. Concerns were also raised about the level of funding to adequately fund implementation of the Habitat Conservation Plan.

Response:
The harvest volumes for the Olympic Experimental State Forest were derived from modeling results that were consistent with the conservation strategies outlined in the Habitat Conservation Plan. The 12-step process is an assessment

procedure intended for managers, foresters, and scientists to ensure that proposed forest management, timber harvest, or research activities do not conflict with the objectives of the riparian conservation strategy or other conservation objectives. The 12-step assessment method is used on each individual timber sale until a landscape plan is developed, but, according to the Habitat Conservation Plan, it may also be used during landscape planning but is not a requirement.

The 20/40 habitat minimums are applied to the original landscapes identified in the Habitat Conservation Plan. Harvest activities will maintain or enhance at least 20 percent cover of old forest habitat in each landscape planning unit, including the maintenance or development of interior old-forest conditions in each landscape. Additionally, harvest activities will maintain the proportion of young and old forest habitat at or above 40 percent of each landscape-planning unit. The Habitat Conservation Plan also states, “Boundaries may be adjusted over time during implementation of this plan”(DNR 1997).

On a biennial basis, or yearly basis if needed, DNR submits to the Washington State Legislature agency operating and capital budgets for asset management that adequately fulfill DNR’s obligations under the Habitat Conservation Plan, Incidental Take Permit, and the Implementation Agreement (DNR 1997). DNR has spent $21 million on Habitat Conservation Plan implementation in the past 8 years.

Subject Area: Olympic Experimental State Forest
Issue: Harvest Levels

Comment Summary:
More detail is needed on environmental protections to be analyzed before aggressive harvest goals in Alternatives 2, 3, and 5 and the Preferred Alternative are considered for the Olympic Experimental State Forest. Increased harvest levels in the Olympic Experimental State Forest are expected to result in more windthrow potential compared to the other Westside HCP Planning Units. Clarify how the 20 percent of old forest conditions in the Olympic Experimental State Forest will be maintained in the Alternatives without restricting harvest of old forests.

Response:
The harvest volumes for the Olympic Experimental State Forest were simulated based on the conservation strategies outlined in the Habitat Conservation Plan. The 20 percent of old forest conditions in the Olympic Experimental State Forest will be maintained in the Preferred Alternative.

Intensive timber management in the form of patch cuts and upland clearcuts can also affect the risk of windthrow in riparian buffers. Data for windthrow within riparian buffers from seven studies reported in Grizzel and Wolf (1998) had a mean windthrow rate of about 15 percent for 344 sites in western Washington and Oregon, with maximum windthrow rates ranging from 17 to 100 percent in the different studies. Pollock and Kennard (1998) reanalyzed several windthrow data sets looking at the relationship between buffer width and likelihood of windthrow. They reached the conclusion that buffers of less than 75 feet have a higher probability of suffering appreciable mortality from windthrow than forests with wider buffers. In general, vulnerability to windthrow tends to return to normal a few years after logging (Moore 1977; Steinblums 1978; Andrus and Froelich 1986).

Removal of some trees from a stand between 75 and 100 feet from the stream would likely reduce large woody debris recruitment but would have minimal effect on shade. In addition, the conversion of hardwood areas (greater than 1 acre of contiguous hardwood) in patches greater than about 0.25 acre may result in a higher risk of windthrow (Huggard and Vyse 2002) in the no-harvest sub-zone. However, it is worth noting that many riparian stands are not fully functioning because of their current structural condition. Consequently, the degree to which low- to moderate-intensity timber management systems would affect near-term riparian function is uncertain. However, active forest management can change species composition and accelerate the development of larger trees (Carey et al. 1996). Such events help to restore longer-term riparian functioning but may have some short-term adverse impacts.

As stated above, all of the Alternatives are consistent with the conservation strategies outline in the Habitat Conservation Plan.

Refer to the response for "Salmon and Fish Habitat" for additional information.

Subject Area: Olympic Experimental State Forest
Issue: Riparian Management

Comment Summary:
The no-harvest policy within 25 feet of a riparian area is not justified in the Draft EIS, and streams will not be protected under any of the Alternatives. There is no discussion of the modeling assumptions or how they may be different in the Olympic Experimental State Forest compared to the other Westside HCP Planning Units, as the goals and objectives are different. What will each Alternative create regarding stand structure development for the Olympic Experimental State Forest? Alternatives 5 and 6 would produce the greatest amount of revenue, but is that sustainable? Alternatives 5 and 6 provided the greatest risks to endangered salmon populations.

There is an error in Appendix E of the Draft EIS, which states that 16 watersheds have streams on the 303(d)list.

Response:
The harvest volumes for the Olympic Experimental State Forest were derived from modeling results that were consistent with the conservation strategies outlined in the Habitat Conservation Plan.

The management strategies proposed under the Alternatives would not result in any probable significant adverse impacts on riparian resources beyond those anticipated in the Habitat Conservation Plan Final Environmental Impact Statement. However, the different levels of management activities under each of the Alternatives are likely to result in greater potential impacts for those Alternatives with higher levels of silvicultural activities than for those with more passive management. These impacts, both beneficial and negative, vary when analyzed in the short term versus the long term. The Preferred Alternative is projected to develop more “functional” riparian forests; however, these projections are the outcome of a short-term active management program of thinnings, snags, and down woody debris treatments.

The Olympic Experimental State Forest has site-specific inner and outer zones. The riparian conservation strategy buffer zones are described in the Appendix C of the Final EIS.

The Olympic Experimental State Forest was established to investigate different scientific and management options. The conservation strategy for the Olympic Experimental State Forest is designed to be more flexible than the other five Westside HCP Planning Units to allow for research and for a better understanding of forested trust lands. The levels of harvest under Alternative 5 and the Preferred Alternative include substantial amounts of thinning activities in riparian zones to reduce the level of competitive exclusion and accelerate tree growth and stand complexity. The Board of Natural Resources recognizes the need for restoration in portions of the Olympic Experimental State Forest and protection of listed fish species and their habitats.

For additional information on how the Preferred Alternative compares to the other Alternatives for Riparian Management, refer to Chapter 4, Section 4.10, of the Final EIS.

Because the levels of harvest activity are substantially higher under Alternative 5 for the Olympic Experimental State Forest and under the Preferred Alternative for all Westside HCP Planning Units, the risk of increased adverse effects resulting from implementation or effectiveness failures is higher in the short term. In addition, the EIS states there is some uncertainty regarding the level of adverse effects to riparian function that might be expected from the thinning activities proposed under Alternative 5 and the Preferred Alternative because of incomplete scientific research. In the long term, adaptive management and other provisions of the Habitat Conservation Plan Implementation Agreement are designed to make corrective changes in the processes, procedures, and mitigation measures if these failures occur or if thinning activities tend to have unacceptable levels of adverse effect.

The 16 watersheds in the Olympic Experimental State Forest listed on the 303(d) list for temperature was the result of Washington Department of Ecology’s 1998 data. A new list was released for public comment in 2004, and the Department of Ecology is currently evaluating the comments. The 2004 list has not been accepted by the U. S. Environmental Protection Agency; therefore, the 1998 list remains the approved 303(d) list.

Subject Area: Trust Mandate
Issue: Alternatives Violating/Fulfilling Trust Mandate

Comment Summary:
The accelerated harvest levels of Alternative 5 or the Preferred Alternative would violate the trust mandate because these levels would provide maximum current income while sacrificing future income. Any Alternative short of the volumes identified in Alternative 5, which provides the fullest value for trust beneficiaries while meeting legal requirements and providing necessary environmental protections, would be in violation of the trust mandate. Alternatives 2, 3, and 5 or the Preferred Alternative would all produce income while conserving soil, water, and native species.

Response:
DNR takes seriously its requirement, based on the common law duties of a trustee, that a trustee and manager make trust property productive of income without unduly favoring current over future beneficiaries. Although providing different forest management approaches, the policies and conditions for each Alternative were analyzed and indicate a sustainable volume of harvested timber for this decade and for future decades to provide intergenerational equity for trust beneficiaries. Integral to the concepts of both sustained yield (RCW 79.10.300-.340) and sustainability is the long-term stability of benefits to the trust beneficiaries. For additional information regarding “Forest Modeling,” refer to Chapter 2, Section 2.3, in the Final EIS.

Trust law does not necessarily require DNR to maximize current income. Rather, a trustee must make trust property productive without unduly favoring present beneficiaries over future beneficiaries (DNR 1992).

Each of the Alternatives is a set of proposed policies and procedures, each of which represents a different way of achieving DNR’s legal mandates and objectives. As noted in the Final EIS, some of the Alternatives may carry with them greater environmental risks. The Preferred Alternative neither maximizes nor minimizes current income when compared to future equity to the beneficiaries. Rather, the Preferred Alternative represents a reasonable level of risk to the environment and to the trusts when considering the entirety of the trust mandate. For additional information regarding selection of the Preferred Alternative and the associated risks, refer to Section 2.4 of Chapter 2 in the Final EIS.

Subject Area: Trust Mandate
Issue: Fiduciary Responsibility

Comment Summary:
DNR’s fiduciary responsibilities are to generate the maximum amount of income to trust beneficiaries, both today and in the future, while maintaining the resource in perpetuity. Trust assets should not be sacrificed to pursue other environmental or social goals or objectives. Forested trust lands need to be managed for the long term and need to be protected in perpetuity. Public schools need to find an alternative funding source to timber revenue.

Response:
Forested trust lands are to be held in trust to provide funds for specific beneficiaries. The requirement of undivided loyalty to each trust beneficiary is fundamental to all policies and activities regarding trust lands. This principle stipulates that trust lands and their asset cannot be used to benefit others at the expense of the trust beneficiaries without compensation, no matter how laudable the cause as stated in *County of Skamania v. State of Washington*, 102 Wn.2d 127, 685 P.2d 576. Integral to the concepts of both sustained yield (RCW 79.10.300-.340) and sustainability is stability of benefits to future generations. As trust managers, DNR intends to provide revenue to the trust beneficiaries by a sustainable even flow of timber from forested trust lands, both today and in the future.

Timber sale revenues do not fund operation and maintenance budgets for public schools. The funds provided to public schools from timber sales are used for school construction projects. For additional information, refer to the comment response for Trust Land Revenue.

Subject Area: Trust Mandate
Issue: Intergenerational Equity
Comment Summary:
Intergenerational equity should be optimized for the long term while keeping forests healthy and providing revenue to all generations of beneficiaries, and should be managed on behalf of all the citizens of the state of Washington. There is a need to protect our ecological resources; increasing harvest volumes would jeopardize the sustainability of state forests, thus violating DNR's trust mandate. The Board of Natural Resources must maintain intergenerational equity and not encumber future generations when meeting current needs.

Response:
See the response for "Fiduciary Responsibility." DNR believes that the harvest volumes in the proposed Alternatives, including the Preferred Alternative, include adequate protections for ecological resources and provide sustainable harvest levels for forested trust lands.

Subject Area: Trust Mandate
Issue: Non-Financial Benefits of Forested Trust Lands
Comment Summary:
The benefits of long-term protections for wildlife and conservation values need to be emphasized and must recognize the intrinsic value of forests, from clean air and water and climate regulation to medicinal plants. Comments requested clarification during the development of a Preferred Alternative on the issue of seeking full value for trust assets versus meeting other environmental and social objectives.

Response:
DNR manages for long-term protections for wildlife and conservation values through implementation of the Habitat Conservation Plan, the Forest Resource

Plan, and compliance with federal and state statutes. Except for compliance with applicable laws, trust resources are not committed to non-trust purposes without compensation.

DNR adopted one of the first habitat conservation plans—a long-term land management plan authorized under the Endangered Species Act to conserve threatened and endangered species. For DNR, it refers to a plan for forested state trust lands that allows for predictability and certainty of timber harvesting and other management activities to continue while providing for species conservation as described in the Endangered Species Act.

As a trust manager, DNR has unique obligations. These obligations are more thoroughly described in the Forest Resource Plan, Appendix B. As noted in the Response for Fiduciary Responsibility, DNR cannot devote trust assets to non-trust purposes, however laudable those purposes may be.

Subject Area: Trust Mandate
Issue: Prudent Person Doctrine

Comment Summary:
Common sense and science suggest the need to preserve the forests for the long term to ensure a steady revenue stream while protecting the forestlands for perpetuity.

Response:
DNR is subject to the common law duties of a trust manager, which includes observance of the prudent person doctrine. A legal requirement is to manage a trust as a prudent person, exercising such care and skill as a person of ordinary prudence would exercise in dealing with his or her own property. In DNR's view, this means, among other things, avoiding undue risk. The Habitat Conservation Plan helps mitigate risk by providing stability. The sustainable harvest calculation ensures the trusts are managed for the long term by examining long-term volume and habitat changes; both of which will increase during the analysis period. DNR believes that the Alternatives proposed in the Final EIS process, and particularly the Preferred Alternative, are prudent means to ensure a steady revenue stream and to protect forested trust lands for future generations.

Subject Area: Trust Mandate
Issue: Purpose of State Trust Lands

Comment Summary:
Forested trust lands should be managed for multiple uses such as social-cultural, ecological, and revenue generation today, while continuing to leave a legacy for future generations. Forests must be managed with a good balance of recreation, revenue, and wildlife protection. In addition, state lands must also provide a steady source of income for rural communities, including timber harvest, recreation visitors, and tourism.

Response:
The majority of forested trust lands were granted under the Enabling Act and the State Constitution when Washington became a state in 1889. The federally

granted lands are to support specific beneficiaries in perpetuity. The beneficiaries include public schools statewide; the Capitol buildings; state universities; and charitable, educational, penal, and reformatory institutions. Additionally, there are 17 counties in western Washington that have State Forest Transfer and State Forest Purchased trusts that are managed to provide financial support to junior taxing districts and counties. Out of approximately 1.4 million acres currently managed in these trusts, nearly all are forested.

Forested trust lands are managed to protect native forest ecosystems and their inhabitants and have historically been open to the public through the "Multiple Use Act" (RCW 79.10.100-.250) and long-standing Board of Natural Resources and DNR policy. The law allows public use of forested trust lands when compatible with management activities and when it does not damage resources or interfere with trust management responsibilities (DNR 1992).

Subject Area: Trust Mandate
Issue: Trust Beneficiaries

Comment Summary:
DNR manages state lands for the trust beneficiaries. Forested trust lands should be managed to benefit all people; they are "held in trust," and revenue generated needs to go to the beneficiaries. The state should not favor private industry or environmental conservatism over their duties to the beneficiaries. Concerns were also expressed concerning the policies and procedures that are beyond the Habitat Conservation Plan requirements and how that would impact the trust beneficiaries. It would be unfortunate to leave a legacy of environmental degradation of these forests. Money from timber sales should go to habitat preservation of the forests and not to trust beneficiaries.

Response:
A trust is a relationship in which one person, the trustee, holds title to property that it must keep or use for the benefit of another. The relationship between the trustee and the beneficiary is a fiduciary relationship, and it requires the trustee to act with strict honesty and candor and solely in the best interests of the beneficiary. A trust includes a trustee (the entity holding the title), one or more beneficiaries (entities receiving the benefits from the assets), and trust assets (the property kept or used for the benefit of the beneficiaries). In the case of Washington's trust responsibility, the trust assets are the trust lands and the trusts' permanent funds.

With the state as trustee, the legislature has designated DNR as manager of the federal grant and forested trust lands. Statutorily, DNR consists of the Board of Natural Resources, the Commissioner of Public Lands as administrator, and the Department Supervisor (RCW 43.30.030). The proposal analyzed in this EIS does not change or affect DNR's trust mandate. Moreover, neither DNR nor the Board has the power to alter their legal duties, which are largely created by the trustee—the state legislature.

The Board policy indicates that DNR is to manage trust assets to ensure healthy forests that will be productive in perpetuity. Board policies also imply that it is important not to foreclose reasonably foreseeable future options for support. For these reasons, it is important to retain the capacity of the forest to sustain its components and biological relationships.

By providing long-term financial support for schools and other public institutions, and by prudently protecting the multiple values of the forested trust estate, DNR serves the interests of all the people of Washington.

Subject Area: Trust Mandate
Issue: Undivided Loyalty

Comment Summary:
In undivided loyalty to each trust, DNR should have a collective management alternative that provides financial support to its beneficiaries by providing full economic value for trust assets. DNR needs to consider the issue of a specific trust bearing a more significant burden to produce habitat due to location of forested trust lands than other trusts, and whether this restricts revenues to trust beneficiaries in a fair manner. Although undivided loyalty extends to the issue of timber companies commitments to their contracts, it does not extend to DNR having to maximize revenue at the expense of critical environmental needs.

Response:
This proposal involves setting a new sustainable harvest level within the required commitments of the Habitat Conservation Plan. The proposed action is not re-analyzing the 1997 decision to enter into the Habitat Conservation Plan or its Implementation Agreement.

Moreover, DNR believes that the common law requirement of undivided loyalty to trust beneficiaries is fundamental. This principle requires that trust land not be diverted to benefit others at the expense of the trust beneficiaries without compensation. There is, however, no requirement to avoid providing others with collateral benefits. The legislature as the trustee and DNR as trust manager simply must make all decisions with the beneficiaries' interest first and foremost in mind (DNR 1992).

Subject Area: Sustainability
Issue: Balance Between Social, Ecological, and Revenue Issues

Comment Summary:
The Alternatives do not provide a sustainable balance between economic, social, and environmental issues; they primarily emphasize economics. All the Alternatives are sustainable because they are guided by the Habitat Conservation Plan. More attention needs to be given to social concerns and the need to generate long-term sources of revenue without foreclosing options for future generations. Maximum flexibility must be maintained that will create a healthy school system as well as a healthy environment.

Response:
The Board of Natural Resources directed DNR to develop a range of Alternatives for the Draft EIS and Final EIS that are consistent with all federal and state statutes, the trust mandate, Habitat Conservation Plan, and the Forest Resource Plan. Each of the Alternatives for sustainable forest management (and setting the sustainable harvest level) offers revenue to the schools; ecological protections for water and diverse habitat for native animal and fish species; and accomplishes social needs for jobs, recreation for an estimated nine million visitors per year, and educational opportunities for students and researchers. Ranges of Alternatives were projected out to 2067 to ensure that the level of harvest can be sustained, and that the improvement in forest habitat structure will also increase over time.

In addition, through the Preferred Alternative, the Board of Natural Resources is examining ways that better accomplish ecological, social, and financial goals through additional thinnings and partial cuts that will help create higher quality and more structurally diverse habitat sooner than the No Action Alternative. This will bring much needed revenue to the schools and universities and county services and provide more forest jobs and wood for local mills. For more information regarding the Board decision process, refer to Chapter 2, Section 2.4, in the Final EIS.

Subject Area: Sustainability
Issue: Managing for the Long Term versus the Short Term

Comment Summary:
Over-harvesting does not make sense from an environmental or economic view. DNR needs to manage our forests for future generations and needs to consider a long-term perspective, longer than a decade. Sustainable forestry will lead to a higher value per tree in the long run, and state forestlands need to remain appealing places for recreation. DNR must not give in to current economic pressures but develop wise policies today that will protect wildlife and the development of fully functioning forests, while providing a continuous source of income for the future generations. DNR needs to consider re-defining sustainability and view it in a context that includes sustainable jobs for local communities and in a more encompassing forestry context, not just harvest levels. DNR cannot log sustainable forever. The Habitat Conservation Plan will keep DNR logging into the future sustaining schools and communities.

Response:
DNR believes that it manages forested trust lands sustainably, does not over-harvest, and ensures all appropriate forest values for the long-term. DNR forest management is internally governed by three dominant mandates: the trust mandate, the Habitat Conservation Plan, and the Forest Resource Plan. The trust mandate looks at the long-term financial management to the trusts and is embodied with four main principles. The most pertinent principle is intergenerational equity, focusing on the issue of sustainability; managing for the long-term without unduly favoring the present beneficiaries over future

beneficiaries. The Habitat Conservation Plan manages for ecological concerns, including for long-term species protection at the landscape level (until 2067, with the possibility of additional extensions). The Forest Resource Plan examines DNR's management strategy for forested trust lands, which focuses on social and ecological issues. DNR uses these three mandates for balanced and sustainable decision-making, thereby focusing on both short-term and long-term visions.

The range of Alternatives analyzed in the Draft EIS and Final EIS represents an array of approaches to trust forest management. DNR is required under the state Public Lands Act (RCW 79.10.300-.340) to periodically adjust the acreage to be included in the sustained yield management program for forested trust lands, and to calculate a sustainable harvest level for the coming 10-year period. However, DNR models the sustainable harvest calculation over a 200-year period to ensure a sustainable flow of timber for the trust beneficiaries.

The Board of Natural Resources also considers the social impacts that DNR forested lands may have on local communities. In addition to the three mandates described above, the Forest Practices Rules, and state and federal laws, the Board also considers the secondary impacts that a sustainable harvest calculation may have on local communities. For more information regarding the Board's decision process, refer to Chapter 2, Section 2.4, of the Final EIS.

Subject Area: Other
Issue: Within DNR's Responsibility but Outside the Purview of the Draft EIS

Comment Summary:
The Final EIS needs to discuss the following issues: blocking of ownerships, Lake Whatcom, expanding state land ownership, release of timber harvest permits, tax benefits for small landowners, establishment of a small landowners office that would provide scientific education, the need to provide notification and coordination of public and private forest practices permit processes, and questions regarding the long-term certainty that the Habitat Conservation Plan provides and whether this still constitutes a good management decision.

Response:
A number of DNR divisions and programs work within their different responsibilities to address the above issues. DNR remains committed to working effectively and efficiently to better manage state lands while fulfilling DNR's legal responsibilities.

Subject Area: Other
Issue: Not Within DNR's Responsibilities

Comment Summary:
Comments were related to a variety of issues that are not within DNR's current responsibilities, such as the following: form an independent committee that focuses on logging and environmental issues, re-define DNR's trust lands, focus on growth management issues, hire a separate entity to handle title searches, change the Commissioner's position to an appointed one rather than an elected one, and make the Forest Practices Rules more effective. There was an expressed

need to address issues regarding federal "takings" on state lands and reimbursements to the trusts due to concern over loss of county tax revenue associated with a reversal in a public county tax sale.

Response:
These issues are beyond the scope of the sustainable harvest calculation and its EIS.

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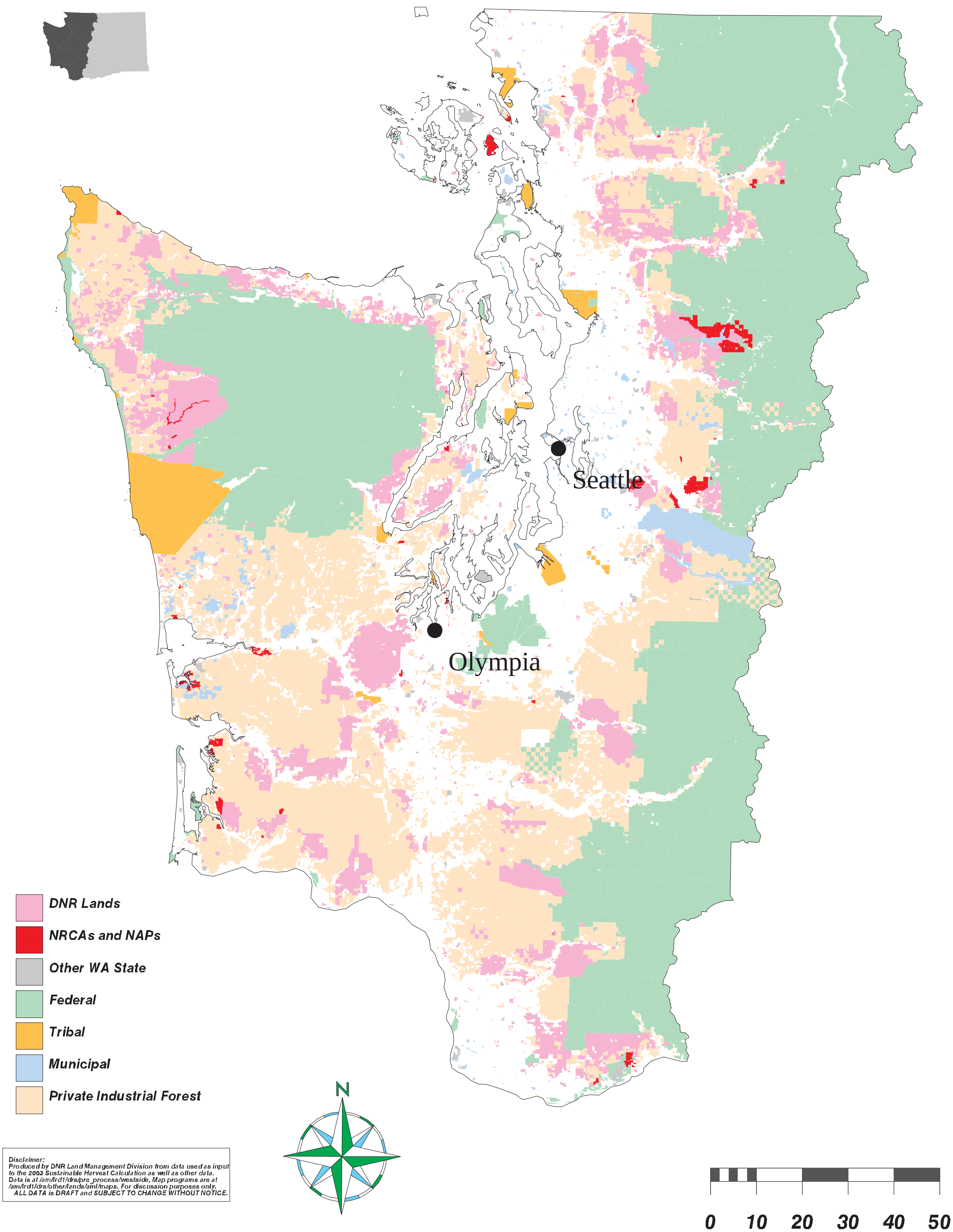
Maps

Map1: State Trust Lands And Adjacent Ownership In Western Washington



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ALL DATA is DRAFT and SUBJECT TO CHANGE WITHOUT NOTICE.

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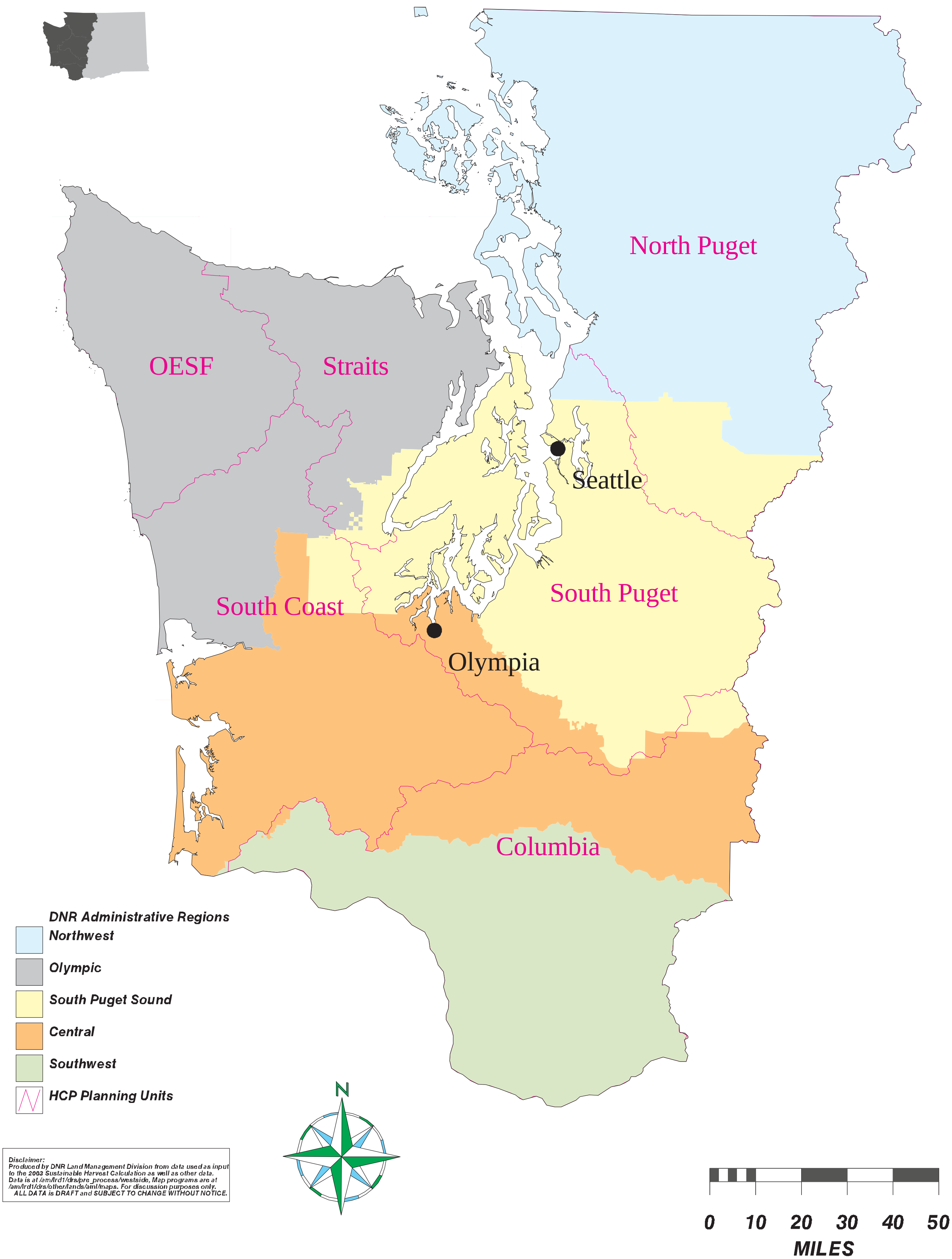
Map 2: DNR Administrative Regions and HCP Management Unit Boundaries



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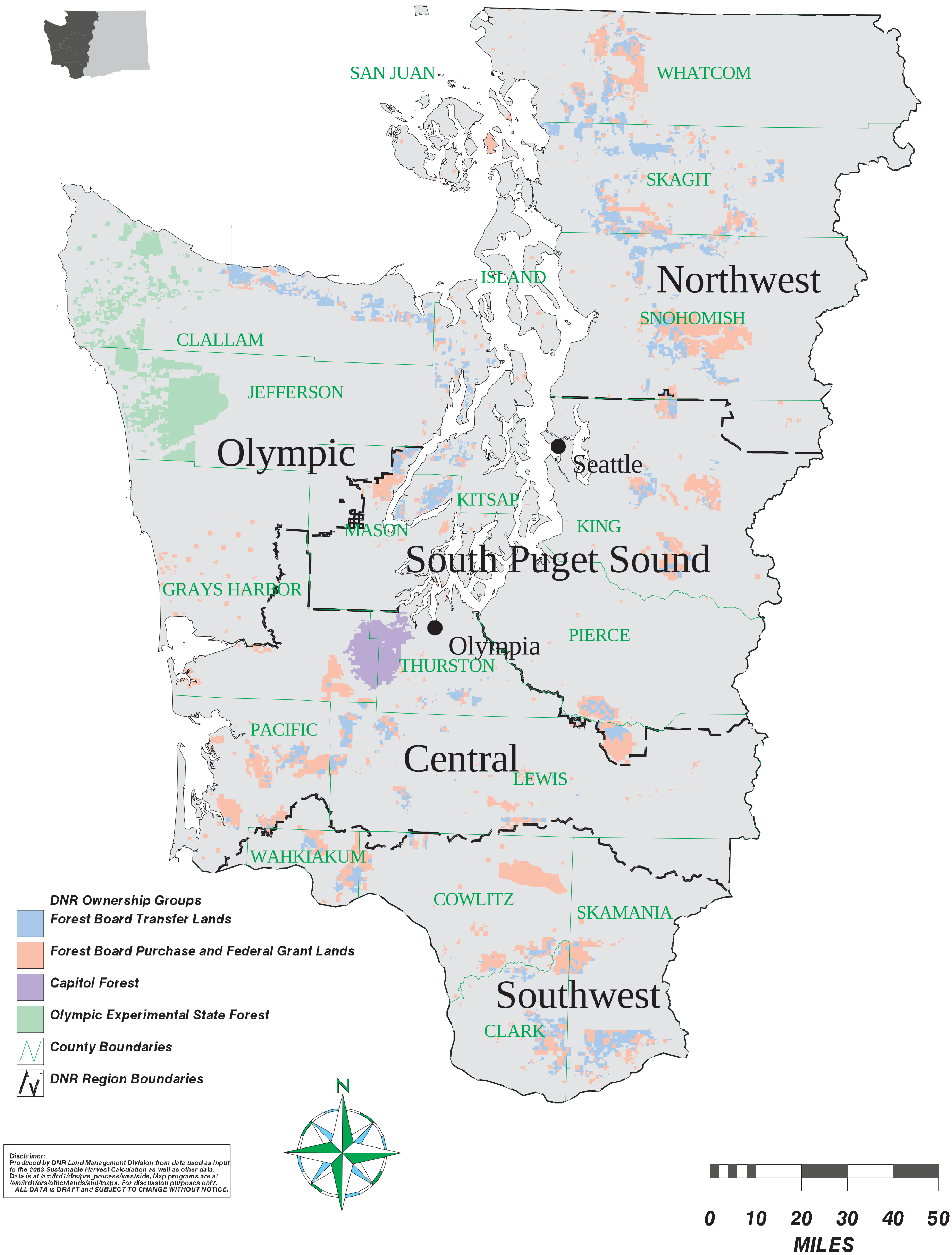
Map 3: DNR-managed lands and Ownership Groups in Alternative 1



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