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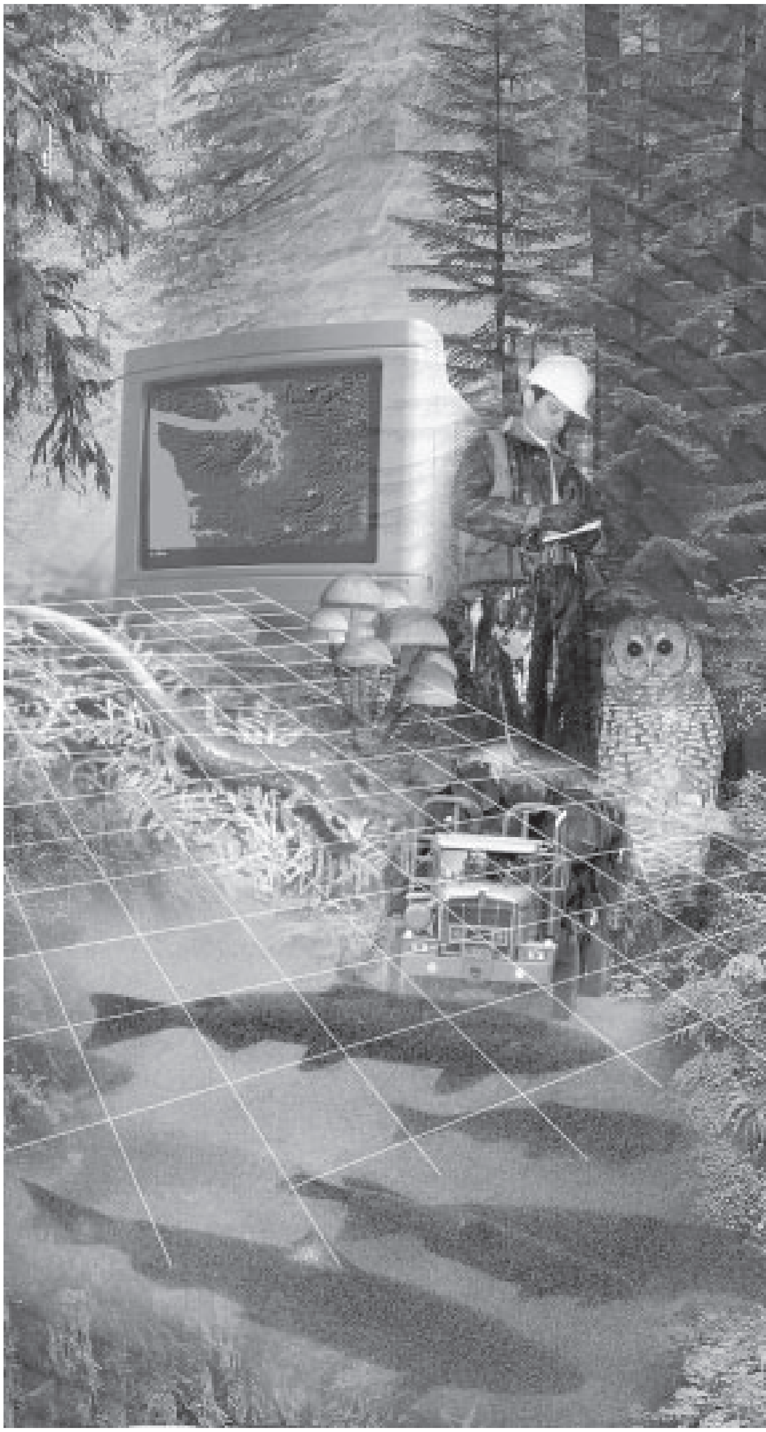

DRAFT
ENVIRONMENTAL IMPACT STATEMENT

on

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

And for Determining the Sustainable Harvest Level

November 2003

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Doug Sutherland - Commissioner of Public Lands

WASHINGTON STATE DEPARTMENT OF
Natural Resources

DOUG SUTHERLAND
Commissioner of Public Lands

November 10, 2003

Dear interested party,

On behalf of the many foresters, biologists, scientists, economists and others at the state Department of Natural Resources who have worked on this project, I am pleased to offer the Draft Environmental Impact Statement (DEIS) for sustainable stewardship of state forest lands in Western Washington.

This (DEIS) is the product of more than two years of work and is the most comprehensive examination of state forest stewardship in Western Washington ever completed. As part of that examination DNR took several important steps.

First, we began with a comprehensive inventory of Washington's state forests. Data was collected not only on forest age, but also on habitat conditions and dozens of other factors critical to understanding forest growth and ecosystem health. Critical to this were the efforts of the independent technical advisory committee, who helped guide that spatial modeling process and provided important and independent scientific and technical advice.

We also made use of the most recent technology to model forest stewardship. Using that new inventory data, we simulated forest growth and management 200 years into the future, examining the impact of various strategies across landscapes.

Finally, early results from the model were verified by DNR foresters in the field to help ensure the accuracy of the projections.

During the next few months, the Board of Natural Resources will begin discussions on the six alternatives in an effort to find the responsible balance of economic benefit, environmental protection and social benefits, and to select a preferred alternative. Public participation is an important part of that examination and we invite anyone who is interested to join us at one of the six public meetings scheduled as part of this effort. A schedule of these meetings is on the "fact sheet" page of this document. Comments also may be made in writing through December 19, 2003.

I want to thank DNR foresters, scientists, economists and others who have put so many hours into this effort. Thanks also to the independent scientists from universities, industry and other agencies that helped ensure the quality of the science you see here. Finally, I want to thank the members of the public who have provided input throughout this process so far.

By balancing revenue for schools and other beneficiaries, healthy ecosystems, and benefits for all the people of Washington, our state can continue to be a leader in sustainable forestry practices.

Doug Sutherland
Commissioner of Public Lands
Chair, Board of Natural Resources

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Fact Sheet

Title: Draft 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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Tentative Implementation Date: July 2004

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Date Issued: November 10, 2003

Comment Period: Comments must be received by December 19, 2003. Comments may be 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:

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

Date of Next Action and Subsequent Environmental Reviews:

Selection of Preferred Alternative by Board of Natural Resources – February 2004
FEIS Tentative Release Date – May 2004

Location of Supporting Documents:
This Draft 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 DEIS 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 Draft 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 draft 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

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Departments of Ecology and Fish and Wildlife

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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'Kallam 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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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

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Jack Hulsey
Regions Operations Manager

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Andrew Hayes
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Olympia, Washington

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EXECUTIVE SUMMARY

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 Draft Environmental Impact Statement is central to an environmental evaluation of sustainable forestry policies for these 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), which have received over $4.55 billion since 1970. Natural Area Preserves and Natural Resource Conservation Areas are included in the sustainable harvest modeling process even though they are not trust assets and are not managed primarily for growing timber. They are evaluated for their habitat contribution at the landscape level because the Habitat Conservation Plan's Implementation Agreement recognizes their conservation benefit role.

There are several key outcomes of the sustainable forest modeling. They range from an understanding of the conservation benefits created by each Alternative to the anticipated levels of sustainable harvest of trees. DNR uses a sophisticated computer model to evaluate how various policy alternatives change the landscapes. The model uses high quality trust land forest inventory and some thirty "layers" of geographical information system data to understand possible landscape level changes. Simply put, the model helps the public and the decision-maker, Washington Board of Natural Resources (the Board), understand what happens, where it happens on the landscape, and show how it would change over time.

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.

Specifically, 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 (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.

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 Act.

This Act creates an open process to gather public input about governmental actions (e.g., sustainable forestry) before final decisions are made. The information gathering process started with public scoping meetings held early in 2002 and continues today in various forums. To date, over two thousand comments have been received from the public, many of which have been integrated into the six Alternatives under consideration.

The Board of Natural Resources has not yet selected a Preferred Alternative; the objective of this approach is to allow the State Environmental Policy Act and the public involvement processes to provide additional information prior to selecting a Preferred Alternative. These processes include public meetings and an extension of the formal comment period beyond the legally required minimum, as well as workshops with the Board. The workshops are designed to help the Board and the public understand the Draft Environmental Impact Statement and the possible next steps.

Following the close of the comment period and the Board workshops, the Preferred Alternative will be selected and analyzed in a Final Environmental Impact Statement. The Preferred Alternative may be one of the current Draft Environmental Impact Statement Alternatives or the Board may take various features of the Alternatives and "mix and match" them. The Board will likely identify their preferred option using the following information:

- Public comments on the Draft Environmental Impact Statement;
- Analyses in the Final Environmental Impact Statement;
- Additional analyses (for example, a financial analysis) provided by DNR staff at the Board's request; and
- Public comments offered at regular monthly meetings.

Ultimately, the Preferred Alternative will become the clear delineation of sustainable forestry for 1.4 million acres of trust land in western Washington.

ENVIRONMENTAL IMPACT STATEMENT 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 Department'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.

In this Draft Environmental Impact Statement, six Alternatives are examined for the management of 1.4 million acres of trust land in western Washington. As required by the State Environmental Policy Act, the Alternatives are examined using reasonably available information to assess their potential significant adverse environmental impacts.

As directed by the Legislature in accordance with the State Environmental Policy Act, Revised Code of Washington 43.21C.020(1)(c), one of the key outcomes of governmental actions is to "fulfill the social, economic, and other requirements of present and future generations of Washington citizens." As acknowledged by the Legislature and others, sustainability requires meeting social, economic, and ecological considerations today without foreclosing options for generations to come.

The following six 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.

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 state trust forestlands 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 current DNR procedures and tasks that were not 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 trusts’ lands when applying the even-flow requirement in Policy No. 4.

Alternative 4 – Passive Management Approach

Alternative 4 represents managing state trust forests 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 forest species and stand care) activity.

Alternative 5 – Intensive Management Approach

Alternative 5 represents managing state trust forests 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.

Alternative 6 – Innovative Silvicultural Management

Alternative 6 represents managing state trust forests in western Washington using “innovative silvicultural management” techniques to generate both increased conservation benefits and revenue for the trusts. 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. Alternative 6 is based on increased silvicultural activity designed to accelerate forest growth and structural development processes.

Features that Vary Among Reasonable Alternatives

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

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 6. In Alternative 3, all westside trust forestlands are placed into one ownership group. In Alternatives 5 and 6 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 6 would require a change to Forest Resource Plan Policy No. 6.

Timber Harvest Levels

Sustainable harvest can be regulated by several means, including volume, acreage, and economic value. Current Board of Natural Resources policy uses timber volume. Alternatives 1 through 4 incorporate current policy, regulating harvest by volume. Alternatives 5 and 6 regulate harvest by economic value, requiring a change to Forest Resource Plan Policy No. 5. Projected harvest levels for the first decade (2004-2013) are presented in Table ES-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**	**6**
Trusts	**First Decade Values in Millions of Board Feet per Year**					
Agricultural School	9	9	7	12	12	13
Capitol Grant	34	37	46	29	74	59
Charitable/Educational/Penal and Reformatory Institution	15	15	17	12	20	26
Community College Forest Reserve	2	1	0	1	1	1
Common School and Indemnity	114	174	179	121	267	259
Escheat	2	2	2	1	2	2
State Forest Board Purchase	32	39	61	35	48	59
State Forest Board Transfer	157	212	300	163	324	307
Normal School	6	12	11	7	14	14
Scientific School	23	22	29	25	33	32
University - Original	1	0	1	1	1	1
University - Transferred	1	13	9	4	21	8
Total	**396**	**536**	**662**	**411**	**817**	**781**

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).

Alternative 1 and Alternative 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).

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, recodified at Laws of 2003, Ch. 334, sec. 555(3)).

Alternatives 5 and 6 propose to implement the sustainable even-flow policy by revenue rather than harvest volume. The policy objective is to have timber harvest flows not vary from a previous decade more than +/-25 percent. This approach uses the flow constraint approach from the University of Washington model (Bare et al. 1997).

None of the Alternatives would require a change to Forest Resource Plan Policy No. 4 even-flow. However, Alternatives 2, 3, 5, and 6 would require a change to the "discussion" section of that policy. If the Board selected a Preferred Alternative that calculates harvest level by value—instead of volume—then Forest Resource Plan Policy No. 5, to control harvest by volume, would need to be amended accordingly.

Alternatives 2 to 6 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).

Maturity Criteria and Rotation Age: Determining the Minimum Regeneration Harvest Age

Maturity criteria determine the earliest age that a stand is considered eligible for regeneration harvest and are applied in even-aged forests. Forest Resource Plan Policy No. 11 describes how DNR determines maturity criteria. Currently, these criteria are determined by balancing the biological productivity and the economic potential of a stand of trees. In western Washington, DNR's current average rotation age is 60 years (Forest Resource Plan Policy No. 4). To meet specific objectives such as stand diversity, the Department may cut some stands as early as 45 years and other stands only when trees reach 100 years (Forest Resource Plan Policy No. 4).

In Alternatives 1, 2, and 3, maturity criteria are determined in accordance with the existing Forest Resource Plan Policy No. 11. In Alternative 4, maturity criteria are determined with an emphasis on tree growth over economic potential. In other words, the emphasis is to harvest a stand of trees as it approaches its culmination of growth (the end of the period of rapid growth).

In Alternative 5, maturity criteria are determined with an emphasis on economic potential over tree growth potential. In this Alternative, the emphasis is on harvesting stands of trees when they have reached their maximum economic value, expressed as maximum net present value.

In Alternative 6, the maturity criteria are determined with an emphasis on economic potential over tree growth potential, as in Alternative 5. However, in Alternative 6, the implementation of biodiversity pathways silviculture presented by Carey et al. (1996) leads to an outcome of alternating harvest ages. For example, harvest ages on some sites may alternate between 60 and 130 years. This feature, in theory, allows for simultaneous increases in production of both habitat and income. This feature, in addition to the implementation of innovative silvicultural techniques such as repeated thinnings that create habitat structures like down logs, snags, and multi-level forest canopies, would require changes to Forest Resource Plan Policy Nos. 30 and 31.

The determination of maturity criteria for each Alternative would require changes to Forest Resource Plan Policy No. 11, the discussion in 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

None of the Alternatives proposes changes to the nesting, roosting, foraging and dispersal habitat strategies outlined in the Habitat Conservation Plan (page IV.3). Alternatives 2 to 6 propose changes to current operations from those defined in Alternative 1 (No Action). Management of Memo 1 owl circles remains the same for all Alternatives (1 to 6) (deferred until 2007).

In Alternative 1, nesting, roosting, foraging and dispersal management strategies are implemented as constraints, whereby if conditions are not met, management is restricted. However, habitat strategies can be implemented as targets**,** as originally articulated in the Habitat Conservation Plan (page IV.1-38).

In Alternative 2, a target of 50 percent desirable habitat is established for designated nesting, roosting, and foraging, or dispersal management areas within a watershed. However, unlike Alternative 1 (and Procedure 14-004-120), thinning is available as a strategy to create and maintain nesting, roosting, and foraging management area objectives. 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. This approach is used in Alternatives 2, 3, and 4 and 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).

Alternatives 5 and 6 propose a variation on the strategy proposed in Alternatives 2 through 4. Northern spotted owl conservation management in Alternative 5 is similar to that in Alternatives 2 to 4, with additional heavier thinnings to accelerate the development of large-diameter trees within stands to create and maintain sub-mature nesting, roosting, foraging, and dispersal habitat. Alternative 6 takes this strategy one step further based on concepts of biodiversity pathways described by Carey et al. (1996). These types of thinnings would be applied in small-diameter dense stands where stand viability would not be compromised. In these stands, the average relative density can be lowered to 35. In larger diameter stands, stand densities are maintained between 45 and 70. Thinning large-diameter closed stands too heavily and opening up the canopy too much may lead to blow-down and destroy much of the existing forest structure (e.g., snags). In all cases, the silvicultural prescriptions would include treatments to create and maintain snags, coarse woody debris, and small openings, as well as areas of heavy thinnings, light thinnings, and unthinned areas. As in Alternatives 2, 3, and 4, implementation of Alternatives 5 and 6 would require a change to Procedure 14-004-120.

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.

Alternatives 2 to 6 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 to 6 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, Alternatives 2 to 6 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 6, 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.

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 Habitat Conservation Plan's definition of old forests.

Rather than specifically preserving all forests of a certain age existing today, Alternatives 5 and 6 propose that 10 to 15 percent of each westside 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 Policy Nos. 3 and 14.

Riparian and Wetland Areas

The riparian management zone strategies in the Alternatives are based on the riparian management activities described in the Habitat Conservation Plan (pages IV.59-62). 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 Habitat Conservation Plan. 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 would not change under Alternatives 1 and 4, requiring no change to DNR policy or procedure.

Newly proposed riparian procedures are under negotiation with the Federal Services (at time of publication). Alternatives 2, 3, 4, 5, and 6 are consistent with the draft riparian procedures.

Alternatives 2, 3, 5, and 6 provide a range of restoration and silvicultural activities that may be allowed under the final riparian procedure. 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 within riparian areas and wetlands is minimized to light access development and maintenance (road and yarding corridors).

In Alternatives 2 and 3, restoration and silvicultural activities are allowed at a low intensity within the riparian zones. Light variable thinnings are the principal silvicultural and restoration method to maintain stands for longer rotations and to increase structural complexity. It was assumed for modeling purposes that activities in Alternatives 2 and 3 would maintain canopy closure (relative density of 45 or greater) over 90 percent of the riparian management area.

In Alternatives 5 and 6, restoration and silvicultural activities are allowed at moderate intensity within the riparian zones. Alternative 5 allows heavier commercial thinnings (see Appendix B of this Draft Environmental Impact Statement for a description of thinning types) to accelerate future large-diameter, structurally complex stands. For modeling purposes, it was assumed that activities in Alternative 5 would maintain canopy closure (relative density of 45 or greater) over 70 percent of the riparian management area.

Alternative 6 proposes a different approach from those in Alternatives 1 through 5. As in Alternative 5, Alternative 6 allows heavier thinnings in the riparian zones. Unlike the other Alternatives, biodiversity pathways management (Carey et al. 1996) is used to achieve desired structural components of a complex riparian forest stand. In these types of thinnings, relative density can be lowered to 35 in small-diameter dense stands. In larger diameter tall stands, relative densities are maintained between 45 and 70. Thinning large-diameter closed stands too heavily and opening up the canopy too much, may lead to blow-down and destroy much of the existing forest structure (i.e., snags and down logs). In all cases, the silvicultural prescriptions would include snag and coarse woody debris treatments, the creation of small openings, areas of heavy thinnings, light thinnings and leave areas. For modeling purposes, it was assumed that activities in Alternative 6, as in Alternative 5, would maintain canopy closure (relative density of 35 or greater) over 70 percent of the riparian management area.

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. The analysis uses 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.

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 a negative environmental impact to occur and/or indicate if an Alternative may fail to meet all of its projected outcomes.

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.

Forest Structure

Alternatives 1 and 4 would provide more old forest and would entail less risk of adversely affecting threatened, endangered, and sensitive plants than the other Alternatives. However, Alternatives 1 and 4 would result in more dense forest stands that achieve lower tree growth rates and are more susceptible to damage from insects and disease. They rely on more passive management and would require less investment for forest management. Alternatives 2 and 3 are ranked intermediate on all factors and would also require an intermediate level of investment needed for successfully implementing the management strategies associated with these Alternatives and achieving the projected level of harvest.

Alternatives 5 and 6 would have fewer restrictions on areas available for stand management and timber harvest and would apply more intensive management strategies than the other Alternatives. Management proposed under Alternatives 5 and 6 would result in higher rates of tree growth, forests that are less susceptible to insect and disease damage, and higher levels of long-term carbon storage. Alternative 6 also ranks relatively high for maintaining stands with old forest characteristics. Alternatives 5 and 6 would entail more risk of adversely affecting threatened, endangered, and sensitive plants due to more harvest and harvest-related disturbance.

Indirect impacts on other resources, such as riparian resources, fish, and wildlife, are the result of different forest management strategies. These differing forest management strategies change the harvest intensity and harvest type. These impacts are summarized in each of the resource discussions below.

Riparian

The proposed different management strategies in riparian areas do not result in any probable significant adverse impacts in terms of development of future forest structures in the riparian zone relative to existing conditions and beyond those anticipated in the Habitat Conservation Plan environmental analysis. However, the level of management activity, such as silvicultural activities, in the different Alternatives could result in variable impacts. Such impacts, both beneficial and negative, vary when analyzed in the short term versus the long term. Alternative 6 is projected to develop more “functional” forest area in riparian areas; however, these projections are the outcome of an active management program of thinnings, snags, and down woody debris treatments.

Each of the Alternatives proposes different amounts of harvest activities in the riparian land class (Appendix D). The estimated average activity level of Alternative 5 is 13 percent per decade; Alternative 3 is 8 percent per decade; Alternative 2 is 7 percent per decade; Alternative 4 is 5 percent per decade; and Alternative 1 is 3 percent per decade.

The average estimated level of activity under Alternative 6, 35 percent per decade, represent substantially higher levels than the other Alternatives, although the majority of the harvest area in Alternative 6 is low volume removal harvests. Alternative 6 model results show a high level of activity within the riparian areas. It appears likely that the modeling outputs for Alternative 6 over-estimates the amount of allowable activity in the riparian areas. Upon examination, the problem is not with the fundamental policy direction in Alternative 6, but rather the outcome of initial modeling assumptions. Additional modeling will be completed for the Final Environmental Impact Statement.

Wildlife

Alternatives are consistent with the Habitat Conservation Plan. Environmental effects anticipated under all Alternatives relative to current conditions would be within the level of impacts anticipated to wildlife species and analyzed in the Habitat Conservation Plan Environmental Impact Statement (DNR 1996). Changes under some Alternatives in procedures that address the management of northern spotted owl habitat would be consistent with the goals and objectives of the Habitat Conservation Plan.

Other policy and procedure changes under the Alternatives would influence the amount and distribution of wildlife habitat on DNR westside 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. In the short term and long term, the amount of structurally complex forest is modeled as increasing in all planning units under all Alternatives. Structurally complex forest cannot, however, be used as a measure of DNR's success in meeting its obligations under the Habitat Conservation Plan. Instead, structurally complex forests serve as a relative indicator of change in the amount of habitats of management concern.

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 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 planning units and for individual watersheds is included in Cumulative Effects (Section 4.15). Alternative 6 carries the highest potential overall relative impact, followed by Alternatives 5, 3, 2, 4, and 1.

Hydrology

None of the Alternatives would be expected to increase peak flows significantly. No changes to Procedure 14-004-060 are proposed; therefore, there would be no significant adverse environmental impacts relative to current conditions, beyond those anticipated in the Habitat Conservation Plan Environmental Impact Statement.

Water Quality

The proposed different management strategies would not result in any probable significant adverse impacts relative to current conditions, beyond those anticipated in the Habitat Conservation Plan Environmental Impact Statement. 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 the no harvest portions of the Riparian Management Zones would prevent most sediment from entering streams. Over the long term, improved riparian function would lead to improved water quality on DNR-managed westside trust lands.

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 supporting procedure 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.

The higher level of harvest in Alternatives 5 and 6 would increase the relative potential risk to wetlands, but no Alternative has the potential for significant adverse environmental impacts relative to current conditions, beyond those anticipated in the Habitat Conservation Plan Environmental Impact Statement.

Fish

The potential for adverse effects of the proposed Alternatives to fish would not be expected to result in any probable significant impacts relative to current conditions, beyond those anticipated in the Habitat Conservation Plan environmental analysis. Over the long term, all Alternatives would be expected to result in improved riparian and aquatic conditions for fish. In part, this is the result of current degraded conditions in many areas that resulted from practices prior to adoption of the Habitat Conservation Plan.

The potential for adverse effects to fish resources from Alternatives 1 though 4 is expected to be minimal during the first decade in all planning units. In contrast, harvest activities in the riparian zone are expected to be at higher levels under Alternative 5 in the Olympic Experimental State Forest and under Alternative 6 in all planning units, largely in the form of more frequent thinning activities. In particular, the estimated levels of activity under Alternative 6, which would be 35 percent per decade, represent substantially higher levels than the other Alternatives, although the majority of the harvest area in Alternative 6 is low-volume removal harvests. It appears likely that the modeling outputs for Alternative 6 over-estimate the amount of allowable activity in the riparian areas. Additional modeling will be completed for the Final Environmental Impact Statement.

Public Utilities and Services

The Alternatives present a wide array of direct economic benefits to the beneficiaries. Potential effects on transportation infrastructure would vary by Alternative, with larger projected harvest volumes resulting in increased logging truck traffic. None of the Alternatives is expected to result in any probable significant adverse environmental impacts relative to current conditions, beyond those anticipated in the Habitat Conservation Plan Environmental Impact Statement. These impacts are in the setting of the total forest management activity within the state of Washington and surrounding regions; current DNR harvests are about 13 percent of total western Washington harvest. Logging companies harvesting timber from forested state trust lands must meet Washington State Department of Transportation weight requirements and DNR regularly meets with local government officials and engineers to discuss the effects of logging-related traffic (DNR 1992). These measures would help mitigate potential impacts associated with increased road traffic.

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, beyond the effects anticipated in the Habitat Conservation Plan Environmental Impact Statement. 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. None of the Alternatives is expected to result in any probable significant adverse environmental impacts relative to current conditions. 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 (Policy Nos. 25 and 29).

The effects of the proposed Alternatives on fish and wildlife could, in turn, affect recreational fishing and hunting on DNR westside trust lands. Fishing and hunting opportunities on DNR westside 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.

Scenic Resources

None of the Alternatives is expected to result in any probable significant adverse environmental impacts relative to current conditions. 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 Department 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.

Cumulative Effects

Landscapes in western Washington are characterized by a particular distribution of forest structures. The distribution of forest structures over time and space appears to be the basis of cumulative effects in the forest environment. It is generally recognized that very large and structurally complex forests are currently scarce and medium-sized closed forests are overabundant across all ownerships in western Washington. Therefore, forest management activities that create a greater balance in forest structure at the landscape level would be expected to reduce cumulative effects.

All Alternatives are modeled as resulting in increases in structurally complex forest over time. However, the rates of change and amount of change vary among the Alternatives. All Alternatives project changes in forest structure that should change the current distribution of structural classes towards more complex forests. All Alternatives create a new balance of forest structure at the landscape level. This new balance suggests that there is little potential for contributing to adverse cumulative effects.

Modeled changes in the percent distribution of forest structure classes on DNR-managed westside state trust lands are presented in Figures ES-1, ES-2, and ES-3. Forest structure is represented as stand development stages, which are defined in Appendix B, Section B.2.1.2 of this Environmental Impact Statement.

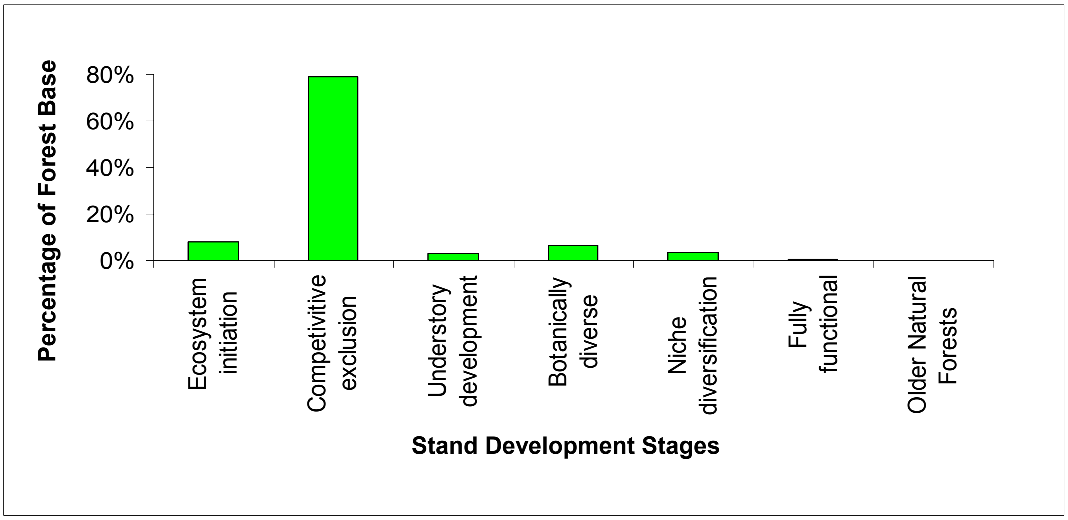

Figure ES-1. Modeled Proportion of State Trust Lands Forest in Each Stand Development Stage in 2004

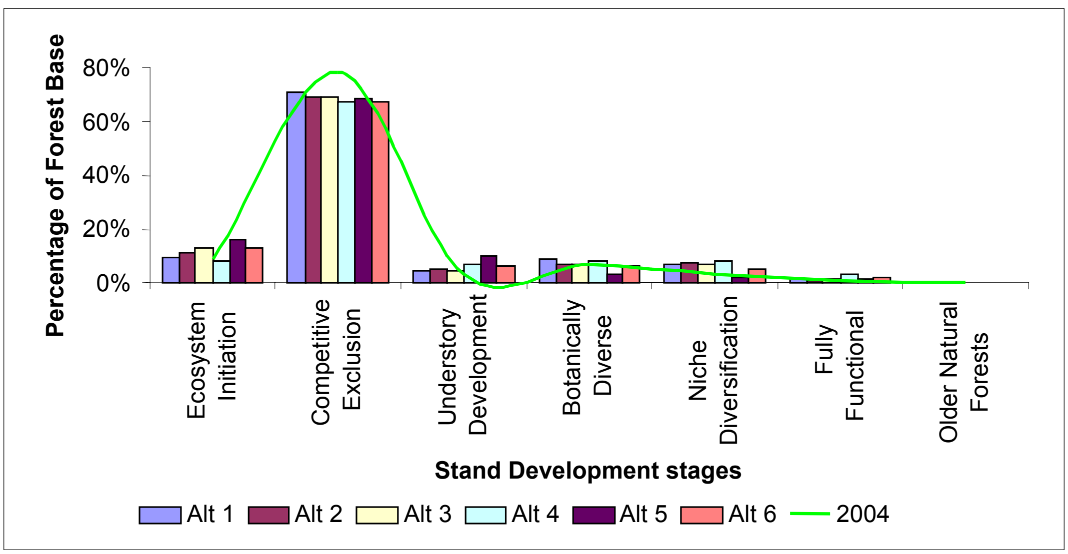

Figure ES-2. Modeled Proportion of State Trust Lands Forest Stand Development in Each Stage in 2013

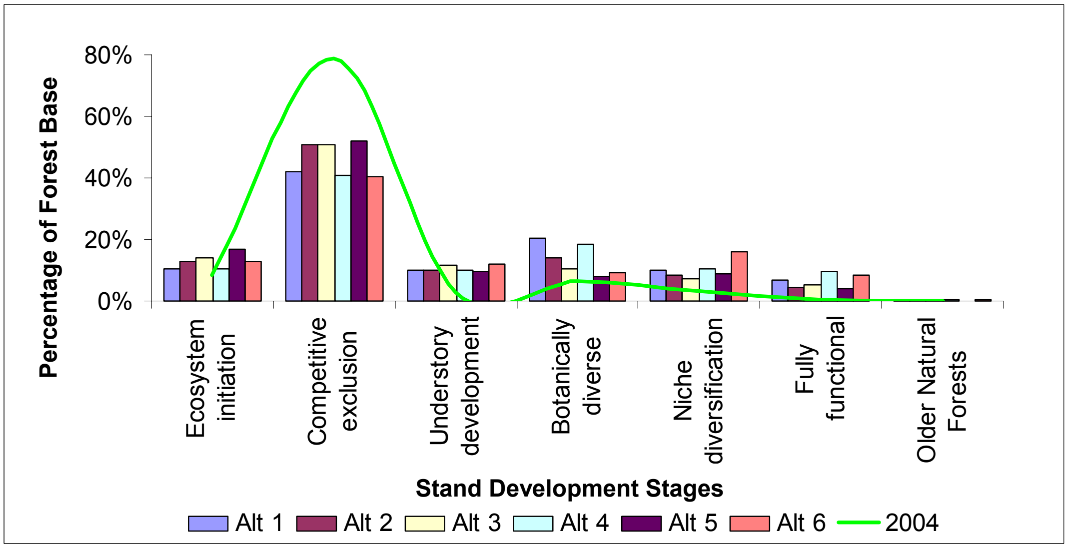

Figure ES-3. Modeled Proportion of State Trust Lands Forest Stand Development in Each Stage in 2067

ANALYSIS OF THE ALTERNATIVES

The fundamental premise of the analyses in this Draft Environmental Impact Statement is that the nature of the forest provides indications of the reasonable likelihood of environmental impacts. Understanding the dynamic nature of forest structure (number of trees, age, horizontal spacing, vertical arrangement of the tree's live foliage, etc.) is basic to most of the analyses. The understanding of forest structure and its interaction with other ecological processes allows us to conceptualize and understand the relative merits of the Alternatives.

The computer model (OPTIONS), which specifically analyzes forestland management impacts and harvest levels associated with each Alternative, is run for a 200-year planning horizon. The results in this document are shown through 2067, the nominal end date of the Habitat Conservation Plan. Because this is a non-project action, the results are displayed in relative terms; absolute analyses are only possible on project actions. Relative ranking allows the public and the Board, the decision-maker, to better understand how the mix of policy features in each Alternative is classified.

The model outputs are not "blueprints" that precisely define policy. The model uses certain identified assumptions that permit some simplifications of how the thirty layers of geographical information system data interact within the model. The model outputs should be taken together; isolation of one output ignores the collective benefits or impacts of how the policies work together.

The purpose of the model outputs is to inform; the outputs do not become objectives nor can they precisely define the policy being simulated. The model outputs, while based on the best reasonably available information, are a simulation, and would be ground-truthed before being implemented. This is demonstrated clearly with Alternative 6. Alternative 6 model results show a high level of activity within the riparian areas. It appears likely that the modeling outputs for Alternative 6 overestimate the amount of allowable activity in the riparian areas. Upon examination, the problem is not with the fundamental policy direction in Alternative 6, but rather the outcome of initial modeling assumptions. Additional modeling will be completed for the Final Environmental Impact Statement.

Relative Effects of the Alternatives

Table ES-2 provides high-level summaries of the Alternatives. This table provides summarized information to assist the public and the decision-maker, the Washington Board of Natural Resources, in developing the Preferred Alternative. Table ES-2 examines the Alternatives from 18 different factors. The factors are identified on the left side of Table ES-2; they range from forest structure, forest health, and trust revenues to scenic resources. Given the non-project nature and the general absence of absolute threshold values, the Alternatives are placed into one of three groups for each factor; that is, the lower, intermediate and higher groups.

Sustainable forestry has social, economic, and ecological components. Table ES-2 shows how the Alternatives relatively address these features. For some of the factors, the Alternatives have very little variability. For instance, air quality has very little difference among Alternatives unlike trust revenues, which is significantly different among Alternatives. While some Alternatives may have higher relative risks of impacts than others, none of the Alternatives is expected to cause significant adverse environmental impacts relative to existing conditions.

Table ES-2. Summary of Alternatives

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Forest Structure	Lower	Intermediate	Higher	Lower	Higher	Intermediate
Old Growth	Lower	Intermediate	Higher	Lower	Higher	Intermediate
Forest Health	Higher	Intermediate	Intermediate	Higher	Lower	Lower
Capturing Greenhouse Gases	Higher	Intermediate	Intermediate	Higher	Lower	Lower
T&E and Sensitive Plants	Lower	Intermediate	Higher	Lower	Higher	Intermediate
Riparian Resources	Lower	Intermediate	Higher	Lower	Higher	Intermediate
Spotted Owl Habitat	Lower	Intermediate	Higher	Intermediate	Higher	Lower
Deer and Elk Habitat	Intermediate	Lower	Lower	Higher	Intermediate	Higher
Air Quality	Lower	Intermediate	Higher	Lower	Higher	Intermediate
Geomorphology, Soils, and Sediment	Lower	Intermediate	Higher	Lower	Higher	Intermediate
Water Quality	Lower	Intermediate	Higher	Lower	Higher	Intermediate
Fish Resources	Lower	Intermediate	Higher	Lower	Higher	Intermediate
Wetlands	Lower	Intermediate	Higher	Lower	Higher	Intermediate
Trust Revenues (2004 to 2013)	Higher	Intermediate	Intermediate	Higher	Lower	Lower
County Revenues (2004 to 2013)	Higher	Intermediate	Intermediate	Higher	Lower	Lower
Cultural Resources	Lower	Higher	Higher	Lower	Intermediate	Intermediate
Recreation	Lower	Intermediate	Higher	Lower	Higher	Intermediate
Scenic Resources	Lower	Intermediate	Higher	Lower	Higher	Intermediate

Alternatives have been placed into three groups:

- Lower group
- Intermediate group
- Higher group

ANTICIPATED KEY EVENTS AND DATES

Understanding this environmental analysis process and being given the opportunity to participate is important. The following are useful dates:

- **Public Draft Environmental Impact Statement Workshops:** To be held from 6:00 to 8:00 pm in Lacey (December 2, 2003), Port Angeles (December 3, 2003), Mount Vernon (December 4, 2003), Vancouver (December 9, 2003), Aberdeen (December 10, 2003), and Des Moines (December 11, 2003)
- **Special Board of Natural Resources Sustainable Forestry Workshops:** December 2, 2003 and February 3, 2004 during regularly scheduled Board of Natural Resources Meetings.
- **Regularly Scheduled Board of Natural Resources Meetings:** All regular meetings will allow for public comments. Meetings are generally held on the first Tuesday of each month. For a detailed schedule, please access: http://dnr.wa.gov/base/boardscouncils/agenda_minutes/2004bnrmtgdates.html

- **Formal Draft Environmental Impact Statement Commenting Period:** Comments may be e-mailed to SEPAcenter@wadnr.gov or mailed to:

  DNR SEPA Center
  P.O. Box 47015
  Olympia, WA 98504-7015

  Commenting period closes at 5:00 pm on December 19, 2003.

- **Final Environmental Impact Statement:** Projected release date is May 21, 2004.

Chapter 1

Chapter 1

1. BACKGROUND AND OBJECTIVES

1.1 INTRODUCTION

The first chapter of this Draft Environmental Impact Statement describes the background and purpose for a new sustainable forestry 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 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 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, which 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 1992). 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 state 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 Forest Board trust land. By statute, the Board of Natural Resources is part of the Department of Natural Resources (former Revised Code of Washington [RCW] 43.30.030, recodified at Laws of 2003, Ch. 334, sec. 128).

Management of state trust forestlands is conducted within the framework of state and federal laws, DNR Forest Resource Plan, DNR's 1997 Habitat Conservation Plan (HCP), 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 DNR-managed forestlands. 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 westside trust forestlands 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 potential 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 forestlands.

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 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" (see Laws of 2003, Ch. 334, sec. 301) be held in trust and administered and protected by DNR, as are other federally granted trust forestlands. 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 which one must keep or use 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 (formerly RCW 43.30.030, recodified at Laws of 2003, Ch. 334, sec. 128). 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" (formerly RCW 43.30.150, recodified at Laws of 2003, Ch. 334, sec. 128).

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 <u>County of Skamania v. State of Washington</u>, 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 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 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 (1992) 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:

> <u>The Prudent Person Doctrine</u>
>
> 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 (DNR Forest Resource Plan, Appendix B).

1.2.2.2 Revenue to Beneficiaries

Since 1970, DNR-managed 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. State 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 (formerly RCW 79.68, recodified at Laws of 2003, Ch. 334, sec. 555(3)) 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 calculate a sustainable harvest level.

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.

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 and 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 (formerly RCW 79.68.050, recodified at Laws of 2003, Ch. 334, sec. 555(2)).

1.3 REGULATORY FRAMEWORK

1.3.1 State Forest Practices Act

In 1974, the Washington state legislature enacted an expanded Forest Practices Act, Chapter 76.09 of the Revised Code of Washington. 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 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 Washington State 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 manage state trust lands. Management activities on trust forestlands 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 trust land management compliance with the federal Endangered Species Act. The plan covers approximately 1.6 million acres of state 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 state trust forestlands 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 forests in western Washington. 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 Department'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 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 state DNR-managed forests in western Washington.

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 trust land forests?
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 westside DNR-managed 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 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 (environmental impact statement 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 though 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.

This draft Environmental Impact Statement is 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 will be identified and evaluated in the Final Environmental Impact Statement.

1.6 FINAL DECISIONS TO BE MADE

The Final Environmental Impact Statement will provide 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 former RCW 79.68.040 [recodified at Laws of 2003, Ch. 334, sec. 555(3)]). 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 will be part of the Final Environmental Impact Statement that, when approved by the Board of Natural Resources, may 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 Board of Natural Resources request; and
- Public comments offered at regular monthly Board of Natural Resources meetings.

Chapter 2

Chapter 2

2. ALTERNATIVES INCLUDING THE PROPOSAL

2.1 INTRODUCTION

This chapter describes and compares the six forest management Alternatives under consideration by the Board of Natural Resources to guide how a sustainable harvest level will be achieved for trust forestlands 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. 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 needs of the project. Finally, Section 2.6 describes and reviews the Alternatives that are under consideration.

2.2 POLICIES, PROCEDURES, AND IMPLEMENTATION STRATEGIES

DNR serves as manager of approximately 1.4 million acres of state-owned forestlands in western Washington. Except for the Natural Area Preserves and the Natural Resource Conservation Areas, these forestlands are managed as a fiduciary trust. Over the short and long term, DNR’s fiduciary responsibility is to maintain the body of the trust lands with undivided loyalty, and generate revenue from those trust lands for the designated 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 state trust forestlands.

- The Board of Natural Resources sets the major policies designed to reflect legislated mandates, state and federal laws, and stakeholder and public interests regarding DNR-managed 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. As stated in Section 1.3, the 2003 sustainable harvest calculation allows the Board and DNR to examine its 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. The six Alternatives were made 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. Insignificant or beneficial impacts need not be discussed. 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 an action. 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.

2.3 SUSTAINABLE FOREST MODELING

There are several key outcomes of the sustainable forest modeling analyses. They range from an understanding of the conservation benefits to the anticipated 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 (formerly RCW 79.68.030, recodified at Laws of 2003, Ch. 334, sec. 128). The state-owned trust forestlands under DNR's jurisdiction are primarily valuable for the purpose of growing forests on a sustained yield basis. In determining the sustainable level of harvest, DNR incorporates statutes and proposed policies, procedures, and operations that would affect management on the state trust forestlands for decades to come.

The foundations of a sustainable forest calculation are (1) an inventory of the forest; (2) a good understanding of the various ways to manage the forest to achieve goals (policies and procedures that form an alternative); and (3) a way to calculate outcomes of various strategies, which is done with computers and is called a model. Models organize and analyze information. The sustainable forestry model helps the public, DNR, and the Board understand the probable outcomes of Alternatives for managing the forest in various ways. The model assists in understanding the changes in forest inventory, habitat conditions, and timber harvest that result from the various Alternatives over the next 64 years, which represents the remainder of the 70-year term of the Habitat Conservation Plan. Decision-making also will rely on information generated during the State Environmental Policy Act (SEPA) analysis and public involvement processes.

Former RCW 79.68.040 (recodified at Laws of 2003, Ch. 334, sec. 555(3)) 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, which have 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 creditability and operational success in building a forest model to derive a sustainable harvest level. DNR followed these steps in modeling the sustainable harvest Alternatives presented in this Environmental Impact Statement. The four steps are:

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.

For more details on the modeling approach, refer to Appendix B. In general, DNR seeks to meet each of these steps, as it proceeds through the sustainable forestry calculation process, as well as implementing the new harvest level once it has been established.

The term "model" (as used in this document) denotes a suite or set of policy preferences expressed in modeling language and simulated by the sustainable forestry modeling software called OPTIONS. OPTIONS is a spatially explicit, land-based planning model, which has been designed specifically to address forestland management issues. OPTIONS can model "what happens, where it happens in the landscape, and show how it would change over time." This model simulates forest growth over time, tracking where management activities happen, and gives DNR the ability to view detailed changes in the forest inventory and conditions over time and space.

2.4 DEVELOPMENT OF FOREST MANAGEMENT ALTERNATIVES

The six forest management Alternatives in this Environmental Impact Statement represent choices the Board of Natural Resources could pursue to guide management of state trust forestlands.

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 and charter). 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 DNR's purposes. Four key strategic questions were examined.

1. How should habitat be managed (actively or passively) to achieve the conservation benefits while providing revenue to the trusts?
2. How can revenue best be generated for the trusts (with a broad or narrow product base)?
3. How can the Board's and DNR's policies best reflect the objectives of the individual trusts?
4. How can the Board's and DNR's policies best reflect public interests?

As a result of this process, Alternatives 3 through 6 were not designed to be "ready-made" alternatives that the Board would simply pick as a Preferred Alternative. The intent is to examine a divergent set of policy expectations that demonstrate passive, active, and innovative approaches to forest management. However, the Board can choose any of the six Alternatives in their entirety if they so desire.

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

The Board can "mix and match" elements of the six Alternatives to design a Preferred Alternative for a final environmental analysis that is not one of the original six. The Board did not select a Preferred Alternative because additional information may provide a better solution than found in any of the current six Alternatives.

The process for arriving at the Preferred Alternative includes:

- Publication of this Draft Environmental Impact Statement;
- A financial analysis;
- A public comment period with public meetings and hearings;
- Two Board workshops to discuss the results, public comments, and to design a Preferred Alternative;

- Public meetings to present the Preferred Alternative and receive comments; and
- Development of the Final Environmental Impact Statement, review, and potential approval by the Board.

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 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 prospective Alternative was to examine an un-zoned management approach for all western Washington state trust forestlands 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, 1997 Habitat Conservation Plan). 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 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 this Environmental Impact Statement. Components not included in the current six Alternatives did not meet the purpose and needs statement (Appendix A).

2.6 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 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.

DNR staff provided the Board and the public with summaries of the Alternatives as they were being developed. In this section, the reasonable Alternatives are described in two ways, 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 other.

2.6.1 Features Common to all Reasonable Alternatives

Alternative 1 (No Action) and each of the reasonable 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 Departmental 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, or a "mix and match" Alternative including similar assumptions would result in Board-adopted amendments to the Forest Resource Plan.

The Preferred Alternative would be part of the final Environmental Impact Statement. When approved by the Board, the Preferred Alternative expressly changes current policies to align them with those included in the Environmental Impact Statement. Concurrent with the Board's approval of the Final Environmental Impact Statement, DNR's procedures and implementation strategies will be adjusted to reflect the policy choices included in the approved Final Environmental Impact Statement Alternative. In the case of some of the Alternatives, adoption of a newly approved procedure documented in the Final Environmental Impact Statement may require that DNR consult with the Federal Services as a part of ongoing Habitat Conservation Plan adaptive management efforts.

There are six westside planning units—North Puget, South Puget, Columbia, South Coast, Straits, and the Olympic Experimental State Forest (see Map 2). These planning units were developed as part of the Habitat Conservation Plan.

The environmental impact analyses in this document are summarized at the level of the planning unit, highlighting differences in likely significant impacts among the units for each Alternative.

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 that distinguish it from the other 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 to the Alternatives would, when coupled with the unique management in the Olympic Experimental State Forest, result in different impacts than anticipated in the other five westside planning units. These differences are described, by resource, in the environmental effects sections of Chapter 4.

2.6.1.2 Forest Roads

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. Roads are best planned and analyzed for their specific environmental impacts at the operational level and are beyond the scope of this analysis. DNR road planning is through Road Maintenance and Abandonment Plans (Forest Practices Rules, 222-24-050).

At the strategic level, it is not known if, over the 64-year analysis period, an Alternative would result in more or less roads. Therefore, the model assumptions around current and future roads are common to all Alternatives.

2.6.1.3 Policies and Procedures Common to all Alternatives

A small proportion of the modeled policies, procedures, and implementation strategies vary among the reasonable Alternatives. Only those that vary among Alternatives 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

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 state trust forestlands 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.

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.

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, the1997 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.

Alternative 4 – Passive Management Approach

Alternative 4 represents managing state trust forests 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 forest species and stand care) activity.

Alternative 5 – Intensive Management Approach

Alternative 5 represents managing state trust forests 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, 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.

Alternative 6 – Innovative Silvicultural Management

Alternative 6 represents managing state trust forests in western Washington using "innovative silvicultural management" techniques to generate both increased conservation benefits and revenue for the trusts. This approach attempts to integrate habitat and revenue generation objectives while maintaining the current Habitat Conservation Plan approach, DNR Forest Resource Plan objectives, and meeting current federal and state statutes. Alternative 6 is based on increased silvicultural activity designed to accelerate forest growth and structural development processes.

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 Ownership Groups

Currently, the sustainable forestry calculation is based on "ownership groups." Ownership groups include the Forest Board Transfer lands (calculated by individual counties (17 total in western Washington), Federal Grant lands and Forest Board Purchase (calculated by DNR administrative regions, of which there are 5 in western Washington), Capitol State Forest, and Olympic Experimental State Forest (see Map 3). 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 6. In Alternative 3, all westside trust forestlands are placed into one ownership group. In Alternatives 5 and 6 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 6 would require a change to Forest Resource Plan Policy No. 6.

2.6.3.2 Timber Harvest Levels

The method of calculating the sustainable forestry levels is central to the management of state trust forestlands. Sustainable harvest can be regulated by several means, including volume, acreage, and economic value. Current Board of Natural Resources policy uses timber volume.

When 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 focus on timber value. This is a significant difference. DNR would harvest more or less volume in response to changing market prices.

Alternatives 1 through 4 incorporate current policy, regulating harvest by volume. Alternatives 5 and 6 regulate harvest by economic value, requiring a change to Forest Resource Plan Policy No. 5.

2.6.3.3 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). It is a method for reaching forest equilibrium over time. However, changes in forest practice regulation, management objectives, land classifications (zoning), listing of threatened and endangered species, variable market conditions, and other factors can disrupt 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 forestry 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 (formerly RCW 79.68.030, recodified at Laws of 2003, Ch. 334, sec. 555(3)) 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.

Alternative 1 and Alternative 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).

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, recodified at Laws of 2003, Ch. 334, sec. 555(3)).

Alternatives 5 and 6 propose to implement the sustainable even-flow policy by revenue rather than harvest volume. The policy objective is to have timber harvest flows not vary from a previous decade more than +/-25 percent. This approach uses the flow constraint approach from the University of Washington model (Bare et al. 1997).

None of the Alternatives would require a change to Forest Resource Plan Policy No. 4 even-flow. However, Alternatives 2, 3, 5, and 6 would require a change to the "discussion" section of that policy. If the Board selected a Preferred Alternative that calculates harvest level by value—instead of volume—then Forest Resource Plan Policy No. 5, to control harvest by volume, would need to be amended accordingly.

Alternatives 2 to 6 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 Maturity Criteria and Rotation Age: Determining the Minimum Regeneration Harvest Age

Maturity criteria determine the earliest age that a stand is considered eligible for regeneration harvest and are applied in even-aged forests. Forest Resource Plan Policy No. 11 describes how DNR determines maturity criteria. Currently, these criteria are determined by balancing the biological productivity and the economic potential of a stand of trees.

The purpose of stand age has become outdated as a management tool for determining suitability for regeneration harvest. Forest structure-based criteria and market-based objectives provide better criteria for implementing silvicultural strategies. In addition, estimating stand age is difficult and expensive. Estimating stand age will become more difficult as DNR manages more areas containing groups of trees with different ages.

The determination of maturity criteria should not be confused with “rotation.” Rotation refers to the time interval between ‘when a new stand is established’ and ‘final harvest’ in even-aged management systems (Helms 1988). A rotation is determined by the silvicultural objectives for the forest stand. For a forest land base consisting of many mixed species stands of trees and with different growing potentials or site classes, an average rotation age generally represents the age at which forest stands are likely to be harvested. The average rotation across forest landscapes managed by DNR is the result of an array of policy goals and forest characteristics.

In western Washington, DNR’s current average rotation age is 60 years (Forest Resource Plan Policy No. 4). To meet specific objectives such as stand diversity, the Department may cut some stands as early as 45 years and other stands only when trees reach 100 years (Forest Resource Plan Policy No. 4).

In Alternatives 1, 2, and 3, maturity criteria are determined in accordance with the existing Forest Resource Plan Policy No. 11, through a balancing of tree growth potential and economic potential. Under this policy direction, neither maximum net present value nor culmination of growth determines when a stand of trees should be harvested. Instead, the decision is based on a balance of these two criteria. As an example, a Douglas-fir stand on site class III ground (average quality) has a minimum regeneration harvest age of 60 years.

In Alternative 4, maturity criteria are determined with an emphasis on tree growth over economic potential. In other words, the emphasis is to harvest a stand of trees as it approaches 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.

In Alternative 5, maturity criteria are determined with an emphasis on economic potential over tree growth potential. In this Alternative, the emphasis is on harvesting stands of trees when they have reached their maximum economic value, expressed as maximum 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. Alternatives 4 and 5, therefore, propose a change to current Forest Resource Plan Policy No. 11.

In Alternative 6, the maturity criteria are determined with an emphasis on economic potential over tree growth potential, as in Alternative 5. However, in Alternative 6, the implementation of biodiversity pathways silviculture presented by Carey et al. (1996) leads to an outcome of alternating harvest ages. For example, a Douglas-fir stand on site class III ground in a habitat resource area (i.e., riparian areas, northern spotted owl habitat areas, or spotted owl dispersal areas) may have harvest ages that alternate between 60 and 130 years. This feature, in theory, allows for simultaneous increases in production of both habitat and income. This feature, in addition to the implementation of innovative silvicultural techniques such as repeated entry thinnings that create habitat structures like down logs, snags, and multi-level forest canopies, would require changes to Forest Resource Plan Policy Nos. 30 and 31.

The determination of maturity criteria for each Alternative would require changes to Forest Resource Plan Policy No. 11, the discussion in 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 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” (Memo 1) owl circles.

Two other groups of owl circles—“Status 1 – Reproductive” (Stat. 1-R) and “Southwest Washington” (SW Washington)—receive explicit consideration in Procedure 14-004-120. Timber harvest activities are allowed only in the non-habitat portions of four SW Washington owl circles, and only habitat enhancement activities are allowed in the non-habitat portion of all Stat 1-R owl circles throughout the planning area. The Washington Department of Fish and Wildlife defined both Status 1 Reproductive and SW Washington owl circles.

Alternatives 2 to 6 propose changes to current operations from those defined in Alternative 1 (No Action). Management of Memo 1 owl circles remains the same for all Alternatives (1 to 6) (deferred until 2007).

Management of Stat. 1-R and SW Washington circles outside the Olympic Experimental State Forest varies among the Alternatives. Alternatives 3 to 6 propose to defer these owl circles from harvest until 2007, while Alternative 2 proposes no deferral of these circles. In all Alternatives, except Alternative 1, deferral of timber harvests in Stat. 1-R owl circles in the Olympic Experimental State Forest would cease in 2004. Adoption of one of Alternatives 2 through 6 would each require a change in Procedure 14-004-120 but no amendment to the Habitat Conservation Plan would be required.

Under current procedure, when the area designated for nesting, roosting, foraging or dispersal management within a Watershed Administrative Unit (based on 2000 Watershed Administrative Unit delineations and referred to in this document as “watershed”) is below 50 percent of the desired habitat, 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, and 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 tree growth and encourage understory development. The optimum time to thin trees depends on the size and number of trees in a given area. This can be expressed as a stand’s average relative density (Curtis 1982). The goal is to maintain a stand above a relative density of 45 and below 70. At a relative density of about 70 and above, forests are closed, with trees competing for growing space, light, and nutrients and some trees are suppressed and die. At a relative density of less than 45, forests become more open, with greater distances between trees where light and water can directly hit the forest floor. The result is a reallocation of energy from trees to the forest floor and understory. Low-impact access development and maintenance (including stream crossings and yarding corridors) is allowed in watersheds below the 50 percent habitat requirement.

This current management is modeled only in Alternative 1 (No Action), and would require no change to procedure.

In Alternative 1, nesting, roosting, foraging and dispersal management strategies are implemented as constraints, whereby if conditions are not met, management is restricted. However, habitat strategies can be implemented as targets, as originally articulated in the Habitat Conservation Plan (page IV.1-38).

In Alternative 2, a target of 50 percent desirable habitat is established for designated nesting, roosting, and foraging, or dispersal management areas within a watershed. However, unlike Alternative 1 (and Procedure 14-004-120), thinning is available as a strategy to create and maintain nesting, roosting, and foraging management area objectives. 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. This approach is used in Alternatives 2, 3, and 4 and 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).

Alternatives 5 and 6 propose a variation on the strategy proposed in Alternatives 2 through 4. Northern spotted owl conservation management in Alternative 5 is similar to that in Alternatives 2 to 4, with additional heavier thinnings to accelerate the development of large-diameter trees within stands to create and maintain sub-mature nesting, roosting, foraging, and dispersal habitat. Alternative 6 takes this strategy one step further based on concepts of biodiversity pathways described by Carey et al. (1996). These types of thinnings would be applied in small-diameter dense stands where stand viability would not be compromised. In these stands, the average relative density can be lowered to 35. In larger diameter stands, stand densities are maintained between 45 and 70. Thinning large-diameter closed stands too heavily and opening up the canopy too much may lead to blow-down and destroy much of the existing forest structure (e.g., snags). In all cases, the silvicultural prescriptions would include treatments to create and maintain snags, coarse woody debris, and small openings, as well as areas of heavy thinnings, light thinnings, and unthinned areas. As in Alternatives 2, 3, and 4, implementation of Alternatives 5 and 6 would require a change to Procedure 14-004-120.

2.6.3.6 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. DNR currently manages old forests with four basic guidelines in addition to the 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 do 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 DNR-managed state forests 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 its forested land in trees 25 years old or older (Task 14-001-010, Maintain Mature Forest Components). This so-called "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.

Alternatives 2 to 6 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 to 6 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, Alternatives 2 to 6 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 6, 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 6 have different approaches to maintaining and/or creating old forest conditions.

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 criteria without structural considerations found in the Habitat Conservation Plan definition of old forests.

Rather than specifically preserving all forests of a certain age existing today, Alternatives 5 and 6 propose that 10 to 15 percent of each westside 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 Policy Nos. 3 and 14.

2.6.3.7 Riparian and Wetland Areas

The riparian management zone strategies in the Alternatives are based on the riparian management activities described in the Habitat Conservation Plan (pages IV.59-62). Frequency and intensity of management within these zones varies 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 Habitat Conservation Plan. No changes are proposed for wetland management zones in any of the Alternatives. 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 are 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 would not change under Alternatives 1 and 4, requiring no change to DNR policy or procedure.

Newly proposed riparian procedures are under negotiation with the Federal Services (at time of publication). Alternatives 2, 3, 4, 5, and 6 are consistent with the draft riparian procedures.

Alternatives 2, 3, 5, and 6 provide a range of restoration and silvicultural activities that may be allowed under the final riparian procedure. 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 within riparian areas and wetlands is minimized to light access development and maintenance (road and yarding corridors).

In Alternatives 2 and 3, restoration and silvicultural activities are allowed at a low intensity within the riparian zones. Light variable thinnings are the principal silvicultural and restoration method to maintain stands for longer rotations and to increase structural complexity. It was assumed for modeling purposes that activities in Alternatives 2 and 3 would maintain canopy closure (relative density of 45 or greater) over 90 percent of the riparian management area.

In Alternatives 5 and 6, restoration and silvicultural activities are allowed at moderate intensity within the riparian zones. Alternative 5 allows heavier commercial thinnings (see Appendix B for a description of thinning types) to accelerate future large-diameter, structurally complex stands. For modeling purposes, it was assumed that activities in Alternative 5 would maintain canopy closure (relative density of 45 or greater) over 70 percent of the riparian management area.

Alternative 6 proposes a different approach from those in Alternatives 1 through 5. As in Alternative 5, Alternative 6 allows heavier thinnings in the riparian zones. Unlike the other Alternatives, biodiversity pathways management (Carey et al. 1996) is used to achieve desired structural components of a complex riparian forest stand. In these types of thinnings, relative density can be lowered to 35 in small-diameter dense stands. In larger diameter tall stands, relative densities are maintained between 45 and 70. Thinning large-diameter closed stands too heavily and opening up the canopy too much, may lead to blow-down and destroy much of the existing forest structure (i.e., snags and down logs). In all cases, the silvicultural prescriptions would include snag and coarse woody debris treatments, the creation of small openings, areas of heavy thinnings, light thinnings and leave areas. For modeling purposes, it was assumed that activities in Alternative 6, as in Alternative 5, would maintain canopy closure (relative density of 35 or greater) over 70 percent of the riparian management area.

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. Recovery allows greater integration of commodity production and conservation. Combined with the current forest conditions and experimental objectives, the Olympic Experimental State Forest riparian strategies are different from the westside HCP Planning Units (page IV.132). For the purposes of modeling, canopy closure is maintained (relative density of 33 or greater) over 67 percent of the riparian management area in the Olympic Experimental State Forest under all Alternatives.

2.6.3.8 Linking Plans to Implementation

The 1997 Habitat Conservation Plan is consistent with the DNR Forest Resource Plan. The Habitat Conservation Plan contains updated information and policy direction; the Forest Resource Plan envisioned such updates. The Habitat Conservation Plan sets management objectives at the landscape level and provides guidance for near and long-term management. It sets wildlife management objectives for the 1.6 million acres covered by the Habitat Conservation Plan, including all the acreage subject to this sustainable forestry calculation. The five western Washington HCP Planning Units are the Habitat Conservation Plan's fundamental building blocks, which set performance standards and reporting functions at the level of these units.

To meet contractual responsibilities and Board policies, operational implementation strategies would be based on a hierarchical planning approach, as previously presented to the Board in August 2001 (see Figure 2.6-1). When the Board selects and ultimately adopts a Preferred Alternative and associated sustainable forestry level, DNR would develop operational implementation plans for the adopted Alternative.

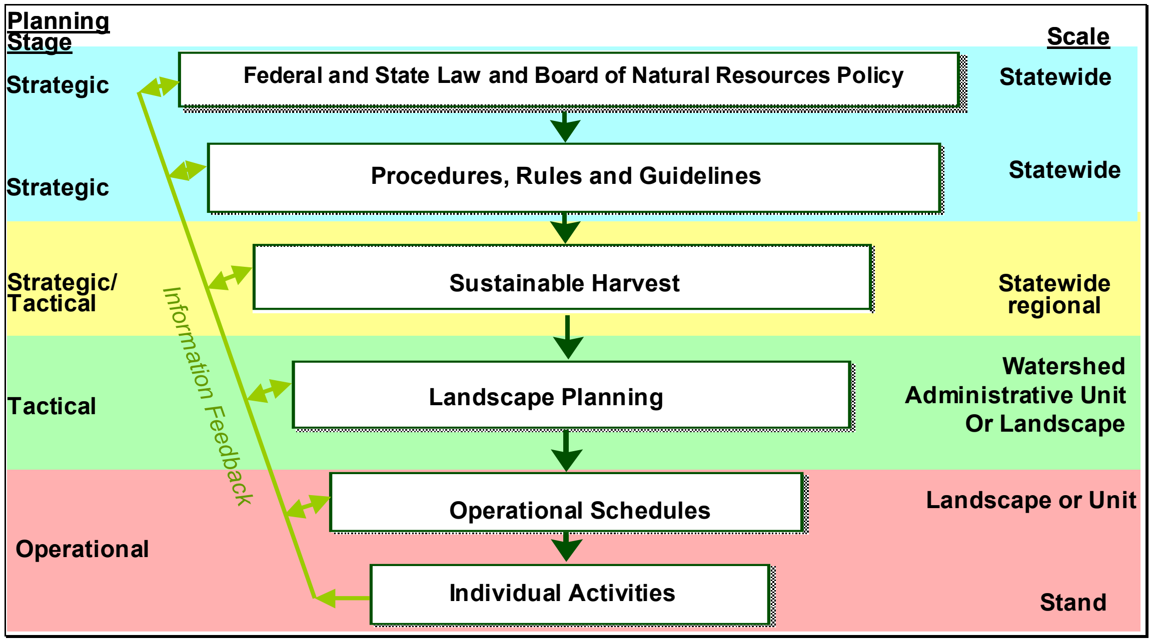

Figure 2.6-1. Hierarchical Planning Model

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 are the decadal sustainable harvest levels by ownership groups 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 do not form the basis of the analyses in this document, however. 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 state forestlands in western Washington. DNR considers the model outputs as the best information available to illustrate the range of likely outcomes for each of the Alternatives at the watershed scale. In Section 4.15, Cumulative Effects, modeling outputs and additional data are used to help describe the relative potential impacts, also at the watershed scale. Watersheds used in this analysis represent the March 2002 Watershed Administrative Unit coverage.

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

Management Issue	Policy, Procedure, Task Reference	Forest Management Alternatives 1	2	3	4	5	6
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 PR 14-001-010 TK 14-001-020	Current policy	Update policy discussion	Update policy discussion	Current policy	Update policy discussion	Update policy discussion
			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, 31 PR 14-005-020	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)	Update policy discussion (Nos. 4, 11, 30,31)
			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	Policy No. 14 (Old Growth Research Areas)	Current policy	Current policy	Current policy	Update policy discussion	Change/new policy	Change/new policy
					New procedure/task	New procedure/task	New procedure/task
	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
Riparian and wetland areas	PR1 14-004-150	Current procedure	Change procedure (Requires Services' agreement)	Change procedure (Requires Services' agreement)	Current procedure	Change procedure (Requires Services' agreement)	Change/new procedure (Requires Services' agreement)

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

		Sustainable Forest Management Alternatives					
		1	2	3	4	5	6
Trust Group	Ownership Group	First Decade Values in Millions of Board Feet per Year					
Federal Granted Trusts	DNR Central Region	38	58		61		
	DNR Northwest Region	48	60		52		
	DNR Olympic Region	7	17		13		
	DNR South Puget South Region	44	36		26		
	DNR Southwest Region	56	67		59		
	Federal Grants as one Westside group					335	386
	Capitol State Forest	38	43		37	44	65
	Olympic Experimental State Forest	19	62		8	170	39
Forest Board Transfer Trust	Clallam County	6	15		15	27	32
	Clark County	11	13		9	16	20
	Cowlitz County	4	6		4	8	8
	Jefferson County	5	6		3	8	9
	King County	10	8		6	14	13
	Kitsap County	3	3		3	3	4
	Lewis County	14	21		17	21	28
	Mason County	9	10		8	12	14
	Pacific County	3	6		6	13	14
	Pierce County	4	4		1	4	1
	Skagit County	32	36		34	50	53
	Skamania County	5	15		3	16	6
	Snohomish County	24	29		28	40	48
	Thurston County	2	6		2	5	6
	Wahkiakum County	4	5		6	11	11
	Whatcom County	10	12		10	22	24
	All trusts as one Westside group			663			
	Westside harvest level	396	537	663	411	819	781

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

	Sustainable Forest Management Alternatives					
	1	2	3	4	5	6
Trusts	First Decade Values in Millions of Board Feet per Year					
Agricultural School	9	9	7	12	12	13
Capitol Grant	34	37	46	29	74	59
Charitable/Educational/Penal and Reformatory Institution	15	15	17	12	20	26
Community College Forest Reserve	2	1	0	1	1	1
Common School and Indemnity	114	174	179	121	267	259
Escheat	2	2	2	1	2	2
State Forest Board Purchase	32	39	61	35	48	59
State Forest Board Transfer	157	212	300	163	324	307
Normal School	6	12	11	7	14	14
Scientific School	23	22	29	25	33	32
University - Original	1	0	1	1	1	1
University - Transferred	1	13	9	4	21	8
Grand Total	**396**	**536**	**662**	**411**	**817**	**781**

Note: Total harvest values in this table do not match all values in Table 2.6-2 due to rounding.

2.6.5 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.

2.6.6 Summary of Environmental Consequences

This section summarizes the environmental analysis detailed in Chapter 4, which examines the effects of proposed changes to the current policy and procedures, under each Alternative. The analysis uses 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 identified using modeling outputs.

In Chapter 4 and the summary below, two aspects of the environmental analysis are identified and discussed—the probable significant adverse impacts and potential risks. Probable significant adverse impacts are identified and defined in Washington Administrative Codes 197-11-782 and 197-11-794.

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 a negative environmental impact to occur and/or indicate if an Alternative may fail to meet all of its projected outcomes.

None of the Alternatives would result in any probable significant adverse impacts to any of the resource areas. 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

Alternatives 1 and 4 would provide more old forest and would entail less risk of adversely affecting threatened, endangered, and sensitive plants than the other Alternatives. However, Alternatives 1 and 4 would result in more dense forest stands that achieve lower tree growth rates and are more susceptible to damage from insects and disease. They rely on more passive management and would require less investment for forest management. Alternatives 2 and 3 are ranked intermediate on all factors and would also require an intermediate level of investment needed for successfully implementing the management strategies associated with these Alternatives and achieving the projected level of harvest.

Alternatives 5 and 6 would have fewer restrictions on areas available for stand management and timber harvest and would apply more intensive management strategies than the other Alternatives. Management proposed under Alternatives 5 and 6 would result in higher rates of tree growth, forests that are less susceptible to insect and disease damage, and higher levels of long-term carbon storage. Alternative 6 also ranks relatively high for maintaining stands with old forest characteristics. Alternatives 5 and 6 would entail more risk of adversely affecting threatened, endangered, and sensitive plants due to more harvest and harvest-related disturbance.

Indirect impacts on other resources, such as riparian resources, fish, and wildlife, are the result of different forest management strategies. These differing forest management strategies change the harvest intensity and harvest type. These impacts are summarized in each of the resource discussions below.

Riparian

The proposed different management strategies in riparian areas do not result in any “probable significant adverse impacts” in terms of development of future forest structures in the riparian zone relative to existing conditions and beyond those anticipated in the Habitat Conservation Plan environmental analysis. However, the level of management activity, such as silvicultural activities, in the different Alternatives could result in variable impacts. Such impacts, both beneficial and negative, vary when analyzed in the short term versus the long term. Alternative 6 is projected to develop more “functional” forest area in riparian areas; however, these projections are the outcome of an active management program of thinnings, snags, and down woody debris treatments.

Each of the Alternatives proposes different amounts of harvest activities in the riparian land class (Appendix D). The estimated average activity level of Alternative 5 is 13 percent per decade; Alternative 3 is 8 percent per decade; Alternative 2 is 7 percent per decade; Alternative 4 is 5 percent per decade; and Alternative 1 is 3 percent per decade.

The average estimated level of activity under Alternative 6, 35 percent per decade, represent substantially higher levels than the other Alternatives, although the majority of the harvest area in Alternative 6 is low volume removal harvests. Alternative 6 model results show a high level of activity within the riparian areas. It appears likely that the modeling outputs for Alternative 6 over-estimates the amount of allowable activity in the riparian areas. Upon examination, the problem is not with the fundamental policy direction in Alternative 6, but rather the outcome of initial modeling assumptions. Additional modeling will be completed for the Final Environmental Impact Statement.

Wildlife

Alternatives are consistent with the Habitat Conservation Plan. Environmental effects anticipated under all Alternatives would be within the level of impacts anticipated to wildlife species and analyzed in the Habitat Conservation Plan Environmental Impact Statement (DNR 1996). Changes under some alternatives in procedures that address the management of northern spotted owl habitat would be consistent with the goals and objectives of the Habitat Conservation Plan.

Other policy and procedure changes under the Alternatives would influence the amount and distribution of wildlife habitat on DNR westside 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. In the short term and long term, the amount of structurally complex forest is modeled as increasing in all planning units under all Alternatives. Structurally complex forest cannot, however, be used as a measure of DNR's success in meeting its obligations under the Habitat Conservation Plan. Instead, structurally complex forests serve as a relative indicator of change in the amount of habitats of management concern.

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. 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 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 planning units and for individual watersheds is included in Cumulative Effects (Section 4.15). Alternative 6 carries the highest potential overall relative impact, followed by Alternatives 5, 3, 2, 4, and 1.

Hydrology

None of the Alternatives would be expected to increase peak flows significantly. No changes to Procedure 14-004-060 are proposed; therefore, there would be no significant adverse environmental impact.

Water Quality

The proposed different management strategies would not result in any probable significant adverse impacts. 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 the no harvest portions of the Riparian Management Zones would prevent most sediment from entering streams. Over the long term, improved riparian function would lead to improved water quality on DNR-managed westside trust lands.

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 supporting procedure 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.

The higher level of harvest in Alternatives 5 and 6 would increase the relative potential risk to wetlands, but no Alternative has the potential for significant adverse environmental impacts.

Fish

The potential for adverse effects of the proposed Alternatives to fish would not be expected to result in any probable significant impacts beyond those anticipated in the Habitat Conservation Plan environmental analysis. Over the long term, all Alternatives would be expected to result in improved riparian and aquatic conditions for fish. In part, this is the result of current degraded conditions in many areas that resulted from practices prior to adoption of the Habitat Conservation Plan.

The potential for adverse effects to fish resources from Alternatives 1 though 4 is expected to be minimal during the first decade in all planning units. In contrast, harvest activities in the riparian zone are expected to be at higher levels under Alternative 5 in the Olympic Experimental State Forest and under Alternative 6 in all planning units, largely in the form of more frequent thinning activities. In particular, the estimated levels of activity under Alternative 6, which would be 35 percent per decade, represent substantially higher levels than the other Alternatives, although the majority of the harvest area in Alternative 6 is low-volume removal harvests. It appears likely that the modeling outputs for Alternative 6 over-estimate the amount of allowable activity in the riparian areas. Additional modeling will be completed for the Final Environmental Impact Statement.

Public Utilities and Services

The Alternatives present a wide array of direct economic benefits to the beneficiaries. Potential effects on transportation infrastructure would vary by Alternative, with larger projected harvest volumes resulting in increased logging truck traffic. None of the Alternatives is expected to result in any probable significant adverse environmental impacts. These impacts are in the setting of the total forest management activity within the state of Washington and surrounding regions; current DNR harvests are about 13 percent of total western Washington harvest. Logging companies harvesting timber from forested state trust lands must meet Washington State Department of Transportation weight requirements and DNR regularly meets with local government officials and engineers to discuss the effects of logging-related traffic (DNR 1992). These measures would help mitigate potential impacts associated with increased road traffic.

Cultural Resources

While there are relative differences among the Alternatives, adverse effects on cultural resources are expected to be insignificant under all Alternatives. 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. None of the Alternatives is expected to result in any probable significant adverse environmental impacts. 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).

The effects of the proposed Alternatives on fish and wildlife could, in turn, affect recreational fishing and hunting on DNR westside trust lands. Fishing and hunting opportunities on DNR westside 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.

Scenic Resources

None of the Alternatives is expected to result in any probable significant adverse environmental impacts. 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 Department 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.

Cumulative Effects

Landscapes in western Washington are characterized by a particular distribution of forest structures. The distribution of forest structures over time and space appears to be the basis of cumulative effects in the forest environment. It is generally recognized that very large and structurally complex forests are currently scarce and medium-sized closed forests are overabundant across all ownerships in western Washington. Therefore, forest management activities that create a greater balance in forest structure at the landscape level would be expected to reduce cumulative effects.

All Alternatives are modeled as resulting in increases in structurally complex forest over time. However, the rates of change and amount of change vary among the Alternatives. All Alternatives project changes in forest structure that should change the current distribution of structural classes towards more complex forests. All Alternatives create a new balance of forest structure at the landscape level. This new balance suggests that there is little potential for contributing to adverse cumulative effects.

Modeled changes in the percent distribution of forest structure classes on DNR-managed westside state trust lands are presented in Figures 2.6-2, 2.6-3, and 2.6-4. Forest structure is represented as stand development stages, which are defined in Table 4.2.14.

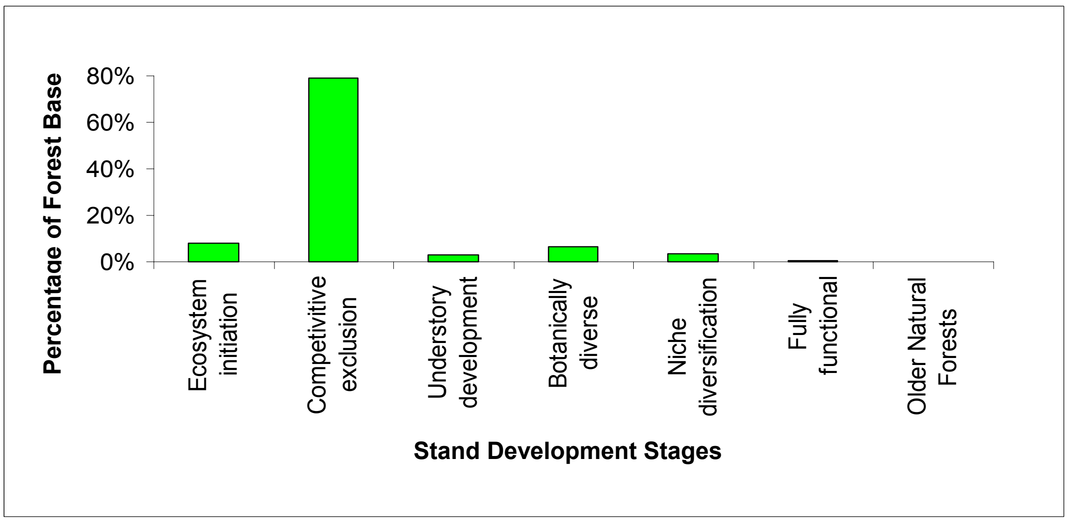

Figure 2.6-2. Modeled Proportion of State Trust Lands Forest in Each Stand Development Stage in 2004

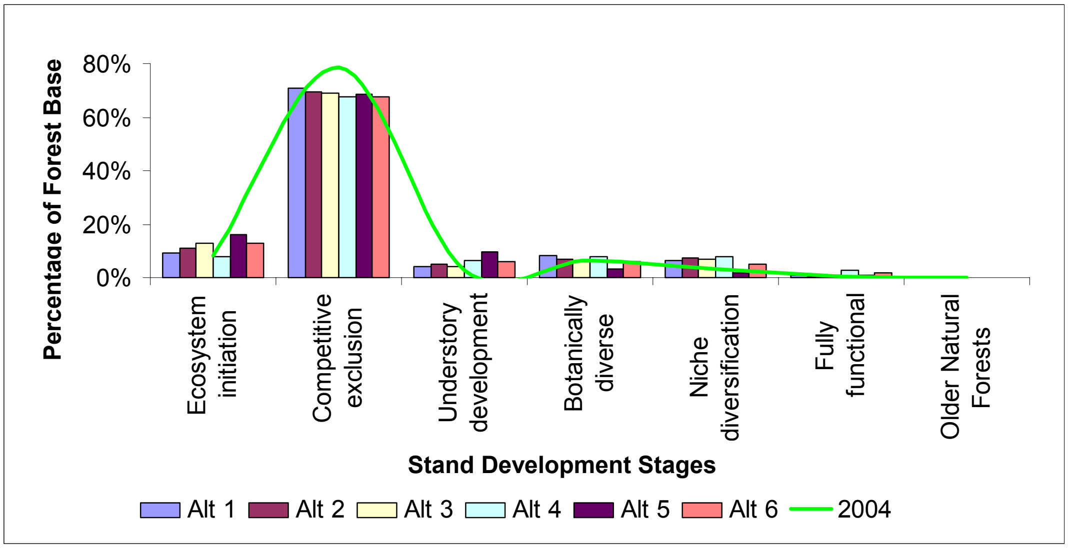

Figure 2.6-3. Modeled Proportion of State Trust Lands Forest Stand Development in Each Stage in 2013

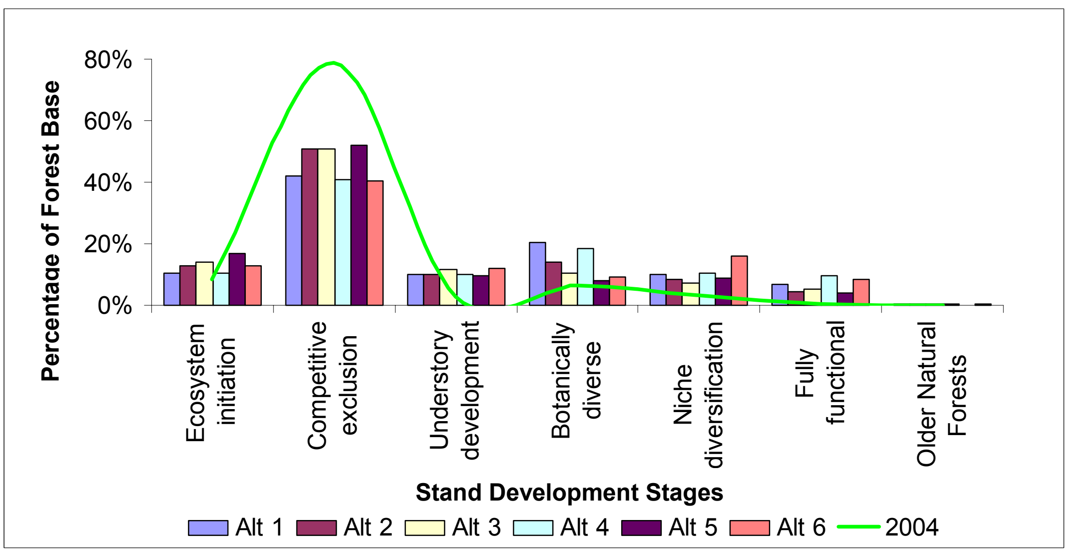

Figure 2.6-4. Modeled Proportion of State Trust Lands Forest Stand Development in Each Stage in 2067

Chapter 3

Chapter 3

3. ENVIRONMENTAL SETTING

3.1 SUMMARY OF DNR-MANAGED LANDS

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 eastside of the Cascades). The Habitat Conservation Plan (DNR 1997) 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.

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, Forest Board lands (both formerly RCW 79.68.030, recodified at Laws of 2003, Ch. 334, sec. 301), 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 Board Transfer[1/]	523,704	490,304	33,400
2	State Forest Board 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**	**1,390,702**	**139,045**

1/ Formerly RCW 79.68.030, recodified at Laws of 2003, Ch. 334, sec. 301
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 westside forested trust lands encompass Federal Grant lands, Forest Board 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-growth 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 westside trust lands were divided into six planning units as part of the Habitat Conservation Plan development process. Five of these 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 planning unit, it was considered separately. The westside 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.

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

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.

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 DNR-MANAGED LANDS

Major disturbance events, both natural and human-caused, have defined the current condition of DNR-managed forests in western Washington. 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 forest land conditions in western Washington, timber harvest is probably the greatest human influence. Most DNR-managed forestland has 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 in western Washington and bear witness to the intensity of logging in the early 20th century. Fire scars on residual trees and charred old-forest stumps show the effect of frequent fires that followed the first logging in those early years. Large parts of these forests seeded back naturally 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

The majority of the forests on DNR-managed trust lands in western Washington are dominated by conifers. 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 DNR-managed 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).

Table 3.4-1. Dominant Size Class Distribution for Westside 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

Chapter 4 of this Draft 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.

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 DNR trust lands on the westside 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 rain storms 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 forested state lands in western Washington, including the policies, procedures, and strategies that govern their management . The affected environment sections describe the current condition of the forested state trust lands against which the proposed Alternatives are evaluated. The following resources 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 by resource area following the presentation of the affected environment for each resource area. 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. After first presenting general background material, the affected environment and the associated environmental effects are presented separately for each of six major subsections.

Many resource areas refer to information presented in the affected environment sections of the Forest Resource Plan Environmental Impact Statement (DNR 1992a) and the Habitat Conservation Plan Environmental Impact Statement (DNR 1996). However, some information has been updated, and other subject areas (e.g., soil productivity, recreation) not covered in either the Habitat Conservation Plan or the Forest Resource Plan Environmental Impact Statements have been added.

The purpose of this analysis is to specifically evaluate whether the alternative policies and strategies proposed for managing DNR westside trust lands, alone or together, would have a significant adverse effect on the environment. 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.

Chapter 4

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 modified under the Alternatives. Conclusions are based on a qualitative analysis, 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 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 westside 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 lifespan of the Habitat Conservation Plan. Data are presented by decade for many resources.

The analyses presented in this chapter found that there are different levels of 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 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 Summary of Effects

This section analyzes the environmental effects on forest structure, old forests, carbon sequestration, and threatened and endangered plant species. The analysis examines the current and proposed changes to policy and procedures under the different Alternatives. The analysis uses the modeling outputs to inform the public and decision-makers of the relative differences in potential environmental impacts. 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 plants than the other Alternatives. However, Alternatives 1 and 4 would result in more dense forest stands that achieve lower tree growth rates and are more susceptible to damage from insects and disease. They rely on more passive management and would require less investment for forest management. Alternatives 2 and 3 are ranked intermediate on all factors and would also require an intermediate level of investment needed for successfully implementing the management strategies associated with these Alternatives and achieving the projected level of harvest.

Alternatives 5 and 6 would have fewer restrictions on areas available for stand management and timber harvest and would apply more intensive management strategies than the other Alternatives. Management proposed under Alternatives 5 and 6 would result in higher rates of tree growth, forests that are less susceptible to insect and disease damage, and higher levels of long-term carbon storage. Alternative 6 also ranks relatively high for maintaining stands with old forest characteristics. Alternatives 5 and 6 would entail more risk of adversely affecting threatened, endangered, and sensitive plants due to more harvest and harvest-related disturbance.

4.2.2 Introduction

This section describes the existing forest structure and vegetation resources on DNR-managed state trust lands in western Washington, and assesses potential effects to these resources resulting from changes to DNR's management policies under the proposed 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 on old forests. The following areas were assessed for the effects of proposed policy changes to the management of forest resources:

- Forest Condition – Change in the proportion of forest acreage within stands at different development stages; changes in the quantity and types of forest management activities.
- Growth and Yield – Annual volume harvested over the (64-year) analysis period; even flow of timber harvest over the analysis period; changes to standing volume of trees over time; and changes to forest stand development stages as an indicator of tree growth.

- 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.

Analysis of effects to the forest vegetation resources focuses on the approximately 1.4 million acres of westside forested state trust lands. Each of the six proposed Alternatives presents a broad range of strategies 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 forested state trust lands in western Washington 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 westside 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 DNR-managed forestland in western Washington 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 16 percent of the westside state 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 westside 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 westside 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 originally 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 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 DNR-managed westside trust lands have followed the same policy and procedural direction as Alternative 1 (No Action) as described in Chapter 2.

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

Table 4.2-2 displays the acres of precommercial 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 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
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**	**2,810**	**3,023**

Data Source: DNR Planning and Tracking database

Area fertilized includes both application of biosolids and aerial fertilizer application in North Puget and South Puget planning units. Area fertilized updated from e-mail communication from Carol Thayer, 7/24/03.

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

Planning Unit	Average Acres/Year Precommercially Thinned	Total Acres Precommercially Thinned 1996-2002
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	**12,624**	**75,745**

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 (formerly Revised Code of Washington 79.68.040, recodified at Laws of 2003, Ch. 334, sec. 555(3)). In 1996, the Board of Natural Resources adopted an annual sustainable harvest level of 655 million board feet for the forested state trust lands statewide. This equates to approximately 570 million board feet as the sustainable harvest level for westside state trust forests.

During the past 5 years (1998 to 2002), an average of just over 430 million board feet of timber per year has been harvested from westside 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 28 percent of the total 5-year timber volume yield. The Southwest Region (Clark, Cowlitz, Klickitat, Pacific, Skamania, and Wahkiakum counties) contributed about 19 percent of the volume. The Olympic (Clallam, Grays Harbor, and Jefferson counties) and South Puget Sound (King, Kitsap, Lewis, Mason, and Pierce counties) Regions produced 15 and 14 percent of the total yield, respectively.

Table 4.2-3 displays the total current standing forest volume by land class. Approximately 24 percent of trust land timber volume is located in the "uplands with general objectives" land class, 44 percent and 32 percent of the volume are in the "uplands with specific objectives" and "riparian" land classes, respectively (see Appendix B for a description of land classes).

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

Land Classification	Volume (billion board feet)
Uplands with General Objectives	12.3
Uplands with Specific Objectives	16.7
Riparian	23.0
Total	**52.0**

Data Source: Model output data (stand development stages)

4.2.4 Forest Structure, Growth, and Yield

4.2.4.1 Affected Environment

Stand development stages describe the structural conditions and developmental processes within a forest stand. Stand structural development stages represent a continuum rather than precise structural stages. The stages used in this analysis are adapted from three separate sources (Brown 1985, Carey et al. 1996, Johnson and O'Neil 2001). The stages are an attempt to better describe predicted forest development under management intended to increase structural complexity, including dead trees (snags) and down logs in order to support biodiversity.

"Stand development stages" differ from the "age classes" used to approximate forest structure for the Habitat Conservation Plan. Age class was the best available data at the time. However, age class is not a reliable indicator of stand structure. 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 (Franklin et al. 2002, Oliver and Larson 1996). While stand development stages can be roughly tied to the age of a stand, there are too many variables to expect a forest to develop along a predictable timeline.

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

- tree size,
- percent of canopy closure,
- canopy layers,
- abundance of dead or decadent trees, and
- abundance of dead down wood.

Descriptions of the stand development stages used in this analysis are provided in Appendix B, Section B.2.1.2. Table 4.2-4 displays the percent distribution of stand development stages on westside forested trust lands by planning unit. The majority of DNR-managed forests are Douglas-fir or western hemlock stands in the sapling, pole, and large tree exclusion stage. About 45 percent (622,000 acres) of the forested lands are in the large-stem exclusion stage (fully stocked stands dominated by 20- to 29-inch trees). About 35 percent (474,000 acres) of the forested lands are in the sapling and pole exclusion stages dominated by even-aged smaller stemmed trees. Approximately 3 percent (42,000 acres) of the forest is in understory reinitiation. Nine percent (125,000 acres) of the forests are in developed understory, botanically diverse, and niche diversification development stages that provide progressively more internal stand biodiversity with each development stage. Less than 1 percent (8,000 acres) of the westside state trust lands are in old natural forest and fully functioning stages.

Ecosystem initiation stages are open, newly regenerated stands that are actively growing. As stands develop into the sapling exclusion stage, pole exclusion, and large tree exclusion stages, competition for direct sunlight, nutrients, water, and space increases (Oliver and Larson 1996). These stands are nearing, or have exceeded, full site occupancy. When growing space is fully occupied, growth declines. The understory reinitiation stage develops as a result of in-stand mortality or silvicultural thinning. Trees that achieve dominance have more growing space. As tree density is reduced, growth of the dominant trees increases. In multi-storied stands such as developed understory, botanically diverse, niche diversification, and fully functional structure stages, the primary factors that influence growth are age, tree species, site, spacing, and density. Growth rates in these stands would be variable. Where density is high, growth rates would be slowed. In mature stands, growth may slow as a factor of tree age. In stands where density is variable, potential growth may be lower due to low stocking.

“Forest growth and yield” refers to the change in standing tree volume over time, and the amount of timber harvested over 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.

Table 4.2-4. Stand Development Stages in Westside Forested State Trust Lands, by Planning Unit

	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 Forest Trust Lands**	**Total Acres**
Ecosystem Initiation	10	8	9	9	9	6	8	114,552
Sapling Exclusion	16	17	16	12	12	26	17	229,980
Pole Exclusion	11	15	16	17	14	28	18	243,856
Large Tree Exclusion	58	45	51	51	53	21	45	621,779
Understory Reinitiation	1	6	1	1	1	1	3	34,941
Developed Understory	<1	<1	<1	<1	<1	<1	<1	4,178
Botanically Diverse Stage	2	5	4	6	6	11	6	87,043
Niche Diversification	1	3	3	3	4	5	3	46, 161
Fully Functional	<1	<1	<1	1	<1	1	<1	6,150
Old Natural Forests	<1	<1	<1	<1	<1	<1	<1	2,064
Total Percent	**100**	**100**	**100**	**100**	**100**	**100**	**100**	
Total Acres Planning Unit	**110,222**	**381,515**	**141,843**	**267,530**	**232,931**	**256,659**		**1,390,703**

Data Source: Model output data – stand development stages
[1/] OESF = Olympic Experimental State Forest
Note: Numbers rounded; when added, may not equal 100%.

Characteristics that affect growth and yield are the density and spacing of trees in stands, the development stages of stands, and the site productivity of stands. The effects of the proposed Alternatives are measured by how management activities change stand density and the stand development stage. Stand development stages represent stand structure and are used to index growth (change in forest volume over time) and yield. Comparing the resulting development stage distribution among Alternatives provides a means for summarizing changes in stand structure, growth rates, and yields. Current amounts of each stand development stage are displayed in Table 4.2-4.

4.2.4.2 Environmental Effects

Table 4.2-5 summarizes the proposed policy, procedure, and operations changes that would affect the forest conditions, standing volume, and distribution of forest stand development stages over the westside trust lands. Appendix C provides an overview of current policy and procedures, and Chapter 2 provides further detail on proposed changes.

Table 4.2-5. Policy, Procedure, and Operational Changes that Affect Forest Structure, Growth, and Yield

Policy and Procedure Changes Proposed	Alternative					
	1	2	3	4	5	6
Policy No. 4 – Sustainable, Even-flow Timber Harvest		X	X	X	X	X
Policy No. 5 – Harvest Levels Based on Volume					X	X
Policy No. 6 – Western Washington Ownership Groups			X		X	X
Policy No. 11 – Management of On-base Lands				X	X	X
Policy No. 30 – Silviculture Activities; Policy No. 31 – Harvest and Reforestation Methods						X
Task 14-001-010 – Maintenance of Mature Forest Components		X	X	X	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
Procedure 14-005-020 - Identification and Prioritization of Stands for Regeneration Harvest		X	X	X	X	X
Operations – Increased Resources needed to Identify Unstable Slopes —Level of Use of Fertilization, Thinning, Planting		X	X		X	X

The effect of the changes to Procedure 14-004-120 and Task 14-001-010 would be an increase in land available for forest management compared to Alternative 1 (No Action) (see Appendix B, Table B-4: Acres of Land Deferred from Timber Harvest and Acres by Land Classification for Each Alternative, for changes in amounts of deferrals for each Alternative). Increasing available land would allow for an increase in total harvest activities across the land base and a resultant increase in harvest levels. Forest management and harvest rates in “Uplands with General Objectives” and “Uplands with Specific Objectives” land classes would increase under Alternatives 2, 3, 4, 5, and 6. As available or ‘on-base’ land increases, so would the distribution of the harvest over the differing land classes (see Table 4.2-6).

All Alternatives would implement DNR’s Habitat Conservation Plan strategies. As a result of these strategies, it is expected that over time conditions on state trust forests would:

- increase the area of more structurally complex forests, and
- increase standing forest inventories.

Table 4.2-6. Average Distribution of Harvest within Land Classes

	Land Classification			
	Uplands with General Objectives	Uplands with Specific Objectives	Riparian	
Alternative	Percent of Total Harvest	Percent of Total Harvest	Percent of Total Harvest	Total
1	56%	37%	8%	100%
2	41%	47%	12%	100%
3	44%	42%	14%	100%
4	52%	37%	11%	100%
5	34%	50%	16%	100%
6	28%	37%	35%	100%

Source: DNR OPTIONS model results (timber flow levels)

Structurally complex forests are categorized here as the developed understory, botanically diverse, niche diversification, fully functional, and old natural forests stand structure stages (Appendix B).

Model projections for all the Alternatives display an increase in standing volume (Table 4.2-7) and more diverse forest conditions in the future (see Figures 2.6-2, 2.6-3, and 2.6-4 in Chapter 2, and Table 4.2-8). Modeled changes in the distribution of stand development stages are discussed at greater length in Sections 4.2.5.2 and 4.4.4.1.

All Alternatives would result in increases in standing tree volume over time, except Alternative 3, which is modeled as resulting in slightly less standing volume in 2067 than in 2004 (Table 4.2-7). All Alternatives are less than Alternative 1 (No Action) in standing volume increases. However, the importance of standing volume is its relationship to the amount of timber harvest (flow) over time, and the structural conditions within a forest.

Model output indicates that all Alternatives would maintain a relatively constant timber harvest flow over the planning period 2004 through 2067 (Figure 4.2-1). In other words, there are no dramatic declines or booms in harvest flow. Even 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. Modeled declines in timber harvest flow from the initial decades are not a result of declines in standing forest volume or inventory, because inventory would increase under all Alternatives except Alternative 3 (Table 4.2-7). Modeled declines in timber harvest flow under any Alternative reflect a transition period that each Alternative passes through, from the current inventory level to a new standing inventory level in the future. This transition and new stand inventory would be determined by changes to policies on sustainable even-flow, the method of calculation (value versus volume), ownership groups, and maturity criteria. The levels of harvest would be a result of different amounts and areas of available land for forest management, as well as the policies mentioned above.

Table 4.2-7. Percent Change in Standing Volume from Base Year 2004 by Alternative through the Analysis Period

Year Modeled	Alternative 1	2	3	4	5	6
2008	4%	2%	1%	4%	1%	2%
2013	9%	5%	1%	9%	3%	4%
2031	25%	13%	5%	23%	6%	7%
2048	35%	14%	5%	32%	15%	10%
2067	39%	10%	-3%	33%	16%	6%

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	6
Ecosystem Initiation	8%	11%	13%	14%	10%	17%	13%
Sapling Exclusion	17%	5%	10%	13%	6%	13%	9%
Pole Exclusion	18%	11%	18%	17%	12%	19%	13%
Large Tree Exclusion	45%	25%	23%	21%	23%	20%	19%
Understory Reinitiation	3%	9%	9%	11%	10%	11%	11%
Developed Understory	<1%	1%	1%	1%	1%	<1%	1%
Botanically Diverse	6%	21%	14%	11%	18%	8%	9%
Niche Diversification	3%	10%	8%	7%	10%	9%	16%
Fully Functional	<1%	7%	4%	5%	10%	4%	9%
Old Natural Forest	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Source: Model output data (stand development stages)

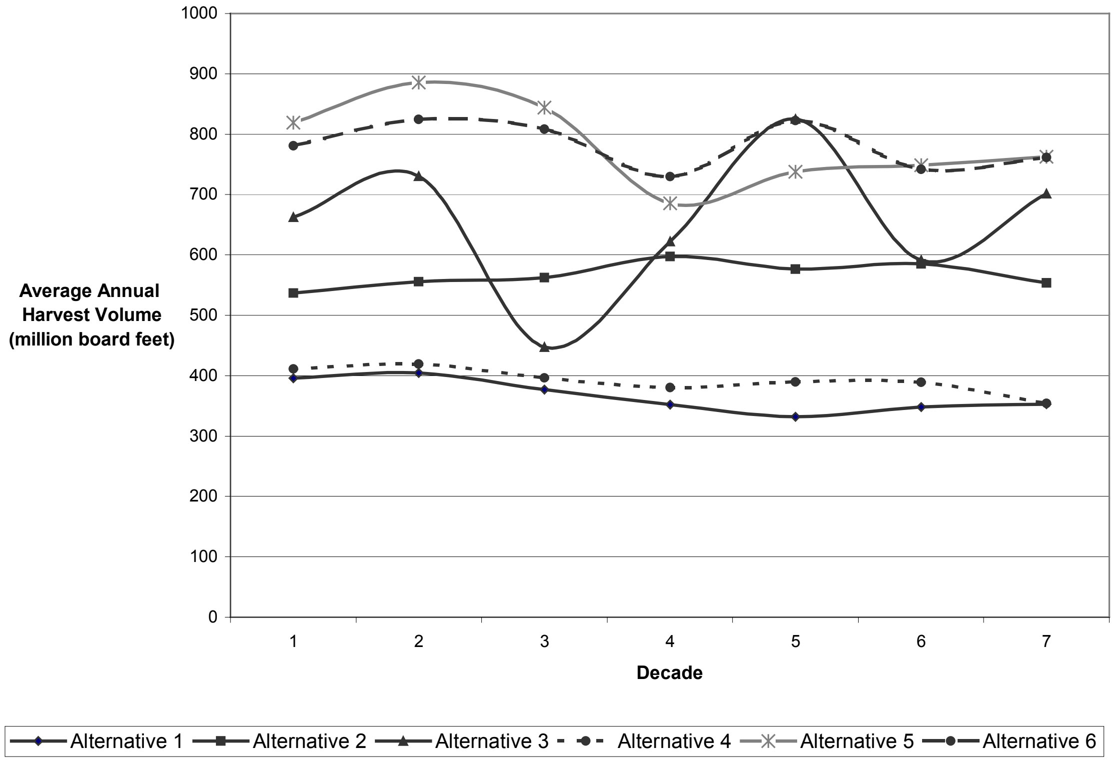

Figure 4.2-1. Average Annual Western Washington State Trust Land Timber Harvest Volume per Decade Over the Planning Period (2004-2067)

Data Source: Model output data (timber flow levels)

The Alternatives would result in differing distributions of stand development stages over time, differing timber harvest flows and levels, and differing inventories of tree volumes. However, this analysis identified no significant adverse environmental impacts on forest conditions or on the potential growth and yield of the forest as a result of the proposed policy and procedural changes in any of the six Alternatives.

4.2.5 Old Forest

4.2.5.1 Affected Environment

There is no single definition of old forest, sometimes referred to as old growth. Depending on the definition of this term, its meaning 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 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
- Forest stands that have various old forest characteristics, labeled here as "**structurally complex forests**" that include the stand development stages of developed understory, botanically diverse, niche diversification, fully functional, and old natural forests

In the Olympic Experimental State Forest, 20 percent of DNR-managed trust forests are managed for old forest conditions (DNR 1997, page IV.88). The Habitat Conservation Plan glossary provides the following definition for old forest (listed under the term 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 Geographic Information System data show about 2,000 acres of old natural forests, as defined by stand development stage class (Table 4.2-4). These stands have high levels of structural complexity, are greater than 250 years old, and are located on the westside trust forestlands. These acres are distributed in Columbia (700 acres), North Puget (600 acres), South Coast (30 acres), and Olympic Experimental State Forest (700 acres) planning units.

DNR estimates there are about 145,000 acres of structurally complex forests on state trust forestlands in western Washington. The distribution of these structurally complex acres among the 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 hemlock/Douglas-fir forests and may not accurately categorize other forest types such as 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 4.2-9.

Table 4.2-9. Policy and Procedure Changes that Affect Old Forest on State Trust Lands

Policy Change Proposed	Alternative 1	2	3	4	5	6
Task 14-001-010 – Maintaining Mature Forest Components (50/25 strategy)		X	X	X	X	X
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		

In all Alternatives, regardless of management strategy, stands that represent old forest conditions would increase substantially over the 64-year planning period. Figure 4.2-2 graphically displays the distribution of structurally complex forest at the end of the planning period. Figure 4.2-3 displays acres of forests 150 years old or greater occurring at the end of the first and last decades of the analysis period. A greater long-term increase in structurally complex forests is projected under Alternatives 1 and 4 than under the other Alternatives (Figure 4.2-2). The passive approach to timber management in Alternative 4, setting aside all 150-year-old stands, and the longer average maturity criteria (80 years), would result in the highest percent of the area in stands with old forest characteristics. There would be a smaller increase in stands with old forest characteristics under Alternatives 2 and 6. The fewest acres with old forest are projected under Alternatives 3 and 5.

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/counts). Often used as a tool to determine when thinning is needed to maintain steady tree growth in the stand, relative density can also be used as an indicator of stand health. As competition among trees for growing space increases, relative density increases and tree vigor declines.

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

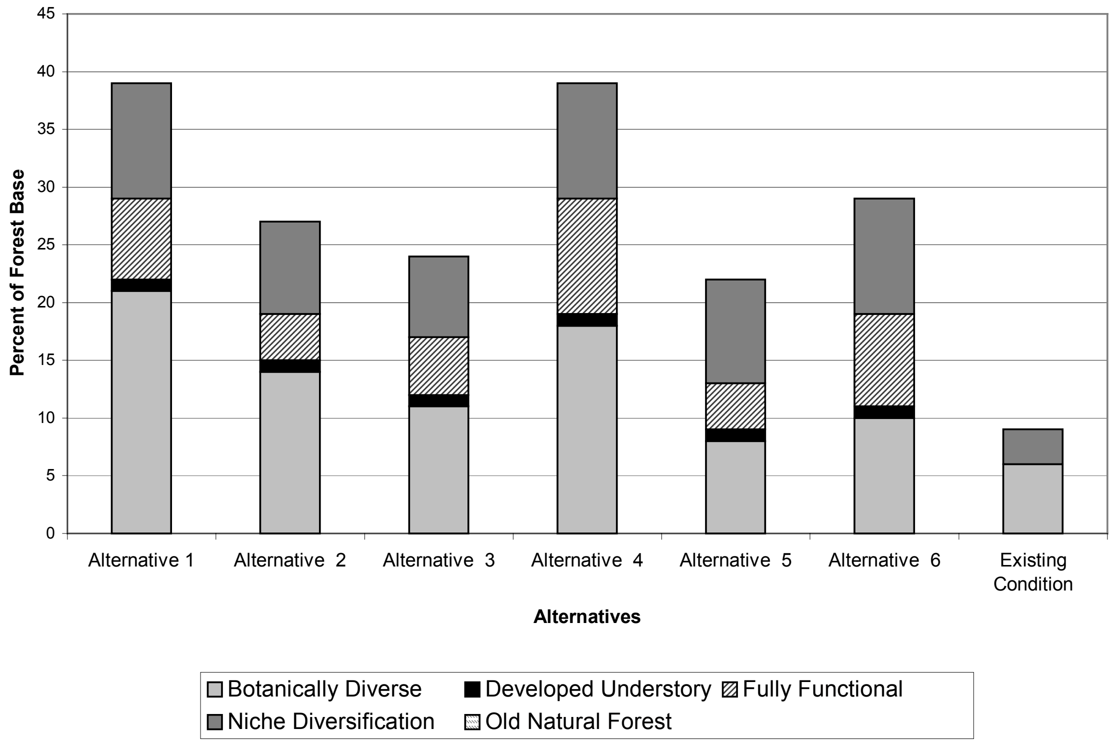

Figure 4.2-2. Percent Distribution of Forests with Structural Complexity Characteristics of Old Forest at Year 2067
Data Source: Model output data (stand development stages)

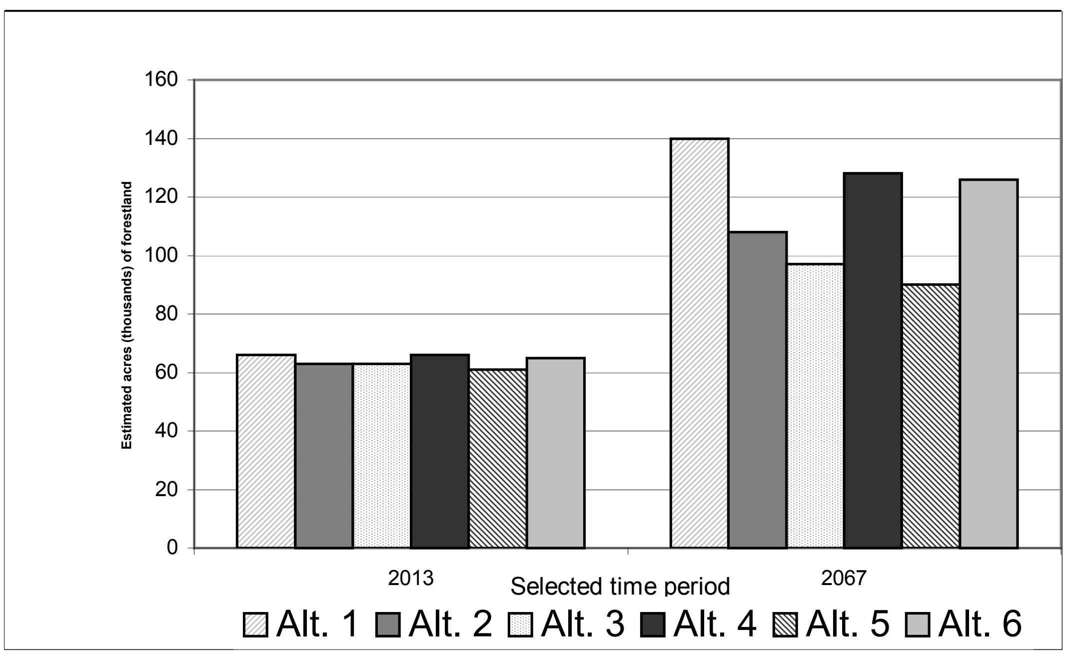

Figure 4.2-3. Acres of Old Forest by Alternative at Years 2013 and 2067
Current conditions are estimated at 60,000 acres of old forest is represented as forests 150 years and greater. Data Source: Model output data (stand development stages)

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 westside 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 4.2-10 shows the relative density level when the susceptibility for competitive mortality increases for the three major tree species in westside trust forestlands. Approximately 226,000 acres of Douglas-fir stands, 374,000 acres of western hemlock stands, and 140,000 acres of red alder stands are nearing or at increased risk to mortality, based on elevated relative density. Thinning to maintain growth has the secondary effect of reducing stocking to increase stand vigor.

Table 4.2-10. 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 DNR Westside Trust Land	Percent of Total Forested Area
Douglas-fir	50 and above	226,000	16
Western hemlock	55 and above	374,000	27
Red alder	44 and above	140,000	10
Total		**740,376**	**53**
Data Source: Model output data (stand development stages)			

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.

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, sometimes girdling the tree.

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 et al. 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 removes 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 increase 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 Alternative 1, there would be a slight reduction in the acres of western hemlock and red alder stands with a high relative density. However, the amount of Douglas-fir-dominated stands with a high relative density would increase over time (Table 4.2-11). Alternatives 2, 3, and 4 are projected to reduce acres with high relative densities by a similar amount, between 7 to 12 percent (Table 4.2-11). The majority of the reduction would occur in western hemlock-dominated stands, though some reduction in the Douglas-fir and red alder stands is also projected. Intensive management that includes regeneration harvest and aggressive thinning strategies under Alternatives 5 and 6 would result in the greatest reduction of acres with high relative densities, a reduction of nearly half (Table 4.2-11). The majority of the reduction would occur in western hemlock-dominated stands, and to a lesser degree, Douglas-fir and red alder stands.

Table 4.2-11. 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	16%	16%	16%	19%	19%	20%
	W. Hemlock	27%	29%	30%	32%	30%	25%
	Red Alder	10%	9%	9%	8%	8%	8%
	Total Acres	**53%**	**54%**	**54%**	**59%**	**58%**	**52%**
2	Douglas-fir	16%	15%	14%	13%	14%	15%
	W. Hemlock	27%	28%	29%	31%	27%	22%
	Red Alder	10%	9%	8%	6%	7%	7%
	Total Acres	**53%**	**52%**	**51%**	**50%**	**49%**	**43%**
3	Douglas-fir	16%	14%	12%	15%	17%	15%
	W. Hemlock	27%	29%	30%	27%	25%	19%
	Red Alder	10%	10%	9%	7%	7%	7%
	Total Acres	**53%**	**52%**	**52%**	**49%**	**49%**	**41%**
4	Douglas-fir	16%	15%	14%	17%	15%	14%
	W. Hemlock	27%	27%	28%	30%	27%	23%
	Red Alder	10%	9%	8%	7%	8%	7%
	Total Acres	**52%**	**51%**	**50%**	**54%**	**51%**	**45%**
5	Douglas-fir	14%	11%	9%	10%	9%	10%
	W. Hemlock	26%	26%	23%	16%	13%	11%
	Red Alder	10%	8%	7%	7%	7%	6%
	Total Acres	**50%**	**45%**	**40%**	**32%**	**30%**	**27%**
6	Douglas-fir	16%	15%	13%	14%	12%	12%
	W. Hemlock	25%	25%	26%	23%	21%	17%
	Red Alder	10%	9%	7%	5%	6%	5%
	Total Acres	**51%**	**49%**	**46%**	**49%**	**40%**	**34%**

[1/] See Table 4.2-10 for relative density levels when tree mortality occurs by tree species
Data Source: Model output data (stand development stages)

The high levels of moderate to heavy thinning associated with Alternatives 5 and 6 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.

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

Alternatives that feature repeated thinning entries (such as Alternative 6) would 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 16 and 18 percent of the westside trust lands in sapling and pole exclusion stands, respectively (Table 4.2-8). Alternatives 2, 3, 5, and 6 would have a greater percent of the area in these stand development stages—between 22 and 32 percent of westside trust forestlands 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). Alternatives 5 and 6 would have the highest harvest intensity levels over the duration of the planning period, with Alternative 5 slightly higher than Alternative 6. 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.

Forest lands 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 (Binkley et al. 1997, Schroeder 1991), 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).

4.2.7.1 Affected Environment

Approximately 80 percent of westside trust forestlands are in a competitive exclusion stage, with 35 percent in sapling and pole exclusion, and 45 percent in large tree exclusion. 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

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. Alternative 6 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 6 and 5 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 3, and 2 produce lower harvest volumes than Alternatives 6 and 5. 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 Alternatives 6 and 5.

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 the westside state trust forestlands. The table also includes the habitat requirements for each species and known occurrences of threatened, endangered, and sensitive plants on the state 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 DNR 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 to 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 to change any policies or procedures for managing threatened, endangered, and sensitive plants. The treatment of these plants is identical under all Alternatives. The difference in effects of 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 necessarily 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. Alternative 6 has the highest level of harvest activities, as much as 35 percent of the riparian area may be affected based on model results (Table 4.2-12). Therefore, Alternative 6 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 13 percent per decade, Alternative 3 at 8 percent per decade, and Alternative 2 at 7 percent per decade. Alternative 4 at 5 percent per decade and Alternative 1 at 3 percent per decade 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 botanical diversity include botanically diverse, niche diversification, fully functional, and old natural forest. The effects to these forest stand development stages are discussed in Section 4.2.4.2 of this document and summarized in Table 4.2-12.

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). Alternatives 1 and 4 would have the largest portion of DNR forest trust lands (38 and 39 percent of acres, respectively) in botanically diverse stand development stages by the year 2067. Therefore, Alternative 1, current operations, and Alternative 4, with longer rotations to retain old forests, are expected to have developed the largest area with diversity of habitats in forested areas.

Table 4.2-12. Harvest in Riparian Zones, and Percent of Forest with Botanical Diversity, by Alternative

	Average Percent of Riparian Land Class Impacted per Decade by Harvest Type				
Alternative	**Low Volume Removal Harvest 1/**	**Medium Volume Removal Harvest 2/**	**High Volume Removal Harvest 3/**	**Total**	**Percent of Forested Acres (Upland and Riparian) with Botanical Diversity 4/ in 2067**
1			3%	3%	38%
2	1%	2%	3%	7%	27%
3	2%	3%	4%	8%	23%
4			5%	5%	39%
5	5%	3%	5%	13%	21%
6	23%	5%	8%	35%	34%

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, fully functional, and old natural forest stages

Alternatives 1 and 4 are followed by Alternative 6 with 34 percent and Alternative 2 with 27 percent of acres that would be expected to be in stand development stages with high levels of botanical diversity by the year 2067. Alternatives 3 and 5 (23 and 21 percent of acres, respectively) are expected to have the fewest acres in these stand development stages.

In summary, for both riparian and forest habitats, Alternatives 1 and 4 are expected to have the least potential to affect threatened, endangered, and sensitive plants. For riparian plants, Alternatives 5 and 6 would have the most potential to physically disturb threatened, endangered, and sensitive plants and their habitats. For forested areas, Alternatives 3 and 5 are expected to provide the fewest 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.

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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 to them proposed under the Alternatives. 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 qualified using modeling outputs.

The management strategies proposed under the six Alternatives would not result in any probable significant adverse impacts on riparian resources beyond existing conditions and those anticipated in the Habitat Conservation Plan Environmental Impact Statement. However, the different levels of management activities under each of the Alternatives are likely to result in greater potential of adverse 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. Alternative 6 is projected to develop more "functional" forest area in riparian areas; however, these projections are the outcome of an active management program of thinnings, snags, and down woody debris treatments.

Each of the Alternatives proposes different amounts of harvest activities in the riparian land class (Appendix B). The estimated average activity level of Alternative 5 is 13 percent per decade; Alternative 3 is 8 percent per decade; Alternative 2 is 7 percent per decade; Alternative 4 is 5 percent per decade; and Alternative 1 is 3 percent per decade.

The average estimated level of activity under Alternative 6—35 percent per decade—represents substantially higher levels than the other Alternatives, although the majority of the harvest area in Alternative 6 is low-volume removal harvests. Alternative 6 model results show a high level of activity within the riparian areas. It appears likely that the modeling outputs for Alternative 6 over-estimates the amount of allowable activity in the riparian areas. Upon examination, the problem is not with the fundamental policy direction in Alternative 6, but rather the outcome of initial modeling assumptions. The model may overestimate the rate and intensity of harvest activities in riparian areas. Model assumptions will be reviewed for the Final Environmental Impact Statement.

4.3.2 Introduction

This section describes the riparian ecosystem and its various functions, the current condition of riparian areas on DNR-managed westside 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 instream 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 DNR-managed westside 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. 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 DNR-managed westside 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, stream bank 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. 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 stream banks, 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.” 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." It is considered by some to be a better measure of the important wood recruitment sizes (DNR 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 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-size streams comes from outside the stream, through the annual contribution of large amounts of leaves, cones, wood, and dissolved organic matter (Gregory et al. 1991, Richardson 1992). In contrast, wide high-order streams with higher levels of direct sunlight, or low-order streams with an open riparian canopy, produce more algae. The source and level of organic debris input can change. 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 shade is an important factor affecting stream temperature. Several factors dictate 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 (OFPACSW 2000). 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 stream-side 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 hill-slopes, 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 Stream Bank 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 (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 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 stream banks 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 Riparian Conditions

Historically, Pacific Northwest forests (including riparian areas) were a mosaic of different forest types and ages, and large areas of old forest were common (Franklin et al. 1981). 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). 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 depending upon the nature and distribution of the riparian communities by stream reach.

Figure 4.3-1 and Table 4.3-1 depict the distribution of stand development stages in the riparian land class for the six westside planning units. 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.

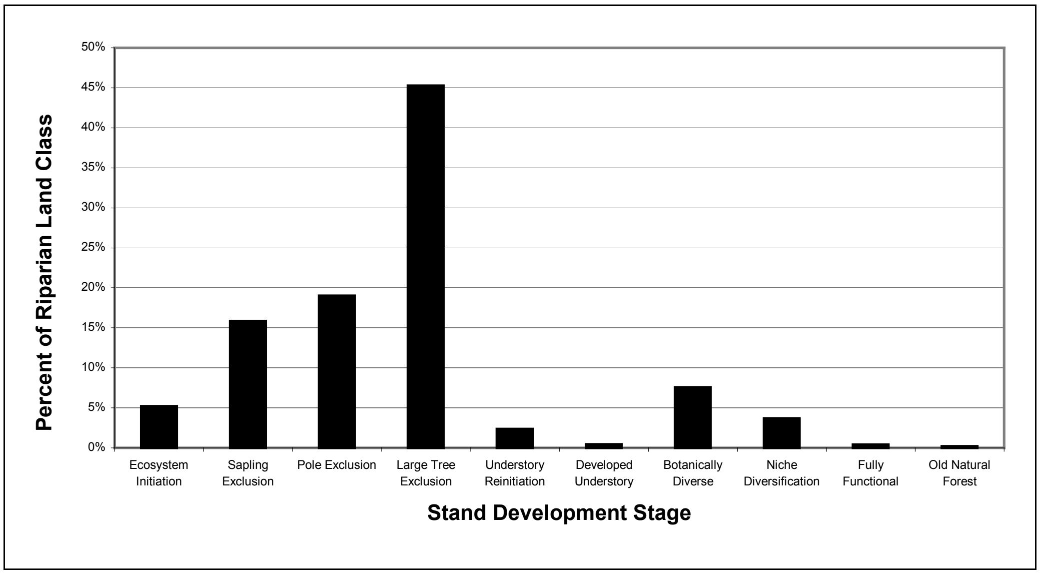


Figure 4.3-1. Distribution of Stand Development Stages within the Riparian Land Class on DNR Westside Forest Trust Lands

Data Source: Model output data – stand development stages

In general, the distribution of stand development stages for riparian areas within the westside planning units is skewed towards sapling, pole, and large tree exclusion stand developmental stages. Some planning units (e.g., the Olympic Experimental State Forest) also have a relatively high proportion of the ecosystem initiation developmental stages. With the exception of the Olympic Experimental State Forest, 51 to 65 percent of riparian areas by planning unit are within the large tree exclusion stage. Within this stand development stage, dominant trees are 20 to 29 inches in diameter and canopy closure is greater than 70 percent. Dominant trees in this stand development stage 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).

Table 4.3-1. Distribution of Stand Development Stages (Carey et al. 1996) Within Riparian Areas[1/] Among the Six Westside Planning Units

Stand Development Stage	North Puget	South Puget	Columbia	South Coast	Olympic Experimental State Forest	Straits	Total
Ecosystem Initiation	5.4%	5.6%	5.7%	4.9%	4.6%	5.4%	5.2%
Sapling Exclusion	13.6%	12.9%	12.3%	11.6%	25.1%	12.9%	15.9%
Pole Exclusion	14.4%	16.7%	17.5%	15.5%	29.0%	9.9%	19.0%
Understory Reinitiation	5.5%	1.4%	1.2%	1.4%	1.6%	2.2%	2.3%
Large Tree Exclusion	51.0%	55.1%	52.4%	55.2%	21.0%	65.1%	45.3%
Developed Understory	0.6%	1.0%	0.5%	0.3%	0.1%	0.9%	0.4%
Botanically Diverse	5.5%	3.8%	6.4%	6.8%	12.8%	2.2%	7.5%
Niche Diversification	3.3%	3.5%	3.4%	4.1%	4.3%	1.5%	3.7%
Fully Functional	0.3%	0.1%	0.3%	0.1%	1.1%	0.0%	0.4%
Old Natural Forest	0.3%	0.0%	0.3%	0.0%	0.3%	0.0%	0.2%
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	**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.

2/ Acreage does not include wetland and wind buffer areas.

In contrast, the riparian land class tends to be deficient in "very large" trees (more than 30 inches in diameter at breast height) found in the botanically diverse, niche diversification, fully functional, and old natural forest stand development stages. 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 distance 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 westside planning units range from approximately 4 to 19 percent of these stand development stages. Notably, the Olympic Experimental State Forest has a higher percentage of stands in the very large stages compared to the other planning units. The Straits Planning Unit has the lowest percentage (about 4 percent) of stands in the stand development stages that provide very large trees, including none in the fully functioning and old natural forest stages. Very large trees are scarce on DNR trust lands in most westside watersheds. In approximately one-third of the watersheds, less than 1 percent of the riparian area consists of very large trees. In nearly half (47 percent) of the watersheds, less than 5 percent of the riparian area consists of very large trees.

Approximately 21 percent of DNR riparian stands are in the ecosystem initiation and sapling exclusion stages, which include trees 0 to 9 inches in diameter at breast height. Nearly 30 percent of the riparian stands in the Olympic Experimental State Forest are in these early developmental stages. Summarization of the data for DNR-managed westside trust lands by watershed indicates that approximately 9 percent of the watersheds have riparian land class areas that are mostly in the ecosystem initiation and sapling exclusion stages, and approximately 35 percent of the watersheds have at least one-quarter of the riparian land class area in these early developmental stages. These levels suggest that a substantial amount of riparian areas were disturbed prior to the implementation of the Habitat Conservation Plan (DNR 1997).

In conclusion, the distribution of stand development stages within riparian areas suggests that many moderate to large streams on DNR westside trust lands may have reduced levels of one or more riparian functions because of low levels of large, fully functioning trees. These areas are likely to remain in this status for the near future because they contain moderate to high levels of early stand developmental stages. In contrast, many small to moderately sized streams may be approaching a moderate to high level of function from trees in intermediate developmental stages. Overall, riparian areas have a relatively high proportion of early and mid-developmental stages and low proportions of older developmental stages of forest.

Forest Management in Riparian Zones

The amount of activity in Riparian Management Zones was estimated in the Habitat Conservation Plan. Use of herbicides or fertilizers in riparian zones is uncommon on DNR westside trust lands. If herbicides or fertilizers are used, they are applied manually within riparian zones.

The effects on riparian functions of low-intensity timber management systems (such as single-tree selection and light small wood thinning) in Riparian Management Zones 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, 49]) are generally based upon fully developed stands and 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.

Removing trees within the Riparian Management Zone may temporarily reduce the level of certain riparian functions, but the extent of the reduction depends on where trees are removed, 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 evaluated against the potential to accelerate functional recovery.

Based upon recent evaluations of riparian function, a fully functioning stand that is 0.75 of a site potential tree height in width from 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 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) may result in a higher risk of blowdown 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 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. Such events help to restore longer-term riparian functioning but may have some short-term impacts.

In addition to causing loss of function through the removal of trees, management activities can disturb soils in the riparian zone. Yarding can result in compaction, rutting, and surface erosion if logs are not adequately suspended during yarding. Maintenance and re-growth of brushy vegetation and trees reduce the risk of adverse effects. Protection of stream bank integrity and adequate soil filtering of surface erosion are 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 buffer along Types 1 through 4 streams for all westside planning units except the Olympic Experimental State Forest. Activities in the adjoining zones would be directed at achieving an old forest condition. Consequently, none of the Alternatives is likely to adversely affect stream bank stability or sediment filtering capacity from surface erosion. Although there is more flexibility for silvicultural prescriptions within riparian management zones for the Olympic Experimental State Forest relative to the other five planning units, bank stability and riparian conservation goals are important features to the Aquatic Conservation Strategy that is considered when silvicultural prescriptions are developed.

A riparian stand may not be fully functioning because of current conditions, previous management activities, 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; and
- retention of large legacy trees.

4.3.4 Environmental Effects

Forest management activities, including road building and stream crossings, yarding corridors, restoration, vegetation management, fertilization and varying levels of timber harvest, will result in changes to the forest structure within the riparian areas.

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, and may unacceptably contribute to 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.

The changes proposed to policies and procedures 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 and 4, are expected to have a higher proportion of riparian area with very large trees that are in competitive exclusion stages. In contrast, Alternatives with higher levels of active management, such as Alternative 6, are expected to have a lower proportion of riparian area with very large trees by the end of the Habitat Conservation Plan, but more riparian area will be fully functioning, or be on a trajectory towards full function. Regardless, riparian conditions are expected to improve under all Alternatives. This is due to changes in stand structure, particularly increases in the amount of stand development stages that include very large trees, which are in short supply throughout much of the DNR-managed westside trust lands (see Figure 4.3-2). The rate of improvement varies by Alternative. Active management is expected to achieve more fully functioning stands within 80 to 90 years, rather than approximately 220 years (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.

Table 4.3-2. Estimated Acres of Forest Management in the Riparian Land Class per Decade Among the Westside Planning Units Under Each Alternative

	Period	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Olympic Experimental State Forest (110,000 total acres in riparian land class)	2004-2013	1,653	4,598	3,180	1,303	23,692	46,073
	2014-2023	1,830	5,561	2,825	1,234	29,033	62,566
	2024-2033	2,956	8,451	9,502	1,621	36,567	62,103
	2034-2043	2,787	10,512	10,722	1,689	29,467	80,279
	2044-2053	2,422	9,390	19,781	1,634	24,649	81,418
	2054-2063	3,128	12,428	16,340	1,724	23,485	60,872
	2064-2067	1,361	4,086	9,653	810	9,742	18,260
	Mean	2,521	8,598	11,251	1,565	27,599	64,308
Five Westside Planning Units (excludes OESF; 315,000 total acres in riparian land class)	2004-2013	7,458	13,248	15,951	15,110	22,505	65,693
	2014-2023	9,219	15,126	21,982	13,908	25,445	54,097
	2024-2033	11,989	20,109	21,779	16,845	33,571	94,253
	2034-2043	10,779	20,911	25,759	18,848	27,370	77,953
	2044-2053	10,432	22,104	31,209	20,483	33,485	119,478
	2054-2063	11,421	25,740	24,097	24,462	30,557	94,130
	2064-2067	3,836	7,772	8,932	9,430	10,474	49,346
	Mean	10,177	19,533	23,392	18,607	28,657	86,711

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

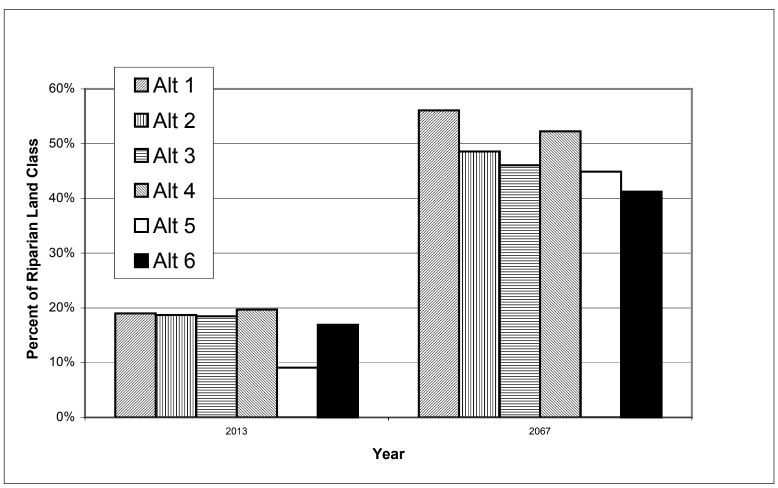


Figure 4.3-2. Percent of the Riparian Land Class that is in Very Large Tree Stand Development Stages (Botanically Diverse, Niche Diversification, Fully Functional, and Old Natural Forest) in the Short Term and Long Term

Note: Current conditions are estimated to be approximately 12% of 426,000 acres.
Source: DNR model output data

Although Alternative 6 would be expected to result in the lowest amount of area with very large trees, this Alternative would likely result in a slightly higher amount (11 percent) of riparian land class area in fully functional or old natural forest stand development stages compared to the other Alternatives. Alternative 3 would be expected to result in the lowest amount (approximately 7 percent) (Figure 4.3-3). Alternative 1, which would likely result in the highest area of very large trees (approximately 56 percent of the riparian land class), would be expected to result in about 9 percent of riparian land class area in fully functioning or old natural forest stand development stages. The major added feature that distinguishes the fully functional and old natural forest stand development stages from other stages with very large trees is the presence of high 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 Alternative 6 would likely yield slightly higher riparian function on more of the riparian land class than Alternative 1, but with the trade-off of having potentially less area with very large trees in the riparian land class. Given stand densities within the riparian areas, Alternative 1 may take a very long time to produce very large trees. Similarly, the heavier thinning proposed under Alternative 5 would be expected to produce higher riparian function on slightly more of the riparian land class than Alternative 1, but with less area supporting very large trees. If no future disturbance occurs to areas with very large trees, these stands would likely achieve full function over time.

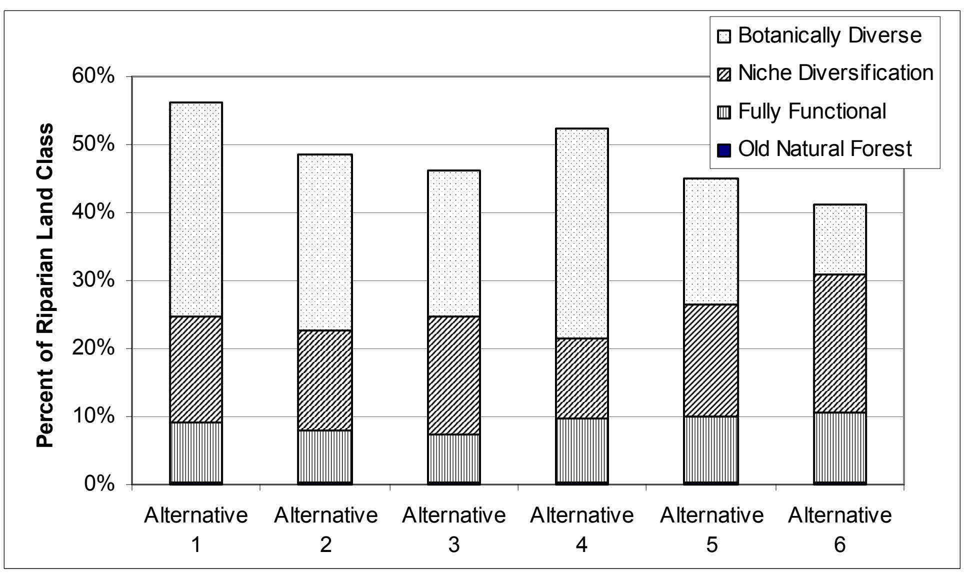


Figure 4.3-3. Estimated Percent of the Riparian Land Class Consisting of Various Stand Development Stages Including Very large Trees over the Long Term (2067) among the Alternatives

Source: DNR Alternative model output data

For most planning units during most decades under Alternative 6, the bulk of harvest activities consist of low-volume removals. In the Olympic Experimental State Forest, approximately 95 percent of the harvest activity is low volume removals. The Olympic Experimental State Forest management strategies are designed to accelerate restoration efforts in close, dense stands that dominate the current conditions of the forest landscape. In the Olympic Experimental State Forest, harvest can currently occur in interior-core buffers, provided that management activities are consistent with conservation objectives. The Olympic Experimental State Forest riparian strategy also allows light partial harvests and relies on experiments for harvesting in the exterior buffer of up to 33 percent of the available volume (DNR 1997, page IV.134).

Large woody debris recruitment, leaf and needle litter production, and shade conditions would be expected to improve under all Alternatives. 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 may occur from the removal of riparian trees. Generally, this impact would be expected to be relatively minor except under Alternative 6, and in the Olympic Experimental State Forest under Alternative 5. Under Alternative 6, reductions in leaf and needle litter, shade, and large woody debris recruitment potential could occur in some planning units during some decades. This would likely occur because the level of disturbance to the riparian land class could be as high as 73 percent of the area during the 2044 to 2053 time period in the Olympic Experimental State Forest, whereas the level of disturbance is commonly 30 percent or greater during other decades and in other westside planning units (Appendix D.3). However, these levels of disturbance from harvest activities are the results of low volume removals or thinnings in close, dense stands in the competitive exclusion phases. These effects would likely be more pronounced in areas where tree removal occurs in the no-harvest and minimal harvest sub-zones.

Activities in the riparian zone under Alternative 6 using ground-based and cable yarding methods could result in low to moderate levels of soil compaction and/or rutting and surface erosion along skid trails, but on a more frequent basis. Under Alternative 5, the Olympic Experimental State Forest would likely experience disturbance levels as high as 33 percent in a decade and over 20 percent for other decades. The highest level of disturbance for planning units during a decade is expected to be about 18 percent or less under all other Alternatives and is usually less than 10 percent (Appendix D.3).

None of the Alternatives proposes activities within the 25-foot no-harvest buffer along Types 1 through 4 streams, except for yarding corridors, roads, and restoration activities. Consequently, none of the Alternatives is likely to cause substantial adverse effects on stream bank stability or sediment filtering capacity from surface erosion.

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 developmental stages with 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 Alternative 6 having the highest likelihood of expressing any difference and Alternatives 1 and 4 having the lowest.

Alternatives 5 and 6 would have the highest likelihood of affecting riparian microclimate, based on the projected relatively high level of harvest activities. However, the majority of these activities are low volume removals, most probably thinnings, and these activities are necessary to produce the increase in the amount of more “fully functional” forests in the riparian zone. The actual nature of these harvest operations, whether they are ground or cable, the type of equipment use, etc., and how they interact with site-specific factors, are beyond the scope of this analysis. The analysis of these interactions will be performed at the project level.

Harvest prescriptions and mitigation measures including avoidance, short-term deferral, harvest and yarding method, restoration, or other measures can be implemented in Riparian Management Zones. The details will be analyzed at the project level. Mitigation in the form of more intensive monitoring would be necessary for Alternatives 5 and 6, which have relatively higher levels of forest management activity in riparian zones. Monitoring of harvest operations is necessary to assess the level of impact in future operations and to ensure the thinnings result in the benefits of accelerated forest development.

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. 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.

All Alternatives are consistent with the goals and objectives of the Habitat Conservation Plan. Environmental effects anticipated under all six Alternatives would be within the level of impacts anticipated to wildlife species and analyzed in the Habitat Conservation Plan Environmental Impact Statement (DNR 1996). Changes in management of northern spotted owl habitat under some Alternatives would be consistent with the goals and objectives of the Habitat Conservation Plan.

Other policy and procedure changes under the Alternatives would influence the amount and distribution of wildlife habitat on DNR westside 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 beyond existing conditions and those anticipated in the Habitat Conservation Plan Environmental Impact Statement. In both the short term and long term, the amount of structurally complex forest is modeled as increasing in all planning units under all Alternatives. Structurally complex forest cannot be used as a measure of DNR's success in meeting its obligations under the Habitat Conservation Plan. Instead, structurally complex forests serve as a relative indicator of change in the amount of habitats of management concern under the Alternatives.

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. Affected Environment 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 would affect wildlife habitats and populations.

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

- the availability 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 species such as the marbled murrelet;
- the maintenance of habitat features that contribute to biological diversity (e.g., snags, logs, 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 DNR-managed westside trust lands, gives examples of species associated with these habitats, and describes their distribution among management zones.

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 forest structure classes, which are a way of classifying forest stands according to various levels of structural and vegetative complexity (Johnson and O'Neil 2001). Forest structure classes are described at greater length (related to the stand development stages described by Carey et al.]1996]) in Section B.2.1.2, Appendix B. Table 4.2-4 provides the current distribution of stand development stages on westside trust lands. The total acreage of these habitat types by planning unit is summarized in Table 4.4-1.

Table 4.4-1. Acres of Wildlife Habitat Types Among Westside Trust Lands by Habitat Conservation Planning Unit

	Planning Unit						
Habitat Type	**Columbia**	**N. Puget**	**OESF[5/]**	**S. Coast**	**S. Puget**	**Straits**	**Total**
Ecosystem Initiation Forest	23,390	32,211	15,657	20,636	12,130	10,528	114,552
Competitive Exclusion Forest[1/]	216,207	316,573	196,216	187,381	119,167	95,011	1,130,555
Structurally Complex Forest[2/]	27,934	32,731	44,786	24,915	10,547	4,682	145,595
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/]	80,163	83,355	65,310	79,224	31,204	18,299	357,555

Data Source: Model output data – stand development stages

1/ Includes sapling exclusion, pole exclusion, and large tree exclusion stages

2/ Includes understory reinitiation, developed understory, botanically diverse, niche diversification, fully functional, and old natural forest stages. Includes approximate acres of old natural forest, defined as unmanaged stands greater than 250 years old, as well as those meeting the criteria of the fully functional stand development stage.

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 around 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 4.9.1.3 for a discussion of how wetlands were identified for this analysis.

5/ OESF = Olympic Experimental State Forest

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). Such stands also provide abundant forage for wide-ranging ungulate species (deer and elk). Other species closely associated with forests in the ecosystem initiation 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).

Currently, about 8 percent of westside forested 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 of the competitive exclusion stages generally have a single, dense canopy layer dominated by trees between 10 and 30 inches 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. Forest structure classes that make up this habitat type include the closed-canopy shrub/sapling class, pole-sized classes, and all large-tree classes described by Johnson and O'Neil (2001), except for multistoried large-tree stands with less than 70 percent canopy cover (Appendix Table B-2).

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 forest stages described by 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 westside trust lands, making up 81 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 Forests

Structurally complex forests typically feature multiple canopy layers, with the top layer dominated by trees greater than 30 inches in diameter at breast height. Forest structure classes that make up this habitat type include multistoried large-tree stands with less than 70 percent canopy cover, and all stands dominated by trees greater than 30 inches diameter at breast height. In the more fully developed stages, snags and down logs play a vital role in providing structural and biological diversity (Section B.2.1.2, Appendix B). Forested stands meeting the criteria of the fully functional stage (Carey et al. 1996), along with those with a stand age greater than 250 years and no history of silvicultural activity, are identified in this analysis as "old forest."

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 important species, including nest sites for 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 10 percent of the total forested area on DNR-managed westside trust lands (Table 4.4-1). Among the planning units, the Olympic Experimental State Forest supports the highest proportion (17 percent) and the Straits Planning Unit supports the lowest (4 percent) of this forest habitat type. Currently, about 18 percent of the structurally complex forest on westside trust lands occurs in areas with general management objectives; the other 82 percent occur in riparian and wetland areas or uplands with specific management objectives (including the entire Olympic Experimental State Forest). Old forest makes up less than 6 percent of the structurally complex forest in westside trust lands.

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 Table D-7). Riparian and wetland habitats occur throughout all the westside planning units, encompassing about 23 percent of the DNR-managed westside trust lands.

Uncommon and Non-forest Habitats

While the great majority of DNR-managed westside trust lands supports forests of various structural classes, non-forested 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, while technically classified as forestlands, warrant specific consideration in the DNR Habitat Conservation Plan 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 non-forested habitat types on DNR-managed forestlands. "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 Environmental Impact Statement are those with a regulatory status that indicates particular concern for their viability on DNR-managed westside 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 westside 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 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, 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 Environmental Impact Statement as discussed above. 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. 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 size classes (Appendix Table B-2), in addition to the stages that make up structurally complex forest.

Notably, the forest structure classes analyzed in this document are defined using a different set of criteria than the habitat definitions described in the Habitat Conservation Plan. Structurally complex forest is not quite the equivalent of nesting, roosting, and foraging habitat; therefore, neither the summaries of current conditions nor the modeled projections of future conditions should be used as a measure of DNR's success in meeting its obligations established under the plan. The two habitat types are similar enough, however, 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.

DNR Procedure 14-004-120, Management Activities Within Spotted Owl Nest Patches, Circles, Designated Nesting, Roosting, and Foraging and Dispersal Management Areas, was designed as a short-term measure to allow DNR to continue to support the current population of owls by maintaining key habitat around certain known owl sites, while new habitat develops in long-term designated areas. Currently, 28 "Memorandum 1" owl circles are identified as overlapping forested state trust lands in western Washington, along with 78 Status 1-Reproductive and 4 Southwestern Washington owl circles. Timber harvest within the non-habitat portions of these circles is deferred until nesting habitat has been identified. To date, only one HCP Planning Unit has met this habitat identification requirement, with the net effect that timber harvest is not allowed throughout most of these circles.

As noted in Table 4.4-1, structurally complex forest (used here as an estimate of nesting, roosting, and foraging habitat) accounts for about 10 percent of forested areas of westside forested trust lands. The proportion is slightly higher (11 percent) within areas specifically designated for nesting, roosting, and foraging management.

When the Habitat Conservation Plan was completed in 1997, several studies had described northern spotted owl populations 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). Additional research and analysis since that time has provided further evidence that spotted owl populations are continuing to decline. Analysis by Franklin et al. (1999) suggested that the population on the Olympic Peninsula was declining at a rate of about 6 percent per year. Further study by Forsman and Biswell (2003) did not suggest any improvement. Forsman and Biswell (2003) offer three possible explanatory factors behind the continued population decline: (1) loss of habitat, (2) the invasion of the Olympic Peninsula by the barred owl, and (3) high mortality resulting from the severe winter of 1998-1999.

Marbled Murrelet

Reflecting the lack of certainty about the specific habitat needs of marbled murrelets, the Habitat Conservation Plan defined an interim conservation strategy for this species. The interim strategy for marbled murrelets involves habitat relationship studies designed to identify marginal habitats that have the greatest potential to support murrelets. These studies have not been completed in all six westside planning units; therefore, analyses in this Environmental Impact Statement take a more general approach, using structurally complex forest as an indicator for suitable nesting habitat for marbled murrelets.

Analyses conducted for DNR’s Habitat Conservation Plan Environmental Impact Statement (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 there is likely 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 145,600 acres of structurally complex forest on westside trust lands (Table 4.4-1), approximately 85 percent occur within 40 miles of marine waters, and an additional 4 percent occur between 40 and 50 miles from marine waters.

Other Threatened, Endangered, and Sensitive Species

Appendix Table D-7 lists the threatened, endangered, and sensitive species that are known or suspected to occur on DNR-managed westside 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. In contrast, 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 a source 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 (Washington State Department of Fish and Wildlife 1996). Data available for this analysis can be analyzed at three scales: all DNR-managed westside state trust lands, the six planning units, 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 (e.g., Jenkins and Starkey 1990).

For this analysis, watersheds in which 30 to 60 percent of the forested area consists of structurally complex, ecosystem initiation, or open-canopy pole- or large-tree forest, are considered to provide suitable habitat for deer and elk. Currently, there are 124 watersheds in which foraging habitat makes up 30 to 60 percent of DNR-managed forests (Table 4.4-2). This amounts to 38 percent of the 324 westside trust land watersheds.

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.

Table 4.4-2. Number of Watersheds[1/] Supporting Percentages of Deer and Elk Foraging Habitat Among Westside Planning Units

Percentage of Foraging Habitat	Number of Watersheds: Columbia	N. Puget	OESF[2/]	S. Coast	S. Puget	Straits	Total
≤30% Forage	26	62	22	21	20	12	163
30%-60% Forage	35	28	8	21	17	15	124
>60% Forage	5	10	1	12	9	0	37
Total	**66**	**100**	**31**	**54**	**46**	**27**	**324**
Percent in 30%-60% range	*53%*	*28%*	*26%*	*39%*	*37%*	*56%*	*38%*

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

[2/] OESF = Olympic Experimental State Forest

The Forest Resource Plan and the Habitat Conservation Plan establish the goals and objectives for management of DNR 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.

Model output results were used to estimate variations in sustainable forest management practices under the six Alternatives. Results show one of many pathways by which DNR might meet sustainable forest management objectives that include full regulatory compliance and providing the important conservation benefits specified by the Habitat Conservation Plan.

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 Table D-8 presents the modeled proportion of westside 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).

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 4.4-1, Appendix Table D-8). 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.

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 planning units in some time periods. For example, model results for Alternative 3 suggest that 28 percent of the Straits Planning Unit would consist of this habitat type in 2013, more than double the proportion in DNR-managed westside trust land as a whole. Alternatives 5 and 6 results also predict that more than 20 percent of the Straits Planning Unit would consist of ecosystem initiation forest.

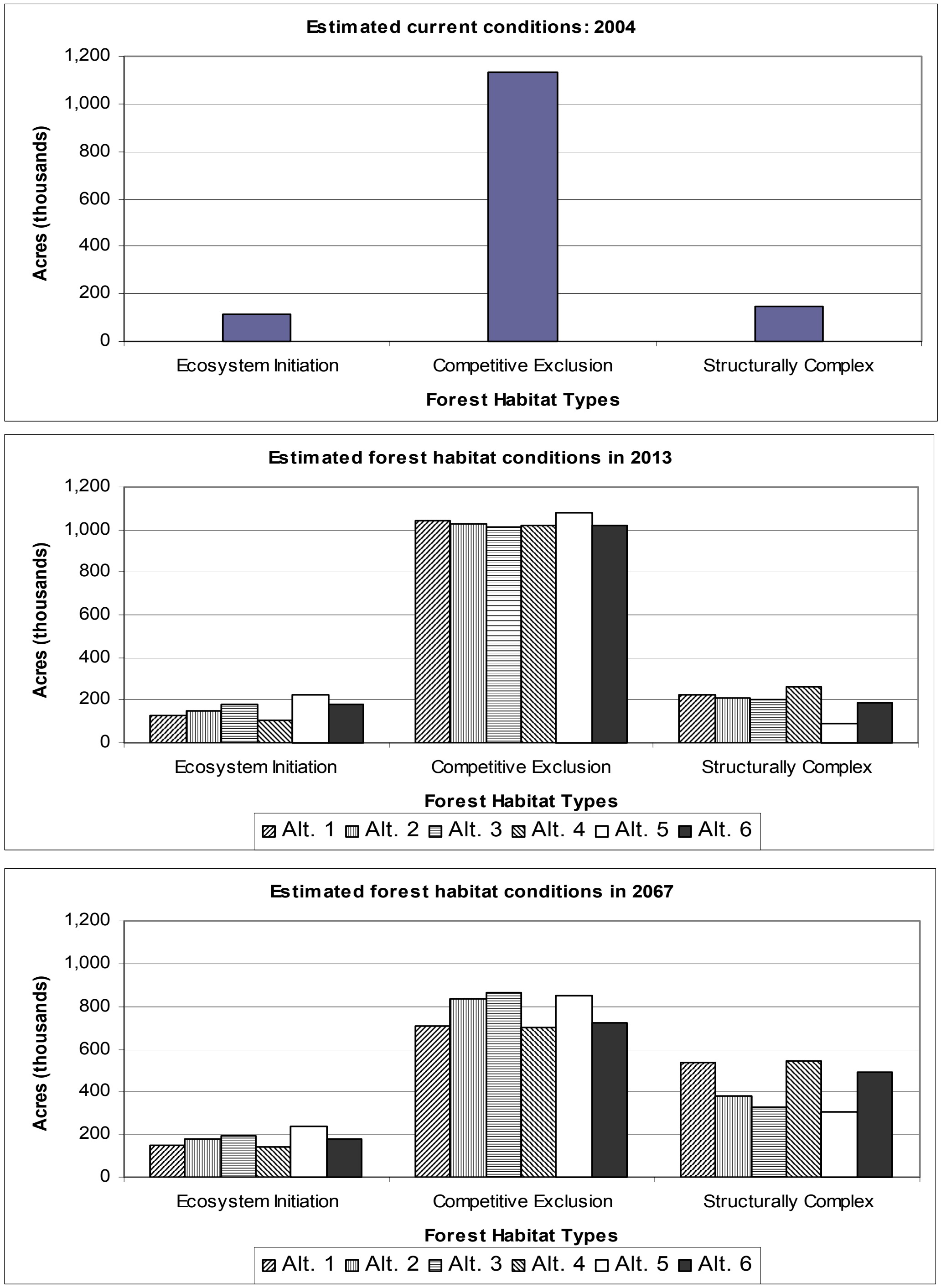
No strict thresholds have been identified for an acceptable amount of ecosystem initiation forest habitat in a given landscape. However, elevated amounts of this habitat type indicate an increased potential risk of habitat fragmentation among closed-canopy forest types (e.g., structurally complex).

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 westside trust lands. Under all Alternatives, the majority of timber harvest is expected to occur in this habitat type. The amount of competitive exclusion forest would likely be affected by two processes: 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 westside trust lands would decline under all six Alternatives in both the short term and the long term (Figure 4.4-1). In the short term, results show very little difference in the amount of



Source: Model output data – stand development stages

Figure 4.4-1. Current (2004) and Estimated Future Amounts of Forested Habitat Types on DNR-managed Westside Trust Lands Under Each Alternative competitive exclusion forest among the Alternatives (Appendix Table D-8). At the end of the planning period, by 2067, the Alternatives separate into two groups: under Alternatives 1, 4, and 6, approximately 50 percent of westside trust lands would consist of competitive exclusion forest, while Alternatives 2, 3, and 5 would have about 60 percent.

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 Alternatives 4, 1, and 6, followed in descending order by Alternatives 2, 5, 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 food 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 (ecosystem initiation and structurally complex) that generally support greater abundance and diversity of wildlife species (Carey et al. 1996).

Structurally Complex Forest

In the short term, changes in the amount of structurally complex forest under the six Alternatives would largely be the result of different levels of management intensity. Alternatives with more high-volume timber harvests (i.e., Alternatives 5 and 6) would be expected to result in less of this habitat type than those with more areas deferred from harvest (Alternative 1), or those with older minimum-average-regeneration-harvest age (Alternative 4). Under the latter two Alternatives, in any given time period, fewer structurally complex stands would be subject to heavy thinning or regeneration harvest; these Alternatives, therefore, would show greater acreage of complex forest relative to an Alternative that emphasizes intensive management. 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 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).

Model output supports this expectation. In both the short term and the long term, Alternatives 1 and 4 result in the greatest amount of structurally complex forest on westside trust lands (Figure 4.4-1). 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. Model results suggest that Alternative 6 would yield a moderate increase in structurally complex forest in the short term, and nearly as much as Alternatives 1 and 4 in the long term.

For the most part, this overall pattern is repeated at the individual planning unit scale. The main exception is the South Puget Planning Unit, where among the proposed Alternatives, Alternative 6 appears to yield some of the greatest increases in structurally complex forest in the long term. Alternative 6 also proposes the most acres of timber harvest in the South Puget Planning Unit, as well as the greatest decline in competitive exclusion forest.

These findings suggest that biodiversity pathways management appears to be compatible with the goal of maximizing the amount of structurally complex forest, at least in some areas. Alternative 5 proposes more traditional heavy thinning prescriptions and appears to yield the second-highest harvest levels in the South Puget 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.

While passive management appears to result in the greatest increases in structurally complex forest as a whole, active management, including more intensive management using biodiversity pathways techniques, appears to result in greater long-term increases in forest structure classes characterized by the highest amounts of snags and logs.

Alternative 6 would result in the third-highest long-term net increase in the amount of structurally complex forest overall, after Alternatives 1 and 4. However, an examination of the three stand development stages that are characterized by abundant woody debris (niche diversification, fully functional, and old forest), puts Alternative 6 ahead of Alternative 1 with the second-highest long-term net increase. If the modeling of "structure" is accurate—and if the resources are available to implement this level of management intensity—then the biodiversity pathway techniques employed by Alternative 6 may provide improvements in forest diversity comparable to a more "hands-off" approach, while increasing timber flow from trust lands (see Figure 4.2-2).

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. The greatest amount of timber harvest activity in the riparian areas (and thus the greatest potential for adverse effects to riparian-associated wildlife species) is modeled as occurring under Alternative 6, followed in descending order by Alternatives 5, 3, 2, 4, and 1. Under current conditions, structurally complex forest is relatively scarce in riparian areas throughout westside state trust lands. Under all Alternatives, model results suggest a gradual improvement, because the amount of structurally complex forest would increase under all Alternatives. During the remaining period of the Habitat Conservation Plan, Alternatives with lower levels of activity, such as Alternatives 1 and 4, are expected to have a higher proportion of riparian area in forest with very large trees. The majority of the riparian forest with very large trees, however, is modeled as being in the botanically diverse stage (Figure 4.3-3), which is characterized by limited biotic diversity overall (Section B.2.1.2, Appendix B). In contrast, the majority of riparian forest with very large trees under Alternative 6 would consist of the niche diversification, fully functional, and old-growth stages, which are characterized by greater levels of structural and biotic diversity. Thus, although Alternative 6 would be expected to result in the smallest long-term increases in the amount of structurally complex forest in riparian areas, it would result in the greatest increases in the forest stages with the highest degree of structural and biotic diversity (Figure 4.3-3).

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 Alternatives 1 through 6 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—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. A greater amount of harvest would carry a relatively greater potential risk of adverse effects to forested wetlands and the species associated with wetland habitat. 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.

Model results indicate that the greatest amount of timber harvest is anticipated under Alternative 6, followed in descending order by Alternatives 5, 2, 3, 4, and 1. This pattern is more marked within the riparian land class, where Alternative 6 is modeled as resulting in more than twice the rate of harvest as the next highest Alternative, Alternative 5 (Table 4.9-1). The amount of harvest in wetland and riparian habitats in the Olympic Experimental State Forest also differs among the Alternatives. Under Alternatives 1 and 4, the maximum percentage of the riparian land class harvested per decade in the Olympic Experimental State Forest would be below the maximum percentage per decade in the other five units combined (Table 4.3-2; percentages based on values in Table 4.3-1). The reverse would occur under Alternatives 2, 3, 5, and 6, and the harvest rate in the Olympic Experimental State Forest would exceed the rate elsewhere. The greatest amount of timber harvest activity in the riparian land class would occur under Alternatives 5 (maximum 33 percent) and 6 (maximum 73 percent). However, under Alternative 6, the great majority of riparian timber harvest would consist of low-intensity harvest (thinning).

Uncommon Habitats

Under Alternatives 2 through 6, legacy and reserve tree requirements in DNR Procedure 14-006-090 would be replaced with language implementing the protection of structurally unique trees and snags described in the Habitat Conservation Plan. The current 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 Plan's requirement of at least 8 trees per acre under the other Alternatives. Procedure 14-006-090 addresses retention of legacy trees in regeneration harvest areas, whereas the strategy in the Habitat Conservation Plan applies to all harvest types. Thus, although Alternatives 2 through 6 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, and pose no significant environmental impacts beyond existing conditions and those anticipated in the Habitat Conservation Plan Environmental Impact Statement.

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., cavity-nesting birds) 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. Native oak is considered a non-commercial tree species, and as such is not included in timber harvest or type conversion 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 4.9-1 in Section 4.9 (Wetlands) summarizes the average harvest per decade under each Alternative. Overall, the greatest area of harvest is anticipated under Alternative 6, followed in descending order by Alternatives 5, 2, 3, 4, and 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 existing conditions and those described in the Habitat Conservation Plan Environmental Impact Statement are anticipated under any of the Alternatives when compared with Alternative 1 (No Action).

4.4.4.2 Species of Interest

Northern Spotted Owl

For this analysis, effects to the northern spotted owl were evaluated using three criteria:

- changes in the amount of structurally complex forest (i.e., habitat that approximates nesting, roosting, and foraging habitat);

- the amount of timber harvest in areas designated for nesting, roosting, and foraging habitat management; and
- changes in the management of owl circles.

Only one procedural change in the proposed Alternatives addresses the implementation of the Habitat Conservation Plan northern spotted owl conservation strategy. Changes to Procedure 14-004-120 would allow forest management in nesting, roosting, and foraging management areas where this habitat type is below designated threshold values. Under all six Alternatives, forest management in below-threshold nesting, roosting, and foraging management areas would continue because the Habitat Conservation Plan states that forest management (e.g., road construction, and timber harvest) can occur in nesting, roosting, and foraging habitat, as long as the modified stand continues to meet the definition of sub-mature habitat after management activities are complete. Thus, none of the Alternatives is expected to exceed the level of risk described in the Habitat Conservation Plan Environmental Impact Statement and agreed to by the Federal Services in charge of overseeing implementation of the Habitat Conservation Plan.

NESTING, ROOSTING, FORAGING, AND DISPERSAL HABITAT AVAILABILITY

As noted above, structurally complex forest is not the equivalent of nesting, roosting, and foraging habitat, and projections of future conditions are not a measure of DNR's success in meeting its obligations established under the Habitat Conservation Plan. Forested areas classified as structurally complex forest are likely to provide nesting, roosting, and foraging habitat to varying degrees, and, for this analysis, serve as an indicator for this habitat type. Differences in the amount of structurally complex forest on westside trust lands may indicate differences in the amount of suitable nesting, roosting, and foraging habitat that would be available under each Alternative over time. A qualitative discussion of the potential for the Alternatives to affect the amount and distribution of structurally complex forest among the planning units is presented in Section 4.4.4.1 above.

Alternatives with less intensive timber harvest would be expected to result in 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 the greatest overall increases in the amount of structurally complex forest in both the short term and the long term. Alternatives 5 and 6 would result in the smallest short-term increases. In the long term, however, both Alternatives 5 and 6 would exceed Alternative 3, and Alternative 6 would exceed Alternative 2 as well.

The amount of structurally complex forest in the Olympic Experimental State Forest merits particular attention because this planning unit has a different set of management strategies than the other 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. Alternatives 1 and 4 would result in the greatest short-term increases in the amount of structurally complex forest in the Olympic Experimental State Forest, exceeding 20 percent of that planning unit by 2013. The greatest long-term gains are modeled for

Alternative 6, under which (along with Alternative 4) structurally complex forest would exceed 40 percent of the area of the Olympic Experimental State Forest by 2048, and would reach 68 percent by 2067. The smallest long-term gains are modeled for Alternatives 3 and 5.

In areas designated for nesting, roosting, and foraging habitat, intensive management under the biodiversity pathway approach of Alternative 6 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 Alternative 6 would be more than double those for Alternatives 2, 3, or 5 (Table 4.4-3). The less-intensive approaches of Alternatives 1 (excluding more areas from timber harvest) and 4 (managing for an older average minimum regeneration age) would result in slightly smaller increases than Alternative 6. Compared to Alternatives 1 and 4, however, Alternative 6 would result in three times as much fully functional and niche diversification-stage forest in designated nesting, roosting, and foraging management areas.

Table 4.4-3. Acres of Structurally Complex Forests in Designated Nesting, Roosting, and Foraging and Dispersal Management Areas in 2067

	Current	Alternative					
	Conditions	**1**	**2**	**3**	**4**	**5**	**6**
Nesting, Roosting, and Foraging Habitat Areas	17,000	71,000	42,000	34,000	62,000	31,000	86,000
Dispersal Habitat Areas	8,600	34,000	29,000	26,000	50,000	21,000	76,000

Data Source: Model output data – standard development stages

Similar to nesting, roosting, and foraging habitat, dispersal habitat would be expected to increase under all Alternatives, largely as a result of the development of structurally complex forest in areas that receive little or no timber harvest. In the short term, model results support that expectation, with Alternative 4 providing the greatest increases and Alternatives 2, 3, and 5 providing less (Appendix Table D-9). Alternative 6 stands out as providing the second-largest short-term increase and the largest long-term increase, due in part to widespread increases in average tree size following low-volume thinning treatments.

All six Alternatives would result in short- and long-term increases in the availability of structurally complex forest, both throughout the westside trust lands and in key management areas. In light of continued spotted owl population declines, the short-term effects of the Alternatives would likely have the greatest relative potential to influence the status of the owls in western Washington. Differences among the Alternatives are small in the short term, suggesting that all six Alternatives have a similar likelihood of minimizing the relative risks to spotted owls.

Effects to Owl Circle Habitat

Under all six Alternatives, habitat within "Memorandum 1" spotted owl circles would be released in 2007 for timber harvest consistent with the objectives and strategies of the Habitat Conservation Plan. Status 1-Reproductive and southwestern Washington circles would also be released in 2007 under Alternatives 3 through 6, and in 2004 under Alternative 2. Under Alternative 1, 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 four southwest Washington circles. This agreement is scheduled to remain in effect until 2006. The agreement was reached after modeling was completed for Alternative 1, and is not reflected in the model or modeling outputs.

Timber harvest in spotted owl circles may reduce or eliminate the habitat available for some spotted owl pairs, but the extent to which this may occur is uncertain. In addition, significant adverse environmental effects to the western Washington spotted owl population beyond existing conditions and the effects anticipated in the Habitat Conservation Plan Environmental Impact Statement are unlikely. In approving DNR's Habitat Conservation Plan, the U.S. Fish and Wildlife Service determined that this species would be best served by the protection of habitat in certain key areas (DNR 1997). The protection of the specified circles was seen as necessary for a limited time period. Risks associated with the loss of reproductive owls outside those 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 spotted owls.

Many owl circles are currently unoccupied, and likely to remain so (personal communication, S. Horton, Wildlife Biologist, DNR, 12 August 2003). Lastly, land ownership within owl circles typically consists of a mix of state, private, and federal lands. Even if DNR is no longer required to maintain suitable habitat on state trust lands, State Forest Practices Rules still closely regulate the harvest of habitat in Spotted Owl Special Emphasis Areas. Some suitable habitat would likely remain within owl circles in these emphasis areas.

It should be noted that state lands deemed to have the greatest potential of providing an appreciable contribution to the maintenance of spotted owl populations were identified during the development of the DNR's Habitat Conservation Plan (1997), and designated as nesting, roosting, and foraging management areas. Based on the analyses conducted for that plan, potential negative effects to individual spotted owls outside those areas are not expected to result in significant adverse effects to recovery efforts for the spotted owl population in western Washington.

Timber Harvest in Areas Designated for Nesting, Roosting, and Foraging Habitat Management

All of the Alternatives are consistent with the Habitat Conservation Plan strategy for the spotted owl. None would allow activities that would reduce the amount of nesting, roosting, and foraging habitat in below-threshold watersheds, or delay the future development of this habitat. Alternative 1 would be expected to result in the least forest management in areas designated for nesting, roosting, and foraging management, and Alternative 6 the most. Model results support this expectation (Table 4.4-4). Alternative 6 would result in the highest level of forest management activity in areas designated for nesting, roosting, and foraging habitat management, with an average of 32 percent of such areas harvested per decade. This level is slightly higher than the rate of forest management activities expected for westside trust lands as a whole, indicating an active approach to managing spotted owl habitat using biodiversity pathways techniques. Under the other 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 (and moderate) amounts, and Alternative 5 is exceeded only by Alternative 6.

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

Alternative	Percent of Designated Nesting, Roosting, and Foraging Management Areas				Percent of Westside Trust Lands Harvest per Decade
	Volume Removal Class				
	Low	Moderate	High	Total	
1	0%	1%	1%	2%	12%
2	4%	4%	6%	14%	17%
3	2%	2%	8%	12%	18%
4	3%	2%	3%	8%	14%
5	7%	5%	8%	20%	26%
6	18%	9%	5%	32%	31%

Data Source: Model output data – timber flow levels

Notably, the majority of harvest in designated nesting, roosting, and foraging management areas under Alternative 6 would consist of thinning (low- and moderate-volume removal harvest), and would therefore be expected to maintain or improve habitat conditions, or increase the potential of a stand to becoming nesting, roosting, and foraging habitat sooner. Only 15 percent of timber harvest in designated nesting, roosting, and foraging management areas under Alternative 6 would consist of heavy thinning or regeneration harvest (high-volume removal harvest) compared to 36 to 62 percent under the other Alternatives. Overall, the greatest amount of high-volume removal harvest in designated nesting, roosting, and foraging management areas would occur under Alternative 5, followed in descending order by Alternatives 3, 2, 6, 4, and 1.

Marbled Murrelet

All Alternatives are consistent with implementation of the Habitat Conservation Plan conservation strategy for marbled murrelets. The variables are the amount of structurally complex forest (the habitat most likely to provide suitable nesting habitat) on DNR-managed westside 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 westside trust lands. In both the short term and long term, Alternatives 1 and 4 are expected to provide the greatest amount of structurally complex forest on westside trust lands, and Alternative 5 the least. Model results show Alternative 6 as providing a moderate increase in structurally complex forest in the short term, and nearly as much as Alternatives 1 and 4 in the long term.

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 band (USFWS 1997). Within the 40 miles, the Alternatives provide equal murrelet nesting habitat. Appendix Table D-10 presents the results of this analysis. In general, the overall pattern of habitat increases in all areas under all Alternatives holds true when the analysis is limited to watersheds that are mostly or entirely within 40 miles of marine waters.

Other Threatened, Endangered, and Sensitive Species

None of the Alternatives proposes changes in the policies or procedures that directly address threatened, endangered, and sensitive species, other than the northern spotted owl and legacy and reserve tree procedures. Therefore, differences among the Alternatives would arise from differences in the amount or quality of the habitats with which these species are associated. Most of these species are associated with non-forested habitats. 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. In addition, 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, therefore, focuses on the differences in the amount of timber harvest modeled under each Alternative, or the potential effects to the habitats with which they are associated, within the 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 Table D-7), 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.

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/] (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 5 6
Oregon Silverspot Butterfly	Effects to uncommon habitats (South Coast)	1 4 2 3 5 6
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 5 6 (b) 4 1 2 3 6 5
Oregon Spotted Frog	Effects to wetlands (South Puget and Columbia)	1 4 2 3 5 6
Western Pond Turtle	Effects to wetlands (North Puget, South Puget, Columbia, and South Coast)	1 4 2 3 5 6
Common Loon	Amount of timber harvest (all planning units except Columbia)	1 4 2 3 5 6
Aleutian Canada Goose	Effects to wetlands (North Puget, South Puget, Columbia, and South Coast)	1 4 2 3 5 6
Bald Eagle	Amount of structurally complex forest, (a) short-term and (b) long-term (all planning units)	(a) 4 1 2 3 6 5 (b) 4 1 6 2 3 5
Peregrine Falcon	(a) Amount of timber harvest activity; (b) effects to wetlands (all planning units)	(a) 1 4 2 3 5 6 (b) 1 4 2 3 5 6
Sandhill Crane	Effects to wetlands (Columbia)	1 4 2 3 5 6
Western Gray Squirrel	Amount of timber harvest (South Puget and Columbia)	1 4 2 3 5 6
Gray Wolf	Amount of timber harvest (North Puget, South Puget, and Columbia)	1 4 2 3 5 6
Grizzly Bear	Amount of timber harvest (North Puget and South Puget)	1 4 3 2 5 6
Pacific Fisher	Amount of structurally complex forest in low-elevation watersheds [3/5/]	4 1 6 2 3 5
Canada Lynx	Harvest activity in high-elevation watersheds[4/5/] (North Puget, South Puget, and Columbia)	6 5 2 3 4 1
Columbian White-tailed Deer	Effects to riparian areas (Columbia)	1 4 2 3 5 6

[1/] See Appendix Table D-7 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 DNR land is in the western hemlock or sitka spruce vegetation zones.
[4/] Defined as watersheds where >1% of DNR land is in the alpine or parkland vegetation zone, and >30% is 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
Data Source: Model output data – stand development stages

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 Planning Unit contain suitable habitat.

Pacific fisher 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 (Lewis and Stinson 1998). In western Washington, most low-elevation forest falls in the western hemlock or Sitka spruce potential vegetation zone, 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 Table D-11).

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 Table D-11; compare to Appendix Table D-8). In both analyses, increases from current conditions result in all time periods under all Alternatives, with the greatest short- and long-term increases anticipated under Alternatives 1 and 4.

One key difference is that all Alternatives show greater increases in structurally complex forest in low-elevation areas compared to overall. This is particularly evident by year 2067, when low-elevation increases exceed overall increases by 16 percentage points under Alternatives 1 and 4, likely due to the faster rate of development of structurally complex forest in more productive areas. Smaller differences under Alternatives 6 (3 percentage points), 2, and 3 (8 percentage points each) may indicate a comparatively higher rate of timber harvest in low-elevation areas under these Alternatives. No significant impacts beyond existing conditions and the effects anticipated in the Habitat Conservation Plan Environmental Impact Statement 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 westside state trust lands are in lower elevation areas; only 10 watersheds (all in the North Puget Planning Unit) meet the criterion of at least 1 percent of DNR lands in the alpine or parkland zone, along with some area in mountain hemlock and/or Pacific silver fir. Dense, young forest provides suitable foraging habitat for lynx; thus, timber harvest in watersheds with high-elevation areas may improve habitat conditions for this species. Any benefits of habitat improvement may be partially offset by disturbance to 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 den sites. Model results indicate that the greatest amount of timber harvest in high-elevation watersheds is anticipated under Alternative 6, followed in descending order by Alternatives 5, 3, 2, 4, and 1. The proportion of trust land harvested in these watersheds per decade ranges from 9 percent (Alternative 6) to 5 percent (Alternative 1), well below the proportions modeled for all westside trust lands (see Table 4.9.1). No significant adverse impacts are therefore anticipated to Canada lynx under Alternatives 2 through 6 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 trust lands is between 30 and 60 percent of the total DNR-managed area. 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, structurally complex forest, and open-canopy forest in the understory reinitiation stage are all considered to provide foraging habitat. Currently, the great majority of westside 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.

In almost all time periods, results suggest that all six Alternatives would result in increases in the number of watersheds in which foraging habitat makes up between 30 and 60 percent of DNR-managed land (Table 4.4-6). In the short term, Alternatives 4 and 5 result in the greatest improvements. Alternative 5, which emphasizes revenue production with shorter rotation cycles and more intensive activities, produces the greatest increase in

Table 4.4-6. Change Over Time Relative to the Current (2004) Number of Watersheds[1/] in which 30 to 60 Percent of State Trust Lands Would Provide Deer and Elk Foraging Habitat, under each Alternative

	Change in Number of Watersheds with 30% to 60% Forage				
Alternative	**Year 2008**	**Year 2013**	**Year 2031**	**Year 2048**	**Year 2067**
1	+ 6	+ 20	+ 41	+ 48	+ 35
2	+ 8	+ 20	+ 52	+ 62	+ 94
3	+ 2	+ 21	+ 40	+ 88	+ 78
4	+ 14	+ 36	+ 30	+ 40	+ 27
5	+ 16	+ 29	+ 73	+ 74	+ 75
6	- 4	+ 11	+ 46	+ 43	+ 28

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

2008, presumably because it results in the sharpest increase in the amount of ecosystem initiation forest. Alternative 4, which employs a more passive management approach to resource protection, results in the greatest increase in 2013, likely associated with the increased availability of structurally complex forest. Alternatives 1, 2, and 3 result in smaller increases that are nearly equal in 2013, while the smallest short-term increase is modeled as occurring under Alternative 6.

Over the long term, Alternative 2 (as modeled) results in steady increases in the number of watersheds with 30 to 60 percent foraging habitat, producing the greatest increase by the year 2067, the end of the planning period. Short-term increases under Alternative 4 do not continue into the long term; instead, the number of watersheds in the optimum range levels off. Alternative 4 has the smallest increases in 2031 and thereafter.

Alternatives 1, 5, and 6 show similar leveling trends after 2031, while Alternative 3 increases through 2048 and then decreases. By 2067, the nominal duration of the Habitat Conservation Plan, Alternative 2 results in the greatest increase in the number of watersheds with 30 to 60 percent foraging habitat, followed in descending order by Alternatives 3, 5, 1, 6, and 4. 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. All projected gains in foraging habitat for deer and elk for Alternatives 2 through 6 are comparable or greater than those found in Alternative 1 (No Action).

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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. 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.

The Alternatives differ slightly in their effects to air quality, but none of the Alternatives has the potential for significant environmental impacts beyond existing conditions and the effects anticipated in the Habitat Conservation Plan Environmental Impact Statement.

4.5.2 Affected Environment

Air quality is regulated by the federal Clean Air Act, which requires the 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 forest land 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 DNR 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 westside 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 westside 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 Environmental Impact Statement (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 Forest Land and Air Quality

One of the ecological benefits of forested 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 airborne 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.

Alternatives 5 and 6 are projected to harvest more timber than the other Alternatives (approximately twice the level projected for Alternatives 1 and 4). This harvest activity is likely to result in more traffic by log trucks and vehicles driven by other forest workers. Alternatives 5 and 6 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 3 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 4 and 6 and slightly higher under Alternatives 2 and 3. 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 DNR 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 below the level anticipated in the Habitat Conservation Plan.

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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. 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 of the Alternatives. 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 are not anticipated under any of the six Alternatives. Increased soil erosion may occur in certain intensely managed areas as road use increases. Further discussion of relative impacts among planning units and for individual watersheds is included in Cumulative Effects (Section 4.15). Alternative 6 carries the highest potential overall relative impact, followed by Alternatives 5, 3, 2, 4, and 1.

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 resources. Issues related to geomorphology, soils, and sediment identified during scoping include sediment movement and soil productivity. Sediment movement is important because mass movement and surface erosion delivered to streams can result in adverse effects to fish and aquatic habitat.

As discussed in Forest Practices Rules Environmental Impact Statement, Section 3 (Washington Forest Practices Board 2001), mass wasting may deliver large volumes of coarse sediment and some fine sediment to streams, which may result in pool filling and loss of rearing habitat. Surface erosion primarily delivers fine 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.

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 and the 2001 Forest Practices Rules Environmental Impact Statement (Washington Forest Practices Board 2001). These were supplemented with peer-reviewed references and data generated from the Alternatives modeling analysis. As part of their project requirements, DNR evaluates geomorphological interactions during site-specific design. An understanding of interactions among geology, climate, and ecosystems leads to balanced actions that reduce significant adverse environmental impacts. Understanding landforms and ecosystem processes, both biotic and abiotic, increases conservation benefits while meeting fiduciary responsibilities.

A number of key processes are important in understanding the potential for significant adverse environmental impacts. These include mass wasting, surface erosion, and soil productivity, which are discussed below.

4.6.3.1 Mass Wasting

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 debris flow. A landslide may turn into a debris flow or debris torrent. Debris flows or torrents may transport more material than the original failure because they may also scour stream channels (Section 3.2, Washington Forest Practices Board 2001).

Landslides are the result of failure of the cohesive strength of the slope material (e.g., vegetation, soil, subsurface deposits). This loss of cohesive 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, or removal of material downslope of the failure. Additionally, stream banks may be susceptible to failure if streamside vegetation is removed. See the Forest Practices Rules Environmental Impact Statement, page 3-10 (Washington Forest Practices Board 2001) for further discussion.

Management activities that potentially increase the risk of mass wasting include road building and timber harvest (Washington Forest Practices Board 2001). Road location, drainage, design, construction, and maintenance can either increase or reduce the risk of mass wasting and its effects. Sediment produced as a result of forest management activities can be delivered to the aquatic system from episodic landslides initiated in harvested areas on unstable slopes. The role of mass wasting in aquatic systems is described in more detail in the Forest Practices Rules Environmental Impact Statement (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 unstable or potentially unstable slopes.

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 potentially have significant adverse effects on the physical habitat of the aquatic system and certain lifestages of aquatic biota, as well as degrade water quality.

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 depends on slope gradient and shape, soil texture, parent material, precipitation, groundwater movement, and vegetation cover. The amount and types of traffic and road maintenance practices also influence delivery.

Harvest activities such as ground-based skidding or cable yarding can cause soil disturbance. Streamside vegetation and hillslope roughness can trap sediment, minimizing the amount that reaches the stream system. These filtering capabilities are affected by timber harvest within streamside buffers. However, additional harvest materials left on the forest floor can offset decreases near the streamside buffer. See the Forest Practices Rules Final Environmental Impact Statement (page 3-9, Washington Forest Practices Board 2001) and the Habitat Conservation Plan Final Environmental Impact Statement (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 Environmental Impact Statement). Forest management relies on soil productivity to 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 plants to uptake nutrients from the soil. External conditions, such as climate, 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 and decrease nutrient content. Adverse impacts may be amended or masked by human inputs. Fertilization and control of undesirable vegetation may improve the productivity of desirable species. However, the influence of management activities on soil productivity depends on the type, timing, and intensity of management, as well as the original soil and site qualities. The significance of management activities depends on the degree they affect ecosystem processes or plant and animal communities.

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 potential to increase compaction or surface erosion, which can decrease soil productivity for some soils.

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, 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. The policy preference established in Forest Resource Plan Policy No. 33 determines operational application of these practices.

4.6.3.4 Existing Conditions on Western Washington DNR-Managed Lands

Mass Wasting

Deep-seated landslides occur on less than 5 percent of forested DNR lands in western Washington (Table 4.6-1). Areas with a high potential for shallow-rapid landslides represent approximately 10 to 15 percent of forested DNR-managed lands in western Washington. These areas are more susceptible to mass wasting under certain types of forest management. The greatest area of potentially unstable slopes is in the North Puget Planning Unit.

Soil Productivity

Over half of the forested DNR-managed westside trust lands can be characterized as having a high potential for soil compaction (Table 4.6-2). Additionally, half of the DNR-managed westside trust lands have been evaluated for response to fertilization. Of the lands evaluated, approximately 40 percent have a low-to-medium response rate to fertilization and only 10 percent have a high response rate. Almost 45 percent of these lands have a low potential for burn damage, and approximately 20 percent have a high potential.

Table 4.6-1. Areas of Deep-Seated Landslides and Potentially Unstable Slopes on DNR Lands in Western Washington, by Planning Unit

Planning Unit	Acres of Identified Deep-Seated Landslides[1/]	Acres of Landslides that Have Occurred[2/]	Acres Designated as High for Potential Slope Instability[3/]
Columbia	8,282	171	16,525
North Puget	13,476	2,146	52,388
OESF	2,886	1,646	53,296
South Coast	5,478	261	23,254
South Puget	890	3,252	11,560
Straits	1,851	3	14,157
Total	**32,864**	**7,479**	**171,181**

Data Sources:
[1/] DNR Geoslide Geographic Information System Data
[2/] DNR Landslide Geographic Information System Data
[3/] DNR SMORPH Geographic Information System Data (10-meter slope stability model)
OESF = Olympic Experimental State Forest

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 the westside trust lands is classified as Class I (the most productive class) (Table 4.6-2). Throughout the forested DNR westside 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 planning unit in Table 4.6-3.

FERTILIZER RESPONSE AND SITE PREPARATION

Table 4.6-3 also shows the fertilizer response of soils on DNR-managed westside lands where data are available. The lands evaluated are approximately equally distributed among low, medium, and high for fertilizer response. Since 1993, between 2,251 and 20,944 acres of forested DNR-managed lands in western Washington were fertilized each year to increase productivity. As shown in Table 4.6-4, 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 application.

Acres of DNR-managed westside lands on which various site preparation methods were applied varied from 75 to 5,900 acres between 1993 and 2002 (Table 4-6.4). 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 4.6-2. 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	Total 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

Environmental Effects

Potential environmental impacts of the Alternatives on geomorphology, sediment, and soils are discussed in terms of changes proposed to policies and procedures, as well as changes to harvest levels and management. Effects on water quality and fish are further discussed in Sections 4.8 (Water Quality) and 4.10 (Fish).

4.6.3.5 Comparison of Alternatives

Impacts to forest soils on DNR-managed 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 roaded area on DNR-managed lands. All road maintenance and abandonment will be accomplished following DNR policies and procedures for all Alternatives. Over the course of the time period covered by the modeling, no significant net changes to roaded area or practices related to road location or construction are anticipated under any of the Alternatives beyond existing

Table 4.6-3. Site Class, Compaction Potential, Fertilizer Response, and Burn Damage Potential by Planning Unit (Percent Area)

	Percent Area by 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

Table 4.6-4. Area of Fertilization, Site Preparation, or Vegetation Management in Forested DNR Lands in Western Washington 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 Planning Units. Area fertilized updated from e-mail communication from Carol Thayer, 7/24/03.

conditions and the effects anticipated in the Habitat Conservation Plan Environmental Impact Statement.

Mass Wasting

There are no anticipated changes to the risk of mass wasting frequency or severity under any of the Alternatives because no policy or procedural changes would occur under any of the Alternatives with respect to potentially unstable slopes. However, continued careful planning is necessary for all Alternatives, as discussed in Appendix C. Specifically, Alternatives 6 and 5, with the highest levels of management activity as measured by total acreage treated, would be expected to require the greatest amount of additional planning related to potentially unstable slopes, followed by Alternatives 3, 2, 1, and 4.

Surface Erosion

Surface erosion affects soil productivity by removing soil mass, including minerals and organic matter. Surface erosion potentially may be caused by, or accelerated by, forest management. Rates of sediment delivery to streams from timber haul or public use of unpaved roads is correlated to traffic volume and the location of the road relative to streams (USDA Forest Service 2001). Road use is assumed to be a function of the amount of timber extracted on the land. Impacts from public road use are expected to be constant for all Alternatives. Higher levels of forest management can be assumed to require more truck trips and, therefore, potentially increase surface erosion caused by road use. Specifically, Alternatives 6 and 5, with the highest levels of management intensity by total acreage, would be expected to require more planning and maintenance to appropriately address surface erosion, followed by Alternatives 3, 2, 1, and 4. Sediment delivery to streams is discussed in Section 4.7 (Hydrology), Section 4.8 (Water Quality), and Section 4.10 (Fish).

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. Also, based on how harvests are prioritized and calculated, less productive stands should have longer rotation ages than more productive stands. Therefore, if site productivity declines, a longer minimum regeneration harvest age would be needed for the stand in the future. This means that if site productivity declines as a result of degraded soils, longer rotations would be required in the future, and the risk of not meeting harvest goals increases. This is discussed in more detail in Section 4.15 (Cumulative Effects).

Factors that may influence soil productivity among the Alternatives are average minimum regeneration harvest age, management strategies, and management intensity. See Appendix C and Chapter 2 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 in the short term, or to surface erosion. Specifically, Alternatives 6 and 5, with the highest levels of management intensity by total acreage, would be expected to have the highest risk of potentially decreasing soil productivity, followed by Alternatives 3, 2, 1, and 4. However, the increased use of fertilizers for Alternatives 5 and 6 may mitigate potential losses of productivity due to increased management intensity. When designing and implementing harvest activities on highly compactable soils, locations of skid trails should be carefully planned, and appropriate yarding techniques should be used to prevent or minimize compaction. These are also discussed in more detail in the Cumulative Effects section (Section 4.15).

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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.

None of the Alternatives would be expected to increase peak flows significantly. No changes to Procedure 14-004-060 (Assessing Hydrologic Maturity) are proposed; therefore, there would be no significant adverse environmental impacts beyond existing conditions and the effects anticipated in the Habitat Conservation Plan Environmental Impact Statement.

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 can affect stream bank 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 Environmental Impact Statement (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 Environmental Impact Statement (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 Environmental

Impact Statement, 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, flows may back up and increase in depth.

4.7.3.1 Existing Conditions on Western Washington DNR Westside 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 westside 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 Type 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 Environmental Impact Statement (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.

Table 4.7-1. Lengths of Streams on Forested DNR Westside Trust Lands by Stream Type and Planning Unit

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

The largest peak flows in western Washington occur after rain-on-snow events (rainstorms that partially or completely melt snowpacks). The rain-on-snow zone is an area (generally defined as an elevation zone) 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 Environmental Impact Statement (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 Habitat Conservation Plan 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.

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 forested DNR-managed westside 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 DNR-managed westside 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.

Table 4.7-2. Areas of Hydrologic Maturity and Immaturity in Significant Rain-on-Snow/Sub-basin Zones by Westside Planning Unit (Current 2004)

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

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 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, 4.4.2, 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. 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, resulting 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.

Alternative 6 would allow more harvest in riparian areas than the other Alternatives. 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.

Chapter 4

4.8 WATER QUALITY

4.8.1 Summary of Effects

This section analyzes the environmental effects on water quality. The analysis 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.

The proposed different management strategies would not result in any probable significant adverse impacts beyond existing conditions and the effects anticipated in the Habitat Conservation Plan Environmental Impact Statement. 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-managed westside trust lands.

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) describes 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 stream bank 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 westside trust lands (Table 4.8-1). Ground applications of herbicides were applied in every planning unit, while aerial applications occurred in all areas except the Olympic Experimental State Forest and the Straits Planning Unit. Fertilization applications were less common, with aerial fertilization occurring only in the North Puget Planning Unit. Ground fertilization occurred only in the North Puget Planning Unit and, to a very limited extent, in the South Puget Planning Unit (less than 100 acres).

Pesticide application rates on forested lands were infrequent (one to two applications every 40 to 60 years). Less than 5 percent of DNR westside 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 westside 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 DNR Westside 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 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 DNR westside 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 forest land 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.

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 NTUs (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 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)

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.

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 DNR-managed 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 4.3.3 (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 6.

Sediment

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. 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.

Alternatives 5 and 6 would involve increased management and, therefore, increased risk of surface erosion compared to Alternatives 1, 2, 3, and 4. The additional harvest in Alternatives 5 and 6 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 Alternatives 5 and 6 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 potential for blowdown in Riparian Management Zones would be slightly greater under Alternatives 5 and 6 than under the other Alternatives because of the increased level of thinning. 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 regeneration methods to prevent surface erosion, and the no harvest zone vegetation would remain in place to filter sediment before it reached a stream. However, openings greater than 1 acre increase the risk of blowdown, which could affect the inner zone (Carey et al. 1996).

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 Alternatives 5 and 6.

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. Alternative 6 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.

Table 4.8-3. Fertilization Intensity by Alternative

	Alternatives					
Approach to Fertilization	**1**	**2**	**3**	**4**	**5**	**6**
Little or none	X	X	X	X		
Available for specific forest types and sites					X	
Budget-limited for specific forest types and sites						X

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 affects to water quality caused by forest chemicals.

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 supporting procedure governs harvest activities in and around wetlands and is not proposed to change in any of 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. The Habitat Conservation Plan and its Environmental Impact Statement acknowledge that wetlands less than 0.25 acre may be affected by forest management activities.

The higher levels of harvest in Alternatives 5 and 6 would increase the relative potential risk to wetlands, but no Alternative has the potential for significant adverse environmental impacts.

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 DNR-managed 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 DNR-managed Westside Trust Lands

Two sources of Geographic Information System data were used to identify acres of wetland in DNR 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 westside 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 DNR-managed westside 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 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, ground water recharge, and habitat for many kinds of organisms:

- **Hydrologic functions**, including 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 stream flow, floodwater attenuation, improved water quality.

- **Biogeochemical functions**, including 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**, including 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 is 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 generalization to harvest in the Pacific Northwest should be done with caution. Brief descriptions are provided for the impacts to wetland functions; more detail is available in 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 (Veery 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 (Veery 1997). As discussed in the Habitat Conservation Plan Environmental Impact Statement (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 is 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 Habitat Conservation Plan Environmental Impact Statement (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 Habitat Conservation Plan 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 Habitat Conservation Plan reduces potential impacts to water quality and other functions through reduction of sedimentation and 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, Habitat Conservation Plan, 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 roaded portion of wetlands, thereby eliminating the associated biological functions and potential for future tree growth. 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 DNR-managed 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 DNR-managed 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 Alternatives 1 through 6 would be a function of the acreage to be harvested and the amount of related activities.

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	3	10	25	12
2	7	18	27	17
3	8	18	30	18
4	5	12	29	14
5	13	30	34	26
6	36	27	34	31

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

Activities in the Upland Land Classes

In upland areas with special management objectives, Alternatives 1 and 4 would have the lowest level of activities, with an average of about 10 and 12 percent of acres disturbed per decade. Therefore, Alternatives 1 and 4 would have the lowest potential to affect wetlands. This is followed by Alternatives 3 and 2, each at 18 percent per decade. Alternatives 5 and 6 would have the highest level of harvest-related activities, with an average of 30 and 27 percent of acres disturbed per decade, respectively. Therefore, Alternatives 5 and 6 would have the highest potential to affect wetlands in the upland areas with special management objectives.

In the upland areas with general management objectives, Alternatives 1 and 2 (25 percent and 27 percent disturbance per decade) would have the lowest potential to affect wetlands. This is followed by Alternative 4 at about 29 percent disturbance per decade and Alternative 3 at 30 percent per decade. Alternatives 5 and 6 would have the highest level of activities, each with an average disturbance of about 34 percent of the upland acres per decade. Therefore, Alternatives 5 and 6 would have the highest potential to affect wetlands in the upland areas with general management 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.

Under the proposed Alternatives, it is expected that fish resources would not have significant adverse effects beyond those anticipated in the Habitat Conservation Plan environmental analysis. 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. In part, this is the result of current degraded conditions in many areas that resulted from practices prior to the Habitat Conservation Plan.

The potential for adverse effects to fish resources from Alternatives 1 though 4 is expected to be minimal during the first decade in all planning units. In contract, harvest activities in the riparian zone are expected to occur at higher levels under Alternatives 5 and 6, largely in the form of more frequent thinning activities. In particular, the estimated level of activity under Alternative 6, which would affect an average of 35 percent of the riparian area per decade, represents substantially higher levels than the other Alternatives, although the majority of the harvest area in Alternative 6 would be low-volume removal harvests. As explained in Section 4.3, it appears likely that the modeling outputs for Alternative 6 over-estimates the amount of allowable activity in the riparian areas. The model may overestimate the rate and intensity of harvest activities in riparian areas. Model assumptions will be reviewed for the Final Environmental Impact Statement.

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 westside 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 DNR-managed 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 under the Endangered Species Act.

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 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 during late 2003 with final determinations to be published in mid-2004.

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 (NOAA Fisheries 2003a). 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) 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 removal in a stream (Sullivan et al. 1987).

Streams that lack a balance between pools and riffles 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, habitat for food organisms such as aquatic macroinvertebrates, and as rearing areas for fish (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. A certain amount of bedload material is necessary to provide substrate for cover and spawning habitat for fish. Increased levels of coarse sediment bedload above background levels can, however, lead to stream bank 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 stream bank 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 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 stream flows 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 et al. 1994 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 (disintegration of) 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, 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 instream 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 adequate 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 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, 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. Other than restoration activities, none of the Alternatives proposes activities within the 25-foot no-harvest buffer along Types 1 through 4 streams, except for yarding corridors, roads, and restoration activities. Consequently, none of the Alternatives is likely to have a significant adverse effect on stream bank stability or sediment filtering capacity from surface erosion as long as appropriate mitigation measures are also implemented, such as Road Maintenance and Abandonment Plans. 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 (the way that water moves through the landscape) 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). Harvest levels in the riparian zone under Alternatives 5 and 6 may have minor short-term adverse effects to the local peak flows of the waterbody, particularly if ground-based yarding systems are used in riparian zones, but these minor effects are unlikely to be detectable at the watershed scale.

Large Woody Debris. The potential of adding more large woody debris is expected to improve under all of the Alternatives. Over the short term, Alternatives 1, 2, 3, and 4 are expected to produce about the same amount of riparian area included in stand development stages with very large trees, i.e., trees more than 30 inches in diameter (about 19 percent of the riparian land class). Alternative 6 is predicted to result in slightly less large woody debris than Alternatives 1 through 4 (with about 17 percent of the riparian land class with very large trees), while Alternative 5 is predicted to result in substantially less large woody debris (about 9 percent with very large trees). Very large trees are important for supplying larger streams with functional large woody debris (Section 4.3).

Over the long term, Alternative 1 is expected to result in the highest amount of riparian area (about 56 percent of the riparian land class) in stand development stages with very large trees, followed in descending order by Alternative 4 (52 percent), Alternative 2 (49 percent), Alternative 3 (46 percent), Alternative 5 (45 percent), and Alternative 6 (41 percent). Although Alternative 6 is predicted to have the lowest area of very large trees among the Alternatives, it is predicted to result in the highest amount (11 percent) of riparian land class area in fully functioning or old natural forest stand development stages, while Alternative 3 is predicted to have the lowest amount (about 7 percent).

The major feature that distinguishes these two stand development stages from other stages with very large trees is the presence of higher levels of decadence such as snags, down coarse woody debris, and epiphytes. Alternative 1, which is expected to have the highest area with very large trees, is predicted to have about 9 percent of riparian land class area in fully functioning or old natural forest stand development stages. Consequently, over the long term, Alternatives 5 and 6 appear to produce higher riparian function on more of the riparian land class relative to Alternative 1, but with the trade-off of having substantially less area supporting 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 Alternatives 1 though 4 for the first decade is expected to be minimal in all planning units because harvest activity levels are relatively low at less than 7 percent of the riparian land class and average about 8 percent for all decades and planning units. The differences would generally be minor except for lands managed under Alternative 6, and the Olympic Experimental State Forest Planning Unit under Alternative 5. Under Alternative 6, large woody debris recruitment potential could be lower in certain planning units during some decades, because of the relatively high level of activity to as much as about 73 percent of the riparian land class during a decade, primarily from low volume thinning. Under Alternative 5, riparian timber harvest in the Olympic Experimental State Forest is expected to result in disturbance levels as high as approximately 33 percent in an individual decade. Alternatives 5 and 6 would likely produce more acres of fully functioning riparian stands and stands on a trajectory towards full function because of thinning and other active silvicultural management. However, these Alternatives would also likely result in fewer riparian acres of very large trees within the Habitat Conservation Plan planning period. Those areas with very large trees that do not receive treatments, particularly under Alternatives 1 and 4, may require substantially longer periods (over 100 years; Carey et al. 1996) to achieve full riparian function.

Additional details concerning large woody debris recruitment and the likely effects of the Alternatives can be found in Riparian Areas (Section 4.3).

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 6 could result in thinning or hardwood conversion activities in these areas that may result in short-term adverse effects, but are expected to be beneficial over the long term.

Water Quality. Water temperatures in westside 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. Over the short term, Alternatives 1 though 4 are expected to result in about the same amount of area in stand development stages with very large trees, while Alternative 6 is predicted to have slightly less area, and Alternative 5 is predicted to have substantially less area. Over the long term, Alternative 1 is expected to have the highest amount of riparian area in stand development stages with very large trees followed in descending order by Alternatives 4, 2, 3, 5, and 6.

Relative to Alternative 1, improvements in stream shade anticipated under Alternatives 2 through 6 may be less because of the harvest of riparian trees and potentially greater numbers of yarding corridors. However, such activities would generally be relatively minor in scope except under Alternative 6 and in the Olympic Experimental State Forest under Alternative 5. Alternative 6 could result in lower levels of stream shading in some planning units during some decades, because of the relatively high level of disturbance to as much as approximately 73 percent of the riparian land class during a given decade. Under Alternative 5, the Olympic Experimental State Forest would be expected to experience disturbance levels as high as about 33 percent in a decade.

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. Use of forest chemicals such as fertilizers and herbicides under Alternatives 1 through 4 is expected to be little or none. Alternatives 5 and 6 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 limited 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, except for under Alternative 6 and in the Olympic Experimental State Forest under Alternative 5.

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.

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4.11 PUBLIC UTILITIES AND SERVICES

4.11.1 Summary of Effects

This section analyzes the potential effects of the Alternatives on public utilities and services. This analysis considers the potential effects of the Alternatives on harvest volumes because harvest volumes potentially affect trust revenues, which are used by some beneficiaries to fund public utilities and services. A separate financial analysis prepared by the DNR addresses the potential impacts to trust revenues in financial terms. 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 present a wide array of direct economic benefits to the beneficiaries. Potential effects on transportation infrastructure would vary by Alternative, with larger projected harvest volumes resulting in increased logging truck traffic. None of the Alternatives are expected to result in any probable significant adverse environmental impacts. Potential impacts would occur in the setting of the 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 state trust lands must meet Washington State Department of Transportation weight requirements and 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.

4.11.2 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 westside 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 trusts 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, Forest Board, and Community College Forest Reserve.

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 were located in westside counties in 2001 (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.

Annual statewide timber harvest is presented by trust beneficiary for Fiscal Year 1998 to Fiscal Year 2002 in Table 4.11-2. Total harvest ranged from 494.8 million board feet in Fiscal Year 2001 to 578.3 million board feet in Fiscal Year 2000, with an annual average of 543.7 million board feet. Federal Grant Trust land accounted for 52 percent of the average annual total; Forest Board lands accounted for the remaining 48 percent.

Federal Grant Trust lands generated a statewide annual average income of $141.2 million between Fiscal Year 1998 and Fiscal Year 2002, with the Common School Grant lands accounting for 73 percent or $103.1 million of this total (Table 4.11-3). Total annual income generated by Federal Grant Trust lands has fluctuated over the last 5 years, ranging from $100.2 million in Fiscal Year 2002 to $164.8 million in Fiscal Year 1999 (Table 4.11-3).

Table 4.11-1. Forested State Trust Lands Managed by DNR, by Trust Beneficiary

	Total Acres[1/]	Total Forested Acres[1/]	Westside Acres[2/3/]	Westside Forested Acres[3/4/]
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**
Forest Board 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	na	na
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/ Although addressed in the DNR Forest Resource Plan, the Community College Forest Reserve is not part of a trust.

Table 4.11-2. Annual Statewide Timber Harvest by Trust Beneficiary, Fiscal Year 1998 to Fiscal Year 2002 (in million board feet)

	Fiscal Year					
	1998	1999	2000	2001	2002	5-year Average
Federal Grant Trust Lands						
Agricultural School Grant (Washington State University)	12.4	13.6	7.9	5.3	8.4	9.5
Capitol Building Grant	26.4	26.6	34.3	28.3	24.2	28.0
Charitable, Educational, Penal and Reformatory Institutions Grant	14.1	12.3	12.4	11.5	22.1	14.5
Common School, Indemnity, and Escheat Grants	202.4	212.3	228.4	178.8	157.3	195.8
Normal School Grant (Eastern Washington University, Central Washington University, Western Washington University, and The Evergreen State College)	13.4	6.9	12.1	10.5	8.2	10.2
Scientific School Grant (Washington State University)	23.7	30.0	19.1	19.5	14.1	21.3
University Grants (University of Washington) Original and Transferred	8.5	6.1	0.9	6.9	0.2	4.5
Federal Grant Land Trust Total	**300.8**	**307.8**	**315.1**	**260.8**	**234.6**	**283.8**
Forest Board Lands (state forestlands)						
Purchase and Transfer	252.0	267.8	263.2	253.4	259.6	259.2
Community and Technical College Reserve						
College Reserve	1.8	0.3	0.0	0.8	0.6	0.7
Total for all Beneficiaries	**554.7**	**576.0**	**578.3**	**515.0**	**494.8**	**543.7**

Notes:

1. Reported trust harvest in 1999 and 2000 included harvest credited to Forest Board Repayment, Parkland Reserve Trust, and Water Pollution Control, which resulted in total harvest volumes of 610.9 and 628 million board feet for 1999 and 2000, respectively.
2. 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.
3. 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.

Data Sources: DNR 1998, 1999, 2000, 2001, 2002a

Table 4.11-3. Annual Statewide 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 Trust Lands						
Agricultural School Grant (Washington State University)	5.8	5.8	3.2	1.7	1.8	3.7
Capitol Building Grant	9.4	10.6	11.8	8.4	10.5	10.1
Charitable, Educational, Penal and Reformatory Institutions Grant	8.2	6.5	7.5	4.5	6.3	6.6
Common School, Indemnity, and Escheat Grants	105.7	119.4	119.5	103.4	67.6	103.1
Normal School Grant (Eastern Washington University, Central Washington University, Western Washington University, and The Evergreen State College)	5.1	5.2	7.9	5.8	5.5	5.9
Scientific School Grant (Washington State University)	11.2	11.4	7.7	6.5	6.8	8.7
University Grants (University of Washington) Original and Transferred	4.0	5.9	1.3	2.4	1.8	3.1
Federal Grant Trust Lands Total	**149.3**	**164.8**	**158.9**	**132.8**	**100.2**	**141.2**
Forest Board Lands						
Purchase and Transfer	121.6	144.9	113.6	89.2	79.6	109.8
Total for all Beneficiaries	**270.9**	**309.7**	**272.5**	**222.0**	**179.8**	**251.0**

Data Sources: DNR 1998, 1999, 2000, 2001, 2002a
[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.

On average, timber sale revenue accounted for 84.2 percent of annual Federal Grant Trust land income between Fiscal Years 1998 and 2002. This percentage ranged from 76.7 percent in Fiscal Year 2001 to 91.3 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 76.7 percent in Fiscal Year 2001 to 83.0 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 the decline is the result of the purchase of timber by the legislature for transfer out of trust ownership into parks and other non-consumptive uses through the trust land transfer program, which is limited to the Common School, Indemnity and Escheat Grants lands.

Table 4.11-4. Timber Sale Revenue as a Proportion of Annual Income by Trust Beneficiary, Fiscal Year 1997 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 Land Trust Total	85.1	75.5	71.7	61.5	71.2	73.0
Forest Board 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.

Forest Board Lands

There are two types of Forest Board lands (state forestlands): Transfer and Purchase. Acquisition of Forest Board Transfer lands was authorized by statute in 1927 to manage logged and abandoned properties formerly owned by individuals and corporations. These lands reverted to the counties when the original owners failed to pay property taxes and were subsequently transferred to the state in the 1920s and 1930s. Revenues produced from Forest Board Transfer lands support county services and junior taxing districts (such as schools, roads, and cemetery districts) in which they are located, although these lands are managed as one trust.

Forest Board Purchase lands were acquired by the state by purchase in 1923 and later by gift or purchase. Revenues go to the county and junior taxing districts in which they are located and the state general fund for the benefit of public schools. These lands are not in trust status, but are managed to earn revenue.

There were approximately 625,000 acres of Forest Board lands in the state of Washington in 2001, with the majority (603,000 acres) located in westside counties (Table 4.11-1). Forest Board lands (purchase and transfer) generated a statewide annual average income of $109.8 million between Fiscal Year 1998 and Fiscal Year 2002, about 44 percent of the total income generated by DNR for trust beneficiaries (Table 4.11-3). Total annual income generated by Forest Board lands has fluctuated over the last 5 years, ranging from $79.6 million in 2002 to $144.9 million in 1999 (Table 4.11-3). On average, timber sale revenue accounted for 99.0 percent of statewide annual Forest Board lands income between Fiscal Years 1998 and 2002 and stayed relatively constant over this period (Table 4.11-4).

DNR state timber sale revenue generated from Forest Board lands (purchase and transfer) is presented as an approximate proportion of total county revenue for the 17 westside counties in Table 4.11-5. This estimated contribution ranges from approximately 0.1 percent of total county revenue in King County to 16.1 percent in Clallam County (Table 4.11-5).

Table 4.11-5. DNR State Timber Sale Revenue as a Proportion of Total County Revenue, 2001

County	Trust Income ($)[1/]	Total County Revenue ($)[2/]	Trust Income as a % of Total Revenue
Clallam	5,908,678	36,611,186	16.1
Clark	2,289,382	247,081,550	0.9
Cowlitz	2,095,225	65,207,943	3.2
Grays Harbor	2,021,929	57,488,226	3.5
Jefferson	1,598,013	22,826,429	7.0
King	1,427,462	2,178,468,989	0.1
Kitsap	1,062,454	164,251,480	0.6
Lewis	5,096,739	56,336,813	9.0
Mason	1,977,874	38,383,105	5.2
Pacific	2,344,181	18,351,891	12.8
Pierce	981,549	388,521,292	0.3
Skagit	6,227,049	77,808,865	8.0
Skamania	1,208,272	16,234,088	7.4
Snohomish	13,238,245	525,842,849	2.5
Thurston	7,845,488	126,481,521	6.2
Wahkiakum	915,544	8,214,047	11.1
Whatcom	6,753,540	83,340,599	8.1

Data Sources:
[1/] DNR 2001
[2/] Washington State Auditor 2003

Community College Forest Reserve

In addition to Federal Grant and Forest Board lands, DNR also manages a small amount (3,339 acres) of forest lands for community colleges. Although these lands are addressed in the 1992 Forest Plan, they are not part of a trust.

4.11.3.2 Transportation Infrastructure

The Final Environmental Impact Statement for the DNR Forest Resource Plan indicated that DNR operated about 12,000 miles of roads, 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. DNR closes and 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 state 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 DNR-managed lands, as well as timber harvesting on other types of land ownership.

Timber harvest data are presented by westside county for state lands (including DNR managed lands) in Table 4.11-6. This table also presents state harvest as a percentage of total harvest (state, federal, and private) by county. Data are presented for 2001, with the annual average for 1997 to 2001 also provided. Harvest volumes from all lands in 2001 were lower than the 1997 to 2001 average for all but two westside counties. Harvest volumes from state lands in 2001 were the same or higher than the 1997 to 2001 average in 6 of the 19 westside counties (Table 4.11-6).

Assuming an average load per logging truck of 4.5 thousand board feet suggests that harvest from all lands in Grays Harbor County in 2001, for example, generated about 98,500 logging truck trips. Using the same assumption, harvest from state lands in Snohomish County in the same year generated about 11,000 logging truck trips. It should be noted that each logging truck trip consists of two legs: one way with a full load, and one way empty.

4.11.4 Environmental Effects

4.11.4.1 State 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

Table 4.11-6. State and All Ownerships Timber Harvest by County, 1997 to 2001 (in million board feet)

County	2001 State Harvest[1/]	2001 Total Harvest[2/]	2001 State as a % of Total	1997-2001 Average State Harvest[1/]	1997-2001 Average Total Harvest[2/]	1997-2001 Average State as a % of Total
Clallam	34.9	230.9	15.1	40.0	259.4	18.4
Clark	15.7	53.9	29.0	23.7	81.5	15.5
Cowlitz	38.6	248.1	15.5	32.5	265.5	9.8
Grays Harbor	25.5	443.3	5.8	42.2	520.4	6.8
Island	0.0	10.7	0.0	0.2	15.0	3.3
Jefferson	11.4	61.8	18.5	13.6	70.4	35.5
King	11.0	144.2	7.6	12.7	155.9	6.2
Kitsap	2.9	25.8	11.4	4.4	32.7	9.9
Lewis	37.5	441.1	8.5	57.8	433.7	11.0
Mason	12.6	144.4	8.7	19.0	177.3	7.9
Pacific	27.6	277.4	9.9	40.8	303.3	10.8
Pierce	17.8	200.1	8.9	13.8	216.9	4.3
San Juan	0.0	1.7	0.0	0.0	2.7	3.1
Skagit	23.3	121.8	19.1	41.2	150.5	22.5
Skamania	8.3	31.4	26.4	13.8	46.9	17.1
Snohomish	50.2	122.4	41.0	44.3	134.8	20.7
Thurston	49.0	107.4	45.6	51.5	119.8	27.3
Wahkiakum	19.2	96.5	19.9	16.9	89.9	16.5
Whatcom	37.6	78.9	47.7	29.5	89.0	24.6
Total Westside Counties	**423.0**	**2,841.8**	**14.9**	**498.0**	**3,165.5**	**13.1**

Data Source: DNR (various years)

[1/] The state harvest volumes presented in this table are for harvest from all state lands, not just those managed by DNR.

[2/] The total timber harvest volumes presented in this table include timber harvest from all land ownerships, including Native American, Forest Industry, private, state (included DNR-managed lands), National Forest, and other.

marketplace. These issues are discussed in the separate financial and economic analysis prepared for this project. 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 4.11-7. The largest projected total harvest would occur under

Alternatives 5 and 6, with total harvests of about 819 and 781 million board feet, respectively. Lower levels of harvest would occur under Alternatives 2 and 3, approximately 537 and 663 million board feet, respectively, with the lowest total harvest levels projected for Alternatives 1 and 4, approximately 396 and 411 million board feet, respectively. These projections suggest that higher trust revenues would be generated under Alternatives 5 and 6 than Alternatives 1 and 4. In addition, it may be noted that, under Alternatives 3, 5, and 6, the total projected average annual harvest for 2004 to 2013 would be higher than the 1998 to 2002 annual average.

The largest amount of harvest would occur on Forest Board lands and Common School, Indemnity, and Escheat Grant lands under all Alternatives. Forest Board lands range from 45 percent of the total projected volume under Alternative 5, to 55 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 Alternatives 2, 5, and 6.

Projected annual average harvest for 2004 to 2013 for Forest Board lands would be higher than the 1998 to 2002 annual average under Alternatives 3, 5, and 6, while projected average annual harvest for the Common School, Indemnity, and Escheat Grant lands would be higher under Alternatives 5 and 6 only.

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 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 4.11-8. Alternative 6 would result in the largest total average annual volume harvested, followed by Alternatives 5, 3, 2, 4, and 1 in that order. Total projected average annual harvest for 2004 to 2013 would be higher than the 1998 to 2001 annual average under Alternatives 2, 3, 5, and 6. 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 182,000 under Alternative 5, compared to a 1997 to 2001 annual average of approximately 110,700 (Table 4.11-9).

Table 4.11-7. Projected Annual Average Harvest by Trust Beneficiary and by Alternative, 2004 to 2013 (in million board feet)

Trust Beneficiary	5-Year Annual Average[1/]	Alternative 1	2	3	4	5	6
Federal Grant Trust Lands							
Agricultural School Grant (Washington State University)	9.5	9.4	8.9	7.4	12.3	12.5	12.6
Capitol Building Grant	28.0	33.7	37.3	46.0	28.9	74.2	58.8
Charitable, Educational, Penal and Reformatory Institutions Grant	14.5	14.7	15.3	17.2	11.7	19.7	25.9
Common School, Indemnity, and Escheat Grants	195.8	115.9	176.1	181.2	122.5	269.2	261.3
Normal School Grant (Eastern Washington University, Central Washington University, Western Washington University, and The Evergreen State College)	10.2	6.4	11.6	10.8	7.2	14.4	14.2
Scientific School Grant (Washington State University)	21.3	23.1	22.3	28.7	24.6	33.1	32.0
University Grants (University of Washington) Original and Transferred	4.5	2.3	13.1	10.0	4.8	22.9	9.8
Federal Grant Land Trust Total	**283.8**	**205.5**	**284.7**	**301.2**	**212.0**	**446.0**	**414.5**
Forest Board Lands							
Purchase and Transfer	259.2	189.1	251.1	361.3	197.9	372.1	365.7
Community and Technical College Reserve							
College Reserve	0.7	1.5	1.0	0.4	1.3	0.9	0.7
Total	**543.7**	**396.1**	**536.8**	**662.8**	**411.2**	**819.0**	**781.0**

[1/] This is the annual average for DNR-managed lands for 1998 to 2002 (see Table 4.11-2).
Data Source: Model output data – timber flow levels

The geographic distribution of the projected harvest and associated logging truck traffic over this period would vary by Alternative. Under Alternatives 5 and 6, annual average projected harvest would be largest in Clallam and Jefferson Counties, with Alternatives 5 and 6 generating about 28,700 and 14,100 logging trips in Clallam County, respectively. Under Alternatives 1 and 4, annual average projected harvest would be 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 would be largest in Jefferson and Skagit Counties, with an estimated annual average 11,900 and 11,200 logging trips, respectively. Projected harvest under Alternative 3 would be largest in Mason and Lewis Counties, with an estimated annual average 13,800 and 13,500 logging trips, respectively.

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 appropriate 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 DNR-managed state 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 who harvest timber from forested state trust lands must meet Washington State Department of Transportation weight requirements. 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.

Table 4.11-8. Projected Annual Average Harvest by County, by Alternative, 2004 to 2013 (in million board feet)

County	5-year Annual Average[1/]	Alternative					
		1	2	3	4	5	6
Clallam	40.0	22.7	37.4	57.6	24.9	129.1	63.6
Clark	23.7	29.6	37.9	56.3	22.9	45.8	53.3
Cowlitz	32.5	32.3	29.2	46.1	28.3	39.9	51.1
Grays Harbor	42.2	23.1	41.3	49.4	31.1	47.8	70.7
Jefferson	13.6	9.4	53.6	54.9	10.0	98.1	50.4
King	12.7	15.6	12.9	15.3	9.5	27.7	21.6
Kitsap	4.4	6.4	5.6	10.4	4.3	7.5	10.3
Lewis	57.8	38.3	46.1	60.7	32.8	57.3	80.1
Mason	19.0	31.0	28.0	62.1	23.7	38.9	61.7
Pacific	40.8	13.2	19.3	23.9	36.1	46.8	60.4
Pierce	13.8	13.3	13.3	8.3	4.1	17.3	5.3
San Juan	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Skagit	41.2	45.5	50.3	37.0	50.2	63.4	62.1
Skamania	13.8	10.6	30.9	43.9	6.7	45.8	13.3
Snohomish	44.3	44.4	49.1	29.8	46.1	54.3	56.7
Thurston	51.5	28.0	37.4	55.2	29.0	32.7	49.6
Wahkiakum	16.9	7.4	7.9	19.0	23.6	24.5	24.7
Whatcom	29.5	25.2	36.5	33.0	27.8	42.0	46.0
Total	**497.7**	**396.1**	**536.8**	**662.8**	**411.2**	**819.0**	**781.0**

[1/] This is the annual average for 1997 to 2001 (see Table 4.11-6). Note that this differs from the period used in Table 4.11-7 because total state harvest data are not yet readily available for 2002. It should also be noted that these data are for the calendar year rather than DNR's fiscal year.
Data Source: Model output data – timber flow levels

Table 4.11-9. Projected Annual Average Logging Truck Traffic by County, by Alternative, 2004 to 2013 (number of trips[1/])

County	5-year Annual Average[2/]	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Clallam	8,900	5,000	8,300	12,800	5,500	28,700	14,100
Clark	5,300	6,600	8,400	12,500	5,100	10,200	11,800
Cowlitz	7,200	7,200	6,500	10,200	6,300	8,900	11,400
Grays Harbor	9,400	5,100	9,200	11,000	6,900	10,600	15,700
Jefferson	3,000	2,100	11,900	12,200	2,200	21,800	11,200
King	2,800	3,500	2,900	3,400	2,100	6,200	4,800
Kitsap	1,000	1,400	1,200	2,300	1,000	1,700	2,300
Lewis	12,800	8,500	10,200	13,500	7,300	12,700	17,800
Mason	4,200	6,900	6,200	13,800	5,300	8,600	13,700
Pacific	9,100	2,900	4,300	5,300	8,000	10,400	13,400
Pierce	3,100	3,000	3,000	1,800	900	3,800	1,200
San Juan	0	0	0	0	0	0	0
Skagit	9,200	10,100	11,200	8,200	11,200	14,100	13,800
Skamania	3,100	2,400	6,900	9,800	1,500	10,200	3,000
Snohomish	9,800	9,900	10,900	6,600	10,200	12,100	12,600
Thurston	11,400	6,200	8,300	12,300	6,400	7,300	11,000
Wahkiakum	3,800	1,600	1,800	4,200	5,200	5,400	5,500
Whatcom	6,600	5,600	8,100	7,300	6,200	9,300	10,200
Total	**110,700**	**88,000**	**119,300**	**147,200**	**91,300**	**182,000**	**173,500**

[1/] Logging truck traffic is an estimate of logging trips based on an average truck load of 4.5 thousand board feet per truck.
[2/] This is the annual average for 1997 to 2001 (see Table 4.11-6). Note that this differs from the period used in Table 4.11-7 because total state harvest data are not yet readily available for 2002. It should also be noted that these data are for the calendar year rather than DNR's fiscal year.
Data Source: Model output data – timber flow levels

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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, adverse effects on cultural resources are expected to be insignificant under all Alternatives. 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 anticipated 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 of DNR-managed forest 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 DNR-managed 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.6.

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 pre-harvest 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 DNR-managed 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 lay 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 do 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 DNR-managed forest 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 including 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 Indian 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.

Table 4.12-1. Ranking of Alternatives According to their Effect on Cultural Resources (A Rank of 1 Equals Lowest Potential for Impacts)

Alternative	Streamside Effects	Harvest of Older Stands[1/]	Harvest Frequency	Rank
1	Harvest in Riparian Management Zone and Wetland Management Zone prohibited (1)	No additional stipulations (4)	60 yr (5)	2
2	Maintain canopy closure (relative density of 45 or greater) over 90% of riparian management area (3)	No additional stipulations (4)	60 yr (5)	5
3	Same as 2 (3)	No additional stipulations (4)	60 yr (5)	5
4	Harvest in Riparian Management Zone and Wetland Management Zone prohibited (1)	Harvest of >150 year stands deferred (1)	80 yr (1)	1
5	Maintain canopy closure (relative density of 45 or greater) over 70% of riparian management area (3)	10 to 15% to be maintained in old forest conditions (2)	40 yr (6)	4
6	Maintain canopy closure (relative density of 35 or greater) over 70% of riparian management area (4)	10 to 15% to be maintained in old forest conditions (2)	Variable 40-80 yr (2)	3

Data Source: Evaluations of Alternatives, Section 2.6
1/ Old forest research areas are deferred and 20 percent of Olympic Experimental State Forest lands are maintained in old forest conditions in all Alternatives.

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 ranks are 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 (Alternative 4) is expected to have the least potential impact on cultural resources and require the lowest level of effort to protect such resources.

Alternatives 2 and 3, which have only moderate protection of streamside lands and no additional protection of old forests, are expected to have the greatest potential impact on cultural resources and require the greatest level of effort to protect these resources. Alternative 4, which protects old forests and streamside environments and would have the longest harvest interval, is likely to have the least potential impact. Also, less effort would be needed for cultural resource protection.

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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. None of the Alternatives is expected to result in any probable significant adverse environmental impacts. 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 (Forest Resource Plan Policies Nos. 25 and 29 [DNR 1992b]).

The effects of the proposed Alternatives on fish and wildlife could, in turn, affect recreational fishing and hunting on DNR westside trust lands. Fishing and hunting opportunities on DNR-managed westside trust lands could be positively affected to the extent that increased amounts and quality of habitat contribute to greater abundance 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 4.4, 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 1992b]).

DNR generally provides public access for multiple uses on state 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 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 equestrian). 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 westside forested 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).

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

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 Habitat Conservation Plan 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 westside 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. 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 4.11-9 and discussed in Section 4.11.3.2, 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 1997 to 2001, to roughly 174,000 truck trips under Alternative 6, about 1.67 times the 1997 to 2001 annual average. Third, the impacts of the proposed Alternatives on fish and wildlife could in turn affect recreational fishing and hunting on westside trust lands.

As noted above, 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 other groups would be negatively affected by increased levels of logging truck traffic on existing roads.

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 (Figure 4.2-2). 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 would occur over larger areas under Alternatives 5 and 6 for all decades that make up the 64-year planning period with two exceptions. These exceptions occur in 2044 through 2053 when high-volume removal harvest would occur over a larger area under Alternative 3 than Alternative 5, and 2064 through 2067 when high-volume removal harvest would occur over a larger area under Alternative 3 than Alternative 6. 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 5 and 6 likely to have relatively high impacts compared to Alternatives 1 and 4. These trends tend to hold true across four of the six planning units, with some limited exceptions when high-volume removal harvest would occur over larger areas under Alternative 3 than Alternatives 5 and/or 6. This occurs more frequently in the South Puget unit with high-volume removal harvest occurring over larger areas under Alternative 3 than Alternatives 5 and 6 in four of the seven time periods analyzed (2004 to 2013, 2034 to 2043, 2044 to 2053, and 2064 to 2067).

The projected area of high-volume removal harvest is noticeably different for the Olympic Experimental State Forest than it is for the other five units, with the area harvested under Alternative 6 lower than the projected harvest areas under Alternatives 2, 3, and 5 across all time periods. This is reflected in the high volume removal harvest acres shown by Alternative in Figure 4.13-2. Viewed in terms of total acres harvested, high volume removal harvest is generally lower in the South Puget and Straits Planning Units than in the other four units (Figure 4.13-2).

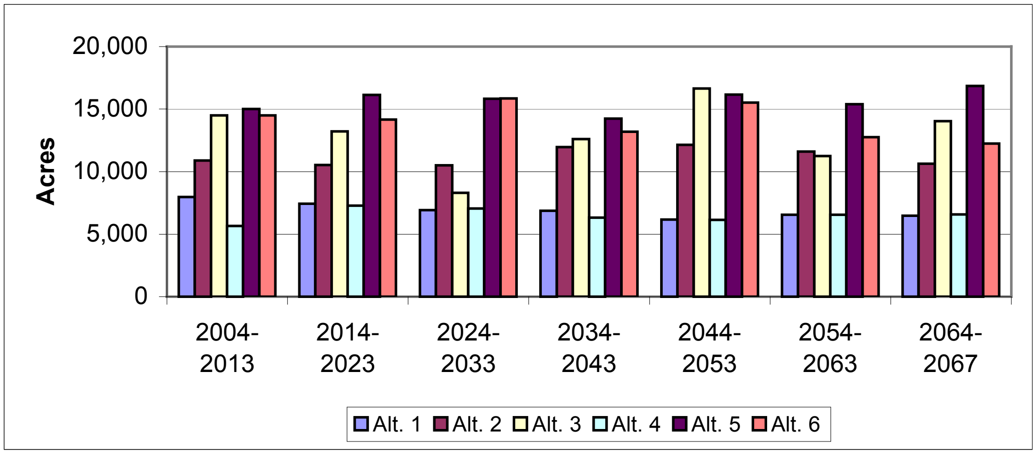

Figure 4.13-1. Average Annual High Volume Removal Harvest Acres, by Alternative and Decade

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.

Source: OPTIONS model output data

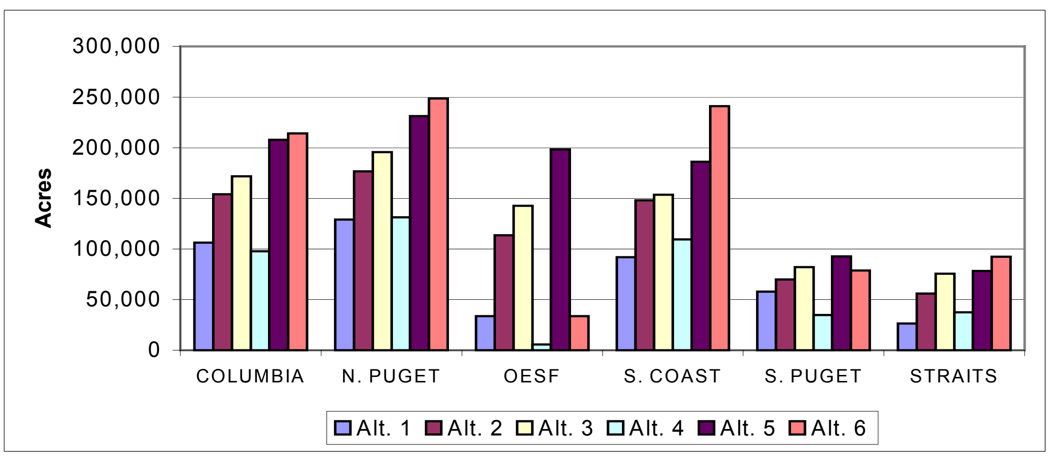

Figure 4.13-2. Total High Volume Removal Harvest Acres by Alternative and Planning Unit

Data Source: Model output data – timber flow levels

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 4.4-1 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.

In the short term (2013), there is no meaningful difference among the Alternatives. In the long term (2067), the amount of ecosystem initiation forest would be largest under Alternative 5, followed by Alternatives 3 and 6, with Alternatives 1, 4, and 2 having the smallest amounts. Alternatives 3, 5, and 6 generally result in greater increases in open forest across all six planning units, with the exception of the South Puget Planning Unit where Alternative 6 produces smaller increases than most Alternatives in both time periods, and Alternative 1 has higher increases than most. Model results indicate Alternative 6 would produce the smallest increases of open forest in the Olympic Experimental State Forest.

The effects of the proposed Alternatives on fish and wildlife could, in turn, affect recreational fishing and hunting on DNR westside trust lands. Fishing and hunting opportunities on DNR westside 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 almost all time periods. The largest short-term increases (by 2013) are projected to occur under Alternatives 4 and 5, with the largest increases occurring over the long term under Alternatives 2, 3, and 5. 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.

None of the Alternatives is expected to result in any probable significant adverse environmental impacts on 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.

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 westside 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 westside forested trust lands that are managed for the support of trust beneficiaries, DNR also manages some westside 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, respectively. 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. 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 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 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 Figure 4.2-2, 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 would occur more frequently under Alternatives 5 and 6 for all decades that make up the 64-year planning period with two exceptions. These exceptions occur in 2044 through 2053 when high-volume removal harvest would occur over a larger area under Alternative 3 than Alternative 5, and 2064 through 2067 when high-volume removal harvest would occur over a larger area under Alternative 3 than Alternative 6. 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 4.4-1 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. In the short term (2013), there is no meaningful difference among the Alternatives. In the long term, the amount of ecosystem initiation forest would be the largest under Alternative 5, followed by Alternatives 3 and 6, with Alternatives 1, 4, and 2 having the smallest amounts. Alternatives 3, 5, and 6 generally result in greater increases in open forest across all six planning units, with the exception of the South Puget Planning Unit where Alternative 6 produces smaller increases than most alternatives in both time periods, and Alternative 1 has higher increases than most.

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 3, 5, and 6 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 of Effects

This section analyzes the cumulative effects of the Alternatives. The analysis examines the potential effects of proposed changes to policy and procedures in the context of the role DNR-managed lands play in resource management in western Washington. The analysis uses the modeling outputs to inform the public and decision-makers of the relative differences in potential cumulative effects. This analysis also allows DNR to assess relative risks that are illustrated using modeling outputs.

Landscapes in western Washington are characterized by a particular distribution of forest structures. The distribution of forest structures over time and space appears to be the basis of cumulative effects in the forest environment. It is generally recognized that forests with very large trees and structurally complex forests are currently scarce, and medium-sized closed forests are overabundant across all ownerships in western Washington. Therefore, forest management activities that contribute to the development of more structurally complex forest and less competitive exclusion forest at the landscape level would be expected to reduce cumulative effects.

All Alternatives are modeled as resulting in increases in structurally complex forest over time. However, the rates of change and amount of change vary among the Alternatives. All Alternatives project changes in forest structure that should change the current distribution of structural classes towards more complex forests. All Alternatives create a new balance of forest structure at the landscape level. This new balance suggests that there is little potential for contributing to adverse cumulative effects.

4.15.2 Introduction

Although cumulative effects are not defined in the Washington State Environmental Policy Act, they are defined in the Washington State Forest Practices Rules as “the changes to the environment caused by the interaction of natural ecosystem processes with the effects of two or more forest practices” (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.

This cumulative effects analysis uses a semi-quantitative approach that ranks watersheds on several key issues. These watersheds represent Washington DNR Watershed Administrative Units per March 2002 delineations. This analysis is a screening tool for discerning the potential for proposed activities on DNR land to result in adverse cumulative effects on fish, hydrology, water quality, soils, and wildlife. While it does not provide precise site-specific conclusions about the current or future existence of cumulative effects, the screening analysis does provide information on *what types* of cumulative effects might occur and *where* these effects might be most likely to 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.

4.15.2.1 Data Adequacy and Assumptions

Geographic Information System data were used to estimate current conditions over 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.

Several datasets were used in the 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 watersheds and planning units, and 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 (Habitat Conservation Plans, the Northwest Forest Plan) and state law (e.g., Forest Practices Law, Rules, Standards and Guidelines). The risk of adverse cumulative effects was then 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 5 and 6 than under Alternatives 1 and 4, because more frequent harvest activities are anticipated under Alternatives 5 and 6.

Vegetation data for this analysis were derived from maps developed by the Interagency Vegetation Mapping Project (2002). (The primary purpose of the 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 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 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: 0–10, 10–20, 20–30, 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.

The Interagency Vegetation Mapping Project data are considered the best available data for a landscape-level analysis encompassing all ownerships, and are considered accurate enough to permit analysis of potential cumulative effects at the watershed level. For the analysis of environmental impacts on state trust lands, DNR's state land forest resource inventory system provides the most detailed information on vegetation cover.

4.15.2.2 Scale of Analysis

Cumulative effects are discussed at the planning unit level. References to the distribution of impacts among watersheds are made, as needed, to explain conditions within a planning unit. Tables summarizing conditions at the watershed level are presented in Appendix E. The analysis focuses on 179 watersheds in which DNR manages at least 5 percent of the watershed.

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 locations that may be more vulnerable to potential cumulative effects.

The discussions below should not be interpreted as identifying watersheds where adverse cumulative effects may or may not be likely to occur. Instead, the data, within the context of a review of existing policy and procedures, serve as a screening tool for identifying areas where DNR land management may be most influential and, conversely, where consideration of resource protection may influence DNR operational planning. An example of the latter may be seen in the discussions of watersheds where northern spotted owl nesting, roosting, and foraging management areas have been designated. In watersheds where both forest with very large trees and federal reserves are scarce, forest management on DNR lands under its Habitat Conservation Plan may play an important role in meeting the goals and objectives for managing spotted owl habitat.

4.15.3 Vegetation and Wildlife Habitats

This section identifies areas where timber harvest on DNR lands may appreciably influence the availability of wildlife habitats and the species 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 DNR lands contain a relatively large proportion of the amount that exists. In these areas, timber harvest on DNR lands may carry the risk of reducing the availability of a particular habitat type. The absolute significance of the reduction cannot be characterized with reasonably available data. Other tables focus on areas where DNR land 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 DNR lands make up at least 5 percent of the total land area. Each of these tables (Appendix Tables E-4, E-5, and E-6) 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-7, 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 non-forested 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 non-forested habitat such as wetlands, habitat quality may be adversely affected by equipment and activities associated with timber harvest (see Section 4.9). Significant regulatory (RCW 79.01 and Forest Practices Rules) and Habitat Conservation Plan protections exist for wetlands, both forested and non-forested, suggesting that the likelihood of significant impacts to these important habitats is low. Wetlands support a diverse assemblage of wildlife species and represent an essential habitat component for some. Riparian areas, which also play a vital role in the lives of numerous wildlife species, are addressed in the discussion of fish habitat quality in this cumulative effects analysis (Section 4.15.4).

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.

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)

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 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

Table 4.15-2. Number of Watersheds[1/] With Small/Open Condition Forest by Habitat Conservation 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

four watersheds have more than 30 percent small/open forest, and 29 have less than 10 percent. 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.

Of the 20 watersheds with the highest proportion of small/open forest (i.e., the top 20), 7 are in the Columbia Planning Unit, 6 are in North Puget, 6 are in South Puget, and three are in the Straits unit. None of the top 20 is in the South Coast unit or the Olympic Experimental State Forest. In nearly all of the top 20, the great majority of small/open forest occurs on private lands. The most obvious exception is Hamilton Creek (280106) in the Columbia Planning Unit, where federal and municipal lands account for 53 percent of the small/open forest. DNR lands contribute at least 40 percent of the small/open forest in two watersheds: Upper South Fork Toutle (260508) in the Columbia Planning Unit, and Deming (010226) in the North Puget Planning Unit. See Appendix Table E-4 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 private or DNR ownership. The more extensive forest management activities on DNR lands, as are projected to occur under Alternatives 5, 3, and 6 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 below acceptable levels. The more intensive management in these watersheds under Alternatives 5, 3, and 6 thus 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 6), the forest management strategies of Alternative 6 indicate substantially greater increases in more structurally complex forests 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 DNR 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 DNR lands (for instance, under Alternatives 5, 3, 2, or 6) may provide appreciable increases in the amount of this habitat type. Table 4.15-4, therefore, identifies potential opportunities for DNR to ensure that small/open forest continues to be available in all westside watersheds with an appreciable amount of DNR land. 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 4.15-3. Percent of Small/Open Forest and Ownership in Watersheds[1/] with the Highest Future Potential to Become Dominated by Small/Open Forest[2/]

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
[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.

Table 4.15-4. Watersheds[1/] Where Management of DNR Lands May Play a Major Role in the Maintenance of Small/Open Forest

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
[1/] The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations

4.15.3.2 Forests with Medium/Large Trees

Nearly three-quarters of the watersheds have at least 40 percent forested land in the forests with medium/large trees (Table 4.15-5). In one watershed in the North Puget Planning Unit (Cypress [030415]), 92 percent of the forested land area is in this condition.

Table 4.15-5. Number of Watersheds[1/] Supporting Various Proportions of Forests with Medium/Large Trees Among 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 planning unit

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 Table E-5 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 this forest condition on DNR lands equals the average proportion on private lands. In three planning units (North Puget, South Puget, and Straits) the average proportion on DNR 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).

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

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
[1/] The term "watershed" is used in this analysis to denote Washington DNR Watershed Administrative Units per March 2002 delineations

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 substantial decrease (30 to 50 percent) in this forest condition on DNR state trust forestlands. Heavy 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 Alternative 6) may accelerate the development of forests with very large trees, providing benefits to wildlife species associated with the latter condition. Forests with medium/large trees would be expected to develop the characteristics of forests with very large trees under passive management (as under Alternatives 1 and 4), but may take longer than projected without active management to develop these characteristics.

4.15.3.3 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.

Table 4.15-7. Number of Watersheds[1/] Supporting Various Proportions of Forest with Very Large Trees among 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

Currently, forest with very large trees is not evenly distributed among the HCP Planning Units. Two 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 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 planning unit have at least 5 percent forest with very large trees. The North Puget 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.

Of the 20 watersheds with the highest proportion of forest with very large trees (i.e., the top 20), the majority of this forest type falls on federal lands in all but two cases. The two exceptions are Spada (070216) and Lower Middle Fork Snoqualmie (070307), both of which are in the North Puget Planning Unit. In both cases, DNR lands provide the largest proportion of existing forest with very large trees, 64 percent and 45 percent, respectively. Fifteen of the top 20 watersheds are in the North Puget Planning Unit; the Olympic Experimental State Forest and the Straits Planning Units have two apiece, and the Columbia Planning Unit has one. In 15 of the top 20, more than 10 percent of DNR lands have been designated as nesting, roosting, and foraging management areas for spotted owls. See Appendix Table E-6 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.

Over the long term, all Alternatives would maintain or substantially increase the area of structurally complex forests on DNR-managed westside trust lands (see Figure 2.6-4 in Chapter 2). Alternative 1 projects an increase in the area in structurally complex forests from 10 percent to 28 percent. Alternatives 2, 3, 4, 5 and 6 project an increase to 16, 13, 29, 11 and 24 percent respectively, of structurally complex forest on the state trust forestland base over the life of DNR's Habitat Conservation Plan.

Designated nesting, roosting, and foraging management areas account for more than 10 percent of DNR 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 may be of concern because less than half of the existing forest with very large trees occurs on federal lands. However, in all Alternatives, the area of structurally complex forest is projected to increase in designated nesting, roosting, and foraging management areas. Alternative 5 projects the smallest increase of structurally complex forest in nesting, roosting, and foraging management areas—from 10 to 20 percent over the life of the Habitat Conservation Plan (to 2067) compared to the projected increase from 10 to 45 percent under Alternative 1. Alternative 6, with biodiversity pathways management, projects an increase to 55 percent, while more passive approaches in Alternative 4 project an increase to 39 percent of the nesting, roosting, and foraging habitat area that would be in structurally complex forest by 2067. Although these areas may be of concern under current conditions, all the Alternatives project increases in structurally complex forests.

Table 4.15-8. Summary of Watersheds[1/] in which at Least 10 Percent of DNR Lands are Designated 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

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% 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 DNR lands. In the short term (i.e., before additional habitat can develop on federal or DNR lands), relatively more intensive timber harvest on DNR 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.

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 DNR 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

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 (Appendix Table E-6), except in areas where such habitats occur on land protected for other policy reasons such as riparian or slope stability. Often, small amounts of older age classes occur in riparian areas, where they routinely receive protection by the Forest Practices Act and the Habitat Conservation Plan.

4.15.3.4 Wetlands

Interagency Vegetation Mapping 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, however,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 may face an elevated relative risk. Additional effort may be needed to ensure that management on trust lands in these watersheds do not contribute to adverse cumulative effects on wetlands. DNR current policy (Forest Resource Plan No. 21), Habitat Conservation Plan, 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.

Table 4.15-10. Areas with an Elevated Potential for Development and Where Wetlands Have Been Identified

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

4.15.3.5 Summary

The tables and discussions above identify watersheds with the greatest risks and opportunities associated with management of DNR lands under the six Alternatives. Table 4.15-8 identifies areas of relative concern with regard to northern spotted owl habitat management. All Alternatives project increases in structurally complex forest over time. However, the rates of change and amount of change vary among the Alternatives. All Alternatives project changes in forest structure that should change the current distribution of forested habitat types towards more structurally complex stands. The result is a potential reduction in the risk of certain types of cumulative effects over the long term. Alternatives that do not include specific strategies to enhance habitat and have higher rates of harvest than Alternative 1 (No Action), have a greater potential of reducing forest with very large trees in areas where it is relatively plentiful and is not protected or designated as a set-aside. Such protections and/or set-asides can be either policy (or contract in the case of the Habitat Conservation Plan) in nature or required by state or federal laws.
Table 4.15-3 identifies areas where intensive forest management may cause the amount of small/open forest to become the dominant forest condition class on the landscape.

4.15.4 Fish

Several factors influence the potential for forest management to contribute to adverse cumulative effects to fish resources. These factors include the presence of fish or fish habitat, the existing condition of these resources, 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) are considered to be potentially more sensitive to cumulative effects. Similarly, areas that have higher levels of disturbance (e.g., small riparian trees) or potential 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 adverse cumulative effects. Federal ownership is expected to result in few forest management activities under the Northwest Forest Plan, while private forest ownership is expected to result in more intensive and frequent management. The level of forest management activities in riparian areas on DNR westside trust lands may be relatively lower (Alternatives 1 and 4) or relatively higher (Alternatives 5 and 6) depending upon the Alternative chosen.

In general, fish resources and their habitat are expected to improve in the long term because of the Northwest Forest Plan, improved Forest Practices Rules, various habitat conservation plans being implemented and developed in the region, and federal, state, and local programs. Each of these has a goal of protecting and restoring fish resources in the Pacific Northwest. Nevertheless, forest management activities will continue to occur in the region, and the risk of adverse cumulative effects needs to be evaluated in light of these activities, current conditions, and the previously identified legal and policy constraints.

The fish resource cumulative effects analysis uses the watershed as the spatial scale for assessing cumulative effects, and the planning unit as the scale for summarizing them. Only watersheds that have at least 5 percent DNR westside trust ownership were included in the analysis. The assessment is a screening tool for identifying the relative risk of cumulative effects. It is based on reasonably available information. It is not a precise determination of effects because the resolution of the available broad-scale data is inappropriate for a more precise assessment.

The cumulative effects analysis for fish resources integrates a number of measures for each watershed. These include:

- Percent of DNR trust land ownership in the total watershed area (Appendix Table E-7)
- Percent of riparian area with small trees (a quadratic mean diameter of less than 10 inches) (Appendix Table E-8)
- Anadromous fish stream density (stream miles per square mile) (Appendix Table E-9)
- Total stream density (stream miles per square mile) (Appendix Table E-10)
- Resident fish stream density (Types 1 to 3 stream miles per square mile) (Appendix Table E-11)
- Bull trout stream density (bull trout stream miles per square mile) (Appendix Table E-12)
- Percent of watershed area with urban or agricultural land use (Appendix Table E-13)

- Percent of rain-on-snow area with hydrologically immature forest (see Section 4.7, Hydrology) (Appendix Table E-14)
- Miles of stream on the 303(d) list for temperature (see Section 4.8, Water Quality) (Appendix Table E-15)
- Miles of stream on the 303(d) list for fine sediment (see Section 4.8, Water Quality) (Appendix Table E-17)
- Percent of watershed area assessed as having a high rating for shallow rapid landslides (see Section 4.6, Geomorphology, Soils, and Sediment) (Appendix Table E-18)

The available information (summarized in Appendix Table E-1) indicates that the highest average proportion of watersheds that was in the upper quartile for the measures described above was in the North Puget Planning Unit (about 42 percent), 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 Planning Units (about 6 percent). The average proportion of watersheds within a planning unit that was in the upper quartile was highest for the Olympic Experimental State Forest (about 33 percent) 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 Planning Units, moderate for the Columbia and South Coast Planning Units, and relatively low for the South Puget and Straits 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 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 DNR-managed westside trust lands may be highest under Alternative 6 compared to other Alternatives. However, thinning dense stands of small and medium trees (trees under 20 inches in diameter) would improve riparian conditions over time. The forest management activities associated with the low-volume harvests in Alternative 6 are based on biodiversity pathways management and are likely to enhance and accelerate the development of fully functional riparian forests for a larger area in an earlier timeframe. Therefore, the relative risks of some adverse cumulative effects from tree removal and ground disturbance may be higher under Alternative 6 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 functional riparian areas are expected to decline more rapidly from active management under Alternative 6 compared to other Alternatives.

4.15.4.1 Evaluation of Potential Cumulative Effects to Fish

In all the Alternatives, riparian management activity on DNR state trust forestlands 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 is highest for the North Puget Planning Unit, followed by the Olympic Experimental State Forest, Columbia, South Coast, South Puget, and Straits 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 DNR westside state trust lands may be highest under Alternative 6 compared to other Alternatives. However, in planning units that have large areas of small and medium tree (less than 20 inches in diameter) competitive exclusion forest in the riparian zones, for example the Olympic Experimental State Forest, the majority of harvest activities in riparian areas in Alternative 6 are low volume harvests to thin overstocked stands. The forest management activities associated with these low volume harvests in Alternative 6 are 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. Therefore, the relative risks of some adverse cumulative effects from tree removal and ground disturbance may be higher under Alternative 6, 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 and a stand age of 25 years or older. Hydrologic immaturity is therefore any forested area that is younger than 25 years old, or that has a relative density of less than 25. 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 DNR 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 Table E-14.

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 can significantly affect only peak flows. Changes in peak flows may lead to slope failure or increased incision and erosion of stream channels depending on local geomorphologic processes. These effects can be lessened by increasing the forest canopy within the watershed, and particularly by maintaining or increasing hydrologic maturity within the significant rain-on-snow zones.

4.15.5.2 Evaluation of Potential Cumulative Effects to Hydrology

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 all of the Alternatives, the percentage of mature forest on DNR 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 (page IV. 68) and procedure 14-004-060. As shown in Appendix Table E-14 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 planning unit in which DNR carries the greatest relative risk for increasing peak flows relative to other ownerships.

Management intensity (indicated by decadal average values for acreage of high-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. Alternatives 1 and 6 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, high-volume removal harvest would occur on an average of approximately 23,000, 22,000, and 31,000 acres per decade, respectively.

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 were at risk for decreased water quality due to proposed changes in harvest levels on DNR lands. See Appendix E and Appendix E Tables E-15, E-16, and E-17.

4.15.5.4 Evaluation of Potential Cumulative Effects to Water Quality

As discussed in Section 4.8, Alternatives 2 through 6 would include increased harvest in riparian areas, meaning that there is 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, Alternative 6 does include harvests of greater than 1 acre in Riparian Management Zones, which could increase the risk of blowdown, 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 inputs to streams. Additionally, of the Alternatives proposed, only Alternatives 5 and 6 would increase fertilizer use. These two Alternatives 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 for implementation of any of the Alternatives, the 303(d) stream listings may be used as an allocation tool for planning resources to assess temperature 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) and this document. Both parameters are analyzed here based on slope stability, soil characteristics, and ownership data, and are discussed below.

4.15.5.6 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 Table E-18 contains data for areas classified as “high” for potential slope instability, and Appendix Table E-19 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. Harvest and management operations can occur in areas identified by the Shaw-Johnson model as having a high potential for slope instability, including those areas verified by field staff and determined in fact to have a high potential for slope instability based on field verified data. 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 4.15-11.

Table 4.15-11. Average Percent Area Classified as High for Potential Slope Instability by Planning Unit and Ownership

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

DNR ownership of these areas does not vary significantly among planning units from the average for DNR westside trust lands. The North Puget Planning Unit and the Olympic Experimental State Forest have the highest percent areas classified as high for potential slope instability as a result of modeling. 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 Planning Units, as shown in Appendix Table E-18.

Existing DNR policies and procedures require specialist resources to identify any potentially unstable areas on which management is proposed. As 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.

The actual risk of landslide should not increase under any of the Alternatives. Alternatives that propose higher levels of harvest in the North Puget Planning Unit and Olympic Experimental State Forest Planning Unit, and increased harvest intensity in general, could be considered to 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 high- volume harvest area (,expressed as the decadal average for the planning period) in the North Puget Planning Unit and Olympic Experimental State Forest as follows: Alternative 4 (10,000 acres), Alternative 1 (13,000 acres), Alternative 6 (20,000 acres), Alternative 2 (27,000 acres), Alternative 3 (31,000 acres), Alternative 5 (36,000 acres).

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 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. 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 non-skid 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 Tables E-20 and E-21 for the analysis of all 179 watersheds.

Table 4.15-12 shows the percent area of planning units that has soils classified as high for potential for moist soil compaction. Four of the six planning units, and therefore a majority of the total area, are dominated by soils classified as high for moist soil compaction.

Table 4.15-12. Average Percent Acreage Classified as High for Moist Soil Compaction Potential

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

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.

A total of 107 of the 179 watersheds evaluated have greater than 50 percent soils rated as having high moist soil compaction potential. Of these, DNR owns 50 percent or more of the watershed area identified as having high moist soil compaction potential in 17 watersheds. Of these, 6 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 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.

DNR policies and procedures described in Chapter 2 and Appendix C give general guidance for harvest 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 Alternatives 2, 3, 6, and 5.

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Chapter 5

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5. REFERENCES CITED

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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 stream flow.

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 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.

Precommercial 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 – 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

SPTH 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. SEPA 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 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.

Nonforested 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 nonforested 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 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

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

Appendix B

B.1. Draft Modeling Results, June 25, 2003

Draft Modeling Results 2003 Sustainable Harvest Calculation for State Trust Forestlands in Western Washington managed by the State Department of Natural Resources. Draft presentation materials for the Washington State Board of Natural Resources Special Meeting on June 25, 2003.

Appendix B

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Draft Modeling Results
2003 Sustainable Harvest Calculation

for

State Trust Forestlands in Western Washington

managed by the State Department of Natural Resources

Draft Presentation Materials for the
Washington State Board of Natural Resources
Special Meeting
25th June, 2003

Table of Contents

What is and what is not included in this presentation

Included

- Model outputs for the six Draft Environmental Impact Statement (DEIS) alternatives
- Harvest Revenue for Trusts and Counties
- Revenue, expressed as Gross Revenues using average stumpage prices
- Forest structures as an indicator of wildlife habitats
- Area summaries of lands that are Off-base (lands not available for harvest) and On-base (lands available for harvest)

Not included

- Environmental impact analysis and information – will be provided in the DEIS in October 2003
- Net revenue projections – these revenue figures will account for all Department production and administration costs. To be released in October 2003
- Socio-economic resiliency – a measure of how well a community or region responds to changes in economic and social conditions, for instance, rebounding from a loss of a major business. Data is being developed by USDA Forest Service and University of Washington. Release date is expected in October 2003.

Introduction and Process Overview

What is Sustainable Harvest?

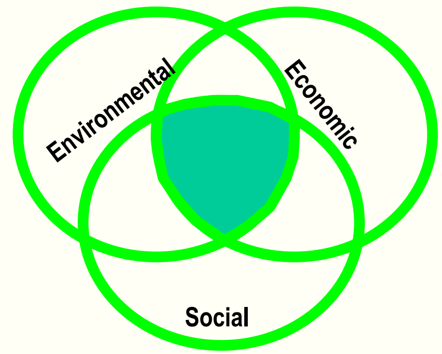
The sustainable harvest level is the amount of timber that can be harvested on average during a decade, assuring that the same amount of trees will be available for harvest each year. This assures that harvests can continue into the future with fairness to all generations of the Trust beneficiaries. DNR carefully plans across landscapes to develop a calculation of this sustainable harvest level.

Why recalculate the Sustainable Harvest?

The Department is required by law (RCW 79.68.040) to "periodically adjust the acreages designated for inclusion in the sustained yield management program and calculate a sustainable harvest level." The last sustainable harvest was calculated in 1996.

Purpose for the management of State Trust forest lands

- Revenue generation for the State Trusts
- Provide conservation benefits for native fish and wildlife species identified in the 1997 Habitat Conservation Plan
- These goals are achieved through socially responsible forest management practices that provide a broad range of benefits for the people of Washington.



Sustainable Harvest Calculation -- Completed Elements of the Public Process Timeline

February – March 2002
The Environmental Impact Statement (EIS) scoping process included six public and numerous stakeholder meetings to gather comments and information for developing EIS alternatives.

July – August 2002
The Department presented initial modeling scenarios ("Tiers") and sensitivity analysis at two public workshops and Board of Natural Resources (Board) retreat.

August – October 2002
With information from scoping process, Technical Review Committee input and Board discussions, DEIS alternatives were developed.

Proposed Public Process Timeline

June 2003
Department presents draft modeling results (this packet) to Board of Natural Resources.

July – September 2003
Interested party and stakeholder meetings offered during an information period.

October – November 2003
Publication of Draft Environmental Impact Statement followed by a 45-day comment period.

November – December 2003
Board workshop to discuss elements for a preferred alternative for the Final Environmental Impact Statement; and to identify key issues for review when the Forest Resource Plan is evaluated and revised during 2004-2005.

January 2004
Board evaluates and approves preferred alternative to be analyzed in the Final Environmental Impact Statement.

Overview of the Alternatives

Purpose of the Alternatives
The design of the alternatives for the Draft Environmental Impact Statement was to examine various policy and management strategy choices that the Board of Natural Resources (Board) could pursue to guide the management of State Trust forest lands.

The six alternatives were designed from information collected during the scoping period, discussion with the Technical Review Committee and discussions with the Board.

In order to provide information and analysis about several options regarding management and harvest levels, the Board was not asked to select a preferred alternative for the development of the Draft Environmental Impact Statement (DEIS).

The six alternatives briefly presented here with draft modeling results, are not designed as "ready-made" preferred alternatives. The six alternatives are designed to provide the Board and the public with information on the potential impacts of strategic policy-level decisions on the sustainable harvest level.

Key Decision Areas
Key strategic level questions that the Department is asking in this process are:
- How should habitat be managed (actively or passively) to achieve the conservation benefits?
- How can revenue best be generated for the Trusts (with a broad or narrow product base)?
- How can the Board's & DNR's policies best reflect the individual Trusts' objectives?
- How can the Board's & DNR's policies best reflect public interests?

Forming a preferred alternative
After the comment period for the DEIS, the Board may request the Department to "mix-'n'-match" elements of the six alternatives into a preferred alternative.

The Six Alternatives

Alternative 1 *(No Action): "Current DNR operations,"* procedures, and Board-approved policies. This alternative reflects land management carried out on the ground today on State Trust forest lands.

Alternative 2: *"HCP intent,"* without additions to existing Board policies. This does not include all current DNR administrative procedures, most of which were not approved by the Board (such as some in the Forestry Handbook).

Alternative 3: *"Combined ownerships"* is similar to Alternative 2, except that it proposes one ownership group, requiring a change in the current Forest Resource Plan Policy No. 6. All Westside Trust forest lands are placed into one ownership group rather than 24 groups.

Alternative 4: *"Passive management approach"* to protect and maintain habitat while producing revenue at lower levels, but with reduced investments and less intensive (more passive) management activities.

Alternative 5: *"Intensive management approach"* to revenue production on lands not dedicated to specific habitat conservation. HCP commitments are retained but with shorter rotation cycles and more intensive activities (such as thinning and fertilization).

Alternative 6: *"Innovative silvicultural management"* techniques increase conservation benefits and Trust revenue. Variation of Alternative 2 with new silvicultural procedures to create habitat "biodiversity pathways."

Policy and Data Modeling Steps

General Description

The Washington State Department of Natural Resources developed computer models for six harvesting alternatives using four guiding steps identified by Dr. John Sessions:

1. Accurately represent the organizational goals and constraints in the model;
2. Use a reliable forest inventory;
3. Develop a appropriate land classification;
4. Ensure a link between the strategic planning process and implementation.

1. Accurately represent the organizational goals and constraints in the model

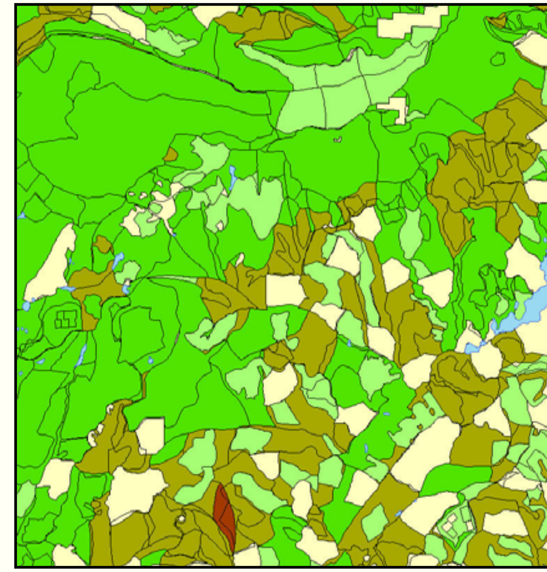
DNR's primary purposes for management of State Trust forest lands in Western Washington are generating revenue and providing conservation benefits and habitat. Policies in the Forest Resource Plan, Asset Stewardship Plan, goals and strategies in the Habitat Conservation Plan (HCP) – in addition to the local knowledge of DNR regional forest managers – are all sources of information that represent DNR's policy goals and management constraints.

Representing these complex goals and constraints in the model took three years of work. The first step was to understand the details of policies, procedural and local information. Second, data was captured and developed to represent the subtleties of this information. Most of this data resided in DNR's systems and represented a wide variety of sources, ranging from GIS data on streams to local information about visually sensitive areas. The third step was to develop "rules" in the modeling software to represent how those policies and procedures affect the forest conditions and harvest levels on the physical landscape in the model.

Figure A. DNR's forest inventory for an area of Western Washington Trust forest approximately 6 miles by 6 miles

Standing Timber Volume in Cubic Feet per acre

- 0 - 100
- 100 - 5,000
- 5,000 - 10,000
- 10,000 - 15,000
- 15,000 +



These three steps were an iterative process rather than a sequenced one, and as such, a number of iterations of data and modeling techniques were developed over time.

2. Use a reliable forest inventory

Since the early 1990's, DNR has been collecting forest inventory data on State Trust forest lands (Figure A). In Western Washington, DNR has detailed forest inventory data – approximately one inventory plot per five acres of sampled forest – for about 75% of State Trust forest lands.

Inventory data contains detailed information about the various species, size and number of live trees and additional information about the number and condition of standing dead trees (snags) and downed woody debris.

Policy and Data Modeling Steps (continued)

General Description

3. Develop an appropriate land classification

A land classification system was developed to represent DNR policy goals and management constraints (Figure B). Also see Pg. 8 for details. This system has two aspects. The system ***first classifies all lands*** *into one of three classes* based upon specific management objectives, resource sensitivity and likely level of management intensity. The three classes in order of decreasing resource sensitivity and resulting management specificity – are:

a) Riparian and wetland areas that have very specific management objectives, labeled as "**riparian**";

b) Upland areas with specific management objectives or resource sensitivities, labeled as **uplands with specific objectives,** including areas such as unstable slopes, rain-on-snow areas, Northern Spotted Owl nesting, roosting, foraging and dispersal habitat;

c) Upland areas with general management objectives where DNR practices general ecological management, labeled as **uplands with general objectives**, which includes practices such as "leave trees" and "green-up".

The system then ***identifies land management objectives*** in terms of availability for timber harvest activities. Three classes are identified:

a) Lands in *long-term deferral* from timber harvest (i.e. for the entire planning period);

b) Lands in *short-term deferral* from timber harvest (i.e. areas that have a restriction on timber harvest that will be removed within the first decade);

c) Lands that have *no deferrals* on them.

Lands that are deferred in the sustainable harvest calculation (short or long-term) are commonly known as "Off-Base" lands.

These classes can overlap the land classes described above as riparian, uplands areas with specific and general objectives.

4. Ensure a link between the strategic planning process and implementation

Over the last three years, the modeling has been refined through a process of review and input from DNR's region offices and field foresters. Once the Board adopts a preferred alternative, and a resulting sustainable harvest level, the process of implementing the new sustainable harvest level will begin. At the top of the hierarchy is the strategic planning process, including the sustainable harvest calculation. Once this level of planning is completed, planning continues at the next level – the tactical planning level.

In DNR, tactical measures are achieved through landscape planning, and include development of schedules that help manage day-to-day implementation of operational activities. Schedules include such activities as silviculture, timber sales, resource assessment and road management. These schedules are typically two-year activity schedules with additional long-range development schedules.

Figure B. Land classification: Riparian (dark green), Uplands with specific objectives (medium green), Uplands with general objectives (light green), long-term deferral (orange) and short-term deferral (light orange).

Land Classification Detailed Information

Land Classes	Description	Examples
Riparian	Complex and site-specific management objectives and strategies for riparian and wetland areas	HCP riparian zones: Inner, outer zone and wind buffers; wetland cores and wetland buffers
Upland areas with specific objectives	Complex landscape-and/or site-specific management objectives and strategies in upland areas	Unstable slopes, Region's operationally-constrained areas, Rain-on-snow areas, HCP-identified species habitats such as Marbled Murrelet, Northern Spotted Owls (NRF/Dispersal/nest patches), Peregrine and Bald Eagle habitats,Visual corridors
Upland areas with general objectives	General ecological management objectives and strategies and practices in upland areas	Practices such as leave tree retention, green-up, and protections for cultural resources are used in these areas

Deferral Classes	Description	Examples
Short-term	Areas with restrictions on timber harvest that will be removed within the first decade (the sustainable harvest planning period)	Memo 1 owl circles, and some other habitats set aside for HCP-identified species
Long-term	Lands with restrictions on timber harvest, long-term deferral from timber harvest for the entire planning period	Unstable slopes within riparian areas, parks and recreation sites, inoperable forest lands, research and other plots, forest gene pool reserve, Natural Area Preserve, Natural Resources, Conservation Area and some habitat for HCP-identified species and areas that reflect a Region's operational constraints are included.
None	Lands that have no deferrals on them, and therefore are open to sustainable harvest planning.	All other non-deferred lands

Alternative Modeling, Forest Inventory and Stand Structure

Modeling the Alternatives: Simulating Policies

DNR used OPTIONS, a forest growth simulation model, to calculate potential harvest levels using various management scenarios (DEIS Alternatives). The model uses forest inventory variables to report estimated timber yields.

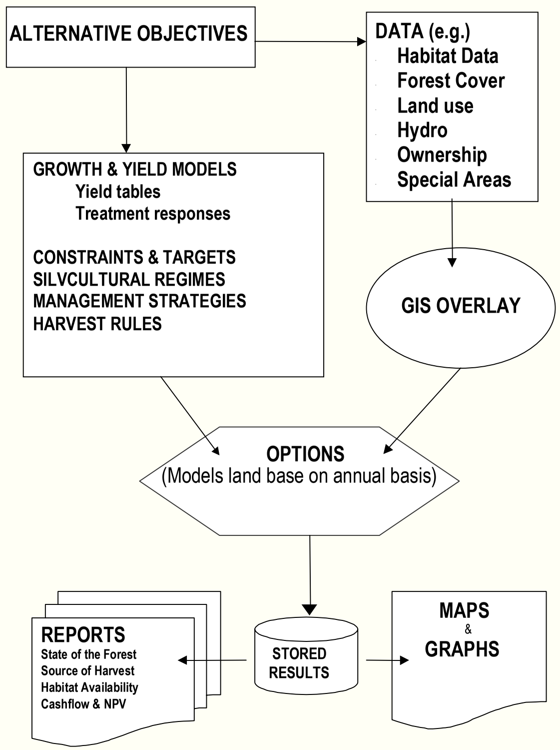


Figure 1. Process used to model the DEIS Alternatives

Forest Inventory

All the DEIS Alternatives use the same starting forest inventory. The Department's detailed forestry inventory is classified in 21 forest types and five site classes (tree-growing potential of a site) for each forest type.

Figure C. illustrates the current (2004) age class distribution and the forests that can be actively managed by DNR in Western Washington.

Notice that in Alternative 1, opportunities for harvesting are limited to upland areas with specific and general management objectives (page 11).

Peaks in age class distribution (20-30 and 60-70 year age class) illustrate current and future opportunities, while the lows (30-50 year age classes) will constrain future management under DNR's current even-flow policy.

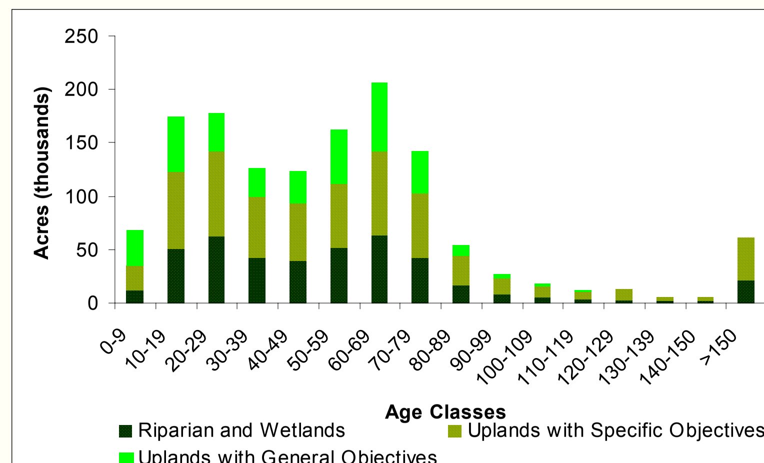


Figure C. Age Class distribution in 2004 for DNR- managed forest lands in Western Washington.

Alternative Modeling, Forest Inventory and Stand Structure (continued)

Describing Stand Structures

DNR has created a classification to describe the forest in terms of stand structure and ecological development. The classification system that DNR has developed was based on research by Johnson and O'Neil (2001). DNR has summarized very detailed forest structures into 19 stages or classes (page 11) using combinations of four structural elements – tree size (DBH); percent of canopy covered; number of canopy layers, and number of standing or downed dead trees – as criteria for distinguishing stand conditions and forest development stages.

The classification has been summarized into seven stand development classes, based on Carey et al. (1996) biodiversity classification, for presentation purposes (Figures D, E and F)

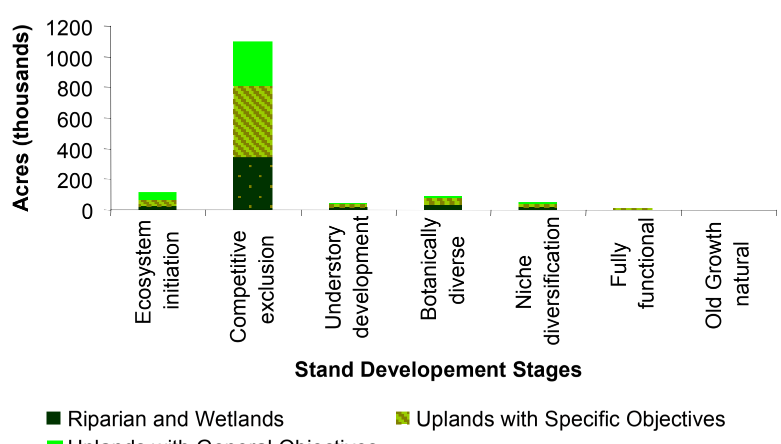


Figure D. Stand Development Stages (SD) in 2004 for the DNR managed forest lands in Western Washington

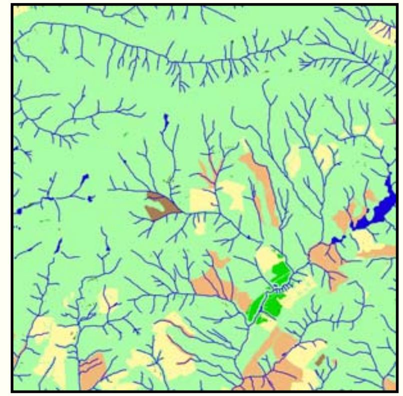
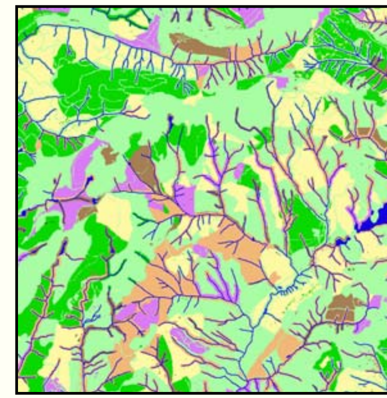


Figure E. Example of data for an area modeled to show stand development stage classification for 2004

Figure F. Alternative 1 stand development stage classification in 2067 for the same area as shown in Figure E



Map Legend

- EIS
- CE
- UD
- BDS
- NDS
- FFS
- OGN

(Detailed Legend on page 11.)

Current Conditions

Data in Figure D. illustrates that a majority of State Trust forest lands in Western Washington are in a "competitive exclusion" stage. In this state, "trees fully occupy the site and compete with one another for light, water, nutrients and space such that most other vegetation and many trees become suppressed and die" (Carey et al. 1996). This stage is a result of 40-50 years of forest management with a primary focus on timber production.

Stand development Classification

Classes	Summarized Classes	Map Legend	
Grass_Forb, ShrubSap	Ecosystem initiation	EIS	
ShrubSap_closed, Pole_single_closed, Pole_multi_closed, Large_single_closed	Competitive exclusion	CE	
Pole_single, Pole_multi, Large_single, Large_multi, Large_multi_closed	Understory development	UD	
Giant_multi	Botanically diverse	BDS	
Giant_multi _HE_ND	Niche diversification	NDS	
Giant_multi _HE_FF	Fully functional	FFS	
OldGrowth_natural	Old growth natural	OGN	

References

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.

Franklin, J.F., T.A Spies, R. Van Pelt, A.B. Carey, D.A. Thornburgh, D.R. Berg, D.B. Lindenmayer, M.E. Harmon, W.S. Keeton, D.C. Shaw, K. Bible, and J. Chen. 2002. Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. Forest Ecology and Management 155: 399-423.

Johnson, D.H. and T.A. O'Neil (*Managing Directors*). 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press.

Description of Classes (adapted from Carey et al. 1996)

Ecosystem initiation – Death or removal of overstory trees by wildfire, windstorm, insects, disease, or timber harvesting leads to establishment of a young forest ecosystem.

Competitive exclusion – Trees fully occupy the site and compete with one another for light, water, nutrients, and space so that most other vegetation and many trees become suppressed and die.

Understory development– Achievement of dominance by some trees and death or removal of other trees leads to reduced competition that allows understory plants to become established. Understory of forbs, ferns, shrubs, and trees has developed after the death or removal of some dominant trees; time has been insufficient for 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, etc., precludes a full, complex biotic community.

Niche diversification – The biotic community becomes complex as coarse woody debris, cavity trees, litter, soil organic matter, and botanical diversity increase; wildlife foraging needs are met.

Fully functional (managed) – Additional development provides habitat elements of large size and interactions that provide for the life requirements of diverse vertebrates, invertebrates, fungi, and plants.

Old growth (natural) – Forest ecosystems after more than 250 years of development uninfluenced by civilization that have achieved elements of large stature, great diversity, and complex function.

A Note on Classifications

Classifications of stand structure and development are arbitrary and they tend to be interpreted as a discreet set of series, rather than a continuum (Franklin et al. 2002). DNR's classification is not different in these ways from other classifications. Its purpose here is to provide a systematic way to evaluate and compare the alternatives.

The Department's effort in developing a stand structural classification to assist its management of habitat is in its infancy. DNR anticipates that the classification presented here will change over time, as scientific and management knowledge grows. One step in this growth is occurring with this process as the Department moves away from using stand age as the substitute for habitat to this new structure-based classification.

Evaluation Criteria for Revenue Generation

Revenue Generation

Two important criteria help evaluate and compare alternatives in terms of revenue generation: quantity and quality.

Revenue quantity is simply the revenue generated under an alternative. In this report, only gross revenue is provided. Gross revenue has been derived using an average stumpage price, by species, and multiplying by the harvest volume for that species. Average stumpage prices were obtained from the last two years (2001 and 2002) of State Trust timber sales.

This simplified calculation does not account for price differentiation between species and/or tree diameters, nor for harvest methods (e.g. thinnings vs. regeneration harvests). These factors, plus marginal production costs will be considered in development of net revenues for the economic analysis in October 2003.

Revenue quality combines two measurements: timber product portfolio, and revenue flow.

Timber product portfolio

The timber product portfolio describes the type of timber products that will be harvested to generate the total gross revenue. The portfolio is described by examining the harvested stands' average tree diameter over a 10-year period. This result is a diameter distribution (Figure 1 on page 14). The tree diameter classes can be equated to value.

Trees smaller than 10 inches in diameter (measured as diameter at breast height, DBH) are generally low value trees used for pulp. These sizes of trees are commonly associated with small-wood thinning harvests.

Trees from 10 to 20 inches in diameter are considered high value, although quality as measured by log grade and sort are price determining factors. Trees of this size-range are typically harvested from thinnings in older stands and regeneration harvest or clear cuts.

Trees that are 25 to 30 inches in diameter are considered large and difficult to market today, and do not necessarily attract a premium price. Trees larger than 30 inches are considered very large, and it is uncertain that there exists much of a market at this time for this size of tree. The majority of timber mills in Western Washington and Oregon have an upper tree size limit that they can mill.

Revenue Flow

Revenue flow is an important measure for those state Trusts seeking stability in revenue supply. While actual revenues earned from timber sales depends upon many factors (e.g. market conditions, operational issues, price), long-term or multiple-decade revenue projections – such as these modeled alternatives – can be used to demonstrate different approaches to revenue management.

The measures used here to describe the revenue flow are: total revenue flow over time (Figure 3) and, for individual Trusts and counties, a measure of the variability about the average revenue, or coefficient of variation over time. The greater the variability of revenue flow (around that average), the greater the coefficient of variation. While this variation is not a clear measure of risk, it is useful to describe the uncertainty of an outcome (see page 29 detailing Trust-by-Trust analysis of long-term revenue flows). Generally, the greater the variability, the greater the level of uncertainty in obtaining it.

The alternatives demonstrate different approaches to income stability and revenue flow. In this report, various approaches dictate different gross revenues. Different conclusions may result when net revenue is calculated, as some silvicultural strategies (such as biodiversity pathways and thinnings) have higher marginal production costs than some other approaches.

Evaluation Criteria for Conservation Benefits

Conservation Benefits

Each of the Alternatives is designed to provide all the conservation benefits of the Department's 1997 Habitat Conservation Plan (HCP). Each uses a "zoned approach" to habitat management, in which specific areas are identified to be managed for specific habitat conditions. In each of the alternatives, the Olympic Experimental State Forest (OESF) continues to be managed with an "un-zoned" forest approach, i.e. a forest in which no special zones are set aside exclusively for either species conservation or commodity production.

In the HCP, three habitat zones are identified with specific habitat management strategies: 1. Nesting, Roosting and Foraging (NRF) zones, and 2. Dispersal zones for the Northern Spotted Owl; and 3. Riparian areas for fish, riparian obligate species and other terrestrial species.

The objectives of these management strategies vary from zone to zone. However, the simplified objective is to manage for more complex forest structures within these zones.

In addition to the zones mentioned above, a long-term conservation strategy for the marble murrelet is being developed that may lead to an additional category of zone.

While the management of habitat areas or zones is designed to support the conservation objectives of the HCP through the development of more complex forests, the remainder of west-side Trust forests are expected to provide continuing opportunities for timber management, and provide a more limited role in multiple species conservation objectives.

Stand Structure

For the development of the HCP, specific forest structures were described to meet specific habitat conservation strategies, e.g. nesting, roosting and foraging habitat for the Northern Spotted Owl. In attempting to describe forest stand structures, stand age was used as its equivalent during the modeling of the HCP's sustainable harvest level. Stand age was used due to the lack of forest inventory data at the time. The model produced an expected age-class distribution at 100 years, using the HCP-defined strategies (HCP, Chapter IV, page 180). The intent of the HCP strategies was to manage to achieve specific forest structures in designated or zoned areas. However, age class does not equal forest structure.

For the evaluation of the 2003 sustainable harvest alternatives, a forest stand development classification has been developed (see pages 11 for details). The relationship between stand age and structure is not direct, i.e. a 60-year old stand is not necessarily in a "competitive exclusion" stage, nor is stand at 200 years old obviously "old-growth." While time is the only variable that determines the age of a stand, many factors and variables play a role in determining a stand's structure – natural disturbance, tree species mix, site potential, landscape location, management history, etc.

As result of this awkward relationship between age and structure, the HCP's expected age-class distribution cannot simply translate into an expected stand development distribution across the landscape.

Therefore, while there are no specific stand structure targets for which DNR should manage, the "measures of success" for evaluating the alternatives is the magnitude of change that occurs to the forest base over time. The magnitude of change is demonstrated for each alternative in Figure 4 (e.g. page 14).

A key policy question will be determining the vision for the "*desired future forest condition"* of State Trust forest lands – a vision that sustains healthy forests in balance with economic and social objective.

Alternative 1: No Action Alternative – Summary of Modeling Results for Western Washington DNR-managed Forests

General Description

Alternative 1 (Alt.1) represents Board of Natural Resources (Board) existing policies and forest management strategies as indicated by 1992 Forest Resource Plan, 1997 Habitat Conservation Plan (HCP), Forestry Handbook (representing Administrative procedures), Region Operations, and all current Federal and State statutes. This alternative represents land management on the ground today on State Trust forest lands.

Key Decisions

Alt. 1 proposes no policy or procedural changes. Adoption of this alternative would endorse all current Department policy and procedures and result in Board action of setting a new sustainable harvest level. (page 15)

Off- and On-base lands

Current policy and procedures place 53% of DNR managed lands into an "Off-base" condition for Alt. 1. For this analysis, the term "Off-base" refers to both long-term (entire planning period) and short–term (decade or less) deferrals. The net affect of current policies and procedures is to focus revenue generation activities in the uplands areas with general management objectives, while habitat develops largely as a result of time on other lands (upland areas with specific objectives, riparian and wetlands area).

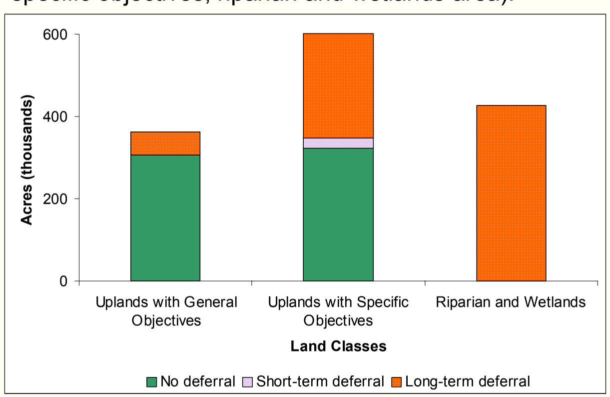


Figure 1. Major land classes and deferrals in 2004

Revenue Generation

Alt. 1 was expected to maintain current revenue generating distribution. However, as Figure 2 illustrates, revenue will depend upon larger diameter wood in the future.

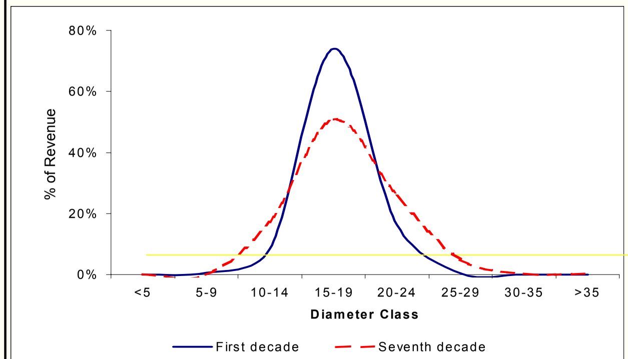


Figure 2. Diameters of harvested stands for selected time periods

The next decade sustainable harvest level for Alt. 1 is 396 million board feet per year for Western Washington State Trust forest lands, generating a gross revenue of approximately $106 million a year (Fig. 3).

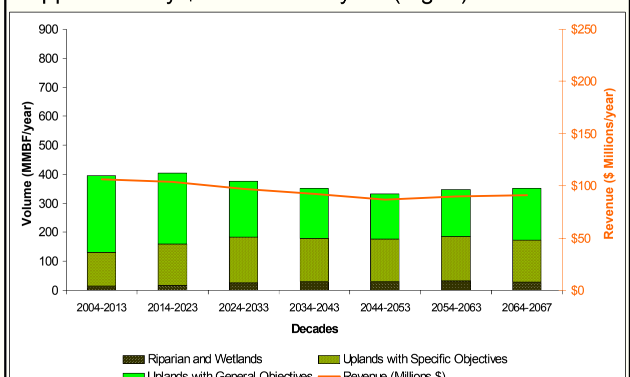


Figure 3. Modeled harvest volumes and revenues

Long-term harvest declines, resulting from various factors such as the interpretation of sustainable even-flow and changes in age class distribution over time. While modeled harvests decline, standing inventory grows steadily over time (Fig. 5).

Habitat Management

In Alt. 1, habitat management was expected to be achieved largely through natural process. During the 70-year HCP, active management has very little impact on riparian areas (0.2%-0.4% per year) and uplands areas (1.5%-1.6% per year). Riparian activities only reflect road, access and yarding corridor development supporting upland activities. Most silvicultural activities in uplands areas with specific management objectives are thinnings and harvests with greater leave tree retention.

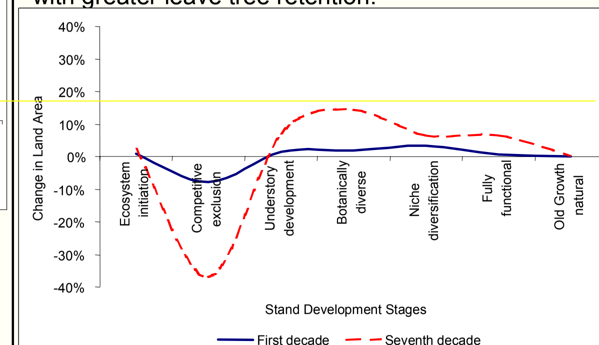


Figure 4. Modeled changes in stand development stages

Alt. 1 provides a distribution of the later stages and a reduction in "completive exclusion". There is neither a net increase nor a reduction in "ecosystem initiation". Acreage of stands moving to the "ecosystem initiation" are the result of regeneration harvest activities.

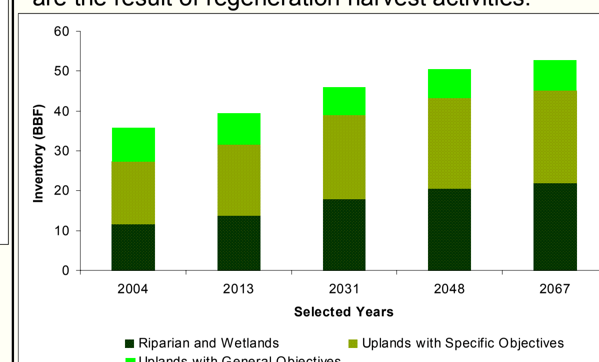


Figure 5. Modeled standing inventory by land class for selected years in billions of board feet.

Alternative 1 – No Action

Summary of Management Strategies and Proposed Actions

Policies

Ownership groups (level of aggregation - combining Trust ownerships together - to which the even-flow criterion is applied to State Trust lands)

- ➢ 24 groups

Even-flow of sustainable harvest (method by which forest managers control timber harvests to assure long-term sustainability of the resource)

- ➢ regulated as a narrow band of variation (+/- 25% of long-term harvest level)

Harvest regulation (measure by which harvest flow is regulated, whether by volume or economic value)

- ➢ regulated by timber volume

Older Forest Components (protection, or deferral of harvest in older forest stands)

- ➢ current acreage of "old growth" research stands that are deferred (2,000 acres currently identified as larger than 80 acres in size and older than 160 years)

Board of Natural Resources Action

- ❖ No policy changes
- ❖ Sustainable harvest level adopted

Procedures and Operations

Average minimum regeneration harvest age – average earliest age at which a stand can be considered eligible for regeneration harvest. For example, the minimum age that a regeneration harvest can occur for a site class III Douglas fir stand is 60 years. The minimum regeneration age varies by site class (higher sites-younger ages; lower sites-older ages) and by species (hardwoods at younger ages; conifers at older ages).

- ➢ 60 years

Northern Spotted Owl nesting, roosting, foraging (NRF) and dispersal habitats (what activities may happen in Watershed Administrative Units (WAUs) with NRF and dispersal habitat)

- ➢ NRF and dispersal habitat strategies managed as ***constraints***

Northern Spotted Owl habitat circles (identified as "Memorandum 1" circles, "Status 1 Reproductive", and "Southwest Washington" administrative owl circles)

- ➢ Memo 1 released in 2007; Status 1, and SW WA maintained for 200-year planning period

Older Forest Components (how mature forest components are maintained on stand and WAU levels)

- ➢ 50% of a WAU maintained at an age of 25 years or older
- ➢ legacy and leave tree levels maintained at a stand level

Riparian Areas (intensity of management of Riparian Management Zones)

- ➢ No harvest in RMZ except access development (roads and yarding corridors)

Management intensity (intensity of management of upland areas)

- ➢ light variable thinnings available
- ➢ current level of resources for unstable slope identification
- ➢ very little fertilization of stands
- ➢ stand regeneration through planting

DNR Administrative Action

- ❖ No procedural or operational changes

Alternative 2: HCP Intent – Summary of Modeling Results for Western Washington DNR-managed Forests

General Description
Alternative 2 (Alt. 2) represents existing Board-approved policies and forest management strategies as defined by 1992 Forest Resource Plan, 1997 Habitat Conservation Plan, and all current Federal and State statutes. It not include all current DNR administrative procedures in the Forestry Handbook.

Key Decisions
Alt. 2 proposes no policy changes. However, several procedural changes are proposed (page 17). Adoption of Alt. 2 would endorse the changes and result in a Board action of setting a sustainable harvest level.
- Administrative Owl Circles to be removed in 2004
- 50-25 WAU rule is removed
- Nesting, Roosting, Foraging and Dispersal management procedure revised to reflect HCP intent
- Riparian management procedure expected no later than 2007

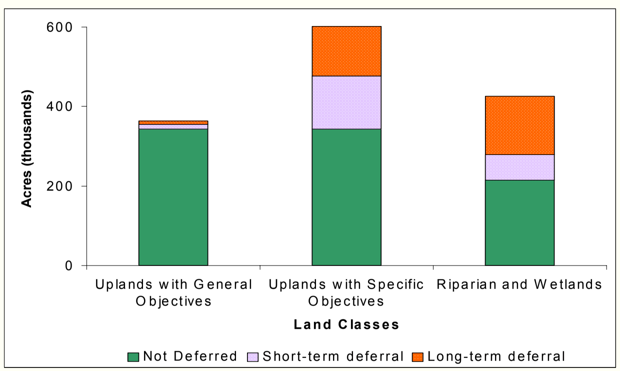


Figure 1. Major land classes and deferrals in 2004

Off- and On-base lands
Alt. 2 places 35% of DNR-managed forest lands immediately into an "Off-base" status. By the end of decade one, off-base land is reduced to 20%, with about 200,000 acres released for harvest planning. The net affect is the increase the area in which revenue generation and conservation benefits can occur. This is achieved through lifting restrictions on long-term deferrals, such as owl circles.

Revenue Generation
Alt. 2 was expected to increase the revenue generating distribution. Figure 2 illustrates that revenue will depend upon larger diameter wood in the future.

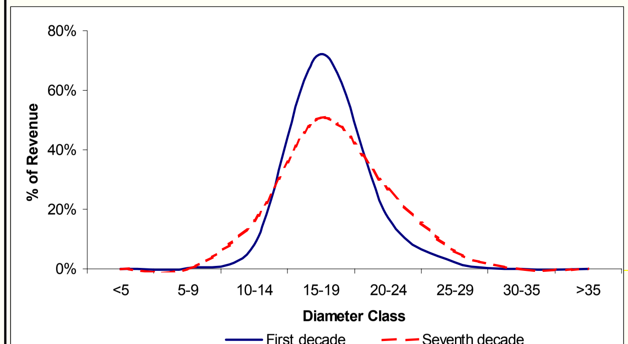


Figure 2. Diameters of harvested stands for selected time periods

The first decade sustainable harvest for Alt. 2 is 537 million board feet per year for Western Washington State Trust forest lands, generating a gross revenue of about $144 million a year (Figure 3).

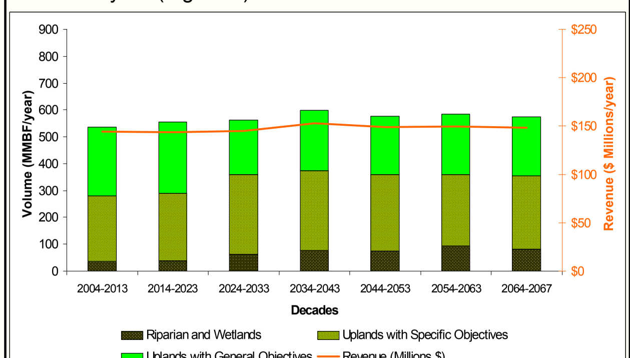


Figure 3. Modeled harvest volumes and revenues

The long-term harvest level fluctuates over time due to various factors, including silvicultural strategies, harvest flow objectives, increased opportunities for thinnings and changes in age class distribution. While modeled harvests climb more with little fluctuation, standing inventory also steadily grows (Figure 5).

Habitat Management
Habitat management is through increased silvicultural activities in Alt. 2. Each year, the level of harvest activity in riparian and upland areas ranges between 1%-1.9% of their respective areas. The majority of activities in Riparian areas are light thinnings and harvests with moderate to high leave tree retention using variable density, older stand thinning and similar treatments in the uplands areas with specific objectives.

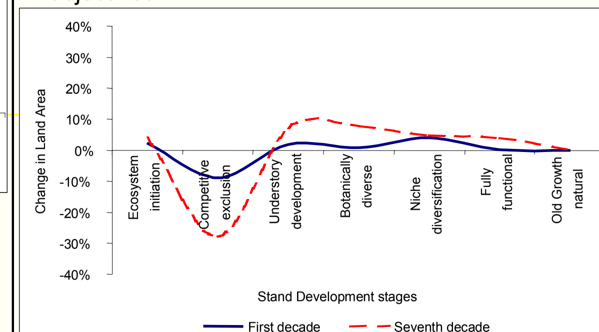


Figure 4. Modeled changes in stand development stages

Alt. 2 demonstrates a greater reduction in the "competitive exclusion" stage. As a result of more thinning, additional acres of stands are in "understory development" and fully functional stages. Increased acres of forest moving to "ecosystem initiation" result from increased regeneration harvest activities compared to Alt. 1.

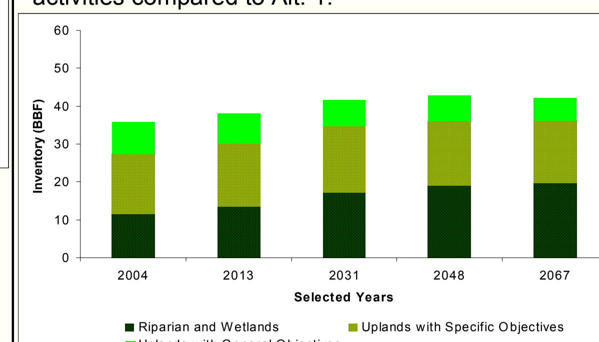


Figure 5. Modeled standing inventory by land class for selected years in billions of board feet

Alternative 2

Summary of Management Strategies and Proposed Actions

Policies

Ownership groups (level of aggregation – combining Trust ownerships together -- to which the even-flow criterion is applied to State Trust lands)
- ➢ 24 groups

Even-flow of sustainable harvest (method by which forest managers control timber harvests to assure long-term sustainability of the resource)
- ➢ regulated as non-declining even-flow (mimic 1996 calculation allowable cut levels by ownership group)

Harvest Regulation (measure by which harvest flow is regulated, whether by volume or economic value)
- ➢ regulated by timber volume

Older Forest Components (protection, or deferral of harvest of older forest stands)
- ➢ current acres of "old growth" research stands that are deferred (2,000 acres currently identified as larger than 80 acres in size and older than 160 years)

Procedures and Operations

Average minimum regeneration harvest age – average earliest age at which a stand can be considered eligible for regeneration harvest. For example, the minimum age that a regeneration harvest can occur for a site class III Douglas fir stand is 60 years. The minimum regeneration age varies by site class (higher sites-younger ages; lower sites-older ages) and by species (hardwoods at younger ages; conifers at older ages).
- ➢ 60 years

Northern Spotted Owl nesting, roosting, foraging (NRF) and dispersal habitats (what activities may happen in Watershed Administrative Units (WAUs) with NRF and dispersal habitat)
- ➢ NRF and dispersal habitat strategies managed as ***targets***
- ➢ light variable thinnings available to help create habitat

Northern Spotted Owl habitat circles (release dates for Memorandum 1, Status 1 Reproductive, and Southwest Washington administrative owl circles)
- ➢ Memo 1 released in 2007, Status 1, and SW WA released in 2004

Older Forest Components (how are mature forest components maintained on stand and WAU levels)
- ➢ "50/25" strategy removed
- ➢ leave tree levels back to HCP intent of 8 trees/acre

Riparian Areas (intensity of management of Riparian Management Zones)
- ➢ Management and restoration through silviculture permitted; requires Federal Services agreement

Management intensity (the level of intensity of management of upland areas)
- ➢ increased (moderate) light variable thinnings available
- ➢ increased (moderate) level of resources available for unstable slope identification
- ➢ very little fertilization of stands
- ➢ stand regeneration through planting

Board of Natural Resources Action
- ❖ No policy changes
- ❖ Sustainable harvest level adopted

DNR Administrative Action
- ❖ Implement procedural and operational changes

Alternative 3: Combined Ownerships – Summary of Modeling Results for Western Washington DNR-managed Forests

General Description

Alternative 3 (Alt. 3) represents existing Board-approved policies (except Policy No. 6 on Ownership Groups) and forest management strategies defined in 1992 Forest Resource Plan, 1997 Habitat Conservation Plan, and current Federal and State statutes.

Key Decisions

Alt. 3 proposes two policy changes, which include a number of procedural changes proposed for Alt. 2 (see page 19).

- Wider fluctuation of the sustainable even-flow
- One (1) Western Washington ownership group

Adoption of this alternative would endorse these changes and result in a Board action of setting a new sustainable harvest level.

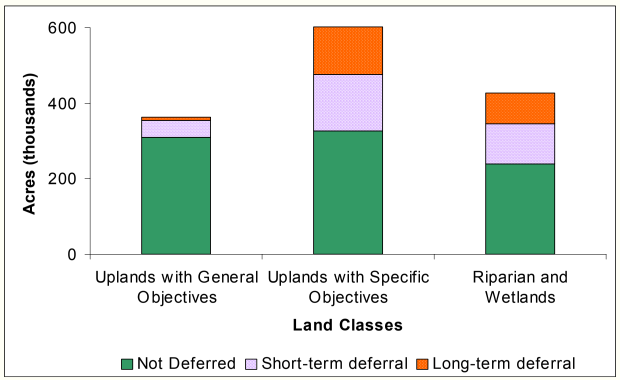


Figure 1. Major land classes and deferrals in 2004

Off- and On-base lands

Alt. 3 places 37% of DNR-managed lands into an "Off-base" condition. During the first decade, about 300,000 acres is released from deferral, resulting in 15% of the forest land base in long-term deferral. The net affect is to increase the area in which revenue generation and habitat management can occur. As in Alt. 2, this is achieved through lifting restrictions on long-term deferrals, such as owl habitat circles in 2004.

Revenue Generation

Alt. 3 was expected to increase current revenue through efficiencies of a combined ownership approach and maintain the current timber product portfolio. Revenue will depend upon some larger diameter wood in the future.

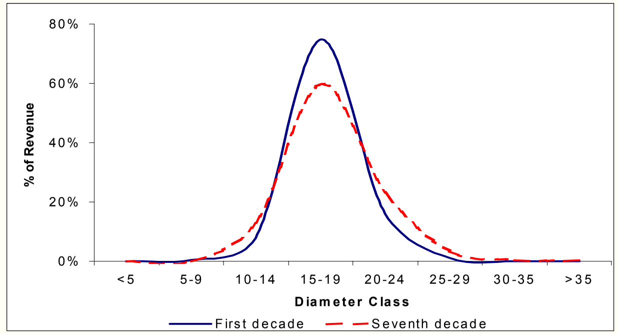


Figure 2. Diameters of harvested stands for selected time periods

The decade harvest level for Alt. 3 is 663 million board feet per year for Western Washington Trust forests, generating a gross revenue of about $178 million a year (Figure 3).

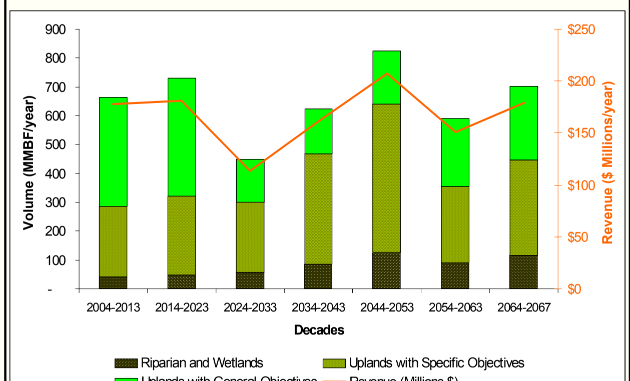


Figure 3. Modeled harvest volumes and revenues

As a result of a combined ownerships and less constrained harvest flow, modeled long-term harvest levels fluctuate more than in other alternatives. Both modeled harvests and standing inventory fluctuate and climb in the future indicating sustainability (Figure 5).

Habitat Management

Habitat development is expected through active management and silvicultural investments. Each year, harvest activity in riparian and upland areas ranges between 0.7-1.8% and 1.9- 2.4% of the total area. The majority of silvicultural activities in riparian and uplands areas with specific objectives are thinning and harvests with greater tree retention levels.

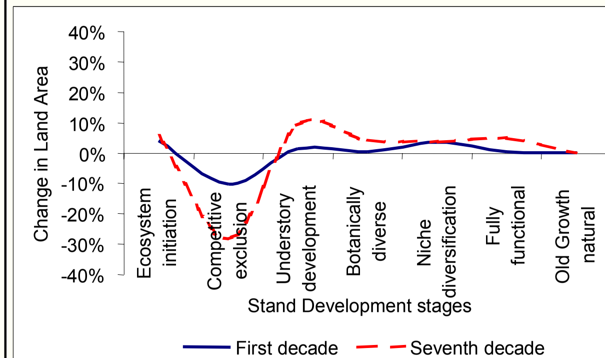


Figure 4. Modeled changes in stand development stages

Over 70 years, Alt. 3 reduces the stands in competitive exclusion, although less than Alt. 1. In addition, the increase in more botanically diverse, niche diversification and fully functional stages is less than Alt. 1. These more complex stages develop in areas of less intense active management, such as riparian, and upland areas with specific objectives. Under Alt. 3, timber and habitat management areas are clearly differentiated due to the zoned model of management.

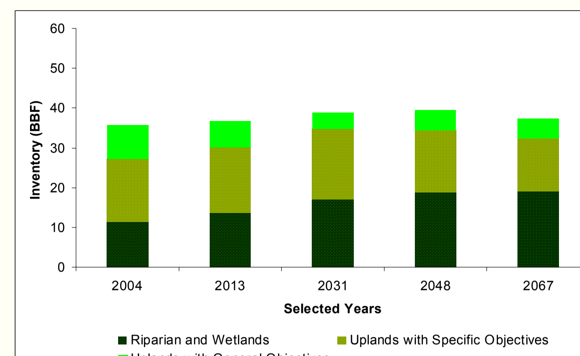


Figure 5. Modeled standing inventory by land class for selected years in billions of board feet

Alternative 3

Summary of Management Strategies and Proposed Actions

Policies

Ownership groups (level of aggregation – combining Trust ownerships together -- to which the even-flow criterion is applied to State Trust lands)

- 1 westside group

Even-flow of sustainable harvest (method by which forest managers control timber harvests to assure long-term sustainability of the resource)

- regulated as a wider band of variation with no cessation or prolonged curtailment of harvest (permits harvest to fluctuate within the 25th and 75th percentiles of estimated historic harvest levels)

Harvest Regulation (measure by which harvest flow is regulated, whether by volume or economic value)

- regulated by timber volume

Older Forest Components (protection, or deferral of harvest in older forest stands)

- current acreage of "old growth" research stands that are deferred (2,000 acres currently identified as larger than 80 acres in size and older than 160 years)

Board of Natural Resources Action

- Amend Policy No. 6
- Sustainable harvest level adopted

Procedures and Operations

Average minimum regeneration harvest age – average earliest age at which a stand can be considered eligible for regeneration harvest. For example, the minimum age that a regeneration harvest can occur for a site class III Douglas fir stand is 60 years. The minimum regeneration age varies by site class (higher sites-younger ages; lower sites-older ages) and by species (hardwoods at younger ages; conifers at older ages).

- 60 years

Northern Spotted Owl nesting, roosting, foraging (NRF) and dispersal habitats (what activities may happen in Watershed Administrative Units (WAUs) with NRF and dispersal habitat)

- NRF and dispersal habitat strategies managed as ***targets***
- light variable thinnings available to help create habitat

Northern Spotted Owl habitat circles (release dates for Memorandum 1, Status 1 Reproductive, and Southwest Washington administrative owl circles)

- Memo 1, Status1 and SW WA released in 2007

Older Forest Components (how mature forest components maintained on stand and WAU levels)

- "50/25" strategy removed
- leave tree levels back to HCP intent of 8 trees/acre

Riparian Areas (intensity of management of Riparian Management Zones)

- Management and restoration through silviculture activity allowed; requires Federal Services agreement

Management intensity (the level of intensity of management of upland areas)

- increased (moderate) light variable thinnings available
- increased (moderate) level of resources available for unstable slope identification
- very little fertilization of stands
- stand regeneration through planting

DNR Administrative Action

- Implement procedural and operational changes

Alternative 4: Passive Management Approach– Summary of Modeling Results for Western Washington DNR-managed Forests

General Description
Alternative 4 (Alt. 4) represents DNR-managed forests in Western Washington with a strong preservationist approach, to provide increased conservation and habitat protect while producing revenue. This approach maintains the 1997 HCP objectives, the 1992 Forest Resource Plan, and current Federal and State statutes.

Key Decisions
Alt. 4 proposes one policy change to Forest Resources Plan Policy No. 11, several procedural changes (page 21). Adoption of this alternative would endorse these changes and result in a Board action of setting a new sustainable harvest level.

- Increase average minimum regeneration harvest age
- Protection of forest stands over 150 years of age
- Minimal management in Riparian areas and other resource sensitive areas

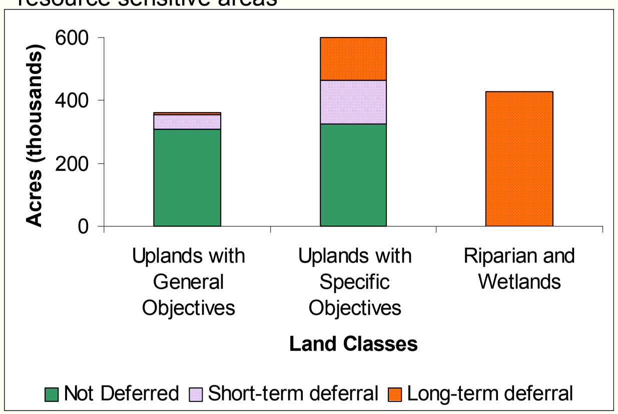


Figure 1. Major land classes and deferrals in 2004

Off- and On-base lands
Alt. 4 places 54% of DNR-managed lands “Off-base,” of which about 180,000 acres (or about 24%) are short-term deferrals. The affect of Alt. 4 strategies is an increase in areas available for active management. Alt. 4 is similar to Alt. 1 in the intensity of management in resource sensitive areas. In addition, emphasis is on biological productivity over economic potential in determining the appropriate harvest age of a stand.

Revenue Generation
Alt. 4 was expected to result in more harvest by thinning and larger diameter wood. As Figure 2 shows, the timber product portfolio profile will be represented by a broader selection with larger diameters.

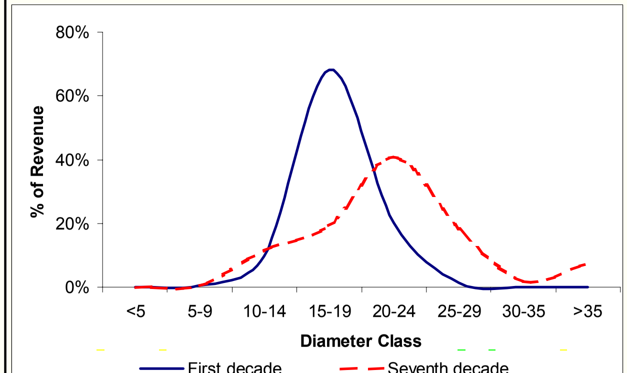


Figure 2. Diameters of harvested stands for selected time periods

The first decade sustainable harvest level for Alt. 4 is 411 million board feet per year for Western Washington Trust forests, generating a gross revenue of about $108 million a year (Fig. 3).

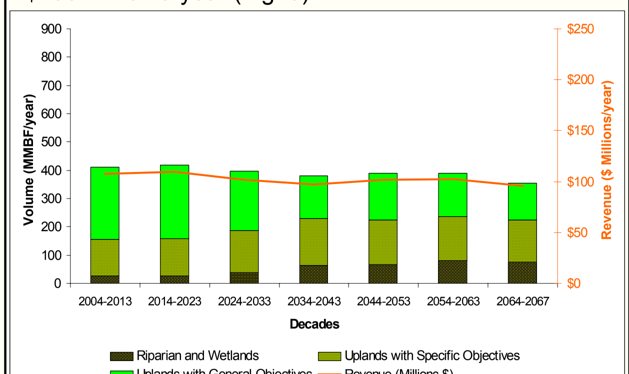


Figure 3. Modeled harvest volumes and revenues

More passive silvicultural strategies and similar flow objectives to Alt. 1 model a long-term harvest that is expected to decline in future decades. However, standing inventory grows in the near term (Fig. 5) with reduced opportunities for regeneration and despite increased thinning.

Habitat Management
Habitat development is expected to mix natural processes in riparian areas, and silviculture in uplands areas with specific objectives. Each year, light harvest activity in riparian and uplands areas range between 1%-1.6% of these areas. All riparian activities are roads, access and yarding corridors supporting upland management activities.

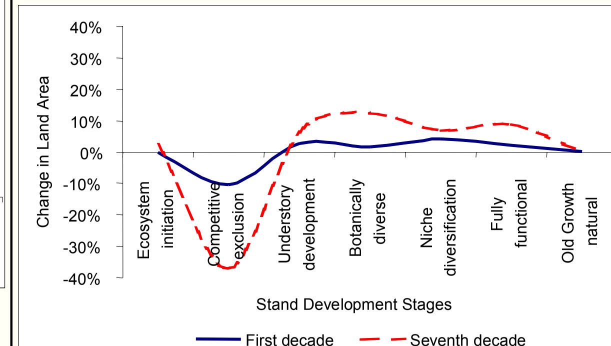


Figure 4. Modeled changes in stand development stages

Alt. 4 is effective in transitioning stands from completive exclusion to the more developed stages by limiting regeneration activities to uplands areas and with more passive management in riparian areas. It provides some of the earliest and largest increases in understory development as well as a greater area in complex stages. This should translate to greater support for associated wildlife species.

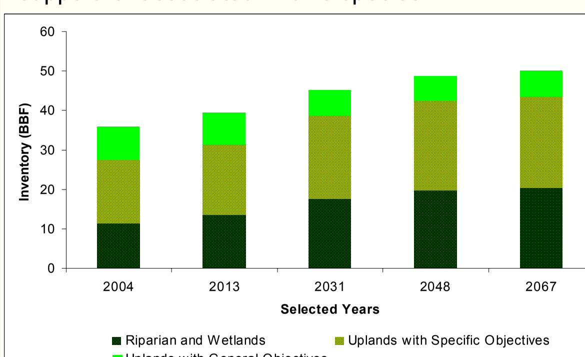


Figure 5. Modeled standing inventory by land class for selected years in billions of board feet

Alternative 4

Summary of Management Strategies and Proposed Actions

Policies

Ownership groups (level of aggregation – combining Trust ownerships together -- to which the even-flow criterion is applied to State Trust lands)

➢ 24 groups

Even-flow of sustainable harvest (method by which forest managers control timber harvests to assure long-term sustainability of the resource)

➢ regulated as a narrow band of variation (+/- 25% of long-term harvest level)

Harvest Regulation (measure by which harvest flow is regulated, whether by volume or economic value)

➢ regulated by timber volume

Older Forest Components (protection/deferral of older forest stands)

➢ current old growth research stands deferred (2,000 acres currently identified as larger than 80 acres in size and older than 160 years)

➢ all standing older forest stands ≥150 years in starting inventory (2001) deferred for 10-year planning period

Procedures and Operations

Average minimum regeneration harvest age – average earliest age at which a stand can be considered eligible for regeneration harvest. For example, the minimum age that a regeneration harvest can occur for a site class III Douglas fir stand is 80 years. The minimum regeneration age varies by site class (higher sites-younger ages; lower sites-older ages) and by species (hardwoods at younger ages; conifers at older ages).

➢ 80 years

Northern Spotted Owl nesting, roosting, foraging (NRF) and dispersal habitats (what activities may happen in Watershed Administrative Units (WAUs) with NRF and dispersal habitat)

➢ NRF and dispersal habitat strategies managed as ***targets***

➢ light variable thinnings available to help create habitat

Northern Spotted Owl habitat circles (release dates for Memorandum 1, Status 1 Reproductive, and Southwest Washington administrative owl circles)

➢ Memo 1, Status 1 and SW WA released in 2007

Older Forest Components (how are mature forest components maintained on a stand and WAU level)

➢ "50/25" strategy removed

➢ leave tree levels back to HCP intent of 8 trees/acre

Riparian Areas (intensity of management of Riparian Management Zones)

➢ No harvest in RMZ except access development (roads and yarding corridors)

Management intensity (the level of intensity of management of upland areas)

➢ light variable thinnings available

➢ current level of resources available for unstable slope identification

➢ very little fertilization of stands

➢ emphasis on natural stand regeneration

Board of Natural Resources Action

❖ Amend Policy No. 11

❖ Sustainable harvest level adopted

DNR Administrative Action

❖ Implement procedural and operational changes

Alternative 5: Intensive Management Approach – Summary of Modeling Results for Western Washington DNR-managed Forests

General Description

Alternative 5 (Alt. 5) represents DNR-managed forests in Western Washington with emphasis on using forest industry approaches for revenue production on lands that are not dedicated to habitat conservation. It maintains 1997 HCP objectives and strategies, 1992 Forest Resource Plan (with exception to proposed changes) and meets current Federal and State statutes.

Key Decisions

Alt. 5 proposes the following policy changes:

- A modulated sustainable even-flow
- Harvest regulation changed from MBF to value
- 20 Westside ownership groups
- Silviculture reflects emphasis on economic potential

Adoption of this alternative would endorse these changes and result in a Board action of setting a new sustainable harvest level.

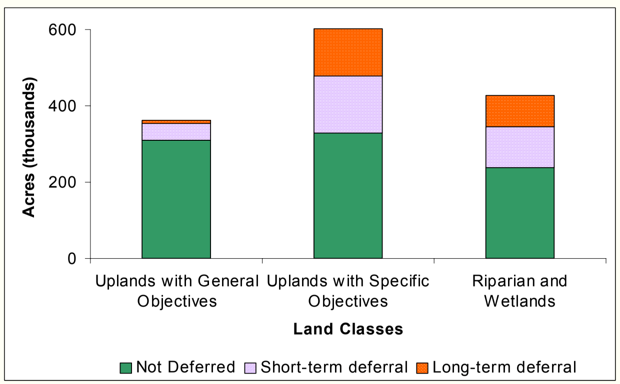


Figure 1. Major land classes and deferrals in 2004

Off- and On-base lands

Alt. 5 places 37% of DNR-managed lands "Off-base." Of this, about 300,000 acres or 60% is released during the first decade. The net affect of Alt. 5 strategies is to implement even-age harvest with intensive silvicultural strategies and management in habitat areas consistent with HCP intent. Shorter rotation ages with more site specific intensive management is based on economic potential while providing all specified HCP conservation benefits.

Revenue Generation

Alt. 5 was expected to increase the volume of timber marketed and revenue generated. Revenue will depend upon some large diameter wood for a period of time in the future (Figure 2).

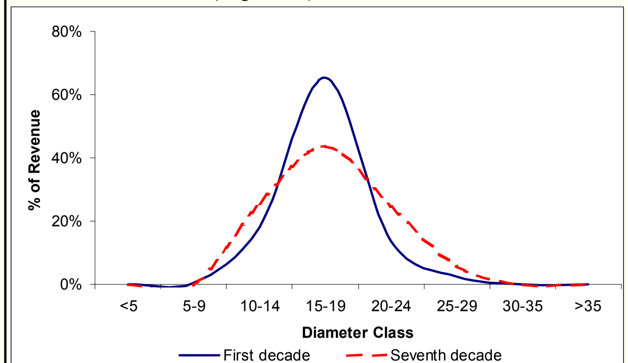


Figure 2. Diameters of harvested stands for selected time periods

The first decade harvest for Alt. 5 is 819 million board feet yearly for Western Washington State Trust forests, generating about $211 million a year (Figure 3).

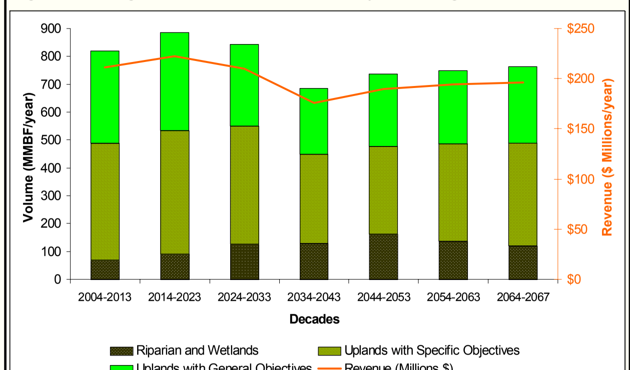


Figure 3. Modeled harvest volumes and revenues

As a result of silvicultural strategies like heavier thinnings and flow objectives, modeled near-term harvest level is much higher than for some other alternatives. While there is a relative reduction in the fourth decade, harvest levels remain higher and standing inventory grows steadily over time (Figure 5).

Habitat Management

Alt. 5 relies on silviculture and natural disturbance to produce complex forest structures. Harvest activity in riparian and upland areas ranges between 1.7%- 2.2% and per year for these areas respectful. In upland areas with specific objectives, silvicultural activities include heavier thinnings and harvests with moderate to lighter retention.

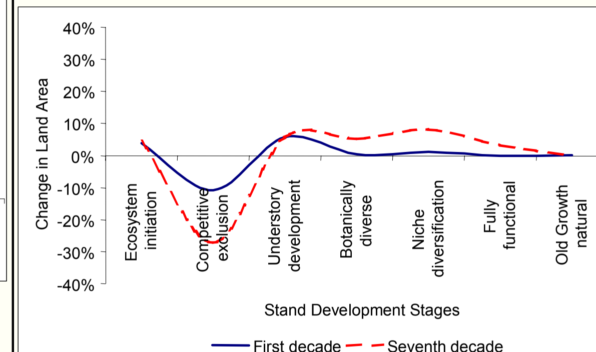


Figure 4. Modeled changes in stand development stages

Habitat is developed with active management and silvicultural investments. Alt. 5 produces reductions in competitive exclusion and initially niche diversification stages, with both near and long-term increases in ecosystem initiation and understory development. Within 70 years, there is an increase in niche diversification stage across the landscape. Alt. 5 produces a less diverse forest landscape than Alt. 1.

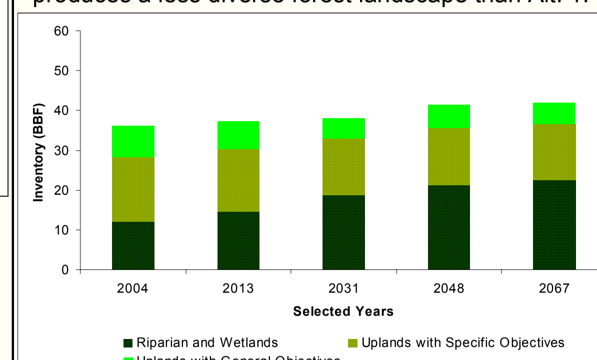


Figure 5. Modeled standing inventory by land class for selected years in billions of board feet

Alternative 5

Summary of Management Strategies and Proposed Actions

Policies

Ownership groups (level of aggregation – combining Trust ownerships together -- to which the even-flow criterion is applied to State Trust lands)

- ➢ 20 groups – Federal Granted lands and Forest Board Purchases are grouped at the Westside level.

Even-flow of sustainable harvest (method by which forest managers control timber harvests to assure long-term sustainability of the resource)

- ➢ regulated as wider band of variation with modulated even-flow (+25% of the 1993-2002 revenue averages)

Harvest Regulation (measure by which harvest flow is regulated, whether by volume or economic value)

- ➢ regulated by economic value

Older Forest Components (protection, or deferral of harvest in older forest stands)

- ➢ current acreage of "old growth" research stands that are deferred (2,000 acres currently identified as larger than 80 acres in size and older than 160 years)
- ➢10-15% of each westside HCP planning unit targeted to be in older forest conditions

Procedures and Operations

Average minimum regeneration harvest age – average earliest age at which a stand can be considered eligible for regeneration harvest. For example, the minimum age that a regeneration harvest can occur for a site class III Douglas fir stand is 50 years. The minimum regeneration age varies by site class (higher sites-younger ages; lower sites-older ages) and by species (hardwoods at younger ages; conifers at older ages).

- ➢ 50 years

Northern Spotted Owl nesting, roosting, foraging (NRF) and dispersal habitats (what activities may happen in Watershed Administrative Units (WAUs) with NRF and dispersal habitat)

- ➢ NRF and dispersal habitat strategies managed as ***targets***
- ➢ heavier industry-type thinnings available to help create habitat

Northern Spotted Owl habitat circles (release dates for Memorandum 1, Status 1 Reproductive, and Southwest Washington administrative owl circles)

- ➢ Memo 1, Stat 1-R and SW WA released in 2007

Older Forest Components (how are mature forest components maintained on a stand and WAU level)

- ➢ "50/25" strategy removed
- ➢ leave tree levels back to HCP intent of 8 trees/acre

Riparian Areas (intensity of management of Riparian Management Zones)

- ➢ Management and restoration through silviculture allowed; requires Federal Services agreement

Management intensity (the level of intensity of management of upland areas)

- ➢ heavier thinnings available
- ➢ increased (moderate) level of resources available for unstable slope identification
- ➢ preference towards fertilization of stands
- ➢ preference towards stand regeneration through plantings

Board of Natural Resources Action

- ❖ Amend Policy Nos. 5, 6 and 11
- ❖ Sustainable harvest level adopted

DNR Administrative Action

- ❖ Implement procedural and operational changes

Alternative 6: Innovative Silvicultural Management– Summary of Modeling Results for Western Washington DNR-managed Forests

General Description

Alternative 6 (Alt. 6) represents DNR-managed forests in Western Washington with innovative silvicultural management techniques to generate both increased conservation benefits and revenue for the Trusts. This approach attempts the integrate habitat and revenue generation objectives while maintaining the current HCP approach, the 1992 Forest Resource Plan and will meet all current Federal and State statutes.

Key Decisions

Alt. 6 proposes the following policy changes and a number of procedural changes (see details).

- A modulated sustainable even-flow
- 20 ownerships groups
- Harvest regulation changed from MBF to value
- Silviculture to reflect biodiversity pathways

Adoption of this alternative would endorse these changes and result in a Board action of setting a new sustainable harvest level.

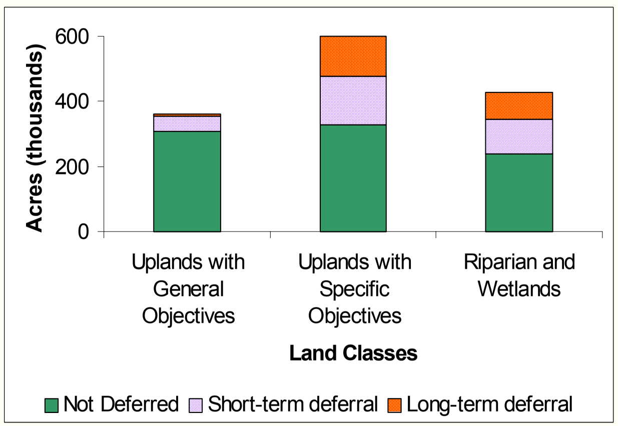


Figure 1. Major land classes and deferrals in 2004

Off- and On-base lands

Alt. 6 places 37% of DNR-managed western forestlands "Off-base." Of this, about 300,000 acres, or 60% of the off-base lands is released during the first decade. The net affect is an increase of available acres for innovative silvicultural management in habitat areas.

Revenue Generation

Alt. 6 was expected to increase revenue through more active management of available forest base, and broaden the timber product portfolio profile with additional large diameter wood (Figure 2).

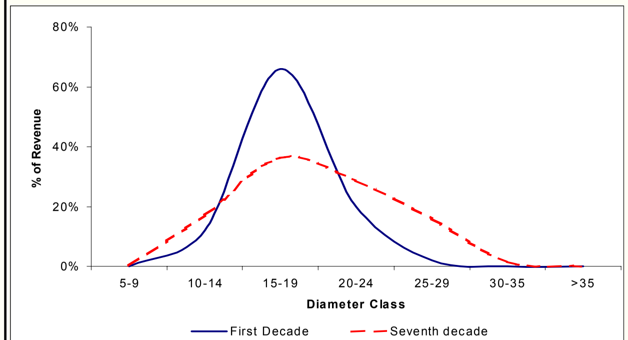


Figure 2. Diameters of harvested stands for selected time periods

The first decade harvest for Alt. 6 is 780 million board feet yearly for Western Washington State Trust forests, generating about $200 million a year (Figure 3).

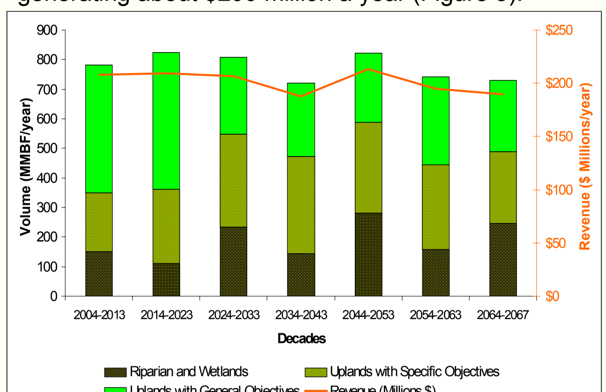


Figure 3. Modeled harvest volumes and revenues

As a result of innovative silvicultural strategies like biodiversity thinnings and modulating flow objectives, modeled near-term harvest level is much higher than for some other alternatives. While there is a relative reduction in the fourth decade, harvest levels remain higher and standing inventory grows steadily over time (Figure 5).

Habitat Management

Alt. 6 relies on biodiversity pathways to accelerate habitat development. Harvest activity in riparian and upland areas is between 1.7%- 3.2% of the total area in these land classes areas per year. Silvicultural activities in riparian and upland areas with specific objectives are biodiversity thinnings and retention harvests.

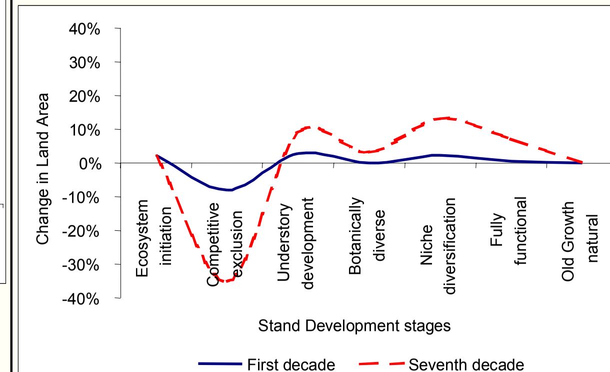


Figure 4. Modeled changes in stand development stages

Habitat is developed with active management and silvicultural investments. Alt. 6 produces significant reductions in the competitive exclusion area, with both near-and long-term increases in understory development. Within 70 years, there is a significant increase in more complex structure stages across the landscape. Alt. 6 produces the most diverse forest landscape among the alternatives.

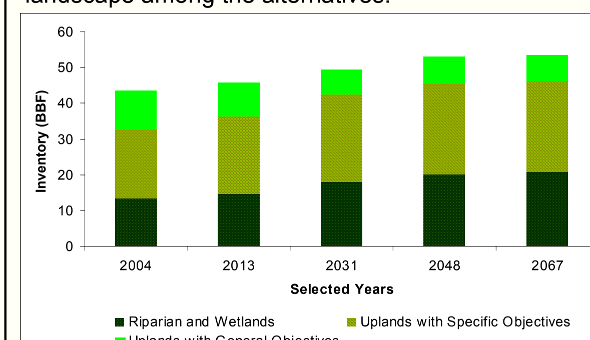


Figure 5. Modeled standing inventory by land class for selected years in billions of board feet

DRAFT – Subject to change

Alternative 6

Summary of Management Strategies and Proposed Actions

Policies

Ownership groups (level of aggregation – combining Trust ownerships together -- to which the even-flow criterion is applied to State Trust lands)

➢ 20 groups - Federal Granted lands and Forest Board Purchases are grouped at the Westside level.

Even-flow of sustainable harvest (method by which forest managers control timber harvests to assure long-term sustainability of the resource)

➢ regulated as wider band of variation with modulated even-flow (+25% of the 1993-2002 revenue averages)

Harvest Regulation (measure by which harvest flow is regulated, whether by volume or economic value)

➢ regulated by economic value

Older Forest Components (protection, or deferral of harvest in older forest stands)

➢ current acreage of "old growth" research stands that are deferred (2,000 acres currently identified as larger than 80 acres in size and older than 160 years)

➢ 10-15% of each westside HCP planning unit targeted to be in older forest conditions

Board of Natural Resources Action

❖ Amend Policy Nos. 5 and 6, update Nos. 30 and 31

❖ Sustainable harvest level adopted

Procedures and Operations

Average minimum regeneration harvest age – average earliest age at which a stand can be considered eligible for regeneration harvest. For example, the minimum age that a regeneration harvest can occur for a site class III Douglas fir stand is 50 years. The minimum regeneration age varies by site class (higher sites-younger ages; lower sites-older ages) and by species (hardwoods at younger ages; conifers at older ages).

➢ variable ages depending on site potential, stand and landscape objectives

Northern Spotted Owl nesting, roosting, foraging (NRF) and dispersal habitats (what activities may happen in Watershed Administrative Units (WAUs) with NRF and dispersal habitat)

➢ NRF and dispersal habitat strategies managed as ***targets***

➢ Biodiversity pathways management used to create habitat

Northern Spotted Owl habitat circles (release dates for Memorandum 1, Status 1 Reproductive, and Southwest Washington administrative owl circles)

➢ Memo 1, Stat 1-R and SW WA released in 2007

Older Forest Components (how are mature forest components maintained on a stand and WAU level)

➢ "50/25" strategy removed

➢ leave tree levels back to HCP intent of 8 trees/acre

Riparian Areas (intensity of management of Riparian Management Zones)

➢ management and restoration through moderate silviculture activity allowed using biodiversity pathways management; requires Federal Services agreement

Management intensity (the level of intensity of management of upland areas)

➢ biodiversity pathways management applied

➢ increased (high) level of resources available for unstable slope identification

➢ budget-limited fertilization of stands

➢ emphasis on natural stand regeneration

DNR Administrative Action

❖ Implement procedural and operational changes

Conservation Benefits – A comparison and summary of habitat management

All alternatives are designed to meet DNR's HCP conservation objectives by implementing the conservation strategies in varying degrees. Stand development stages provide a measure for describing the future forest conditions under the alternatives.

The current condition of DNR-managed forests in Western Washington demonstrate an abundance of competitive exclusion forest stands and a lack of more structurally complex forest stages – identified here as the botanically diverse, niche diversification, fully functional, and old growth stages of natural stand development. These later stages are important for many specialized native species, such as the Northern Spotted Owl, that help to maintain important ecological functions throughout the entire forest ecosystem. The competitive exclusion stage is more associated with forests being managed for timber production.

Figures H and I, regarding Stand Development stages in 2013 and 2067, illustrate the results of various management strategies implemented in the alternatives. All the alternatives show that over a 70-year period, a more diverse and complex forest will develop on State Trust forest lands to meet the objectives of the HCP. However, in addition to achieving HCP goals, a key policy decision will be to determine the *desired future forest condition* of State Trust lands that balances healthy forests with other economic and social objectives.

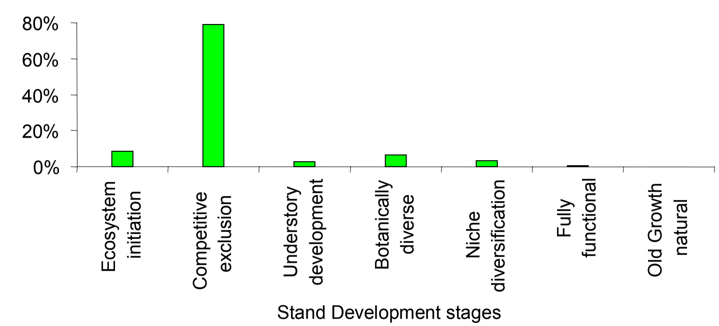


Figure G. Modeled stand development classes in 2004 in Westside Trust forests

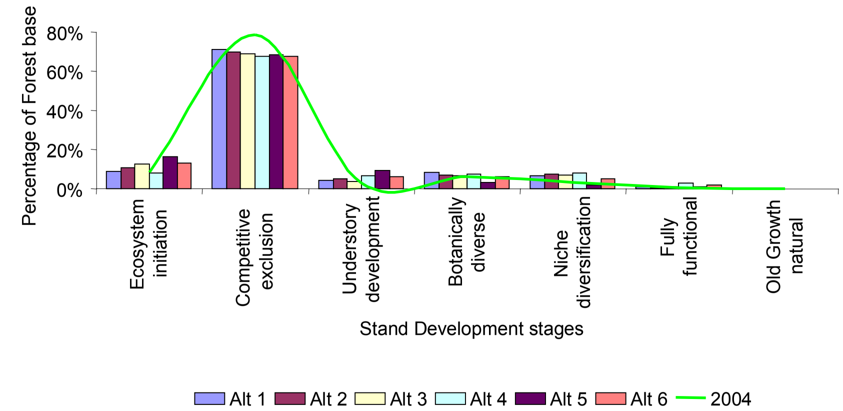


Figure H. Modeled stand development classes in 2013 in Westside Trust forests

Of the alternatives, Alts. 1, 4 and 6 develop more of the complex forest stages than Alts. 2 and 5 over the 70-year HCP.

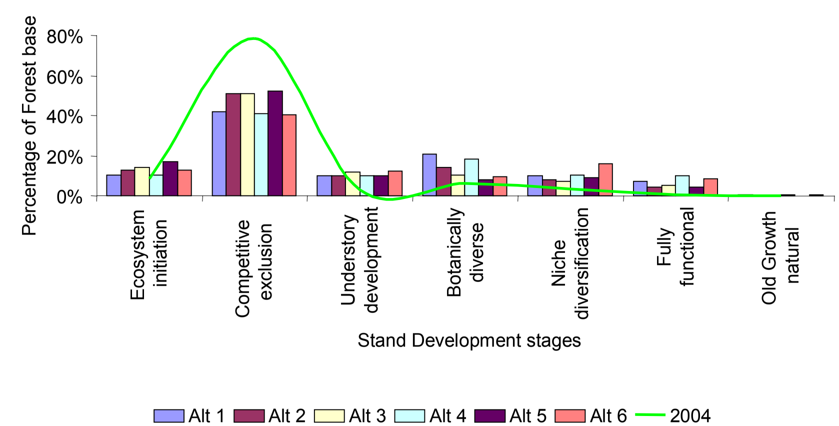


Figure I. Modeled stand development classes in 2067 in Westside Trust forests

Conservation Benefits – A comparison and summary of habitat management (continued)

Alts. 1 and 4 were expected to be slower at producing more complex forest structures as a consequence of passive management. However, since the majority of the forestlands (about 45%) are currently in a "large tree exclusion" stage (a sub-phase of competitive exclusion), only a relatively short period of time is assumed to be needed to develop these stands to more complex types.

Passive management in habitat areas will only be effective in creating habitat by the end of the 70-year HCP:

- if those designated habitat areas have significant areas of large tree exclusion today (Fig. J), and
- if the assumption is correct that 70 years is sufficient for natural disturbances to develop these stands into more complex structures.

Alt. 6 provides a different approach to developing forests into desired habitat conditions. Active management is the core of this approach and relies on innovative silviculture using biodiversity pathway principles to achieve objectives – retaining large legacy trees, developing growing space for future large trees to develop, minimizing soil disturbance, encouraging understory development and improving habitat quality by creating cavity trees and adding coarse woody debris (Carey et al. 1996). Alt. 6 provides a more effective approach of developing habitat in the desired areas (Fig. K).

Alt. 6 demonstrates that active purposeful management is a more effective tool to develop habitat structure than passive approaches. However, the current Alt. 6 may not demonstrate the most efficient approach to active management in habitat designated zones. The question of efficiency begs consideration of production costs of these systems (to be reported in October 2003).

In addition, it should be noted that biodiversity pathways management is an experimental concept to date, without any large scale operational application.

While Alt. 4 demonstrates the benefit of longer rotations in habitat areas, it also produces the more complex stand structures across the entire landscape. This strategy, although it may be beneficial from a ecosystem health perspective, comes at a large economic cost (see Gross Revenue summary, page 28).

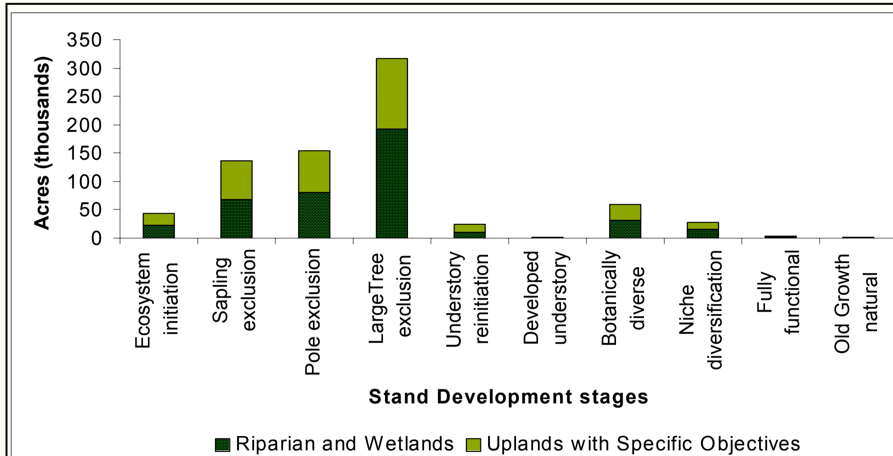


Figure J. Modeled stand development classes in designated habitat areas in 2004

Alts. 2, 3 and 5 show less increase in development of complex stages in habitat areas than Alts 1, 4 and 6. However, Alts. 2, 3, 5 and 6 maintain more uplands with general management objectives in "competitive exclusion," indicating the areas are managed primarily for timber production. Under the zoned forest concept, this is efficient and appropriate.

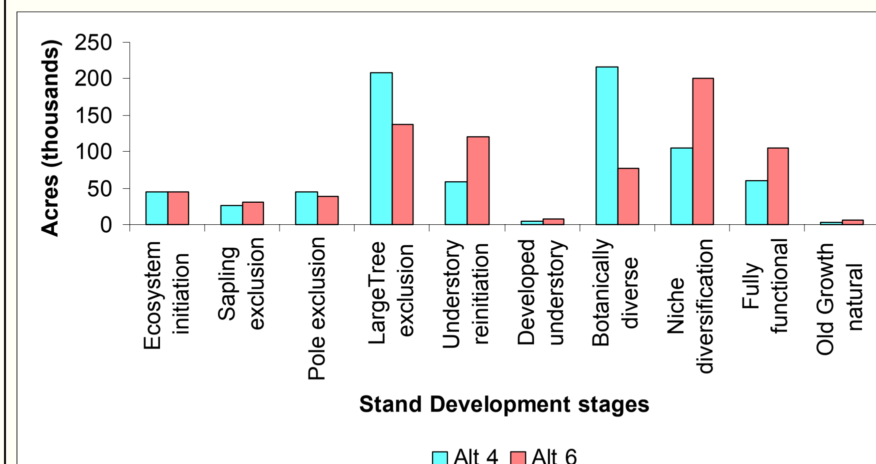


Figure K. Modeled stand development classes in designated habitat areas in 2067

Revenue Generation – A Comparison and Summary

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
	Revenue ($ Millions/year)[a]	Volume MMBF/year	Revenue ($ Millions/year)	Volume MMBF/year	Revenue ($ Millions/year)	Volume MMBF/year	Revenue ($ Millions/year)	Volume MMBF/year	Revenue ($ Millions/year)	Volume MMBF/year	Revenue ($ Millions/year)	Volume MMBF/year
2004-2013	106	396	144	537	178	663	108	411	211	819	208	781
2014-2023	104	404	144	556	181	731	110	419	223	886	209	825
2024-2033	97	377	145	562	114	448	102	397	210	844	207	809
2034-2043	92	352	153	598	161	623	97	380	176	686	188	720
2044-2053	87	332	149	577	208	825	102	390	190	738	213	823
2054-2063	90	348	150	585	151	591	103	389	194	749	195	742
2064-2067	91	353	148	575	179	702	96	354	196	763	190	729

Table Notes

a. Revenue represents average annual gross revenue from timber stumpage values only. Management costs have not been deducted.

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Comments

At this time, the differences between the alternatives in volume and revenue appears to be the result of the following key three variables:

- **Available area for timber harvesting** – on base
- **Ownership Groups**
- **Flow control** – how the Sustainable Even-flow policy is interpreted and implemented.

Available Area

Two variables – total area, and volume available for silvicultural activities and timber harvests – are key to determining the amount of timber available during a specific period of time, e.g. today and in the future. The more land and volume available in the harvest base, the more likely a higher sustainable harvest level can be achieved.

Ownership groups

The organization of the harvest groups (Trusts grouped or not grouped) influences both the total harvest level, the quantity and quality of the revenue flow to the Trusts. Trusts with less forest acreage, when lumped with Trusts with more acres, will have greater variability in revenue flow over the long-term than if they were separated (see Trust by Trust comparison, page 29).

Greater potential revenue is often accompanied by higher variability revenue flow. Higher variability is expressed by a higher coefficient of variation value (see Trust by Trust comparison, page 29). Understanding individual Trust revenue needs, in terms of income stability and flow, appears to be paramount for determining the appropriate type of flow control.

(Comments continue on page 31)

Trust by Trust Comparison of draft modeling results

Trust	Revenue Distribution	Alternative 1 Average Revenue[b] Millions $	Alternative 1 CV[c] %	Alternative 2 Average Revenue Millions $	Alternative 2 CV %	Alternative 3 Average Revenue Millions $	Alternative 3 CV %	Alternative 4 Average Revenue Millions $	Alternative 4 CV %	Alternative 5 Average Revenue Millions $	Alternative 5 CV %	Alternative 6 Average Revenue Millions $	Alternative 6 CV %
Agricultural School	Permanent[d]	$1.9	22%	$3.0	11%	$3.6	29%	$2.4	23%	$4.1	37%	$4.5	16%
Capitol Grant	Current[e]	$5.9	28%	$8.5	13%	$11.1	21%	$5.8	20%	$12.8	31%	$12.8	11%
CEP&RI[a]	Current	$2.4	33%	$3.2	21%	$3.4	32%	$2.7	16%	$4.1	30%	$5.7	12%
Community College Forest Reserve	Current	$0.5	46%	$0.5	46%	$0.5	64%	$0.4	44%	$0.5	66%	$0.7	62%
Common School and Indemnity	Current	$29.9	5%	$50.2	9%	$57.7	25%	$32.2	7%	$63.1	28%	$62.6	9%
Escheat	Current	$0.3	44%	$0.4	33%	$0.5	46%	$0.4	55%	$0.5	29%	$0.5	14%
State Forest Board Purchase	Current	$7.5	17%	$10.4	15%	$11.2	31%	$7.8	16%	$11.5	28%	$15.1	12%
State Forest Board Transfer	Current	$37.9	6%	$57.1	2%	$64.1	23%	$41.7	4%	$68.4	26%	$81.3	5%
Normal School	Permanent	$1.7	18%	$3.2	23%	$3.2	16%	$1.8	17%	$3.9	30%	$3.6	13%
Scientific School	Permanent	$4.6	27%	$6.4	12%	$7.3	33%	$5.4	18%	$8.2	36%	$10.1	21%
University - Original	Permanent	$0.2	41%	$0.3	58%	$0.3	45%	$0.2	37%	$0.4	36%	$0.4	14%
University - Transferred	Current	$2.5	46%	$4.5	31%	$4.3	46%	$1.6	54%	$5.7	37%	$3.9	34%
Total		$95.2		$147.7		$167.3		$102.4		$183.2		$201.4	

Table Notes

a. CEP&RI = Charitable/Educational/Penal & Reformatory Institute

b. Average Revenue is the average annual decadal revenue for seven decades. Annual Revenue represents stumpage values only. Management costs have not been deducted.

c. CV = Coefficient of Variation. It is presented here as a measurement to describe the variability of the seven decade values representing mean revenue. The wider the variability between the seven decade values, the higher the CV value. Often in financial analysis, a higher CV signifies a greater the level of uncertainty in the mean.

d. Permanent: Trust land revenue is deposited into a permanent fund. Income to the beneficiary is through investment earnings from those funds, managed by the State Investment Board.

e. Current: Trust land revenue is available to the beneficiary for capital construction or debt service.

County by County Comparison of draft modeling results for Forest Board Transfer and Purchase Trusts

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
County	Average Revenue[a]	CV[b]	Average Revenue	CV	Average Revenue	CV	Average Revenue	CV	Average Revenue	CV	Average Revenue	CV
	Millions $	%	Millions $	%	Millions $	%	Millions $	%	Millions $	%	Millions $	%
CLALLAM	$2.52	15%	$8.05	14%	$10.87	52%	$4.96	4%	$13.39	17%	$10.95	12%
CLARK	$2.96	9%	$3.69	19%	$4.35	39%	$2.45	6%	$4.44	17%	$5.39	8%
COWLITZ	$1.22	6%	$1.45	18%	$1.60	50%	$1.22	10%	$1.69	21%	$2.07	16%
GRAYS HARBOR	$3.37	15%	$4.04	20%	$4.66	33%	$3.01	29%	$4.92	16%	$5.45	13%
JEFFERSON	$1.09	22%	$1.50	14%	$2.08	59%	$0.92	20%	$1.89	9%	$2.18	13%
KING	$1.97	28%	$2.15	4%	$2.59	54%	$1.50	3%	$2.91	29%	$3.08	18%
KITSAP	$0.52	33%	$0.80	16%	$0.86	53%	$0.64	14%	$0.90	9%	$1.06	6%
LEWIS	$4.08	7%	$5.66	8%	$6.21	25%	$4.89	8%	$7.02	12%	$8.52	2%
MASON	$1.64	37%	$2.62	11%	$3.30	89%	$1.83	18%	$2.82	18%	$3.56	9%
PACIFIC	$1.37	8%	$3.21	18%	$3.21	46%	$2.63	13%	$4.10	32%	$5.98	20%
PIERCE	$1.43	10%	$1.74	18%	$1.18	64%	$0.48	18%	$2.18	15%	$1.69	52%
SKAGIT	$7.19	14%	$9.65	8%	$9.52	28%	$7.85	18%	$12.34	7%	$13.60	9%
SKAMANIA	$1.92	17%	$3.93	15%	$4.75	33%	$1.18	15%	$5.34	16%	$4.03	49%
SNOHOMISH	$5.65	7%	$7.61	3%	$7.59	53%	$6.47	11%	$9.37	16%	$11.17	14%
THURSTON	$4.94	14%	$5.89	17%	$6.63	46%	$4.73	19%	$6.84	13%	$8.77	15%
WAHKIAKUM	$0.97	5%	$1.58	15%	$2.10	33%	$1.51	9%	$2.35	21%	$2.64	14%
WHATCOM	$2.61	7%	$3.93	6%	$3.85	24%	$3.17	6%	$4.87	14%	$6.28	7%
Total	$45.5		$67.5		$75.4		$49.4		$87.4		$96.4	

Table Notes

a. Average Revenue is the average annual decadal revenue for seven decades. Average Revenue represent stumpage values for Forest Board Purchase and Forest Board Transfer Trust lands only. Management costs have not been deducted.

b. CV = Coefficient of Variation is calculated by dividing the Standard Deviation of the mean by the mean of the observations. It is presented here as a metric to describe the variability of the seven decade values representing mean revenue. The wider the variability between the seven decade values, the higher the CV value. Often in financial analysis, a higher CV signifies a greater the level of uncertainty in the mean.

Revenue Generation– A comparison and summary (continued from page 28)

Flow control

The alternatives demonstrate different approaches to revenue flow control and regulation (Figure L.)

In an attempt to provide more stable revenue flow to the individual State Trusts, **Alts. 1 and 4** demonstrate a constrained approach to revenue flow in management of the current land base and forest inventory.

Relaxing the flow constraint in **Alts. 2 and 3** demonstrates greater potential for timber volume harvested and revenue generation. However, fluctuations in harvest levels can be expected to be greater, especially at the individual Trust and county levels.

A modulating type of flow control in combination with harvests regulated by economic value, as in **Alts. 5 and 6**, not only increase near-term opportunities but also improve the management of fluctuations. It appears that the combination of modulating flow control, consolidating Federally Granted Lands and regulating harvests by economic value results in more timely silviculture leading to greater yields and more conservation benefits.

The different approaches to flow control in **Alts. 3, 5 and 6** all eventually trend toward a similar sustainable harvest level over the long run (in the 7th decade and beyond). This trend indicates that the choice of a flow control policy can focus on how to manage the State Trust lands near-term, without foregoing future options to long-term sustainability. In other words, Alts. 3, 5 and 6 demonstrate that the current forest inventory on State Trust lands provides a large amount of management flexibility to generate revenue when an appropriate set of land management strategies and flow controls are combined to meet economic, environmental and social objectives.

Alts 1, 2 and 4 demonstrate the results of a more constrained flow control approach with differing management strategies that result in lower sustainable harvest volumes and lower revenue flows.

The net revenue analysis (to be presented in October 2003), will re-examine the three key variables, available area, ownership groups and flow control, in more detail.

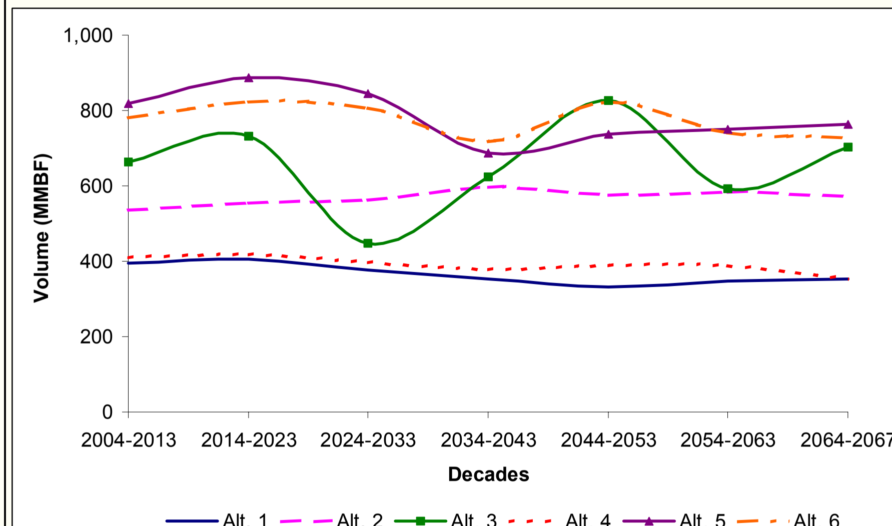

Figure L. Variation in volume over time due to different flow control and management strategies

Summary Points

Revenue Generation

- Less constrained flow control provides significant opportunities for active management
- Ownership groups policy needs further discussion and a focus on individual Trust objectives
- Harvest regulated by value, and economically determined rotations in non-habitat areas provide greater returns

Conservation Benefits

- Longer rotations benefit more complex structures
- Active management has to be the “right type” of silviculture to accelerate the development of complex stand structures
- Passive management appears to be an option for developing complex forest structure, albeit a risky and expensive one ($106 vs. $208 million in gross revenues between Alts. 1 and 6)

B.2. Modeling Input and Process

B.2.1 Forest Stand Development Stage Classifications

The Department uses OPTIONS, a forest estate 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, which describes forest conditions in terms of habitat values 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.

DNR's internal literature reviews, expert consultation, and data from a recently published compendium on wildlife habitat associations and ecological functions (Johnson and O'Neil 2001), were used to build a structural classification: the "Forest Structure Classes" (FSC[1]).

An additional forest classification was developed to evaluate effects of alternative silvicultural regimes used in the six Alternatives that are based on the "biodiversity pathway" approach developed for the Washington Landscape Management Project by Carey et al. (1996). The Washington Landscape Management Project employed a more generalized classification that focuses on the ecological processes underlying the stages of forest development. Physical characteristics associated with "Stand Development Stages" (SDS)[2] serve as indicators of these processes at work.

The distinction between "Stand Development Stages" (SDS) and "Forest Structure Classes" (FSC) is critical to the validity of any conclusions that may be drawn from assessments that are based on either or both of these classifications. The classifications serve different purposes.

SDS support general assessments of forest ecosystem processes and stand development. The FSC were stratified according to wildlife species' associations, with finer measures of structural conditions (Johnson and O'Neil, 2001).

The variables are similar between the two classifications, but the range of structural conditions comprising each "Stand Development Stage" is much broader than the defining criteria for the "Forest Structure Classes."

Carey et al (1996) also used the habitat relationships data in Brown (1985) as the starting point for their indices of vertebrate species diversity, biotic integrity and carrying capacity of SDS for several species' assemblages. Stand conditions in Brown (1985) were adapted to fit the SDS classification.

[1] Forest Structure Classes are represented in the database as WHERL_SC

[2] Stand Development Stages are represented in the database as RLMP_SDS

B.2.1.1 Descriptions of Forest Characteristics Classes

The following descriptions use combinations of values for the four structural attributes displayed in Table B-4, as criteria for distinguishing the stand structure classes and development stages.

Table B-1. Four Structural Attributes Used as Classification Criteria *

Structural Attributes	Variables
Tree Size (DBH class)	Grass/Forb <1" Shrub/Sapling 1-9" Pole 10-19" Large 20-29" Giant >30"
Percent Canopy Cover	Open/Moderate 10-69% Closed 70-100%
Number of Canopy Layers	Single-story 1 stratum Multi-story 2 or more strata
Tree Decadence Habitat Elements	Standing dead/decadent trees in trees/acre (TPA) >25"DBH Dead down coarse wood in linear feet/acre 20"diameter

* Please refer to Table B-2 for the classification framework, and comparison with other classifications.

B.2.1.2 Stand Development Stages (SDS) [Forest Structure Classes (FSC)]

SDS: <u>Ecosystem Initiation Stage</u>

FSC: <u>Grass/Forb</u>

STRUCTURES: These sites are openings dominated by grasses and forbs. Some shrubs may be present. Tree seedlings are less than 1" diameter at breast height (DBH) and constitute less than 10 percent of the vegetation cover. Some larger trees remaining from the previous stand may be present, but provide less than a 10 percent canopy cover.

PROCESSES: This is the Ecosystem Initiation Stage, the result of a disturbance of sufficient intensity to remove or kill the overstory tree component of the stand. Wind, fire, disease or timber harvest may leave varying amounts of biological legacies (understory trees, nonvascular plants, humus, soil microbes and invertebrates, large snags and down wood, etc.), which influence rate of stand re-development and maintenance of biodiversity and ecological processes.

FSC: <u>Shrub/Sapling</u> (open, moderate)

STRUCTURES: This stage is characterized by sapling trees ranging between 1-9" DBH. At the smaller end of this diameter range, saplings are similar to shrubs in structure; when combined with shrubs, canopy cover is between 10-69 percent. Shrubs contribute less canopy cover as saplings grow to the larger end of the diameter range. Scattered larger trees remaining from the previous stand may be present, but provide less than 10 percent canopy cover. Grasses and forbs are present, their abundance varying with the amount of canopy cover. There is only one canopy stratum.

PROCESSES: Later in the Ecosystem Initiation Stage, shrubs and sapling trees increase in density, with an incremental increase in vertical diversity and foliage (foliar biomass). Depending upon the presence of legacy or old trees, this stage may support high diversities and abundances of vertebrate generalists and species associated with openings, but lower total biodiversity, when compared to all of the other stages except the competitive exclusion stages.

SDS: Sapling Exclusion Stage

FSC: Shrub/Sapling (closed)

STRUCTURES: Sapling trees range from 1-9" DBH. They are structurally similar to shrubs at smaller diameters, and begin to resemble poles as they reach the upper end of the diameter class. Canopy cover exceeds 70 percent. Shrubs contribute less canopy cover as saplings grow into poles. Scattered larger trees remaining from the previous stand may be present, but provide less than 10 percent canopy cover. Grasses and forbs are likely scarce to absent. There is only one canopy layer.

PROCESSES: The Sapling Exclusion Stage marks the beginning of the competitive exclusion stages. Trees begin to compete with shrubs for space, light and nutrients. Shrubs decrease in density and grass/forb vegetation begins to disappear.

SDS: Pole Exclusion Stage

FSC: Pole - Multi (closed)

STRUCTURES: These stands have canopies dominated by pole-sized trees (10-19"DBH), with a distinct understory canopy of saplings (1-9"DBH). Two or more canopy layers are present. Scattered large/giant relict trees may be present, but contribute less than 10 percent canopy cover. Although multi-storied, canopy cover from poles exceeds 70 percent, with another 10 percent or more canopy cover from saplings, creating a closed stand. A grass/forb or shrub understory is scarce to absent.

PROCESSES: In the Pole Exclusion Stage, suppression mortality begins to exert an influence on the stand. Taller, faster-growing trees become dominant; growth of smaller trees becomes suppressed, causing mortality and creating the first cohort of small snags. Unless present in the form of biological legacies, large snags and down wood are depauperate in this stand. Crown closure among conifers suppresses grass, forb and shrub growth; if present, deciduous hardwood trees become suppressed and die, creating a short-term source of small snags and logs.

FSC: Pole - Single (closed)

STRUCTURES: Canopies are dominated by pole-sized trees ranging from 10-19"DBH and averaging greater than 70 percent canopy cover. The stand has a single canopy stratum. Scattered large/giant relict trees may be present, but contribute less than 10 percent of the canopy cover. Smaller trees, if present, provide less than 10 percent canopy cover. Grass/forb or shrub vegetation is scarce to absent.

PROCESSES: In this form of the Pole Exclusion Stage, structural and vegetative complexity are at their lowest levels. The high density and uniform size of relatively short trees creates the darkest conditions under their closed crowns. This stage features the lowest diversity and abundances of wildlife species, and is thought to support the lowest levels of biodiversity among all stages. Continuing suppression processes may create a small, second cohort of pole-sized snags.

SDS: Large Tree Exclusion Stage

FSC: Large - Single (closed)

STRUCTURES: Canopies are dominated by large trees ranging from 20-29"DBH and averaging greater than 70 percent canopy cover. Some giant trees may also be present within the stand's single canopy stratum. Smaller trees, if present, provide less than 10% canopy cover. If present, grass/forb or shrub vegetation is scarce.

PROCESSES: In Large Tree Exclusion, tree competition and crown closure still preclude overall establishment of understory trees and vegetation. However, suppression mortality has been at work, gradually reducing the density of trees. They are also taller. Scattered, sparse pockets of ground vegetation gain a foothold where light begins to penetrate the stand. This is the precursor to the next set of processes, Understory Reinitiation. Small snags created during Pole Exclusion stages are in late decay stages or have fallen, creating a small, first cohort of small down logs. Unless present as biological legacies, large snags and down wood are absent from the stand.

SDS: Understory Reinitiation Stage

FSC: Pole - Single (open, moderate)

STRUCTURES: Trees that define this stage are between 10-19"DBH. Their canopies dominate the single-storied stand, creating from 10-69% canopy cover. Only one canopy stratum exists. Scattered large/giant relict trees may be present, but contribute less than 10% canopy cover. If present, canopy cover from other tree sizes is less than 10%. Grass, forb and shrub cover exceeds 10%, but abundance varies with the amount and variation in canopy cover.

PROCESSES: On medium to high sites in western Washington, this form of Understory Reinitiation is more likely to be created by silvicultural processes than natural processes. Wider spacing of pole-sized trees allows light to enter the stand, and makes nutrients and water available for the establishment of understory plants. If present, small snags or down logs are in advanced stages of decay. Large decadence elements are absent, unless they exist as legacies from the previous stand.

FSC: Pole - Multi (open, moderate)

STRUCTURES: These multi-layered stands have canopies dominated by pole-sized trees, with a distinct understory canopy of smaller trees. Two or more canopy layers are present. Canopy cover from poles (10-19"DBH) ranges from 10-69 percent; saplings (1-9"DBH) contribute 10 percent or more canopy cover. Scattered large/giant relict trees may be present, but contribute less than 10 percent canopy cover. Grass/forb or shrub vegetation exceeds 10 percent cover, but varies in abundance relative to canopy cover.

PROCESSES: Like the previous on the westside, these conditions are more likely a result of silvicultural processes than natural processes. Poles are likely at the higher end of the diameter class, and occur at lower densities. The understory cohort likely contains shade tolerant species, occurring in varying densities, allowing for the establishment of patches of shrubs, forbs and tree seedlings. Any small snags or down logs are in advanced stages of decay. Large decadence elements are absent, unless they exist as legacies from the previous stand.

FSC: Large - Single (open, moderate)

STRUCTURES: This stage is defined by trees 20-29"DBH, whose canopy dominates the stand. Some giant trees may also be present. Their combined canopy cover ranges from 10-69 percent and forms a single canopy stratum. Trees of other sizes may be present but constitute less than 10 precent canopy cover. Grass/forb or shrub understory cover exceeds 10 percent.

PROCESSES: This Understory Reinitiation stage features a single canopy stratum of large trees, occurring at low enough densities to allow establishment of grasses, forbs, shrubs, and understory trees. On the westside, it is most likely to be created as a result of silvicultural treatments.

SDS: Understory Reinitiation Stage (continued)

FSC: Large - Multi (closed)

STRUCTURES: This stage features multi-layered canopies dominated by large (20-29"DBH) trees. Some giant trees (>30"DBH) are usually present, along with one or more distinct canopy layers of smaller trees. Two or more canopy strata are present. Total canopy cover exceeds 70 percent with 30 percent or more cover from large and/or giant trees. Cover from giant trees does not exceed 30 percent. Canopy cover from poles (10-19"DBH) contributes another 10% or more; saplings (1-9"DBH) may also contribute 10 percent or more canopy cover. Cover from grasses, forbs and/or shrubs exceeds 10 percent, but densities are low, except in canopy gaps.

PROCESSES: The attributes of this form of Understory Reinitiation Stage indicate a stand that could result from natural processes or silvicultural treatments. The large trees occur at lower and more variable densities. Understory cohorts likely contain shade tolerant species, also occurring in varying densities, allowing for growth of shrubs, forbs and tree seedlings. Canopy gaps are developing. Most small snags from the pole exclusion stages have decayed and fallen. Any small down logs are in advanced stages of decay or have disintegrated into the forest floor. Large decadence elements are scarce or absent, unless they exist as legacies from the previous stand.

SDS: Developed Understory Stage

FSC: Large - Multi (open, moderate)

STRUCTURES: These multi-layered stands feature canopies dominated by large (20-29"DBH) trees. Some giant trees (>30"DBH) are usually present, along with one or more distinct canopy layers of smaller trees. Two or more canopy strata are present. Total canopy cover is from 10-69 percent with 10% or more cover from large and/or giant trees. Cover from giant trees does not exceed 30 percent. Canopy cover from poles (10-19"DBH) contributes another 10 percent or more; saplings (1-9"DBH) may also contribute 10 percent or more canopy cover. Grass, forb and/or shrub cover exceeds 10 percent, with higher abundance in canopy gaps.

PROCESSES: The Developed Understory Stage features an increase in abundance of understory tree layers and other vegetation. Although shade tolerant species occur, overall plant species diversity has not fully developed. Unless legacies from the previous stand still occur, large decadence elements may be depauperate in this stage.

SDS: Botanically Diverse Stage

FSC: Giant - Multi

STRUCTURES: These stands feature a multi-layered canopy dominated by giant trees (>30"DBH), with one or more distinct canopy layers from smaller trees. Giant trees provide 30 percent or more canopy cover; large trees are usually present but their canopy cover does not exceed 30 percent. Canopy cover from poles (10-19"DBH) contributes another 10% or more; saplings (1-9"DBH) may also contribute 10 percent or more canopy cover. Grass, forb and/or shrub cover exceeds 10 percent, with highest abundance in canopy gaps. Tree decadence elements are present, with 3-12 snags (>25"DBH) per acre and up to 150 linear feet per acre (LFPA) of logs (>20"average diameter).

PROCESSES: Fewer but larger trees occur in the overstory; the appearance of distinct canopy gaps and small openings, allows increased abundance and diversification in pockets of grass/forb/shrub vegetation. Abundance and diversity of tree and plant species are maximal in the Botanically Diverse Stage. Some decadence elements begin to appear, but are relatively scarce. Structural complexity and diversity have not fully developed; associated biotic diversity and community composition remain limited.

SDS: Niche Diversication Stage

FSC: Giant - Multi (ND)

STRUCTURES: This stage has the same minimum structural criteria as the previous Giant - Multi stand, with the exception of higher densities of snags and down logs. Snag densities (>25"DBH) increase to 13-24 per acre; up to 1200 linear feet per acre (LFPA) of logs (>20"average diameter) now exists.

PROCESSES: The Niche Diversification Stage features increasing amounts of tree decadence and associated microhabitat elements. The bark of aging trees, in the moderated microclimate of the stand, supports the appearance of lichens and other epiphytes. As tree architecture coarsens, canopy detritus begins to accumulate on bulky limbs and in bark fissures, broadening the composition of invertebrate communities. Increased canopy volume and vertical diversity brings commensurate increases in bird and arboreal mammal abundance. Accumulations of detritus on the forest floor bring higher abundances of fungi and soil invertebrates. Trophic pathways become more complex, ecological functions, more robust.

SDS: Fully Functional Stage

FSC: Giant - Multi (FF)

STRUCTURES: This stage has the same minimum structural criteria as the first Giant - Multi stand, with the exception of higher densities of snags and down logs. The number of snags (>25"DBH) now exceeds 24 per acre; coarse wood accumulations exceed 3000 linear feet per acre (LFPA) of logs (>20"average diameter).

PROCESSES: A stand in the Fully Functional Stage is distinguished by increasing additions of large tree decadence elements; accumulations now resemble those present in natural old growth stands. Trees continue to age; some become larger, some die and fall. Those growing in openings begin to develop architectural attributes similar to individual, ancient trees that may persist through disturbances, for centuries in old growth forests. Higher levels of biotic diversity, species abundance and trophic complexity, create redundancy in ecological functions and processes. This is thought to improve ecosystem resilience and likelihood of continued production of goods and services through time.

For modeling purposes, the Fully Functional Stage approximates old growth, but is not of natural origin; management treatments have shaped the stand's development.

SDS: Old Natural Forests

FSC: Old Natural Forests

STRUCTURES: The structural description is the same as Giant - Multi (FF), but classification criteria differ. The stand must be older than 250 years and must have never been subject to management activities. The age criterion also serves as an indicator of natural origin.

PROCESSES: The same basic description of Fully Functional applies, but by distinguishing old growth stands based on their natural origin and lack of management history, the classification acknowledges that unknown attributes and organisms may exist, that cannot be replicated in younger stands that did not develop from the same processes as old growth.

Table B-2. Analogous Forest Stand Development Classes

adapted from Johnson and O'Neil (2001)				adapted from Carey et al (1996)		Brown (1985)				DNR-HCP (1996)	
Forest Structure Class (FSC)	Dominant Tree DBH	Total Canopy Cover	# Canopy Layers	Stand Development Stage (SDS)		Stand Condition	est. duration (yrs)	Avg. Tree DBH or HT	Total Canopy Cover	Forest Structural Type (FST)	Avg Age (yrs)
Grass_Forb	<1"	<10%	n/a	EIS	Ecosystem Initiation	Grass-forb	2-10	<5' tall	<40%	Open	0-10
ShrubSap	1" - 9"	10% - 69%	1	EIS	Ecosystem Initiation	Shrub	3-20	<1"	<40%	Open	0-10
ShrubSap	1" - 9"	10% - 69%	1	EIS	Ecosystem Initiation	Open sapling/pole	8-20	1"-9"	<60%	none	
ShrubSap_closed	1" - 9"	>70%	1	SES	Sapling exclusion	Closed sap/pole/saw	40-100	1"-21"	>60%	Regeneration	10-20
Pole_multi	10" - 19"	10% - 69%	>=2	URS	Understory reinitiation	none				none	
Pole_multi_closed	10" - 19"	>70%	>=2	PES	Pole exclusion	Closed sap/pole/saw	40-100	1"-21"	>60%	Pole	20-40
Pole_single	10" - 19"	10% - 69%	1	URS	Understory reinitiation	none				none	
Pole_single_closed	10" - 19"	>70%	1	PES	Pole exclusion	Closed sap/pole/saw	40-100	1"-21"	>60%	Pole	20-40
Large_multi_closed	20" - 29"	>70%	>2	URS	Understory reinitiation	Large sawtimber	10-100	>21"	<100%	Closed	40-70
Large_single	20" - 29"	10% - 69%	1	URS	Understory reinitiation	Large sawtimber	10-100	>21"	<100%	none	
Large_single_closed	20" - 29"	>70%	1	LTS	Large tree exclusion	none				Closed	40-70
Large_multi	20" - 29"	40% - 69%	>2	DUS	Developed understory	Large sawtimber	10-100	>21"	<100%	none	
Giant_multi	>30"	40% - 69%	>2	BDS	Botanically diverse	none				Complex	>70
Giant_multi + HE_ND	>30"	40% - 69%	>2	NDS	Niche diversification	none				Complex	>70
Giant_multi + HE_FF	>30"	40% - 69%	>2	FFS	Fully functional (mgd)	none				Fully functional	>150
Old Natural Forests	>32"	40% - 69%	>2	ONF	Old Natural Forests	Old growth	~700			none	

B.2.2 Definition of Harvest Types

Washington's Department of Natural Resources carries out many types of silvicultural activities that result in the harvest of trees on 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—whereas 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.2.2.1 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 which 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-age seed tree silvicultural system. The purpose is to remove overstory trees which create shade levels that are too high for the new understory trees to thrive.

Selective Product Logging (typically harvest Type A): A timber harvest which 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 - 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-age 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 10-15 years). Several separate patches are harvested at a single point in time within a forest management unit. After an adequate green-up period (5-10 years) of new trees in the cut areas additional patches are harvested and the process 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 ten trees per acre.

Shelterwood Intermediate Cut (typically harvest Type C): The first timber harvest in a series conducted as part of the even-age 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-age 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.2.3 Harvest Deferrals

Table B-3. Westside Harvest Deferral Periods

Description	Alt1	Alt2	Alt3	Alt4	Alt5	Alt6
0.25 mile buffer around location of Eagle nests	9999	-	-	-	-	-
Older forests equal to or greater than 150 yrs	-	-	-	9999	-	-
Marbled Murrelet occupied sites	9999	2007	2007	2007	2007	2007
Marbled Murrelet reclassified habitat (occupied)	9999	2007	2007	2007	2007	2007
Marbled Murrelet reclassified habitat (non-occupied)	9999	2007	2007	2007	2007	2007
Additional M. Murrelet rcls habitat for NW and SPS	9999	2007	2007	2007	2007	2007
Buffer around NRF mgmt nest core areas	9999	2052	2052	2052	2052	2052
300 acre nest patch core areas	9999	2052	2052	2052	2052	2052
Admin Stat 1R Spotted Owl circles	9999	2007	2007	2007	2007	2007
Admin SW Spotted Owl circles	9999	2007	2007	2007	2007	2007
Admin Stat 1R Spotted Owl circles	9999	2002	2002	2002	2002	2002
Admin SW Spotted Owl circles	9999	2002	2002	2002	2002	2002
Memo 1 Spotted Owl circles	2007	2007	2007	2007	2007	2007
0.25 mile buffer around location of Peregrines	9999	-	-	-	-	-

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.

- DNR is currently developing a long-term conservation strategy for the marbled murrelet. For all Alternatives, it was assumed that the long-term strategy would involve landscape management of marbled murrelet habitat. Therefore, for modeling the Alternatives, currently identified and deferred marbled murrelet habitat was released and put into either "riparian and wetlands" or the "uplands with specific management objectives" land class.

Table B-4. 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	306,000
	2	281,000	208,000	215,000	343,000	344,000
	3	213,000	302,000	239,000	328,000	310,000
	4	238,000	280,000	238,000[1/]	326,000	309,000
	5	213,000	302,000	239,000	328,000	310,000
	6	213,000	302,000	239,000	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
	6	213,000		346,000	477,000	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.2.4 Silvicultural Implementation Strategies

Table B-5. Summary of the Range of Implementation Strategies Modeled in the Alternatives

Silvicultural Elements		Alternatives 1	2	3	4	5	6
Thinning – stand level	Removed volume limit[1/]	Up to 35%	Up to 35%	Up to 35%	Up to 35%	Up to 35%	Up to 60% for biodiversity pathways
	Pre-thin stand RD	55	None	55	55	55	None
	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	Third
	Target[3/]	17%	20%	17%	32%	22%	30%
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 removes 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.2.5 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, Julie Sandberg, and then John Baarspul.
- Region Participation, various participants.

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- Joseph B. Buchanan (WDFW)
- Dr. Andrew Carey (USDA Forest Service),
- William Hamilton (American Forest Resources),
- Dr. Jim Hotvedt (DNR),
- Dr. Valerie LeMay (UBC),
- Bruce Lippke (UW),
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- Steven McConnell Northwest Indian Fisheries Commission
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B.3. Modeled Harvest Levels

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Table B-6. 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[3]	2	3	4	5	6	7	1	2	3	4	5	6	7
Federal Granted Trusts	DNR Central Region	38	44	41	38	39	42	36	58	67	71	71	66	73	74
	DNR Northwest Region	48	42	27	33	32	37	45	60	61	43	61	59	61	55
	DNR Olympic Region	7	7	8	8	7	7	7	17	15	17	14	14	14	12
	DNR South Puget South Region	44	45	43	31	26	25	25	36	36	39	37	36	37	38
	DNR Southwest Region	56	58	55	43	41	42	46	67	60	57	68	66	57	58
	Federal Grants as one group														
Forest Board Transfer[5]	Capital State Forest	38	38	38	34	32	37	34	43	47	41	51	43	44	32
	OESF[4]	19	22	29	30	29	29	30	62	55	101	97	98	95	103
	Clallam County	6	8	8	6	6	7	6	15	28	18	17	17	19	17
	Clark County	11	12	11	11	9	10	6	13	16	9	12	11	13	6
	Cowlitz County	4	4	4	4	4	4	4	6	6	6	5	5	4	4
	Jefferson County	5	5	4	4	3	3	4	6	5	7	5	5	5	5
	King County	10	10	10	8	9	5	4	8	9	9	9	8	8	9
	Kitsap County	3	2	2	2	2	1	1	3	4	2	3	3	3	3
	Lewis County	14	14	14	14	13	13	14	21	19	19	20	19	17	20
	Mason County	9	8	7	7	4	3	3	10	9	8	11	9	10	8
	Pacific County	3	4	4	4	4	4	4	6	8	8	8	8	8	8
	Pierce County	4	4	4	4	4	4	4	4	4	4	5	4	5	4
	Skagit County	32	29	20	27	27	30	32	36	39	31	41	39	41	40
	Skamania County	5	6	7	7	7	6	7	15	11	15	10	13	15	8
	Snohomish County	24	24	23	23	19	22	24	29	32	31	31	29	32	29
	Thurston County	2	3	3	3	3	2	3	6	2	5	2	4	1	2
	Wahkiakum County	4	4	3	3	3	4	4	5	6	6	5	5	6	6
	Whatcom County	10	11	11	9	10	10	10	12	16	15	16	15	14	15
Westside harvest level		396	404	377	352	332	348	353	537	556	562	598	577	585	554

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								61	66	64	51	55	60	44
	DNR Northwest Region								52	51	49	38	47	49	48
	DNR Olympic Region								13	14	13	14	12	14	12
	DNR South Puget South Region								26	26	25	27	24	24	22
	DNR Southwest Region								59	59	58	47	55	50	49
	Federal Grants as one group														
Forest Board Transfer[5]	Capital State Forest								37	36	38	32	36	31	29
	OESF[4]								8	7	6	8	10	11	10
	Clallam County								15	19	19	18	16	17	17
	Clark County								9	9	9	9	8	8	8
	Cowlitz County								4	4	5	5	4	4	4
	Jefferson County								3	3	4	3	3	3	3
	King County								6	6	6	6	6	6	6
	Kitsap County								3	3	2	2	2	3	2
	Lewis County								17	17	14	18	16	16	15
	Mason County								8	8	6	7	7	6	4
	Pacific County								6	6	6	7	6	6	5
	Pierce County								1	1	1	1	1	1	1
	Skagit County								34	32	19	35	33	32	31
	Skamania County								3	4	4	4	4	4	5
	Snohomish County								28	28	27	28	26	26	19
	Thurston County								2	3	3	3	2	3	3
	Wahkiakum County								6	6	6	6	5	5	6
	Whatcom County								10	13	13	13	11	12	12
Westside harvest level		663	731	448	623	825	591	702	411	419	397	380	390	389	354

Trust Group	Ownership Group	Alternative 5							Alternative 6						
		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 South Region														
	DNR Southwest Region														
	Federal Grants as one group	335	383	370	270	299	316	313	386	418	379	316	401	347	400
Forest Board Transfer[5]	Capital State Forest	44	54	58	51	58	47	46	65	64	66	43	62	64	57
	OESF[4]	170	172	152	138	143	151	147	39	39	61	73	62	49	45
	Clallam County	27	25	30	27	22	24	26	32	33	36	26	24	24	34
	Clark County	16	15	12	12	15	13	13	20	18	18	16	19	17	19
	Cowlitz County	8	6	5	5	5	6	5	8	7	8	5	7	8	6
	Jefferson County	8	7	7	7	6	6	7	9	9	8	6	7	8	7
	King County	14	16	14	6	12	9	12	13	15	14	14	14	10	7
	Kitsap County	3	4	3	3	3	3	3	4	4	4	4	4	4	4
	Lewis County	21	22	30	25	22	20	28	28	28	29	28	29	28	29
	Mason County	12	7	8	11	9	11	12	14	13	12	11	13	13	10
	Pacific County	13	14	8	8	10	8	9	14	14	14	12	13	13	14
	Pierce County	4	8	8	6	5	5	5	1	2	7	7	7	5	4
	Skagit County	50	49	50	42	46	49	54	53	62	55	54	55	51	43
	Skamania County	16	16	18	17	13	18	19	6	5	7	17	19	19	19
	Snohomish County	40	49	40	31	38	35	30	48	49	49	48	49	45	30
	Thurston County	5	5	3	5	5	4	4	6	5	7	6	6	6	5
	Wahkiakum County	11	12	7	8	9	7	11	11	13	9	8	10	9	10
	Whatcom County	22	20	21	15	18	17	17	24	26	26	24	22	23	20
Westside harvest level		819	886	844	686	738	749	763	781	825	809	720	823	742	761

[3] Numbers represent a decade periods (1= 2004 to 2013, 2 = 2014 to 2023, etc..) except 7 which represents four years (2064 to 2067)

[4] OESF = Olympic Experimental State Forest

[5] Grays Harbor County is not included in the table above as the acres and volume harvested a significantly smaller than other counties and trust groups

Table B-7. Westside Sustainable Forestry Harvest Levels in Million Board Feet per Year by State Trust, by Alternative, for Period 2004-2067

Trusts	Alternative 1							Alternative 2							Alternative 3						
	1[6]	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	6	5	8	6	9	14	13	12	11	12	11	7	19	14	12	21	14	12
Capitol Grant	34	29	22	20	17	19	19	37	33	39	36	28	29	32	46	45	30	37	63	46	47
Charitable/Educational/Penal & Reformatory Institute	15	11	9	10	6	8	6	15	14	10	10	10	12	12	17	19	7	11	16	10	11
Community College Forest Reserve	2	2	1	2	2	1	3	1	3	1	3	2	1	3	0	4	1	3	2	1	2
Common School and Indemnity	114	127	121	111	110	109	120	174	166	191	211	209	214	203	179	203	171	227	306	197	320
Escheat	2	1	1	0	2	1	2	2	1	1	1	2	1	2	2	1	1	2	2	1	4
State Forest Board Purchase	32	29	28	24	19	29	31	39	47	34	46	32	36	31	61	52	20	41	40	38	41
State Forest Board Transfer	157	155	144	145	135	139	136	212	225	219	219	213	222	215	300	300	148	233	301	227	221
Normal School	6	5	9	7	6	8	6	12	10	8	16	12	16	10	11	11	11	17	13	15	12
Scientific School	23	25	18	17	14	14	12	22	28	23	26	27	20	21	29	50	22	21	28	22	24
University - Original	1	0	1	1	0	1	1	0	3	1	2	1	1	2	1	2	1	1	2	1	1
University - Transferred	1	10	16	7	15	13	12	13	12	22	17	30	21	12	9	25	21	17	32	20	7
Grand Total	396	404	376	350	331	350	354	536	556	562	599	577	585	554	662	731	447	622	826	592	702

Trusts	Alternative 4							Alternative 5							Alternative 6						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Agricultural School	12	11	9	6	9	10	11	12	22	26	17	15	17	15	13	20	21	17	21	16	13
Capitol Grant	29	27	23	21	22	21	14	74	65	51	46	48	52	60	59	56	44	48	49	49	54
Charitable/Educational/Penal & Reformatory Institute	12	12	12	11	8	10	8	20	19	18	13	15	18	16	26	23	21	20	21	20	22
Community College Forest Reserve	1	1	1	1	3	2	1	1	4	2	3	1	1	7	1	5	2	4	1	2	6
Common School and Indemnity	121	130	125	110	123	130	124	267	301	315	235	268	264	255	259	233	251	214	276	227	259
Escheat	1	1	2	1	1	1	3	2	2	2	2	2	2	2	2	2	1	2	2	2	3
State Forest Board Purchase	35	31	31	27	30	25	21	48	57	43	40	48	43	45	59	68	54	45	55	55	53
State Forest Board Transfer	163	166	151	170	160	158	145	324	310	297	260	272	271	284	307	325	330	313	325	303	278
Normal School	7	5	6	7	7	9	7	14	18	17	18	19	17	14	14	12	17	15	15	14	13
Scientific School	25	25	23	22	21	17	15	33	51	37	21	31	33	37	32	57	40	29	39	40	38
University - Original	1	1	1	0	1	1	1	1	3	1	1	2	2	2	1	1	2	2	2	2	1
University - Transferred	4	8	14	5	4	6	4	21	33	35	29	16	30	25	8	22	24	12	17	12	22
Grand Total	411	418	398	381	389	390	354	817	885	844	685	737	750	762	781	824	807	721	823	742	762

[6] Numbers represent a decade periods (1= 2004 to 2013, 2 = 2014 to 2023, etc..) except 7 which represents four years (2064 to 2067)

B.4. References

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Appendix C
Overview of Policies and Procedures

Appendix 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

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 state 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 reintroduction of 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 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 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 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 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 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 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 westside 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 DNR-managed 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 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 state 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 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 westside 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 is described in the discussion of spotted owls below.

Procedures for management of forest, riparian areas, and wetlands influence wildlife habitat conditions. See Section 4.2 (Forest Structure and Vegetation) 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)
- 14-004-230 Protecting Mineral Springs

C.3.2 Northern Spotted Owl

Northern spotted owl habitat requirements are addressed in DNR's Habitat Conservation Plan through the provision of habitat in nesting, roosting, and foraging management areas and in dispersal management areas. In implementing the spotted owl conservation strategy, 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.

DNR Procedure 14-004-120 directs the implementation of the Habitat Conservation Plan's conservation strategy for northern spotted owls. The procedure addresses three aspects of the conservation strategy as follows:

1. *Spotted owl nest patches*: No management activities are permitted.
2. *Spotted owl circles*: Prior to 2007, no timber harvest is allowed within certain spotted owl circles, and harvest is allowed only within non-habitat areas of several other circles. In addition to these circles (collectively referred to as "Memorandum 1" owl circles), two other groups of circles also receive explicit consideration. Timber harvest activities are allowed only in the non-habitat portions of four northern spotted owl circles in southwestern Washington, and only habitat enhancement activities are allowed in the non-habitat portion of all Status 1-Reproductive owl circles throughout DNR westside trust lands.

3. *Management activities within designated nesting, roosting, and foraging and dispersal management areas*: In watersheds where the amount of nesting, roosting, and foraging or dispersal habitat is below the 50 percent threshold, no timber harvest is allowed in areas that currently provide habitat, and only habitat enhancement activities are allowed within non-habitat portions.

DNR Procedure 14-004-120 differs from the Habitat Conservation Plan with respect to the third item above. The Habitat Conservation Plan permits timber harvest in nesting, roosting, and foraging management areas in watersheds that consist of less than 50 percent of this habitat, provided the stand still meets the definition of nesting, roosting, and foraging habitat after thinning. In addition, regeneration harvest is allowed in stands that do not count towards the required amount of nesting, roosting, and foraging habitat in a watershed.

The Habitat Conservation Plan does not designate any specific areas in the Olympic Experimental State Forest for management of spotted owl habitat. Instead, DNR has divided the Olympic Experimental State Forest into 11 landscape planning units, each made up of one or more watersheds. Within each landscape planning unit, DNR is maintaining or restoring threshold proportions of potential habitat. These proportions are (1) at least 20 percent of DNR-managed lands in the understory reinitiation to old natural forest stages, and (2) at least 40 percent of DNR-managed lands in the stem exclusion to old natural forest stages. As noted above, the forest structure classes used for analyses in this document are not the same as those by which DNR is monitoring the progress of its Habitat Conservation Plan conservation strategies. Forest structure classes serve as an analogous measure, and may provide an index for the relative changes in the amounts of these habitats over time. For this analysis, therefore, structurally complex forest can be considered a surrogate for the first (20 percent) threshold, and competitive exclusion plus structurally complex forest can be considered a surrogate for the second (40 percent) threshold.

C.3.3 Marbled Murrelet

Reflecting the lack of certainty about the specific habitat needs of marbled murrelets, the Habitat Conservation Plan defined an interim conservation strategy for this species. The interim strategy for marbled murrelets involves a habitat relationship study designed to identify marginal habitats that are expected to support murrelets. These lands (with the exception of any known occupied sites contained therein) are then managed for timber harvest. All remaining suitable habitat is surveyed for marbled murrelets, and unoccupied habitat is released for harvest on three conditions: (1) it is not in southwestern Washington; (2) it is more than 0.5 mile from a known occupied site; and (3) at least 50 percent of the suitable habitat on DNR-managed lands in the watershed will remain following harvest.

Habitat relationship studies have been conducted in the Olympic Experimental State Forest, South Coast, Columbia, Straits, and North Puget Sound Planning Units. Habitat relationships studies have not been conducted in South Puget Sound Planning Unit: neither higher quality ("reclassified") habitat (95 percent of occupied sites) nor marginal habitat (5 percent of occupied sites) has been identified. South Puget Sound is still operating under Step 1 of the interim conservation strategy, which entails identifying and deferring timber harvest of suitable habitat blocks (defined on p. IV.41 of the Habitat Conservation Plan).

Inventory surveys have been completed in South Coast, Columbia, and Straits planning units. About 80 percent of inventory surveys have been completed in the Olympic Experimental State Forest. Roughly 25 percent of inventory surveys have been completed in North Puget Sound. No inventory surveys have been completed in South Puget Sound. Surveyed, unoccupied reclassified habitat has been released, with the above three restrictions, in the portions of the Straits and South Coast Planning Units that are not situated in southwestern Washington. Reclassified habitat would not likely be released in the Olympic Experimental State Forest, Columbia, or North Puget Sound Planning Units until the long-term strategies are in place. Long-term strategy planning is moving forward for Olympic Experimental State Forest, Straits, South Coast, and Columbia Planning Units.

Suitable nesting habitat for marbled murrelets generally occurs in forested areas within 50 miles of marine waters, and is characterized by a multi-layered canopy and large, high branches that serve as nesting platforms (USFWS 1997). Most nest stands are dominated by low-elevation conifers such as Douglas-fir, western red cedar, Sitka spruce, and western hemlock (USFWS 1997). “Reclassified” habitat, which is based on predictive models built from the habitat relationship studies mentioned above, occurs in areas with the greatest potential to support nesting marbled murrelets. Unless surveyed and found unoccupied, such areas are considered “off-base,” that is, not available for timber harvest. Because murrelet habitat relationship studies have not been completed in all six westside Habitat Conservation planning units, analyses in this Environmental Impact Statement take a more general approach, using structurally complex forest as a substitute for suitable nesting habitat for marbled murrelets.

C.3.4 Other Threatened, Endangered, and Sensitive Wildlife Species

Appendix Table D-7 lists the Threatened, Endangered, and Sensitive species that are known or suspected to occur on DNR-managed westside trust lands. It includes the species’ state and federal listing status, and the habitats with which they are associated.

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
- 14-004-390 Protecting Aleutian Canada Goose Habitat

C.4. GEOMORPHOLOGY, SOILS, AND SEDIMENT

C.4.1 Current Policies and Procedures

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 are 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 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 and foraging and 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
- 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 the Department 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 the Department 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 the Department 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 6 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 6. 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 6 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 westside trust forest 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 westside trust forest 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 in all alternatives except 1 and 4 (particularly in upland and riparian areas under Alternatives 5 and 6), 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 forested westside 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 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, 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 Department of Ecology adopted updated water quality standards in June 2003 (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. 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 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.

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 (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)

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). DNR Procedures relevant to protection of water quality include:

- 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, DNR Forest Resource Plan, or Habitat Conservation Plan, whichever is more restrictive. The regulations, policies, and procedures of each document guiding forest management activities on DNR westside 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 acres in size 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 three acres, classifying the type of wetland that is within or adjacent to the proposal and determination of acres of non-forested wetlands, and determination 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 acres in size, forested and non-forested, are provided with buffers. Wetland buffers are defined as follows:

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 Westside 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 westside 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 westside planning units (not including the Olympic Experimental State Forest). The procedures for harvest in forested wetlands and their associated buffers are:

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 Westside 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 acres 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 policies for protecting aquatic systems, including fish and fish habitat. These policies are:

- 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 state 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 state forest 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 DNR-managed 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

DNR manages approximately 1.4 million acres of forested westside trust lands. 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.

The primary guiding principles for the management of the forest resource on DNR 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 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 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 DNR-managed 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 westside forested trust lands that are managed for the support of trust beneficiaries, DNR also manages some westside 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.

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Appendix D

Additional Information to Support Resource Analyses

Appendix D

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 planning units in western Washington. Site class is predominantly moderate to high on state trust land in western Washington. Four percent of these lands are highly productive Site Class I. Site Class II covers 30 percent of the westside trust lands. Site Class III covers approximately 44 percent of the trust lands. Site Class IV and Site Class V are found on 18 and 5 percent of the area, respectively.

Table D-1. Site Class for Western Washington Forested Trust Lands, by Planning Unit

	Site Class									
	I		II		III		IV		V	
Planning Unit	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Straits	410	<1%	10,456	10%	62,396	57%	32,864	30%	4,095	4%
North Puget	15,506	4%	95,098	25%	152,355	40%	75,936	20%	42,621	11%
South Puget	1,580	1%	31,653	22%	69,255	49%	34,950	25%	4,405	3%
Columbia	9,275	4%	98,741	37%	102,651	38%	48,564	18%	8,299	3%
South Coast	23,844	10%	138,845	60%	64,177	26%	4,540	2%	1,526	1%
OESF	3,076	1%	36,689	14%	156,259	61%	52,940	21%	7,694	3%
Total Acres	**53,690**	**4%**	**411,483**	**30%**	**607,094**	**44%**	**249,794**	**18%**	**68,641**	**5%**

Data Source: Model output data – SDS. Some percentages do not sum to 100 due to rounding.
OESF = Olympic Experimental State Forest

The North Puget, South Coast, and Columbia 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 westside trust lands. Site Class III occurs on 10 to 25 percent of the forestland in each planning unit. More than 60 percent of Site Class V lands are in the North Puget Planning Unit.

D.1.2 Harvest Intensity

Figures D-1, D-2, and D-3 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

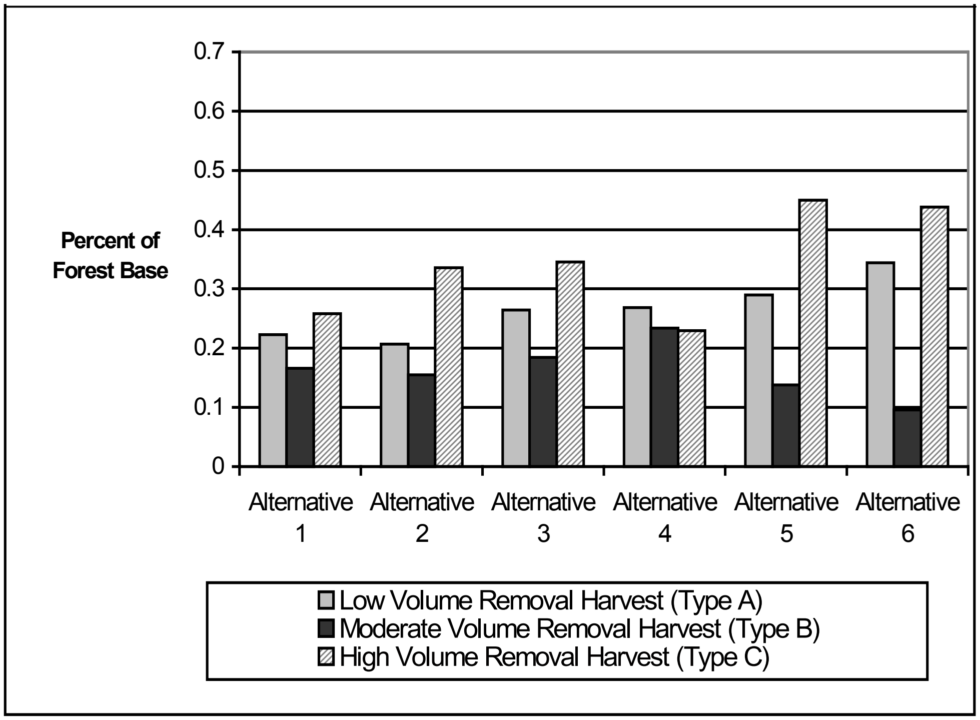

Figure D-1. Harvest Intensity in Forested Trust Lands with General Management Objectives Land Class (annual average percent of total forest base area by harvest type over the analysis period)
Data Source: Model output data (Timber Flow Level)

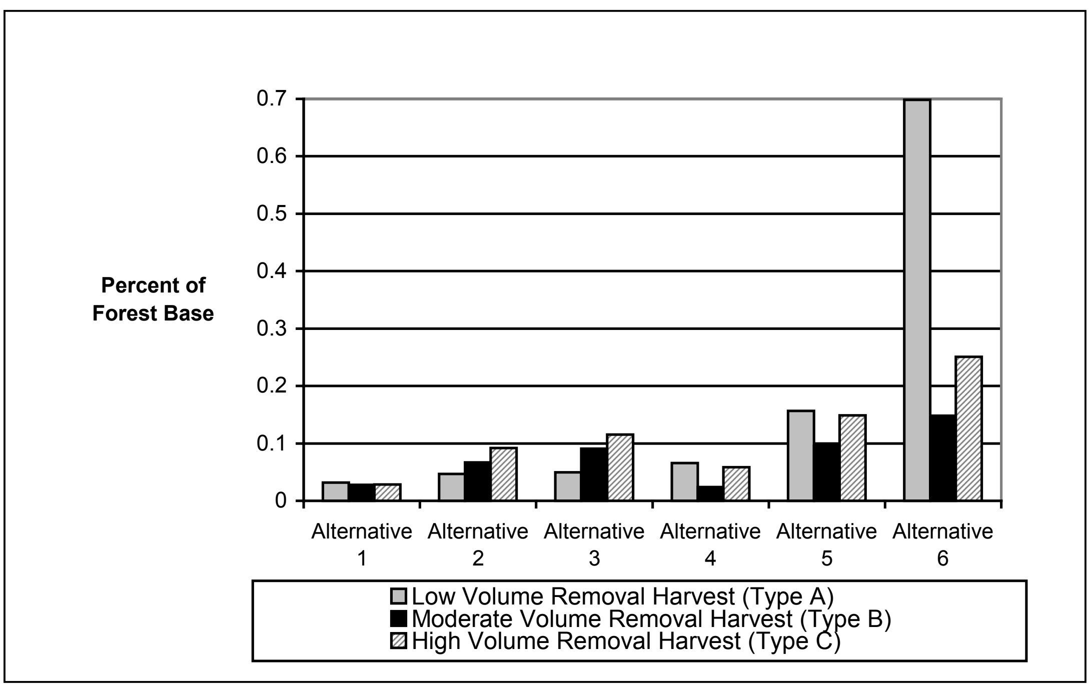

Figure D-2. Harvest Intensity in Forest Trust Lands with Specific Location Management Objectives Land Class (annual average percent of total forest base area by harvest type over the analysis period)
Data Source: Model output data (Timber Flow Level)

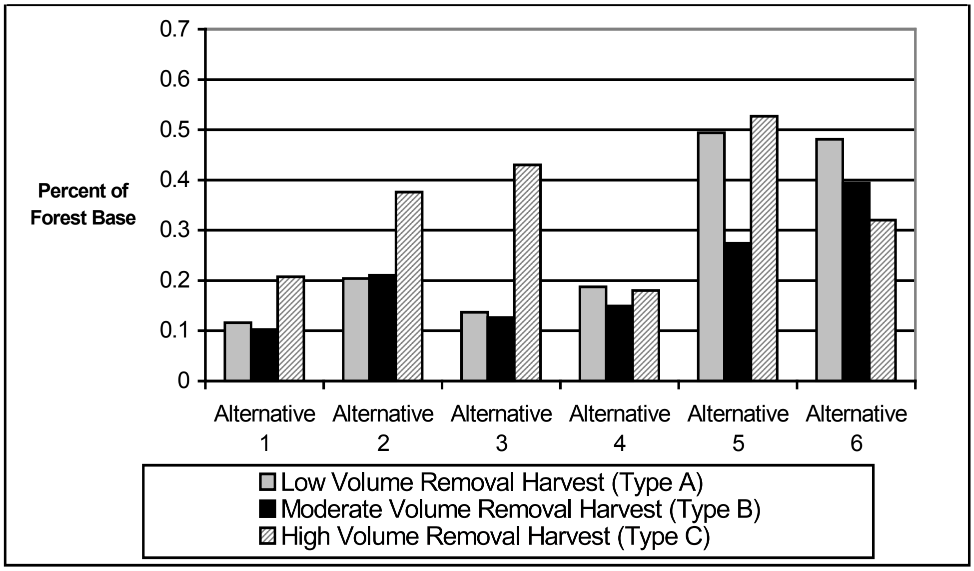

Figure D-3. Harvest Intensity on Trust Lands in the Riparian Land Class (annual average percent of total forest base area by harvest type over the analysis period)
Data Source: Model output data (Timber Flow Level)

combination of harvest constraints in riparian areas and proposed longer harvest maturity criteria. Alternatives 2, 3, 5, and 6 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. Under Alternative 6, the combination of managing some lands with economic objectives and multiple entries associated with biodiversity pathways management to enhance wildlife and riparian habitat would result in the highest level of harvest intensity among the alternatives.

Figure D-4 displays harvest type (low, moderate, and high volume removal) over time by alternative, expressed as a percent of the total DNR Westside 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 6, 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 6 would result in higher harvest intensity levels, partly due to higher amounts of thinning. Under Alternative 6, biodiversity pathways management would entail multiple harvest entries to encourage the development of stand structure needed for wildlife habitat and riparian structure.

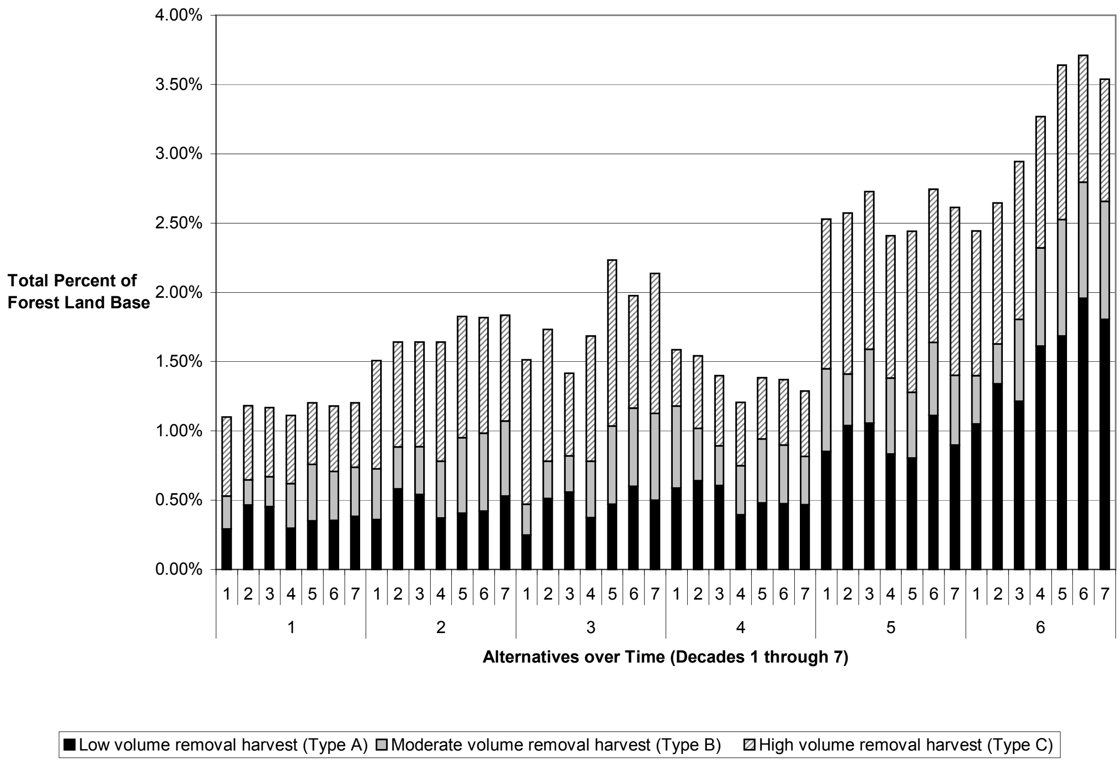

Figure D-4. Harvest Intensity by Alternative (average annual percent of Westside Trust Lands by harvest type)
Data Source: Model output data (Timber Flow Level)

Harvest intensity viewed at the planning unit level shows a similar pattern, with the following exceptions (Tables D-2 and D-3). The Olympic Experimental State Forest Planning Unit (OESF) would consistently have lower harvest levels than the other planning units in Alternatives 1, 2, 3 and 4. Under Alternatives 5 and 6, there is an increased percentage of low volume removal harvest in the OESF. In Alternatives 1, 2, 3, and 4, South Coast Planning Unit would have a slightly higher harvest intensity than the other planning units.

Table D-2. Harvest Intensity by Planning Unit for Westside Trust Lands

		Average Annual Percent of Planning Unit Area Affected		
Alternative	**Planning Unit**	**Low Volume Removal Harvest (Harvest Type A)**	**Moderate Volume Removal Harvest (Harvest Type B)**	**High Volume Removal Harvest (Harvest Type C)**
1	Columbia	0.5%	0.4%	0.6%
	North Puget	0.4%	0.3%	0.6%
	OESF[1/]	<0.1%	0.1%	0.2%
	South Coast	0.5%	0.4%	0.6%
	South Puget	0.5%	0.4%	0.6%
	Straits	0.3%	0.2%	0.3%
2	Columbia	0.5%	0.4%	0.9%
	North Puget	0.6%	0.5%	0.7%
	OESF	0.2%	0.1%	0.7%
	South Coast	0.6%	0.6%	1.0%
	South Puget	0.4%	0.5%	0.8%
	Straits	0.5%	0.6%	0.8%
3	Columbia	0.6%	0.5%	1.0%
	North Puget	0.5%	0.4%	0.8%
	OESF	0.1%	0.2%	0.9%
	South Coast	0.6%	0.6%	1.0%
	South Puget	0.3%	0.3%	1.0%
	Straits	0.6%	0.6%	1.1%
4	Columbia	0.6%	0.5%	0.6%
	North Puget	0.6%	0.4%	0.5%
	OESF	0.1%	0.1%	<0.1%
	South Coast	0.7%	0.6%	0.7%
	South Puget	0.5%	0.4%	0.4%
	Straits	0.8%	0.8%	0.5%
5	Columbia	0.8%	0.5%	1.2%
	North Puget	0.8%	0.5%	1.0%
	OESF	1.3%	0.3%	1.2%
	South Coast	0.7%	0.6%	1.2%
	South Puget	0.9%	0.6%	0.9%
	Straits	1.0%	0.6%	1.1%
6	Columbia	1.4%	0.8%	1.3%
	North Puget	1.2%	0.6%	1.0%
	OESF	3.0%	0.6%	0.2%
	South Coast	0.8%	0.6%	1.6%
	South Puget	1.5%	0.9%	0.8%
	Straits	1.0%	0.5%	1.3%

[1/] OESF = Olympic Experimental State Forest
Data Source: Model output data (Timber Flow Level)

Table D-3. Summary of Management Intensity for DNR Planning Units by Alternative

	Decadal Average of Acres Harvested by Type of Harvest (Volume of Harvest Removed)			
Alternative 1				
Planning Unit	**A[1/]**	**B[2/]**	**C[3/]**	**All types**
Columbia	12,783	10,016	16,580	39,379
North Puget	15,521	11,166	20,175	46,862
Olympic Experimental State Forest	1,276	1,736	5,252	8,264
South Coast	11,453	9,367	14,347	35,167
South Puget	7,281	5,356	9,056	21,693
Straits	3,107	2,850	4,101	10,059
Grand Total	**51,421**	**40,492**	**69,511**	**161,424**
Alternative 2				
Planning Unit	**A**	**B**	**C**	**All types**
Columbia	11,941	10,814	24,073	46,828
North Puget	21,403	17,643	27,607	66,653
Olympic Experimental State Forest	4,478	3,595	17,757	25,830
South Coast	13,529	14,224	23,144	50,897
South Puget	6,268	6,489	10,895	23,652
Straits	5,273	6,938	8,739	20,950
Grand Total	**62,892**	**59,702**	**112,215**	**234,809**
Alternative 3				
Planning Unit	**A**	**B**	**C**	**All types**
Columbia	14,673	12,327	26,823	53,823
North Puget	20,746	13,846	30,552	65,144
Olympic Experimental State Forest	2,636	5,075	22,291	30,003
South Coast	14,863	13,470	24,007	52,340
South Puget	4,854	4,518	12,836	22,208
Straits	6,633	5,915	11,802	24,350
Grand Total	**64,406**	**55,151**	**128,311**	**247,868**
Alternative 4				
Planning Unit	**A**	**B**	**C**	**All types**
Columbia	15,701	13,413	15,284	44,398
North Puget	23,394	14,573	20,497	58,464
Olympic Experimental State Forest	1,568	2,152	896	4,616
South Coast	17,085	13,906	17,119	48,109
South Puget	7,028	5,833	5,420	18,281
Straits	8,479	7,423	5,868	21,770
Grand Total	**73,255**	**57,299**	**65,083**	**195,637**
Alternative 5				
Planning Unit	**A**	**B**	**C**	**All types**
Columbia	22,869	13,493	32,468	68,831
North Puget	30,434	18,231	36,153	84,818
Olympic Experimental State Forest	36,510	8,149	31,011	75,670
South Coast	17,144	14,743	29,086	60,973
South Puget	13,940	8,543	14,472	36,955
Straits	10,694	7,540	12,230	30,463
Grand Total	**131,591**	**70,699**	**155,421**	**357,710**

Table D-3. Summary of Management Intensity for Planning Units by Alternative (continued)

	Decadal Average of Acres Harvested by Type of Harvest (Volume of Harvest Removed)			
Alternative 6				
Planning Unit	**A**	**B**	**C**	**All types**
Columbia	37,401	19,369	33,453	90,223
North Puget	43,729	20,260	38,837	102,826
Olympic Experimental State Forest	76,696	15,640	5,267	97,602
South Coast	19,055	12,421	37,682	69,157
South Puget	20,412	12,777	12,326	45,515
Straits	10,930	5,374	14,421	30,726
Grand Total	**208,222**	**85,842**	**141,987**	**436,050**

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

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D.2 ADDITIONAL DATA FOR THREATENED, ENDANGERED, AND SENSITIVE PLANTS

Table D-4 provides detailed information on Washington threatened, endangered, and sensitive vascular plants.

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Table D-4. Washington Threatened, Endangered, and Sensitive Vascular Plants for Counties with DNR State 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 AK; 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-4. Washington Threatened, Endangered, and Sensitive Vascular Plants for Counties with DNR State 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-4. Washington Threatened, Endangered, and Sensitive Vascular Plants for Counties with DNR State 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. S1S2) 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. G1G2) 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 (USESA) 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-5a through D-5f and D-6a through D-6f present detailed riparian data by Alternative.

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Table D-5a. Percentage Distribution of Stand Development Stages in Riparian Areas Under Alternative 1, by Planning Unit and Year

		Percent of Riparian Areas - Alternative 1									
HCP Unit	**Year**	**Ecosystem Initiation**	**Sapling Exclusion**	**Pole Exclusion**	**Large Tree Exclusion**	**Understory Reinitiation**	**Developed Understory**	**Botanically Diverse**	**Niche Diversification**	**Fully Functional**	**Old Growth - Natural**
Columbia	2004	5.7%	12.3%	17.5%	52.4%	1.2%	0.5%	6.4%	3.4%	0.3%	0.3%
	2008	3.9%	11.1%	15.4%	53.2%	2.3%	0.5%	7.8%	5.2%	0.3%	0.3%
	2013	1.9%	8.6%	15.4%	51.8%	3.5%	0.6%	10.1%	7.4%	0.4%	0.3%
	2031	2.0%	0.8%	11.1%	42.2%	6.2%	0.8%	21.9%	12.9%	1.7%	0.3%
	2048	3.3%	1.3%	4.8%	32.4%	6.3%	0.9%	31.5%	14.9%	4.4%	0.3%
	2067	2.4%	1.2%	4.8%	23.9%	7.3%	1.1%	35.7%	12.2%	11.1%	0.3%
N. Puget	2004	5.4%	13.6%	14.4%	51.0%	5.5%	0.6%	5.5%	3.3%	0.3%	0.3%
	2008	3.5%	12.5%	15.0%	48.6%	7.0%	0.7%	7.6%	4.4%	0.4%	0.3%
	2013	1.8%	8.5%	17.4%	44.7%	8.2%	0.7%	9.5%	8.4%	0.4%	0.3%
	2031	1.7%	1.6%	10.5%	41.7%	8.5%	1.0%	16.8%	16.8%	0.8%	0.5%
	2048	2.6%	1.5%	5.1%	35.9%	9.9%	1.2%	24.6%	16.2%	2.6%	0.5%
	2067	2.4%	1.5%	4.7%	27.1%	11.3%	1.3%	29.3%	14.5%	7.4%	0.5%
OESF	2004	4.6%	25.1%	29.0%	21.0%	1.6%	0.1%	12.8%	4.3%	1.1%	0.3%
	2008	2.6%	20.8%	30.4%	23.8%	2.1%	0.2%	13.6%	5.1%	1.1%	0.3%
	2013	0.9%	11.9%	33.8%	28.5%	2.3%	0.2%	14.4%	6.5%	1.1%	0.3%
	2031	1.6%	0.9%	14.8%	49.7%	3.6%	0.4%	18.3%	8.8%	1.8%	0.3%
	2048	2.0%	1.4%	3.6%	48.3%	5.5%	0.4%	23.4%	12.4%	2.5%	0.4%
	2067	2.0%	1.4%	3.3%	30.3%	5.8%	0.4%	27.5%	23.1%	5.4%	0.8%
S. Coast	2004	4.9%	11.6%	15.5%	55.2%	1.4%	0.3%	6.8%	4.1%	0.1%	0.0%
	2008	2.9%	9.2%	17.9%	51.7%	2.6%	0.4%	8.3%	6.9%	0.1%	0.0%
	2013	1.6%	5.5%	19.3%	48.8%	3.5%	0.4%	11.2%	9.5%	0.3%	0.0%
	2031	1.8%	0.8%	5.7%	44.2%	4.6%	0.7%	22.4%	17.1%	2.7%	0.0%
	2048	3.4%	1.1%	4.2%	29.6%	6.0%	0.7%	31.0%	16.4%	7.6%	0.0%
	2067	2.3%	1.5%	5.6%	20.5%	6.4%	1.0%	34.1%	13.2%	15.4%	0.0%
S. Puget	2004	5.6%	12.9%	16.7%	55.1%	1.4%	1.0%	3.8%	3.5%	0.1%	0.0%
	2008	2.3%	14.0%	15.5%	55.4%	2.3%	1.0%	4.8%	4.3%	0.3%	0.0%
	2013	1.8%	8.7%	18.2%	53.0%	3.7%	1.1%	6.7%	6.4%	0.5%	0.0%
	2031	2.0%	1.6%	10.3%	49.7%	6.2%	1.5%	17.1%	10.7%	0.9%	0.0%
	2048	3.2%	1.3%	4.0%	42.4%	6.5%	1.9%	24.5%	14.2%	2.0%	0.0%
	2067	2.7%	1.8%	3.9%	32.3%	7.2%	2.1%	33.4%	10.8%	5.8%	0.0%
Straits	2004	5.4%	12.9%	9.9%	65.1%	2.2%	0.9%	2.2%	1.5%	0.0%	0.0%
	2008	4.0%	11.0%	12.1%	63.8%	3.5%	0.9%	2.7%	2.0%	0.0%	0.0%
	2013	2.2%	9.1%	13.9%	61.6%	4.7%	1.0%	3.6%	3.9%	0.0%	0.0%
	2031	1.2%	1.3%	12.0%	54.6%	6.6%	1.3%	13.4%	9.5%	0.1%	0.0%
	2048	1.5%	1.5%	3.8%	50.4%	7.6%	1.6%	23.0%	9.5%	0.9%	0.0%
	2067	2.2%	1.2%	3.8%	39.2%	8.8%	1.6%	32.3%	8.5%	2.4%	0.0%
Westside Total	2004	5.2%	15.9%	19.0%	45.3%	2.3%	0.4%	7.5%	3.7%	0.4%	0.2%
	2008	3.1%	13.8%	19.6%	44.9%	3.4%	0.5%	8.9%	5.1%	0.5%	0.2%
	2013	1.6%	8.9%	21.5%	44.2%	4.3%	0.5%	10.7%	7.5%	0.6%	0.2%
	2031	1.8%	1.1%	10.9%	45.6%	5.7%	0.8%	19.1%	13.1%	1.6%	0.3%
	2048	2.7%	1.4%	4.3%	38.4%	6.9%	0.9%	26.8%	14.5%	3.8%	0.3%
	2067	2.3%	1.4%	4.4%	27.0%	7.7%	1.0%	31.5%	15.4%	8.8%	0.4%

Table D-5b. Percentage Distribution of Stand Development Stages in Riparian Areas Under Alternative 2, by Planning Unit and Year

		Percent of Riparian Areas - Alternative 2									
HCP Unit	**Year**	**Ecosystem Initiation**	**Sapling Exclusion**	**Pole Exclusion**	**Large Tree Exclusion**	**Understory Reinitiation**	**Developed Understory**	**Botanically Diverse**	**Niche Diversification**	**Fully Functional**	**Old Growth - Natural**
Columbia	2004	6.2%	12.0%	17.2%	52.0%	1.5%	0.8%	6.4%	3.4%	0.3%	0.3%
	2008	4.6%	10.9%	15.3%	52.5%	2.3%	0.9%	7.6%	5.3%	0.3%	0.3%
	2013	2.9%	8.6%	15.3%	50.6%	3.7%	1.0%	9.5%	7.8%	0.4%	0.3%
	2031	3.5%	1.7%	11.6%	39.9%	6.2%	1.2%	19.8%	13.9%	1.8%	0.4%
	2048	5.7%	2.6%	6.5%	29.9%	6.8%	1.2%	27.7%	15.2%	4.2%	0.3%
	2067	4.4%	3.2%	7.3%	22.2%	8.9%	1.3%	29.9%	13.7%	8.9%	0.3%
N. Puget	2004	5.9%	13.4%	14.2%	50.9%	5.3%	0.9%	5.4%	3.4%	0.2%	0.3%
	2008	4.6%	12.3%	14.8%	47.9%	7.0%	0.9%	7.4%	4.5%	0.4%	0.3%
	2013	3.1%	8.5%	17.1%	44.0%	8.0%	1.0%	9.2%	8.4%	0.4%	0.3%
	2031	2.9%	2.3%	11.1%	39.5%	9.1%	1.4%	15.8%	16.4%	1.0%	0.5%
	2048	4.1%	2.6%	6.4%	32.9%	11.1%	1.6%	22.6%	15.7%	2.5%	0.5%
	2067	4.0%	3.0%	6.3%	25.5%	12.8%	1.8%	26.7%	13.2%	6.4%	0.5%
OESF	2004	4.8%	25.0%	28.8%	20.3%	2.3%	0.3%	12.8%	4.3%	1.1%	0.3%
	2008	3.2%	20.7%	30.1%	23.0%	2.5%	0.3%	13.3%	5.4%	1.2%	0.3%
	2013	2.0%	11.8%	33.4%	27.9%	2.8%	0.4%	12.4%	7.8%	1.2%	0.3%
	2031	4.1%	2.6%	14.9%	46.2%	4.2%	0.8%	14.3%	10.8%	2.0%	0.3%
	2048	6.2%	5.1%	6.1%	41.6%	6.6%	1.0%	17.8%	12.9%	2.4%	0.4%
	2067	6.7%	5.9%	8.8%	25.9%	7.2%	1.0%	20.2%	18.8%	4.9%	0.7%
S. Coast	2004	5.5%	11.3%	15.3%	55.0%	1.3%	0.7%	6.8%	4.1%	0.1%	0.0%
	2008	4.1%	8.9%	17.7%	51.1%	2.4%	0.7%	7.8%	7.1%	0.2%	0.0%
	2013	3.3%	5.5%	18.9%	47.2%	3.7%	0.8%	10.3%	9.8%	0.5%	0.0%
	2031	3.0%	1.8%	7.1%	40.8%	5.7%	1.2%	19.8%	17.9%	2.6%	0.0%
	2048	5.8%	2.7%	5.6%	25.9%	7.9%	1.2%	26.6%	16.9%	7.4%	0.0%
	2067	5.4%	3.0%	7.7%	18.4%	9.5%	1.3%	26.8%	14.4%	13.5%	0.0%
S. Puget	2004	5.7%	12.8%	16.6%	55.0%	1.3%	1.2%	3.8%	3.5%	0.1%	0.0%
	2008	2.8%	13.8%	15.4%	55.3%	2.0%	1.3%	4.8%	4.3%	0.3%	0.0%
	2013	2.3%	8.6%	18.0%	53.2%	3.0%	1.4%	6.6%	6.4%	0.6%	0.0%
	2031	2.6%	1.8%	10.3%	50.4%	4.7%	1.8%	17.0%	10.4%	1.0%	0.0%
	2048	4.2%	2.2%	4.5%	42.7%	5.2%	2.1%	23.9%	13.3%	1.8%	0.0%
	2067	3.1%	2.8%	5.5%	32.1%	7.1%	2.2%	32.2%	9.9%	5.0%	0.0%
Straits	2004	5.9%	12.5%	9.7%	65.5%	1.3%	1.4%	2.2%	1.5%	0.0%	0.0%
	2008	4.7%	10.7%	11.8%	63.8%	2.7%	1.5%	2.5%	2.3%	0.0%	0.0%
	2013	3.5%	8.7%	13.6%	61.0%	4.2%	1.6%	3.3%	4.0%	0.2%	0.0%
	2031	3.7%	2.2%	11.8%	49.3%	8.8%	2.2%	11.9%	9.7%	0.3%	0.0%
	2048	4.2%	3.0%	5.1%	42.8%	10.5%	2.8%	20.6%	9.8%	1.1%	0.0%
	2067	5.1%	2.9%	5.9%	31.0%	12.5%	2.9%	26.0%	9.9%	3.8%	0.0%
Westside Total	2004	5.6%	15.7%	18.8%	45.0%	2.5%	0.7%	7.5%	3.7%	0.4%	0.2%
	2008	4.0%	13.6%	19.3%	44.3%	3.4%	0.8%	8.6%	5.3%	0.5%	0.2%
	2013	2.8%	8.8%	21.2%	43.3%	4.4%	0.8%	9.8%	8.0%	0.6%	0.2%
	2031	3.4%	2.1%	11.4%	42.9%	6.2%	1.2%	16.9%	13.9%	1.7%	0.3%
	2048	5.3%	3.3%	6.0%	34.5%	7.9%	1.4%	23.2%	14.6%	3.6%	0.3%
	2067	5.0%	3.8%	7.4%	24.4%	9.4%	1.5%	26.1%	14.5%	7.6%	0.4%

Table D-5c. Percentage Distribution of Stand Development Stages in Riparian Areas Under Alternative 3, by Planning Unit and Year

		Percent of Riparian Areas - Alternative 3									
HCP Unit	**Year**	**Ecosystem Initiation**	**Sapling Exclusion**	**Pole Exclusion**	**Large Tree Exclusion**	**Understory Reinitiation**	**Developed Understory**	**Botanically Diverse**	**Niche Diversification**	**Fully Functional**	**Old Growth - Natural**
Columbia	2004	6.0%	12.2%	17.4%	51.8%	1.6%	0.5%	6.1%	3.7%	0.3%	0.3%
	2008	4.9%	11.1%	15.4%	51.6%	3.1%	0.6%	7.0%	5.8%	0.3%	0.3%
	2013	3.7%	8.7%	15.4%	49.2%	4.6%	0.6%	8.8%	8.2%	0.4%	0.3%
	2031	3.7%	2.5%	11.8%	38.8%	7.1%	0.9%	18.7%	14.4%	1.8%	0.3%
	2048	6.3%	3.0%	7.0%	29.1%	8.0%	0.9%	25.1%	16.2%	4.1%	0.3%
	2067	5.2%	3.8%	7.9%	22.0%	10.2%	1.1%	25.4%	15.7%	8.4%	0.3%
N. Puget	2004	5.8%	13.6%	14.3%	51.4%	5.0%	0.6%	5.6%	3.2%	0.2%	0.3%
	2008	3.7%	12.5%	15.0%	50.1%	5.5%	0.7%	7.5%	4.4%	0.3%	0.3%
	2013	2.2%	8.7%	17.4%	45.3%	7.3%	0.7%	9.3%	8.4%	0.4%	0.3%
	2031	3.9%	2.3%	10.9%	38.4%	10.1%	1.1%	15.2%	16.7%	0.9%	0.5%
	2048	5.0%	2.8%	6.8%	31.7%	11.9%	1.2%	20.7%	16.9%	2.4%	0.5%
	2067	3.8%	4.2%	6.8%	24.5%	13.9%	1.5%	23.7%	14.9%	6.3%	0.5%
OESF	2004	4.6%	25.1%	29.1%	21.0%	1.5%	0.1%	12.8%	4.3%	1.1%	0.3%
	2008	2.9%	20.8%	30.3%	23.8%	2.0%	0.2%	12.5%	5.9%	1.2%	0.3%
	2013	1.6%	11.8%	33.8%	28.5%	2.4%	0.2%	12.7%	7.4%	1.1%	0.3%
	2031	3.3%	1.4%	15.1%	47.7%	4.6%	0.4%	14.0%	11.3%	1.9%	0.3%
	2048	6.4%	4.9%	4.7%	37.4%	11.6%	0.5%	16.0%	15.5%	2.5%	0.4%
	2067	9.7%	8.0%	8.6%	18.9%	12.4%	0.6%	12.7%	23.9%	4.5%	0.6%
S. Coast	2004	5.3%	11.6%	15.5%	54.8%	1.6%	0.3%	6.5%	4.3%	0.1%	0.0%
	2008	4.2%	9.2%	17.9%	50.6%	3.0%	0.4%	7.2%	7.5%	0.1%	0.0%
	2013	3.4%	5.6%	19.2%	47.3%	4.0%	0.4%	9.5%	10.3%	0.3%	0.0%
	2031	3.8%	2.4%	7.1%	39.6%	6.2%	0.8%	17.7%	19.8%	2.7%	0.0%
	2048	7.9%	2.6%	6.4%	24.5%	9.7%	0.8%	22.0%	19.4%	6.6%	0.0%
	2067	4.3%	4.0%	9.5%	17.6%	11.6%	1.1%	22.7%	17.0%	12.1%	0.0%
S. Puget	2004	5.7%	12.9%	16.6%	55.1%	1.4%	1.0%	3.8%	3.5%	0.1%	0.0%
	2008	2.9%	13.9%	15.5%	54.9%	2.4%	1.0%	4.8%	4.3%	0.3%	0.0%
	2013	2.6%	8.7%	18.2%	52.3%	3.7%	1.0%	6.5%	6.3%	0.5%	0.0%
	2031	2.0%	2.2%	10.6%	50.6%	5.0%	1.4%	16.9%	10.2%	1.0%	0.0%
	2048	4.8%	2.0%	4.7%	41.3%	6.7%	1.8%	22.9%	14.1%	1.7%	0.0%
	2067	4.6%	3.0%	5.6%	30.4%	8.7%	2.0%	30.8%	10.6%	4.4%	0.0%
Straits	2004	5.6%	12.9%	9.9%	66.0%	1.2%	0.9%	2.0%	1.6%	0.0%	0.0%
	2008	4.9%	11.0%	12.0%	62.3%	4.2%	1.1%	2.1%	2.5%	0.0%	0.0%
	2013	5.0%	9.3%	13.7%	54.4%	9.3%	1.2%	3.0%	4.2%	0.1%	0.0%
	2031	3.9%	3.8%	11.9%	44.8%	12.9%	1.5%	9.7%	11.3%	0.2%	0.0%
	2048	6.1%	2.9%	6.9%	39.9%	13.5%	1.9%	14.8%	13.5%	0.6%	0.0%
	2067	5.7%	5.8%	6.6%	28.6%	16.4%	2.4%	20.2%	13.2%	1.1%	0.0%
Westside Total	2004	5.4%	15.9%	19.0%	45.2%	2.3%	0.5%	7.4%	3.7%	0.4%	0.2%
	2008	3.8%	13.8%	19.5%	44.6%	3.3%	0.5%	8.2%	5.5%	0.5%	0.2%
	2013	2.7%	8.9%	21.5%	43.1%	4.7%	0.6%	9.6%	8.1%	0.6%	0.2%
	2031	3.5%	2.2%	11.5%	42.4%	7.1%	0.9%	16.0%	14.6%	1.7%	0.3%
	2048	6.2%	3.3%	6.1%	32.5%	10.3%	1.0%	20.5%	16.5%	3.4%	0.3%
	2067	5.9%	5.0%	7.9%	21.9%	12.0%	1.2%	21.4%	17.4%	7.0%	0.3%

Table D-5d. Percentage Distribution of Stand Development Stages in Riparian Areas Under Alternative 4, by Planning Unit and Year

HCP Unit	Year	Ecosystem Initiation	Sapling Exclusion	Pole Exclusion	Large Tree Exclusion	Understory Reinitiation	Developed Understory	Botanically Diverse	Niche Diversification	Fully Functional	Old Growth - Natural
		Percent of Riparian Areas - Alternative 4									
Columbia	2004	5.8%	12.2%	17.5%	51.9%	1.5%	0.5%	6.2%	3.7%	0.3%	0.4%
	2008	4.0%	11.1%	15.4%	52.3%	2.5%	0.6%	7.7%	5.7%	0.4%	0.4%
	2013	2.0%	8.7%	15.3%	51.0%	3.2%	0.7%	10.0%	8.1%	0.7%	0.4%
	2031	2.6%	1.0%	11.1%	43.3%	4.1%	0.9%	21.7%	12.5%	2.5%	0.4%
	2048	4.3%	1.8%	5.1%	32.6%	4.8%	0.8%	32.5%	11.0%	6.6%	0.4%
	2067	6.5%	3.4%	5.5%	24.7%	5.7%	0.9%	35.8%	5.7%	11.3%	0.4%
N. Puget	2004	5.5%	13.6%	14.4%	50.6%	5.8%	0.7%	5.6%	3.3%	0.3%	0.3%
	2008	3.6%	12.5%	15.0%	47.6%	7.6%	0.8%	7.6%	4.6%	0.4%	0.3%
	2013	2.0%	8.6%	17.3%	43.5%	8.6%	0.9%	9.4%	8.9%	0.6%	0.3%
	2031	2.1%	1.9%	10.5%	40.3%	8.9%	1.1%	17.1%	16.4%	1.2%	0.5%
	2048	5.0%	1.9%	5.5%	34.5%	9.7%	1.2%	23.5%	14.3%	3.9%	0.5%
	2067	5.4%	3.5%	6.3%	26.3%	10.3%	1.4%	28.1%	9.4%	8.8%	0.5%
OESF	2004	4.6%	25.1%	29.0%	21.1%	1.6%	0.1%	12.8%	4.3%	1.1%	0.3%
	2008	2.6%	20.8%	30.3%	23.9%	2.0%	0.2%	13.5%	5.3%	1.2%	0.3%
	2013	0.9%	11.8%	33.8%	28.5%	2.5%	0.2%	14.3%	6.5%	1.2%	0.3%
	2031	1.0%	0.8%	14.8%	50.8%	2.8%	0.4%	18.3%	8.9%	1.9%	0.3%
	2048	1.5%	0.7%	3.5%	50.6%	3.8%	0.4%	23.6%	12.8%	2.7%	0.4%
	2067	1.4%	1.1%	2.5%	31.6%	4.2%	0.4%	28.9%	23.5%	5.6%	0.8%
S. Coast	2004	5.0%	11.6%	15.5%	54.4%	2.0%	0.4%	6.7%	4.3%	0.1%	0.0%
	2008	3.0%	9.2%	17.8%	49.8%	3.4%	0.4%	7.9%	7.8%	0.6%	0.0%
	2013	2.0%	5.6%	19.0%	46.5%	3.9%	0.5%	10.4%	11.0%	1.0%	0.0%
	2031	3.9%	1.1%	5.9%	42.2%	5.1%	0.7%	20.7%	16.8%	3.6%	0.0%
	2048	5.0%	2.5%	5.1%	27.9%	6.3%	0.8%	28.4%	14.3%	9.8%	0.0%
	2067	8.7%	3.6%	6.6%	20.3%	6.9%	1.0%	30.0%	7.1%	15.8%	0.1%
S. Puget	2004	5.5%	12.9%	16.7%	55.2%	1.3%	1.0%	3.8%	3.6%	0.1%	0.0%
	2008	2.2%	13.9%	15.5%	55.6%	1.7%	1.1%	5.0%	4.7%	0.3%	0.0%
	2013	1.5%	8.6%	18.2%	53.3%	2.9%	1.2%	7.0%	6.9%	0.6%	0.0%
	2031	1.7%	1.4%	10.2%	51.9%	3.7%	1.5%	18.0%	10.3%	1.3%	0.0%
	2048	3.2%	1.4%	4.1%	44.6%	4.0%	1.6%	25.8%	12.6%	2.6%	0.0%
	2067	3.5%	2.0%	4.5%	34.1%	4.9%	1.7%	35.3%	8.4%	5.6%	0.0%
Straits	2004	5.3%	12.9%	9.9%	64.5%	2.7%	1.0%	2.2%	1.5%	0.0%	0.0%
	2008	3.9%	11.0%	12.0%	62.2%	4.6%	1.1%	2.5%	2.6%	0.1%	0.0%
	2013	2.6%	9.0%	13.9%	58.3%	6.6%	1.2%	3.4%	4.9%	0.2%	0.0%
	2031	3.3%	1.8%	11.5%	49.8%	8.9%	1.5%	11.8%	10.5%	0.9%	0.0%
	2048	6.0%	2.9%	4.5%	43.7%	9.9%	1.7%	19.4%	10.0%	2.0%	0.0%
	2067	5.7%	3.9%	7.2%	31.6%	10.1%	1.8%	25.4%	9.6%	4.7%	0.0%
Westside Total	2004	5.2%	15.9%	19.0%	44.9%	2.6%	0.5%	7.5%	3.8%	0.4%	0.2%
	2008	3.2%	13.8%	19.5%	44.1%	3.7%	0.6%	8.7%	5.5%	0.6%	0.2%
	2013	1.7%	8.9%	21.4%	43.2%	4.4%	0.6%	10.5%	8.2%	0.8%	0.2%
	2031	2.3%	1.2%	10.9%	45.4%	5.2%	0.8%	18.8%	12.9%	2.1%	0.3%
	2048	3.8%	1.7%	4.6%	38.3%	6.1%	0.9%	26.3%	12.9%	5.1%	0.3%
	2067	5.1%	2.8%	5.1%	27.1%	6.7%	1.0%	30.7%	11.8%	9.3%	0.4%

Table D-5e. Percentage Distribution of Stand Development Stages in Riparian Areas Under Alternative 5, by Planning Unit and Year

		Percent of Riparian Areas - Alternative 5									
HCP Unit	**Year**	**Ecosystem Initiation**	**Sapling Exclusion**	**Pole Exclusion**	**Large Tree Exclusion**	**Understory Reinitiation**	**Developed Understory**	**Botanically Diverse**	**Niche Diversification**	**Fully Functional**	**Old Growth - Natural**
Columbia	2004	7.8%	13.4%	22.9%	48.8%	3.5%	0.5%	2.2%	0.5%	0.3%	0.1%
	2008	6.4%	12.3%	19.9%	51.7%	5.3%	0.7%	2.3%	0.9%	0.4%	0.1%
	2013	5.3%	9.5%	18.1%	52.6%	7.7%	0.9%	3.1%	2.2%	0.6%	0.1%
	2031	6.9%	2.6%	13.2%	45.8%	10.5%	1.1%	9.9%	9.0%	0.9%	0.1%
	2048	8.4%	4.7%	9.1%	29.6%	9.7%	1.1%	20.4%	14.3%	2.8%	0.1%
	2067	7.4%	3.8%	9.5%	21.3%	10.6%	1.1%	21.1%	16.4%	8.7%	0.1%
N. Puget	2004	8.0%	15.3%	15.8%	50.2%	5.9%	0.6%	2.7%	0.9%	0.3%	0.3%
	2008	6.3%	14.1%	15.7%	50.7%	7.4%	0.8%	3.2%	1.2%	0.3%	0.3%
	2013	4.7%	10.5%	17.0%	50.4%	9.7%	1.0%	4.2%	1.8%	0.4%	0.3%
	2031	5.6%	2.7%	12.4%	41.3%	12.1%	1.3%	10.8%	12.7%	0.6%	0.5%
	2048	7.4%	4.0%	7.6%	27.8%	12.3%	1.3%	20.1%	16.8%	2.4%	0.2%
	2067	6.2%	4.4%	8.0%	19.6%	13.3%	1.4%	23.3%	16.3%	7.4%	0.2%
OESF	2004	6.7%	27.6%	28.2%	20.9%	2.7%	0.2%	8.1%	1.1%	4.3%	0.3%
	2008	5.3%	24.0%	28.5%	23.8%	3.8%	0.3%	8.0%	1.8%	4.4%	0.3%
	2013	5.3%	14.9%	29.1%	28.8%	5.6%	0.4%	8.0%	3.5%	4.0%	0.4%
	2031	12.2%	6.5%	12.9%	33.4%	10.5%	0.9%	6.5%	11.1%	5.7%	0.3%
	2048	12.0%	13.5%	10.7%	19.2%	9.3%	0.7%	5.0%	17.1%	12.2%	0.2%
	2067	12.2%	13.4%	14.1%	16.8%	7.0%	0.9%	5.7%	16.5%	12.6%	0.7%
S. Coast	2004	8.8%	14.4%	14.6%	55.3%	2.4%	0.4%	2.2%	1.7%	0.1%	0.0%
	2008	7.9%	10.9%	17.3%	52.8%	4.6%	0.5%	2.9%	3.0%	0.2%	0.0%
	2013	6.9%	6.3%	19.2%	51.3%	6.5%	0.5%	4.3%	4.6%	0.3%	0.1%
	2031	7.1%	1.9%	9.1%	42.9%	7.8%	0.9%	13.2%	15.7%	1.3%	0.1%
	2048	8.8%	4.5%	7.2%	20.3%	7.7%	0.8%	25.3%	21.5%	4.0%	0.1%
	2067	7.2%	3.9%	9.8%	11.0%	8.1%	0.9%	25.5%	20.1%	13.5%	0.1%
S. Puget	2004	7.3%	15.6%	22.4%	49.1%	2.3%	1.0%	1.7%	0.6%	0.1%	0.0%
	2008	4.9%	15.0%	20.6%	51.8%	3.7%	1.2%	2.0%	0.7%	0.1%	0.0%
	2013	4.4%	10.7%	20.2%	52.6%	6.3%	1.5%	2.6%	1.5%	0.2%	0.0%
	2031	5.4%	2.6%	12.6%	54.5%	8.9%	2.0%	6.7%	6.8%	0.5%	0.0%
	2048	7.6%	4.3%	6.3%	44.4%	7.6%	2.2%	15.6%	10.6%	1.4%	0.0%
	2067	6.4%	4.9%	7.8%	29.8%	8.2%	2.0%	25.3%	11.8%	3.8%	0.0%
Straits	2004	8.4%	13.2%	15.2%	57.7%	3.2%	0.9%	0.5%	0.9%	0.0%	0.0%
	2008	7.8%	13.1%	14.2%	55.3%	6.4%	1.1%	0.8%	1.1%	0.1%	0.0%
	2013	6.3%	10.3%	15.0%	53.8%	9.8%	1.4%	0.9%	2.3%	0.1%	0.0%
	2031	6.8%	2.9%	11.4%	51.8%	13.7%	1.9%	2.9%	8.0%	0.6%	0.0%
	2048	8.2%	5.4%	6.0%	43.0%	13.9%	2.3%	7.8%	11.7%	1.8%	0.0%
	2067	8.5%	5.3%	8.2%	30.6%	15.4%	2.3%	13.6%	10.7%	5.4%	0.0%
Westside Tot	2004	7.7%	17.9%	20.8%	43.5%	3.5%	0.5%	3.7%	1.0%	1.3%	0.2%
	2008	6.3%	15.7%	20.5%	44.6%	5.2%	0.6%	4.0%	1.6%	1.3%	0.2%
	2013	5.5%	10.6%	21.0%	45.7%	7.4%	0.8%	4.7%	2.9%	1.3%	0.2%
	2031	7.9%	3.5%	12.0%	42.0%	10.4%	1.2%	9.3%	11.4%	2.1%	0.2%
	2048	9.1%	6.8%	8.5%	26.6%	9.8%	1.1%	16.2%	16.5%	5.2%	0.1%
	2067	8.3%	6.6%	10.2%	19.0%	9.8%	1.2%	18.4%	16.4%	9.8%	0.3%

Table D-5f. Percentage Distribution of Stand Development Stages in Riparian Areas Under Alternative 6, by Planning Unit and Year

		Percent of Riparian Areas - Alternative 6									
HCP Unit	Year	Ecosystem Initiation	Sapling Exclusion	Pole Exclusion	Large Tree Exclusion	Understory Reinitiation	Developed Understory	Botanically Diverse	Niche Diversification	Fully Functional	Old Growth - Natural
Columbia	2004	13.4%	12.4%	19.6%	37.3%	4.0%	0.5%	7.5%	3.4%	1.8%	0.1%
	2008	14.2%	11.7%	16.4%	37.7%	4.8%	0.6%	7.9%	4.2%	2.4%	0.1%
	2013	12.0%	11.2%	14.4%	39.0%	5.4%	0.6%	9.0%	5.1%	3.2%	0.1%
	2031	13.9%	4.0%	17.9%	27.4%	7.4%	0.7%	12.6%	9.4%	6.4%	0.1%
	2048	13.2%	7.2%	12.6%	20.6%	10.9%	1.1%	11.9%	13.2%	9.1%	0.1%
	2067	13.9%	8.7%	12.6%	15.9%	14.8%	1.4%	7.7%	11.4%	13.6%	0.1%
N. Puget	2004	12.3%	13.2%	17.1%	38.0%	7.5%	0.6%	6.1%	4.4%	0.8%	0.1%
	2008	15.1%	12.2%	16.3%	33.5%	9.0%	0.7%	6.2%	5.9%	0.9%	0.0%
	2013	12.7%	9.6%	17.0%	34.9%	9.9%	0.8%	7.5%	6.3%	1.3%	0.0%
	2031	11.7%	3.8%	17.1%	31.2%	11.2%	1.1%	9.5%	11.3%	3.1%	0.1%
	2048	11.7%	6.2%	9.3%	26.1%	13.8%	1.6%	14.2%	12.4%	4.6%	0.1%
	2067	10.5%	8.2%	9.6%	19.6%	15.3%	1.7%	14.3%	12.6%	8.2%	0.1%
OESF	2004	6.2%	29.9%	26.5%	19.0%	1.9%	0.1%	8.2%	2.7%	5.1%	0.4%
	2008	3.4%	25.3%	29.3%	20.5%	3.0%	0.2%	5.2%	7.5%	5.5%	0.2%
	2013	1.1%	15.8%	33.5%	26.2%	3.6%	0.2%	5.6%	8.1%	5.6%	0.3%
	2031	0.7%	0.2%	20.3%	44.5%	6.0%	0.5%	7.5%	13.6%	6.5%	0.3%
	2048	0.7%	0.0%	1.7%	38.3%	15.0%	0.6%	7.6%	26.1%	9.9%	0.1%
	2067	0.7%	0.0%	0.3%	21.4%	9.7%	0.6%	8.2%	44.9%	13.6%	0.7%
S. Coast	2004	14.1%	12.8%	13.2%	41.3%	4.5%	0.4%	8.5%	3.8%	1.4%	0.0%
	2008	20.7%	10.2%	14.1%	32.1%	9.3%	0.4%	5.2%	6.0%	2.0%	0.0%
	2013	21.3%	7.0%	14.9%	30.1%	10.1%	0.4%	5.6%	6.9%	3.5%	0.1%
	2031	22.2%	5.6%	16.9%	25.0%	8.1%	0.5%	5.8%	10.1%	5.8%	0.1%
	2048	17.9%	12.4%	14.7%	16.4%	11.0%	0.8%	8.5%	11.6%	6.7%	0.1%
	2067	17.2%	16.1%	15.0%	14.7%	14.4%	1.0%	5.1%	10.1%	6.3%	0.1%
S. Puget	2004	8.2%	13.2%	20.7%	44.4%	2.2%	1.0%	7.4%	2.3%	0.5%	0.0%
	2008	7.1%	12.6%	19.7%	44.5%	3.6%	1.1%	7.8%	2.8%	0.7%	0.0%
	2013	6.7%	9.1%	19.8%	43.1%	4.5%	1.3%	9.1%	4.3%	2.1%	0.0%
	2031	4.3%	1.5%	13.5%	41.7%	6.8%	1.8%	14.7%	10.1%	5.5%	0.0%
	2048	4.6%	1.5%	3.7%	36.1%	9.6%	2.8%	19.9%	14.2%	7.7%	0.0%
	2067	5.2%	2.0%	3.0%	21.7%	13.3%	2.9%	25.9%	14.8%	11.2%	0.0%
Straits	2004	15.0%	11.6%	10.1%	49.7%	4.2%	1.0%	5.0%	2.6%	0.9%	0.0%
	2008	18.2%	11.2%	10.5%	38.3%	10.0%	1.1%	5.6%	4.2%	0.9%	0.0%
	2013	21.4%	10.4%	11.4%	31.5%	9.9%	1.0%	8.3%	4.9%	1.1%	0.0%
	2031	16.4%	9.0%	17.4%	27.4%	8.7%	1.1%	9.0%	8.6%	2.4%	0.0%
	2048	16.3%	8.9%	13.8%	24.2%	12.0%	2.0%	11.2%	9.5%	2.3%	0.0%
	2067	17.3%	10.4%	14.1%	20.1%	14.3%	2.3%	10.2%	7.0%	4.2%	0.0%
Westside Total	2004	11.1%	17.2%	19.3%	34.6%	4.2%	0.5%	7.5%	3.4%	2.2%	0.1%
	2008	12.4%	15.1%	19.3%	31.8%	6.2%	0.6%	6.2%	5.6%	2.6%	0.1%
	2013	11.1%	11.0%	20.3%	33.1%	7.0%	0.6%	7.1%	6.4%	3.3%	0.1%
	2031	10.9%	3.3%	17.8%	33.4%	8.0%	0.8%	9.3%	11.1%	5.3%	0.1%
	2048	9.9%	5.7%	8.8%	27.0%	12.6%	1.2%	11.3%	16.0%	7.4%	0.1%
	2067	9.8%	7.3%	8.5%	18.6%	13.3%	1.3%	10.4%	20.2%	10.4%	0.2%

Table D-6a. Percent of Riparian Area in which Timber Harvest Activities would Occur per Decade under Alternative 1, by Planning Unit

Percent of Riparian Area Harvested - Alt 1						
		Harvest Type				
Planning Unit	Decade	A (Area_Net)	B (Area_Gross)	C (Area_Gross)	Grand Total	Total RMZ Acres
Columbia	2004-2013			2.9%	2.9%	86,443
	2014-2023			3.2%	3.2%	
	2024-2033			4.0%	4.0%	
	2034-2043			3.6%	3.6%	
	2044-2053			3.1%	3.1%	
	2054-2063			4.6%	4.6%	
	2064-2067			1.8%	1.8%	
	Mean 2004-2063			3.6%	3.6%	
N. Puget	2004-2013			2.4%	2.4%	92,724
	2014-2023			2.7%	2.7%	
	2024-2033			3.2%	3.2%	
	2034-2043			3.2%	3.2%	
	2044-2053			3.1%	3.1%	
	2054-2063			3.2%	3.2%	
	2064-2067			0.8%	0.8%	
	Mean 2004-2063			2.9%	2.9%	
OESF	2004-2013			1.5%	1.5%	111,308
	2014-2023			1.6%	1.6%	
	2024-2033			2.7%	2.7%	
	2034-2043			2.5%	2.5%	
	2044-2053			2.2%	2.2%	
	2054-2063			2.8%	2.8%	
	2064-2067			1.2%	1.2%	
	Mean 2004-2063			2.3%	2.3%	
S. Coast	2004-2013			2.3%	2.3%	80,966
	2014-2023			3.4%	3.4%	
	2024-2033			4.7%	4.7%	
	2034-2043			3.5%	3.5%	
	2044-2053			4.2%	4.2%	
	2054-2063			3.5%	3.5%	
	2064-2067			1.0%	1.0%	
	Mean 2004-2063			3.5%	3.5%	
S. Puget	2004-2013			1.6%	1.6%	34,606
	2014-2023			2.9%	2.9%	
	2024-2033			3.6%	3.6%	
	2034-2043			3.8%	3.8%	
	2044-2053			3.5%	3.5%	
	2054-2063			3.3%	3.3%	
	2064-2067			1.6%	1.6%	
	Mean 2004-2063			3.2%	3.2%	
Straits	2004-2013			1.5%	1.5%	20,684
	2014-2023			0.9%	0.9%	
	2024-2033			2.5%	2.5%	
	2034-2043			2.4%	2.4%	
	2044-2053			1.3%	1.3%	
	2054-2063			2.5%	2.5%	
	2064-2067			0.8%	0.8%	
	Mean 2004-2063			1.9%	1.9%	
Total	2004-2013			2.1%	2.1%	426,731
	2014-2023			2.6%	2.6%	
	2024-2033			3.5%	3.5%	
	2034-2043			3.2%	3.2%	
	2044-2053			3.0%	3.0%	
	2054-2063			3.4%	3.4%	
	2064-2067			1.2%	1.2%	
	Mean 2004-2063			3.0%	3.0%	

Table D-6b. Percent of Riparian Area in which Timber Harvest Activities would Occur per Decade under Alternative 2, by Planning Unit

		Percent of Riparian Area Harvested - Alt 2				
		Harvest Type				
Planning Unit	Decade	A (Area_Net)	B (Area_Gross)	C (Area_Gross)	Grand Total	Total RMZ Acres
Columbia	2004-2013	2.0%	1.2%	1.3%	4.5%	86,443
	2014-2023	2.6%	0.9%	1.4%	4.9%	
	2024-2033	2.3%	1.6%	2.5%	6.4%	
	2034-2043	1.0%	2.8%	3.4%	7.2%	
	2044-2053	0.8%	3.0%	3.7%	7.5%	
	2054-2063	1.3%	3.7%	2.7%	7.7%	
	2064-2067	0.3%	1.5%	0.7%	2.5%	
	Mean 2004-2063	1.6%	2.3%	2.4%	6.4%	
N. Puget	2004-2013	1.3%	1.3%	1.3%	3.9%	92,724
	2014-2023	1.8%	1.4%	1.7%	4.9%	
	2024-2033	2.3%	1.7%	1.8%	5.8%	
	2034-2043	0.8%	1.9%	2.4%	5.2%	
	2044-2053	1.4%	1.9%	3.2%	6.6%	
	2054-2063	0.9%	3.3%	3.3%	7.5%	
	2064-2067	0.4%	1.0%	0.7%	2.1%	
	Mean 2004-2063	1.4%	2.0%	2.3%	5.6%	
OESF	2004-2013	1.5%	0.6%	2.0%	4.1%	111,308
	2014-2023	1.8%	1.3%	1.9%	5.0%	
	2024-2033	1.1%	1.5%	5.0%	7.6%	
	2034-2043	1.0%	2.5%	6.0%	9.4%	
	2044-2053	0.7%	2.5%	5.2%	8.4%	
	2054-2063	1.0%	2.8%	7.4%	11.2%	
	2064-2067	0.4%	0.7%	2.5%	3.7%	
	Mean 2004-2063	1.2%	1.9%	4.7%	7.7%	
S. Coast	2004-2013	2.0%	1.7%	1.6%	5.3%	80,966
	2014-2023	2.6%	1.1%	1.6%	5.4%	
	2024-2033	3.0%	2.4%	2.9%	8.3%	
	2034-2043	1.7%	3.0%	3.7%	8.5%	
	2044-2053	1.2%	3.2%	3.7%	8.1%	
	2054-2063	1.4%	4.8%	4.5%	10.7%	
	2064-2067	0.4%	1.5%	1.1%	3.0%	
	Mean 2004-2063	1.9%	2.8%	3.0%	7.7%	
S. Puget	2004-2013	0.6%	0.9%	0.9%	2.4%	34,606
	2014-2023	1.7%	0.6%	0.8%	3.1%	
	2024-2033	1.8%	1.1%	1.3%	4.3%	
	2034-2043	1.0%	1.7%	2.6%	5.3%	
	2044-2053	0.9%	1.6%	2.5%	5.0%	
	2054-2063	1.5%	1.8%	1.5%	4.8%	
	2064-2067	0.3%	0.9%	0.6%	1.8%	
	Mean 2004-2063	1.2%	1.3%	1.6%	4.2%	
Straits	2004-2013	1.0%	1.2%	0.8%	3.0%	20,684
	2014-2023	1.2%	1.7%	1.5%	4.3%	
	2024-2033	2.1%	1.4%	1.4%	4.9%	
	2034-2043	2.0%	2.0%	1.6%	5.6%	
	2044-2053	1.9%	2.2%	1.9%	6.0%	
	2054-2063	3.0%	3.6%	2.4%	8.9%	
	2064-2067	1.2%	0.9%	0.8%	2.9%	
	Mean 2004-2063	1.9%	2.0%	1.6%	5.6%	
Total	2004-2013	1.5%	1.2%	1.5%	4.2%	426,731
	2014-2023	2.1%	1.2%	1.6%	4.8%	
	2024-2033	2.0%	1.7%	2.9%	6.7%	
	2034-2043	1.1%	2.5%	3.8%	7.4%	
	2044-2053	1.1%	2.5%	3.8%	7.4%	
	2054-2063	1.3%	3.4%	4.3%	8.9%	
	2064-2067	0.4%	1.1%	1.2%	2.8%	
	Mean 2004-2063	1.5%	2.1%	3.0%	6.6%	

Table D-6c. Percent of Riparian Area in which Timber Harvest Activities would Occur per Decade under Alternative 3, by Planning Unit

Planning Unit	Decade	A (Area_Net)	B (Area_Gross)	C (Area_Gross)	Grand Total	Total RMZ Acres
		Percent of Riparian Area Harvested - Alt 3				
		Harvest Type				
Columbia	2004-2013	2.5%	1.8%	2.2%	6.5%	86,443
	2014-2023	3.2%	1.7%	1.9%	6.8%	
	2024-2033	3.0%	1.6%	2.4%	7.0%	
	2034-2043	1.3%	3.3%	4.2%	8.8%	
	2044-2053	0.9%	3.8%	4.8%	9.5%	
	2054-2063	1.4%	4.5%	3.3%	9.2%	
	2064-2067	0.5%	1.2%	1.0%	2.7%	
	Mean 2004-2063	2.0%	2.8%	3.1%	7.9%	
N. Puget	2004-2013	1.0%	1.1%	1.1%	3.1%	92,724
	2014-2023	2.3%	2.2%	2.3%	6.9%	
	2024-2033	3.0%	1.8%	1.7%	6.5%	
	2034-2043	1.4%	2.3%	2.9%	6.6%	
	2044-2053	1.1%	3.7%	5.2%	10.1%	
	2054-2063	1.1%	3.5%	2.3%	6.9%	
	2064-2067	0.4%	1.2%	0.7%	2.3%	
	Mean 2004-2063	1.6%	2.5%	2.5%	6.6%	
OESF	2004-2013	0.7%	1.0%	1.2%	2.9%	111,308
	2014-2023	1.0%	0.7%	0.8%	2.5%	
	2024-2033	1.4%	3.5%	3.7%	8.5%	
	2034-2043	1.2%	3.4%	5.0%	9.6%	
	2044-2053	1.3%	5.6%	10.9%	17.8%	
	2054-2063	0.9%	4.8%	9.0%	14.7%	
	2064-2067	0.5%	1.9%	6.3%	8.7%	
	Mean 2004-2063	1.1%	3.3%	5.8%	10.1%	
S. Coast	2004-2013	2.1%	2.0%	2.1%	6.2%	80,966
	2014-2023	4.4%	2.1%	2.6%	9.1%	
	2024-2033	4.1%	2.3%	2.5%	8.9%	
	2034-2043	1.5%	3.3%	4.9%	9.7%	
	2044-2053	1.0%	4.8%	6.3%	12.1%	
	2054-2063	1.0%	4.4%	2.6%	8.0%	
	2064-2067	0.5%	2.3%	0.7%	3.5%	
	Mean 2004-2063	2.3%	3.3%	3.4%	9.0%	
S. Puget	2004-2013	0.6%	1.0%	1.2%	2.8%	34,606
	2014-2023	1.4%	0.8%	0.9%	3.1%	
	2024-2033	1.9%	0.9%	1.2%	4.1%	
	2034-2043	1.3%	2.5%	2.5%	6.2%	
	2044-2053	0.8%	1.4%	2.7%	4.8%	
	2054-2063	0.9%	2.2%	2.3%	5.5%	
	2064-2067	0.5%	1.3%	1.3%	3.1%	
	Mean 2004-2063	1.2%	1.6%	1.9%	4.6%	
Straits	2004-2013	1.7%	3.1%	2.2%	7.0%	20,684
	2014-2023	2.7%	2.0%	1.5%	6.3%	
	2024-2033	3.5%	0.8%	0.8%	5.2%	
	2034-2043	1.9%	5.1%	2.8%	9.9%	
	2044-2053	1.6%	4.5%	4.4%	10.6%	
	2054-2063	1.1%	3.3%	2.4%	6.8%	
	2064-2067	0.4%	1.5%	0.7%	2.6%	
	Mean 2004-2063	2.0%	3.2%	2.3%	7.6%	
Total	2004-2013	1.4%	1.5%	1.6%	4.5%	426,731
	2014-2023	2.5%	1.6%	1.7%	5.8%	
	2024-2033	2.7%	2.2%	2.4%	7.3%	
	2034-2043	1.4%	3.1%	4.1%	8.5%	
	2044-2053	1.1%	4.3%	6.6%	11.9%	
	2054-2063	1.1%	4.1%	4.3%	9.5%	
	2064-2067	0.5%	1.6%	2.3%	4.4%	
	Mean 2004-2063	1.7%	2.9%	3.6%	8.1%	

Table D-6d. Percent of Riparian Area in which Timber Harvest Activities would Occur per Decade under Alternative 4, by Planning Unit

Planning Unit	Decade	A (Area_Net)	B (Area_Gross)	C (Area_Gross)	Grand Total	Total RMZ Acres
		Percent of Riparian Area Harvested - Alt 4				
		Harvest Type				
Columbia	2004-2013			5.2%	5.2%	86,443
	2014-2023			4.6%	4.6%	
	2024-2033			5.7%	5.7%	
	2034-2043			5.9%	5.9%	
	2044-2053			6.3%	6.3%	
	2054-2063			7.7%	7.7%	
	2064-2067			2.9%	2.9%	
	Mean 2004-2063			6.0%	6.0%	
N. Puget	2004-2013			4.1%	4.1%	92,724
	2014-2023			3.3%	3.3%	
	2024-2033			4.4%	4.4%	
	2034-2043			5.7%	5.7%	
	2044-2053			6.4%	6.4%	
	2054-2063			7.1%	7.1%	
	2064-2067			2.5%	2.5%	
	Mean 2004-2063			5.2%	5.2%	
OESF	2004-2013			1.2%	1.2%	111,308
	2014-2023			1.1%	1.1%	
	2024-2033			1.5%	1.5%	
	2034-2043			1.5%	1.5%	
	2044-2053			1.5%	1.5%	
	2054-2063			1.5%	1.5%	
	2064-2067			0.7%	0.7%	
	Mean 2004-2063			1.4%	1.4%	
S. Coast	2004-2013			6.3%	6.3%	80,966
	2014-2023			6.3%	6.3%	
	2024-2033			6.7%	6.7%	
	2034-2043			7.1%	7.1%	
	2044-2053			7.8%	7.8%	
	2054-2063			10.5%	10.5%	
	2064-2067			4.0%	4.0%	
	Mean 2004-2063			7.6%	7.6%	
S. Puget	2004-2013			2.5%	2.5%	34,606
	2014-2023			2.8%	2.8%	
	2024-2033			3.2%	3.2%	
	2034-2043			3.6%	3.6%	
	2044-2053			3.6%	3.6%	
	2054-2063			3.7%	3.7%	
	2064-2067			1.9%	1.9%	
	Mean 2004-2063			3.3%	3.3%	
STRAITS	2004-2013			4.1%	4.1%	20,684
	2014-2023			3.7%	3.7%	
	2024-2033			6.1%	6.1%	
	2034-2043			7.3%	7.3%	
	2044-2053			7.5%	7.5%	
	2054-2063			7.3%	7.3%	
	2064-2067			3.3%	3.3%	
	Mean 2004-2063			6.2%	6.2%	
Total	2004-2013			3.8%	3.8%	426,731
	2014-2023			3.5%	3.5%	
	2024-2033			4.3%	4.3%	
	2034-2043			4.8%	4.8%	
	2044-2053			5.2%	5.2%	
	2054-2063			6.1%	6.1%	
	2064-2067			2.4%	2.4%	
	Mean 2004-2063			4.7%	4.7%	

Table D-6e. Percent of Riparian Area in which Timber Harvest Activities would Occur per Decade under Alternative 5, by Planning Unit

		Percent of Riparian Area Harvested - Alt 5				
		Harvest Type				
Planning Unit	Decade	A (Area_Net)	B (Area_Gross)	C (Area_Gross)	Grand Total	Total RMZ Acres
Columbia	2004-2013	5.0%	2.2%	1.7%	8.9%	86,443
	2014-2023	4.1%	1.6%	3.1%	8.8%	
	2024-2033	4.0%	2.7%	3.9%	10.5%	
	2034-2043	1.3%	2.6%	4.8%	8.7%	
	2044-2053	1.1%	4.0%	5.3%	10.3%	
	2054-2063	2.0%	5.5%	3.1%	10.6%	
	2064-2067	0.7%	1.4%	1.1%	3.2%	
	Mean 2004-2063	2.8%	3.1%	3.6%	9.5%	
N. Puget	2004-2013	2.0%	1.6%	1.4%	5.0%	92,724
	2014-2023	3.5%	1.4%	2.1%	7.0%	
	2024-2033	3.4%	3.4%	3.0%	9.9%	
	2034-2043	1.6%	2.0%	4.0%	7.7%	
	2044-2053	1.6%	4.0%	4.8%	10.4%	
	2054-2063	2.2%	3.3%	2.8%	8.2%	
	2064-2067	0.8%	1.0%	1.2%	3.0%	
	Mean 2004-2063	2.4%	2.6%	3.0%	8.0%	
OESF	2004-2013	13.4%	3.2%	4.7%	21.3%	111,308
	2014-2023	15.4%	3.7%	7.0%	26.1%	
	2024-2033	18.1%	3.7%	11.1%	32.9%	
	2034-2043	10.9%	4.1%	11.4%	26.5%	
	2044-2053	5.3%	2.9%	13.9%	22.1%	
	2054-2063	9.0%	2.9%	9.3%	21.1%	
	2064-2067	4.0%	1.9%	2.9%	8.8%	
	Mean 2004-2063	11.9%	3.5%	9.4%	24.8%	
S. Coast	2004-2013	4.0%	1.9%	1.9%	7.8%	80,966
	2014-2023	4.8%	1.6%	2.7%	9.0%	
	2024-2033	4.3%	3.7%	4.3%	12.3%	
	2034-2043	1.7%	3.3%	5.2%	10.2%	
	2044-2053	1.4%	5.3%	5.8%	12.4%	
	2054-2063	2.5%	4.7%	3.3%	10.4%	
	2064-2067	0.7%	1.8%	1.0%	3.6%	
	Mean 2004-2063	3.0%	3.5%	3.8%	10.3%	
S. Puget	2004-2013	3.6%	1.6%	1.4%	6.5%	34,606
	2014-2023	3.9%	1.0%	2.2%	7.2%	
	2024-2033	3.1%	2.4%	3.4%	8.9%	
	2034-2043	1.9%	1.9%	3.7%	7.5%	
	2044-2053	1.7%	2.3%	4.0%	8.0%	
	2054-2063	2.4%	2.8%	3.2%	8.4%	
	2064-2067	1.3%	1.1%	1.1%	3.4%	
	Mean 2004-2063	2.8%	2.0%	3.0%	7.8%	
Straits	2004-2013	4.6%	2.3%	1.3%	8.2%	20,684
	2014-2023	5.0%	1.0%	1.4%	7.4%	
	2024-2033	5.3%	3.1%	2.7%	11.1%	
	2034-2043	2.3%	2.8%	4.0%	9.1%	
	2044-2053	4.5%	2.5%	3.2%	10.2%	
	2054-2063	4.5%	3.7%	3.4%	11.5%	
	2064-2067	1.0%	1.4%	1.3%	3.7%	
	Mean 2004-2063	4.3%	2.6%	2.7%	9.6%	
Total	2004-2013	6.2%	2.2%	2.4%	10.8%	426,731
	2014-2023	7.0%	2.0%	3.7%	12.8%	
	2024-2033	7.6%	3.3%	5.6%	16.4%	
	2034-2043	4.0%	3.0%	6.3%	13.3%	
	2044-2053	2.6%	3.7%	7.3%	13.6%	
	2054-2063	4.1%	3.9%	4.7%	12.7%	
	2064-2067	1.7%	1.5%	1.6%	4.7%	
	Mean 2004-2063	5.2%	3.1%	4.9%	13.2%	

Table D-6f. Percent of Riparian Area in which Timber Harvest Activities would Occur per Decade Under Alternative 1, by Planning Unit

		Percent of Riparian Area Harvested - Alt 6				
		Harvest Type				
Planning Unit	**Decade**	**A (Area_Net)**	**B (Area_Gross)**	**C (Area_Gross)**	**Grand Total**	**Total RMZ Acres**
Columbia	2004-2013	9.7%	2.7%	5.0%	17.3%	86,443
	2014-2023	9.5%	3.4%	8.3%	21.2%	
	2024-2033	10.7%	6.6%	12.1%	29.5%	
	2034-2043	15.8%	5.4%	8.8%	30.0%	
	2044-2053	20.4%	8.6%	16.2%	45.3%	
	2054-2063	24.8%	5.9%	10.1%	40.8%	
	2064-2067	9.0%	4.6%	6.9%	20.4%	
	Mean 2004-2063	15.6%	5.8%	10.5%	32.0%	
N. Puget	2004-2013	11.0%	3.3%	6.0%	20.3%	92,724
	2014-2023	10.9%	1.8%	4.9%	17.7%	
	2024-2033	11.6%	5.1%	11.2%	27.8%	
	2034-2043	15.9%	3.7%	5.7%	25.3%	
	2044-2053	17.1%	6.2%	13.5%	36.8%	
	2054-2063	18.5%	3.8%	7.0%	29.2%	
	2064-2067	6.5%	3.5%	4.9%	14.9%	
	Mean 2004-2063	14.3%	4.3%	8.3%	26.9%	
OESF	2004-2013	39.6%	1.5%	0.3%	41.4%	111,308
	2014-2023	54.4%	1.6%	0.2%	56.2%	
	2024-2033	52.8%	2.7%	0.3%	55.8%	
	2034-2043	68.7%	2.9%	0.5%	72.1%	
	2044-2053	69.7%	2.9%	0.5%	73.1%	
	2054-2063	52.1%	2.2%	0.4%	54.7%	
	2064-2067	15.6%	0.7%	0.1%	16.4%	
	Mean 2004-2063	55.1%	2.3%	0.4%	57.8%	
S. Coast	2004-2013	7.6%	6.7%	12.1%	26.4%	80,966
	2014-2023	3.6%	3.4%	7.9%	15.0%	
	2024-2033	1.7%	11.9%	21.9%	35.4%	
	2034-2043	1.3%	4.6%	9.2%	15.0%	
	2044-2053	2.1%	7.9%	26.7%	36.7%	
	2054-2063	1.0%	4.0%	14.1%	19.0%	
	2064-2067	0.8%	4.4%	9.3%	14.4%	
	Mean 2004-2063	2.8%	6.7%	15.8%	25.3%	
S. Puget	2004-2013	11.5%	2.0%	2.9%	16.4%	34,606
	2014-2023	11.9%	1.3%	1.2%	14.5%	
	2024-2033	15.6%	4.1%	6.0%	25.7%	
	2034-2043	27.5%	3.7%	4.3%	35.5%	
	2044-2053	21.5%	6.3%	5.2%	33.0%	
	2054-2063	25.1%	7.1%	4.6%	36.8%	
	2064-2067	9.9%	2.3%	1.3%	13.6%	
	Mean 2004-2063	19.2%	4.2%	4.0%	27.4%	
Straits	2004-2013	5.6%	5.1%	13.0%	23.6%	20,684
	2014-2023	5.6%	2.5%	2.6%	10.7%	
	2024-2033	4.0%	6.1%	16.2%	26.3%	
	2034-2043	4.5%	5.7%	9.8%	20.0%	
	2044-2053	3.5%	8.0%	13.1%	24.6%	
	2054-2063	3.4%	5.1%	9.0%	17.5%	
	2064-2067	0.7%	2.4%	4.0%	7.1%	
	Mean 2004-2063	4.3%	5.4%	10.6%	20.3%	
Total	2004-2013	17.3%	3.3%	5.6%	26.2%	426,731
	2014-2023	20.4%	2.4%	4.5%	27.3%	
	2024-2033	20.2%	6.0%	10.4%	36.6%	
	2034-2043	27.3%	4.1%	5.7%	37.1%	
	2044-2053	28.3%	6.3%	12.5%	47.1%	
	2054-2063	25.0%	4.1%	7.2%	36.3%	
	2064-2067	8.3%	3.0%	4.5%	15.8%	
	Mean 2004-2063	23.0%	4.6%	7.9%	35.4%	

D.4 ADDITIONAL ANALYSES FOR THE WILDLIFE SECTION

Tables D-7 through D-11 support discussions of effects to wildlife species and habitats.

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Table D-7. Status, Habitat Associations, and Distribution of Threatened, Endangered, and Sensitive (TES) Wildlife Species that May Occur on DNR Westside 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 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 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 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 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 planning units.
Aleutian Canada Goose *Branta canadensis leucopareia*	ST	Migrant or winter resident in lakes, ponds, wetlands, grasslands, or agricultural fields in SW 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 planning units.
Peregrine Falcon *Falco peregrinus*	SS FCo	Cliffs provide breeding habitat; foraging habitat includes wetlands and open habitats; found in all 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 planning unit.
Marbled Murrelet *Brachyramphus marmoratus*	ST FT	Structurally complex and old-growth forests; found in all 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 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 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 planning units.
Grizzly Bear *Ursus arctos*	SE FT	Areas with low levels of human activity; may occur in North Puget and South Puget planning units.
Pacific Fisher *Martes pennanti*	SE FCo	Structurally complex forest, especially at low to moderate elevations; may occur in all 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 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.

Table D-8. Estimated Proportion of DNR Westside Trust Lands in Different Forest Habitat Types under Each Alternative

Forest Type	Alternative	2004[1/]	2008	2013	2031	2048	2067
	1	8%	8%	9%	8%	10%	10%
	2	9%	10%	11%	10%	12%	13%
Ecosystem	3	8%	10%	13%	11%	14%	14%
Initiation	4	8%	7%	8%	10%	9%	10%
	5	12%	15%	16%	16%	16%	17%
	6	11%	11%	13%	12%	11%	13%
	1	81%	79%	75%	65%	57%	51%
	2	81%	78%	74%	67%	63%	60%
Competitive	3	81%	78%	73%	67%	63%	62%
Exclusion	4	81%	78%	74%	61%	55%	50%
	5	83%	80%	77%	71%	65%	61%
	6	78%	77%	73%	67%	60%	52%
	1	10%	13%	16%	27%	33%	38%
	2	10%	12%	15%	22%	25%	27%
Structurally	3	10%	12%	15%	22%	24%	24%
Complex	4	11%	14%	19%	29%	36%	39%
	5	5%	5%	6%	13%	19%	22%
	6	11%	12%	14%	21%	28%	35%

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 6 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 Alternatives 5 and 6 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-9. OPTIONS Model Estimates of Percent Change from the Current Amount of Spotted Owl Dispersal Habitat under Each Alternative

Alternative	2008	2013	2031	2048	2067
1	+ 2	+ 6	+ 31	+ 41	+ 42
2	+ 1	+ 5	+ 15	+ 18	+ 16
3	+ 1	+ 2	+ 15	+ 17	+ 11
4	+ 5	+ 12	+ 34	+ 44	+ 40
5	+ 1	+ 2	+ 1	+ 13	+ 12
6	+ 5	+ 10	+ 24	+ 48	+ 55

Source: DNR alternative modeling output data

Table D-10. Estimated Percentage of DNR Land within 40 Miles of Marine Waters Comprising Structurally Complex Forest under Each Alternative

Alternative	2008	2013	2031	2048	2067
1	11%	13%	17%	28%	33%
2	11%	13%	16%	23%	25%
3	11%	12%	15%	23%	24%
4	11%	15%	19%	29%	35%
5	5%	6%	7%	13%	20%
6	11%	12%	14%	20%	28%

Source: DNR alternative modeling output data

Table D-11. Estimated Proportion of Low-elevation[1/] DNR Westside Trust Lands Comprising Structurally Complex Forest under Each Alternative, Compared to the Estimated Proportion on DNR Westside Trust Lands Overall

	Low-elevation					Overall				
Alternative	2008	2013	2031	2048	2067	2008	2013	2031	2048	2067
1	10%	12%	16%	28%	33%	13%	16%	27%	33%	38%
2	10%	12%	15%	23%	25%	12%	15%	22%	25%	27%
3	10%	12%	15%	23%	24%	12%	15%	22%	24%	24%
4	10%	14%	19%	30%	36%	14%	19%	29%	36%	39%
5	4%	5%	6%	12%	19%	5%	6%	13%	19%	22%
6	10%	12%	13%	21%	28%	12%	14%	21%	28%	35%

Source: DNR alternative modeling output data

1/ Defined as Watershed Administrative Units where at least 50% of DNR land is in the Western Hemlock or Sitka Spruce vegetation zones.

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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
Indian 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. (Date 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 Planning Units, and Cascade in the Columbia 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 planning units. In the South Puget, Straits, and Columbia Planning Uunits, 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 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 sub alpine 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 (e.g., 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 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 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 (Schalk 1988). 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 sub alpine 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, Indian tribes maintain a strong interest in Washington's upland forests, exercising rights guaranteed by treaty (Table D-12). 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-12. Major Tribes Associated with the Planning Units in Western Washington

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 Indian 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 Planning Units by the late 1840s. In the upland areas that include most of DNR forest 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 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 state 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

E.1 INTRODUCTION

The following discussions provide additional information to support the analyses of cumulative effects to fish and water resources in Section 4.15 of this Environmental Impact Statement. Tables E-4 through E-21 summarize conditions at the watershed scale for each of the resource areas addressed in Section 4.15.

E.1.1 Fish

E.1.1.1 Columbia Planning Unit

DNR-managed trust lands make up at least 5 percent of the total area in 38 watersheds in the Columbia Planning Unit (Table E-1). DNR 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 DNR trust lands. In addition:

- Stream density in the Columbia Planning Unit is relatively high compared to other 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, DNR 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 DNR trust land 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. DNR 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 DNR trust lands are only a minor owner (less than 25 percent of the watershed.
- Urban and agricultural land use is moderate in the Columbia Planning Unit relative to other planning units (averaging 7.5 percent of watershed area). Just over one-quarter of the watersheds in the planning unit were in the upper quartile for the percentage of area in the urban or agricultural land use categories (Table E-1).

The Columbia Planning Unit has a moderate risk of cumulative effects to fish resources relative to other westside Planning Units. The measures for which the Columbia Planning Unit ranked high relative to other planning units include the number of watersheds in the upper quartile for small trees in riparian areas, stream density, area of hydrologic immaturity in the significant rain-on-snow zones, and the percent area in urban or agricultural land use (Table E-1). Watersheds of potential concern to DNR because of major amounts of westside trust land ownership and high rankings in two or more of the measures include the Upper Washougal and Abernethy. The Upper Washougal has a high

Table E-1. Number of Watersheds in the Upper Quartile, Percent of Upper Quartile, and Percent of Watersheds in a Planning Unit with at Least 5 Percent DNR Trust Land Ownership for each Measure of Cumulative Effects to Fish Resources

	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% DNR ownership	38			24			23			18			61			15			179

Data Source: DNR MASK Geographic Information System layer 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 Planning Unit, with private industrial or private non-industrial ownership averaging about 64 percent of the area of watersheds with at least 5 percent DNR trust lands. DNR trust lands and Federal Ownership averages about 21 percent and 20 percent, respectively. Consequently, forest management activities on private lands under State 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 Alternative 6 is expected to have forest management activities on about 17 percent of the riparian land class. Alternatives that propose more riparian harvest (particularly Alternative 6) on DNR trust lands would have a higher relative risk of contributing to adverse cumulative effects to fish resources.

E.1.1.2 South Coast Planning Unit

DNR-managed trust lands make up at least 5 percent of the total area in 24 watersheds in the South Coast Planning Unit, and most of these are located in the southern part of the unit. DNR 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 DNR trust land ownership include anadromous fish streams, and 7 watersheds have bull trout, but none of the watersheds with bull trout has a majority proportion in DNR 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 planning units.
- Six watersheds have a high percentage (greater than 33 percent) of the riparian zone as small trees, and DNR 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 DNR trust land 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. DNR 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 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 planning units and over one-third of the watersheds were in the upper quartile for this measure

Similar to the Columbia Planning Unit, the South Coast Planning Unit is considered to be at moderate relative risk of adverse cumulative effects relative to the other planning units. The measures for which the South Coast 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 westside trust land 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 DNR trust land ownership. Private forest ownership accounts for an average of about 65 percent of watershed area, while DNR trust lands account for an average of about 29 percent. Over the first decade of the planning period, harvest activities in riparian zones on DNR trust lands for the South Coast 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 Alternative 6 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.1.1.3 Olympic Experimental State Forest Planning Unit

DNR-managed trust lands make up at least 5 percent of the total area in 23 watersheds in the Olympic Experimental State Forest Planning Unit. DNR 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 DNR trust land 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 planning units with and 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, DNR 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 DNR 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. DNR 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. DNR trust lands are a majority owner in four of the watersheds with a high proportion of unstable slopes.

Relative to other 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 DNR trust land ownership had two or more measures ranked in the upper quartile. The Lower Clearwater and the Middle Hoh had six and seven, respectively, of the ten measures in the upper quartile.

Ownership patterns in the Olympic Experimental State Forest is 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 DNR trust land (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 DNR 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 Alternative 6, 90 percent of the harvest area will 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 planning units, forest management activities on DNR trust lands will require careful planning and monitoring to reduce potential adverse cumulative effects, especially at the levels proposed under Alternative 5.

E.1.1.4 Straits Planning Unit

DNR-managed trust lands make up at least 5 percent of the total area in 18 watersheds in the Straits Planning Unit. DNR 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 DNR trust land ownership and 6 watersheds that have bull trout. DNR trust land makes 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, DNR 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 DNR trust land 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 DNR trust land ownership.
- Five watersheds have streams on the 303(d) list for temperature of which DNR trust lands are substantial owners in the Dabob watershed.
- Approximately one-third of the watersheds in the Straits Planning Unit ranked in the upper quartile for urban or agricultural land use and 2 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 DNR trust land ownership is major in one these watersheds (Lyre) and substantial in another (Twins).

Relative to other westside planning units, the Straits 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, DNR trust land 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 DNR trust land 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 Planning Unit is predominately private, averaging about 52 percent of the watersheds with at least 5 percent DNR 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 DNR trust land 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 DNR 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 Alternative 6 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 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.1.1.5 North Puget Planning Unit

DNR-managed trust lands make up at least 5 percent of the total area in 61 watersheds in the North Puget Planning Unit. DNR 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-1). Most of the watersheds (51) include anadromous fish streams and 48 watersheds have bull trout. The North Puget Planning Unit has the highest density of bull trout streams of all the 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, DNR 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 DNR trust land 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 DNR 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. DNR 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 Planning Unit has 17 watersheds within the upper quartile for the amount of urban and agricultural land use.

Compared to other westside planning units, the North Puget Planning Unit has a relatively high risk for adverse cumulative effects to fish resources. The 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 DNR trust land ownership and ranked in the upper quartile for three or more measures: Warnick, Hutchinson Creek, Ebey Hill, Rinker, and Alder.

DNR trust lands in the North Puget 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 DNR trust lands, followed by federal ownership (35 percent) and DNR 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 DNR 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 Alternative 6 (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 Alternative 6 to avoid potentially contributing to adverse cumulative effects in watersheds that are relatively higher at-risk.

E.1.1.6 South Puget Planning Unit

DNR-managed trust lands make up at least 5 percent of the total area in 15 watersheds in the South Puget Planning Unit. DNR 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). DNR 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. DNR 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 DNR trust land ownership have rain-on-snow areas with more than 20 percent of the trees in a hydrologically immature status. DNR 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. DNR 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 DNR trust lands are a minor component.

The South Puget Planning Unit is considered to be at low-to-moderate relative risk of adverse cumulative effects to fish resources relative to other planning units. Just over half (8) of the 15 watersheds with at least 5 percent DNR trust lands ranked in the upper quartile for have 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 DNR trust land 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).

DNR trust lands ownership is are primarily in the upper watersheds in the South Puget Planning Unit and concentrated in two blocks located to the north and south in the planning unit. Similar to the North Puget Planning Unit, the South Puget 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 DNR trust lands. Forest management activities on DNR 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 Planning Unit and relatively higher under Alternative 6 (about 16 percent of the riparian land class, in which 70 percent are projected to be low volume removal harvests).

E.1.2 Hydrologic Maturity

This section analyzes the areas (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 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 was not available for all ownerships at the sub-basin level, and other ownerships do not follow this DNR procedure. Instead, watersheds and 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-2 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 planning unit. The South Coast planning unit has no watersheds in the top quartile for this analysis, while Columbia 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, eleven watersheds have more than one third of their area classified as immature in the significant rain-on-snow zone, as shown in Appendix H1. Ten of these units have DNR ownership in less than 5 percent of the classified areas, and one watershed has DNR ownership of 18 percent of the classified areas. Of the 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 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 percentage of mature forest on DNR 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

Table E-2. 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

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

significant rain-on-snow zones under DNR ownership, meaning that this is the planning unit in which DNR has relatively the greatest opportunity and 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. Alternatives 1 and 6 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.1.3 Water Quality

E.1.3.1 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 DNR ownership, 41 are located in the North Puget and Olympic Experimental State Forest planning units. As shown in Table E-3, the planning unit where DNR has the largest ownership along 303(d) listed streams is Columbia. South Puget, Columbia and Straits

Table E-3. Miles of 303(d) Listed Streams that are Listed for Temperature, by Planning Unit and Ownership

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

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 planning unit level, the lengths of stream listed by planning unit are dominated by private timber ownership.

The watersheds where 303(d) listings occur for temperature under majority DNR ownership along listed length are:

- Abernethy (250104) and Upper South Fork Toutle (260508) in the Columbia Planning Unit
- Skookum Creek (010309), French Boulder (050204), and Ebey Hill (050214) in the North Puget Planning Unit
- Middle Hoh (200607) and Rain Forest (200505) in the Olympic Experimental State Forest Unit

These watersheds carry the greatest relative risk for temperature.

E.1.3.2 Dissolved Oxygen

As discussed in Section 4.8, Water Quality, 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 DNR 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 Planning Unit. The majority of ownership along these stream miles is privately held forest land. All watersheds with streams listed for dissolved oxygen are below 530 feet average elevation (see Table E-16). 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.1.3.3 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-17, 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 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-4. 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 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%
Planning Unit Average			***19%***	***4%***	***1%***	***13%***	***0%***
North Puget 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-4. 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 (070307	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-4. 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 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-4. 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 (24040	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 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 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-4. 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-5. 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 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%
Planning Unit Average			***44%***	***14%***	***6%***	***24%***	***1%***
North Puget 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-5. 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-5. 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%
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%
Planning Unit Average			***51%***	***18%***	***11%***	***20%***	***2%***
South Coast 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-5. 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%
Planning Unit Average			***49%***	***18%***	***0.0%***	***27%***	***3.1%***
South Puget 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%
Planning Unit Average			***49%***	***22%***	***4%***	***17%***	***6.5%***
Straits 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-5. 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-6. 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 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%
Planning Unit Average			***3.4%***	***1.3%***	***1.1%***	***1.0%***	***0.1%***
North Puget 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-6. 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-6. 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%
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%
Planning Unit Average			***8.0%***	***2.3%***	***4.8%***	***0.6%***	***0.3%***
South Coast 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-6. 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%
Planning Unit Average			***0.4%***	***0.1%***	***0.0%***	***0.2%***	***0.1%***
South Puget 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%
Planning Unit Average			***2.0%***	***0.8%***	***0.4%***	***0.6%***	***0.2%***
Straits 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%
Planning Unit Average			***7.1%***	***1.3%***	***4.3%***	***1.5%***	***0.1%***

Table E-6. 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-7. Percent of Each Watershed in Each Ownership Class

Watershed Name (and number)	Total Acres	Forested Acres[1/]	Percentage of Watershed in Each Ownership Class: DNR	Federal	Private[2/]	Other[3/]
Columbia 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%
Planning Unit Average			***21.2%***	***11.4%***	***63.8%***	***3.5%***
North Puget 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-7. Percent of Each Watershed in Each Ownership Class

Watershed Name (and number)	Total Acres	Forested Acres[1/]	Percentage of Watershed in Each Ownership Class: DNR	Federal	Private[2/]	Other[3/]
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 (07030	28,375	26,901	52%	27%	20%	0%
Lower Pilchuck Creek (05031	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-7. Percent of Each Watershed in Each Ownership Class

Watershed Name (and number)	Total Acres	Forested Acres[1/]	Percentage of Watershed in Each Ownership Class: DNR	Federal	Private[2/]	Other[3/]
Youngs Creek (070219)	23,776	21,907	12%	2%	85%	0%
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%
Planning Unit Average			***33.0%***	***19.5%***	***42.5%***	***5.0%***
South Coast 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 (2404C	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-7. Percent of Each Watershed in Each Ownership Class

Watershed Name (and number)	Total Acres	Forested Acres[1/]	Percentage of Watershed in Each Ownership Class: DNR	Federal	Private[2/]	Other[3/]
Willapa Headwaters (240306)	62,581	58,273	30%		69%	1%
Planning Unit Average			***29.1%***	***0.0%***	***65.5%***	***5.4%***
South Puget 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%
Planning Unit Average			***35.8%***	***6.5%***	***46.6%***	***11.1%***
Straits 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%
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-8. Percent of the Riparian Area in Each Watershed in the Small Tree Stages [1/]

Watershed Name (and number)	Total Acres	Riparian Acres[2/]	Riparian Area[3/]	Percentage Breakdown by Ownership[4/] DNR	Federal	Private[5/]	Other[6/]
Columbia 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%
Planning Unit Average			*27%*	*6%*	*2%*	*18%*	*1%*
North Puget 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-8. Percent of the Riparian Area in Each Watershed in the Small Tree Stages [1/]

Watershed Name (and number)	Total Acres	Riparian Acres[2/]	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-8. Percent of the Riparian Area in Each Watershed in the Small Tree Stages [1/]

Watershed Name (and number)	Total Acres	Riparian Acres[2/]	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%
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%
Planning Unit Average			*28%*	*10%*	*3%*	*13%*	*1%*
South Coast 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-8. Percent of the Riparian Area in Each Watershed in the Small Tree Stages [1/]

Watershed Name (and number)	Total Acres	Riparian Acres[2/]	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%
Planning Unit Average			***30%***	***9%***	***0%***	***19%***	***2%***
South Puget 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%
Planning Unit Average			***36%***	***16%***	***2%***	***15%***	***3%***
Straits 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%
Planning Unit Average			***26%***	***8%***	***4%***	***13%***	***1%***

Table E-8. Percent of the Riparian Area in Each Watershed in the Small Tree Stages 1/

Watershed Name (and number)	Total Acres	Riparian Acres 2/	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-9. 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	Private[1/]	Other[2/]
Columbia 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
Planning Unit Average		***0.32***	***18.1***	***1.9***	***1.0***	***12.7***	***2.4***
North Puget 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-9. 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	Private[1/]	Other[2/]
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-9. 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	Private[1/]	Other[2/]
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
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
Planning Unit Average		***0.70***	***35.0***	***8.7***	***5.3***	***18.1***	***2.7***
South Coast 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-9. 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	Private[1/]	Other[2/]
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
Planning Unit Average		*0.45*	*26.3*	*3.8*	*0.0*	*20.6*	*1.9*
South Puget 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
Planning Unit Average		*0.22*	*19.2*	*3.4*	*0.1*	*12.6*	*3.1*
Straits 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-9. 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	Private[1/]	Other[2/]
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
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-10. 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	Private[1/]	Other[2/]
Columbia 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
Planning Unit Average		***7.45***	***425.4***	***87.7***	***58.0***	***262.9***	***16.8***
North Puget 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-10. 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	Private[1/]	Other[2/]
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-10. 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	Private[1/]	Other[2/]
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
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
Planning Unit Average		***6.59***	***337.1***	***122.3***	***60.2***	***136.5***	***18.0***
South Coast 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-10. 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	Private[1/]	Other[2/]
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
Planning Unit Average		***8.34***	***476.7***	***119.9***	***0.1***	***333.5***	***23.2***
South Puget 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
Planning Unit Average		***5.82***	***272.8***	***82.0***	***15.7***	***150.4***	***24.8***
Straits 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
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-11. 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	Private[1/]	Other[2/]
Columbia 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
Planning Unit Average		***1.45***	***83.6***	***10.2***	***7.2***	***58.1***	***8.1***
North Puget 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-11. 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	Private[1/]	Other[2/]
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-11. 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	Private[1/]	Other[2/]
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
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
Planning Unit Average		***2.09***	***108.0***	***29.9***	***15.6***	***53.5***	***9.0***
South Coast 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-11. 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	Private[1/]	Other[2/]
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
Planning Unit Average		***2.03***	***116.1***	***23.0***	***0.0***	***84.9***	***8.1***
South Puget 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
Planning Unit Average		***1.37***	***73.0***	***14.8***	***1.6***	***45.2***	***11.5***
Straits 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
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-12. 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	Private[1/]	Other[2/]
Columbia 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
Planning Unit Average		***0.03***	***1.8***	***0.1***	***0.1***	***1.5***	***0.1***
North Puget 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-12. 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	Private[1/]	Other[2/]
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-12. 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	Private[1/]	Other[2/]
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
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
Planning Unit Average		***0.07***	***4.7***	***0.3***	***2.0***	***1.7***	***0.7***
South Coast 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-12. 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	Private[1/]	Other[2/]
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
Planning Unit Average		***0.05***	***3.4***	***0.2***	***0.0***	***2.0***	***1.2***
South Puget 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
Planning Unit Average		***0.03***	***1.6***	***0.0***	***0.0***	***1.0***	***0.6***
Straits 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
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-13. Percent of Watershed Area in Each Land Use Category

Watershed Name (and number)	Total Acres	Percent of Watershed Area: Forested	Agricultural	Urban	Water and Wetland	Other[1/]
Columbia 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%
Planning Unit Average		***88%***	***6%***	***2%***	***3%***	***2%***
North Puget 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-13. Percent of Watershed Area in Each Land Use Category

Watershed Name (and number)	Total Acres	Percent of Watershed Area: Forested	Agricultural	Urban	Water and Wetland	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-13. Percent of Watershed Area in Each Land Use Category

Watershed Name (and number)	Total Acres	Percent of Watershed Area: Forested	Agricultural	Urban	Water and Wetland	Other[1/]
Tenas (040319)	36,688	97%	0%	0%	1%	2%
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%
Planning Unit Average		***97%***	***1%***	***0%***	***1%***	***1%***
South Coast 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-13. Percent of Watershed Area in Each Land Use Category

Watershed Name (and number)	Total Acres	Percent of Watershed Area: Forested	Agricultural	Urban	Water and Wetland	Other[1/]
Joe-Moclips (210408)	50,805	98%	0%	0%	0%	1%
Mill Creek (240305)	15,699	99%	0%	0%	0%	1%
Planning Unit Average		***89%***	***7%***	***2%***	***0%***	***1%***
South Puget 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%
Planning Unit Average		***94%***	***1%***	***3%***	***2%***	***0%***
Straits 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%
Planning Unit Average		***86%***	***8%***	***3%***	***0%***	***2%***

1/ Includes areas that are barren, data noise, snow, and other areas.

Table E-14. 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 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
Planning Unit Average		***19***	***3***	***4***	***11***	***0***
North Puget 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-14. 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-14. 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
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
Planning Unit Average		***11***	***3***	***7***	***1***	***1***
South Coast 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
Planning Unit Average		***2***	***0***	***0***	***2***	***0***

Table E-14. 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 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
Planning Unit Average		***14***	***3***	***1***	***9***	***1***
Straits 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
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-15. Lengths of Streams in Each Watershed that Have 303(d) Listings for Temperature [1/]

Watershed Name (and Number)	Total Acres	Elevation of Watershed (feet)	Miles of 303(d) listed Stream	Rank[2/]	Miles Breakdown by Ownership			
					DNR	Federal	Private[3/]	Other[4/]
Columbia 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
Planning Unit Total			***11.69***		***2.17***	***0.57***	***8.42***	***0.53***
North Puget 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
Planning Unit Total			***3.95***		***2.91***	***0.17***	***39.90***	***1.02***

Table E-15. Lengths of Streams in Each Watershed that Have 303(d) Listings for Temperature [1/]

Watershed Name (and Number)	Total Acres	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
Planning Unit Total			***6.70***		***7.19***	***0.79***	***38.05***	***3.50***
South Coast								
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
Planning Unit Total			***3.94***		***0.00***	***0.00***	***12.12***	***1.08***

Table E-15. Lengths of Streams in Each Watershed that Have 303(d) Listings for Temperature [1/]

Watershed Name (and Number)	Total Acres	Elevation of Watershed (feet)	Miles of 303(d) listed Stream	Rank[2/]	Miles Breakdown by Ownership DNR	Federal	Private[3/]	Other[4/]
South Puget								
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
Planning Unit Total			***13.30***		***0.72***	***1.40***	***3.02***	***4.03***
Straits								
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
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) forest land
4/ Includes, municipal, tribal, non-DNR state lands, and other lands

Table E-16 Lengths of Streams in Each Watershed that Have 303(d) Listings for Dissolved Oxygen [1/]

Watershed Name (and Number)	Total Acres	Elevation of Watershed (feet)	Miles of 303(d) listed Stream	Miles Breakdown by Ownership			
				DNR	Federal	Private[2/]	Other[3/]
Columbia Planning Unit							
Lacamas (280202)	41,185	525	8.57		0.57	7.80	0.20
Planning Unit Total			***8.57***	***0.00***	***0.57***	***7.80***	***0.20***
North Puget 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
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
Planning Unit Total			***7.01***	***0.04***	***0.34***	***6.27***	***0.35***
South Coast 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
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) forest land
3/ Includes, municipal, tribal, non-DNR state lands, and other lands

Table E-17. 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 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) forest land
3/ Includes, municipal, tribal, non-DNR state lands, and other lands

Table E-18. 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 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-18. 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
Planning Unit Average			***7.5***	***1.6***	***1.0***	***4.8***	***0.1***
North Puget 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-18. 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-18. 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
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
Planning Unit Average			***16.2***	***6.3***	***4.6***	***4.6***	***0.7***
South Coast 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-18. 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
Planning Unit Average			***11.3***	***3.1***	***0.0***	***7.9***	***0.3***
South Puget 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-18. 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
Planning Unit Average			***10.0***	***3.8***	***1.7***	***3.9***	***0.5***
Straits 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
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) forest land

3/ Includes, municipal, tribal, non-DNR state lands, and other lands

Table E-19. 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 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-19. 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%
Planning Unit Average			***18%***	***5%***	***2%***	***11%***	***0%***
North Puget 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-19. 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%
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-19. 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%
Planning Unit Average			***8%***	***3%***	***2%***	***3%***	***0%***
South Coast 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-19. 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%
Planning Unit Average			***14%***	***6%***	***0%***	***8%***	***0%***
South Puget 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%
Planning Unit Average			***24%***	***11%***	***3%***	***9%***	***1%***
Straits 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-19. 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%
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) forest land

3/ Includes, municipal, tribal, non-DNR state lands, and other lands

Table E-20. 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 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-20. 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%
Planning Unit Average			***64%***	***13%***	***1%***	***49%***	***1%***
North Puget 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-20. 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-20. 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%
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%
Planning Unit Average			***62%***	***24%***	***2%***	***34%***	***2%***
South Coast 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-20. 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	Federal	Private[2/]	Other[3/]
				Percentage Breakdown by Ownership			
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%
Planning Unit Average			***89%***	***27%***	***0%***	***57%***	***5%***
South Puget 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-20. 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/]
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%
Planning Unit Average			***27%***	***10%***	***0%***	***13%***	***3%***
Stratits 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%
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) forest land

3/ Includes, municipal, tribal, non-DNR state lands, and other lands

Table E-21. 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 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-21. 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%
Planning Unit Average			***19%***	***6%***	***2%***	***10%***	***1%***
North Puget 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-21. 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%
Planning Unit Average			***11%***	***3%***	***1%***	***7%***	***0%***

Table E-21. 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%
Planning Unit Average			***19%***	***9%***	***2%***	***8%***	***1%***
South Coast 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-21. 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%
Planning Unit Average			***6%***	***1%***	***0%***	***5%***	***0%***
South Puget 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%
Planning Unit Average			***36%***	***10%***	***1%***	***18%***	***7%***

Table E-21. 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 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%
Planning Unit Average			***45%***	***12%***	***1%***	***31%***	***1%***

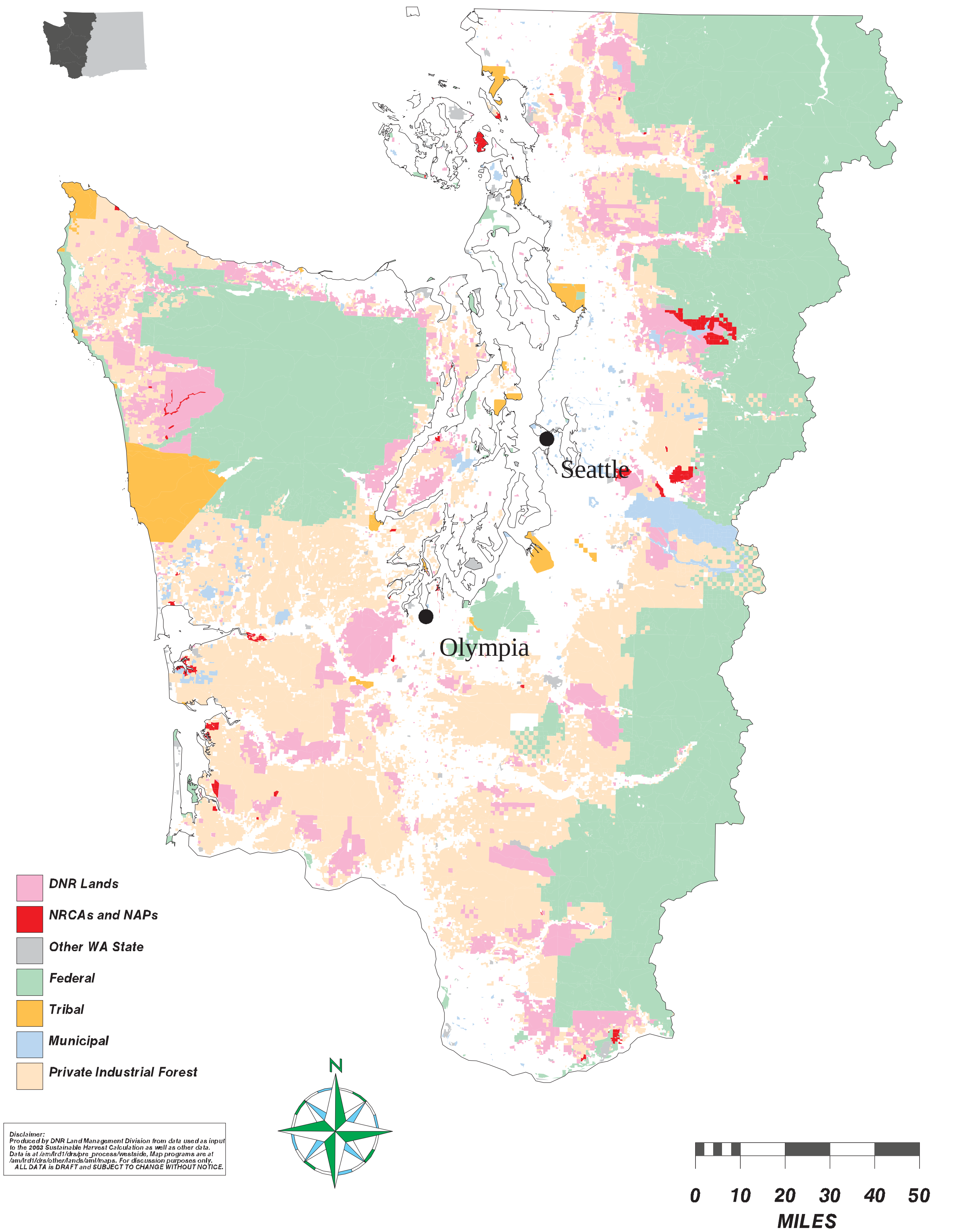
1/ Watershed with greater than 5% ownership that have soils classified as moderate for moist soil compaction potential are ranked by percent area of watershed that meets these criteria.

2/ Includes privately owned industrial and non-industrial (i.e., small landowner) forest land

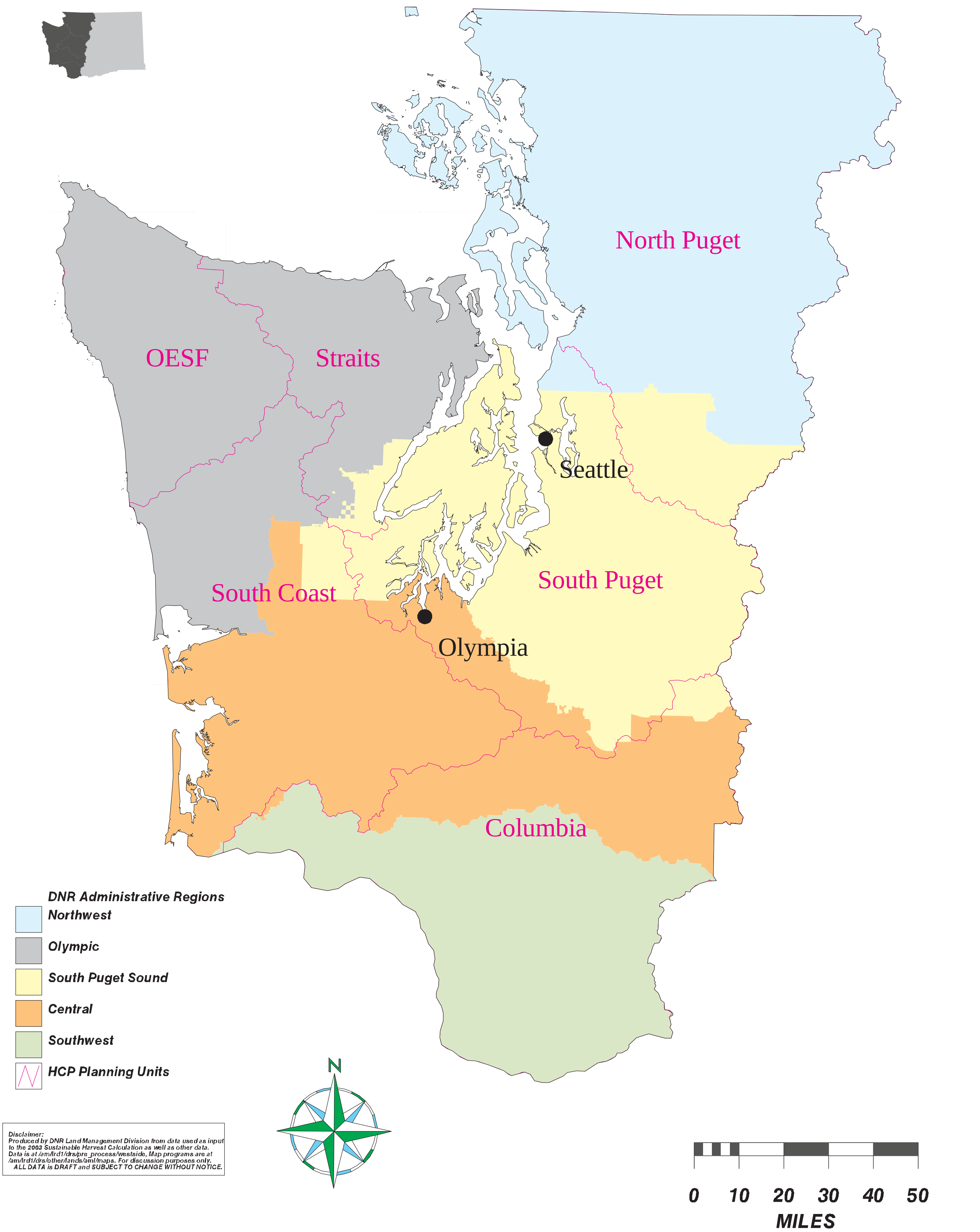
3/ Includes, municipal, tribal, non-DNR state lands, and other lands

Maps

Map1: State Trust Lands And Adjacent Ownership In Western Washington



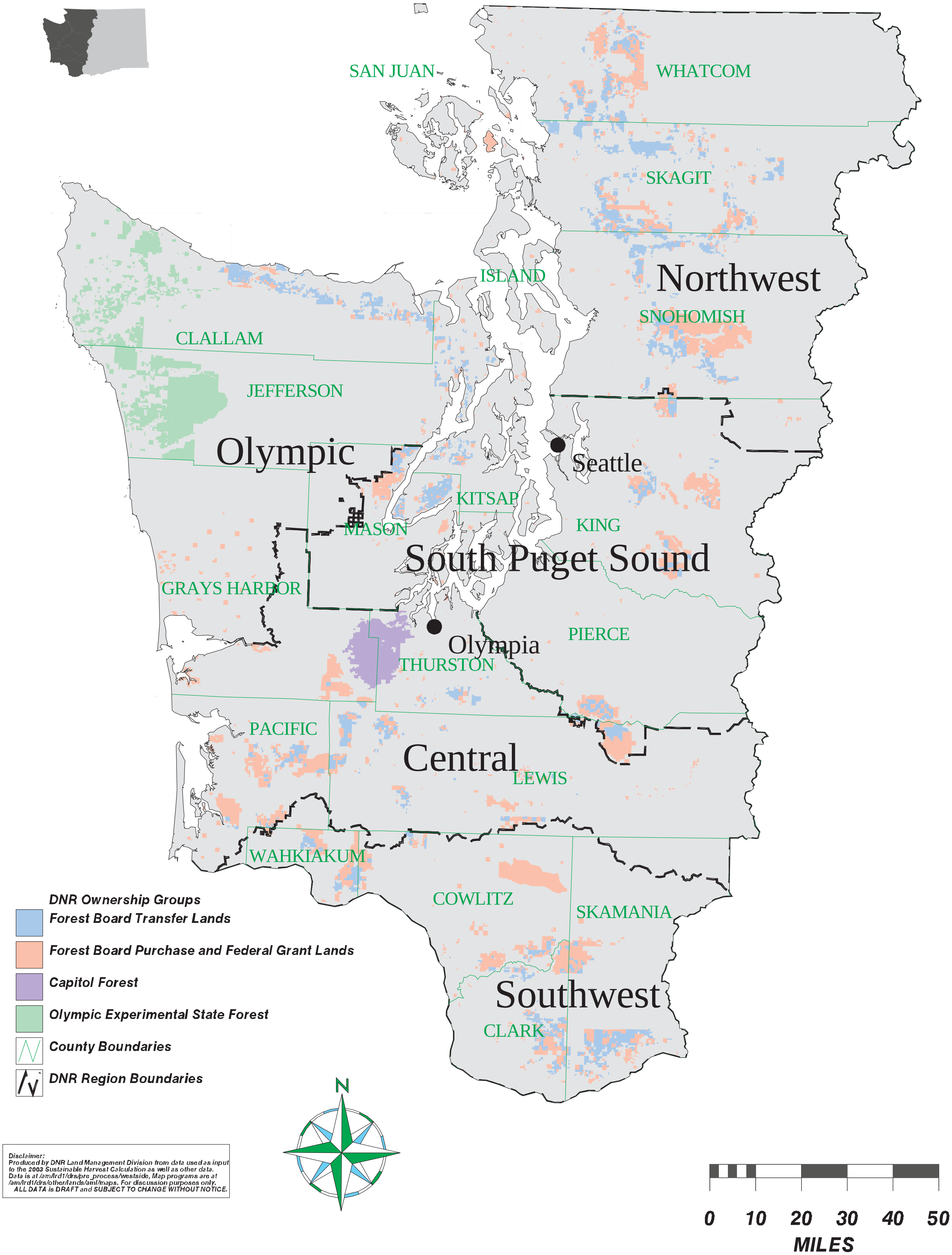
Map 2: DNR Administrative Regions and HCP Management Unit Boundaries



Disclaimer:
Produced by DNR Land Management Division from data used as input to the 2003 Sustainable Harvest Calculation as well as other data. Data is at /am/lrd1/drs/pre_process/westside, Map programs are at /am/lrd1/drs/other/lands/aml/maps. For discussion purposes only.
ALL DATA is DRAFT and SUBJECT TO CHANGE WITHOUT NOTICE.

/am/lrd1/drs/other_lands/aml/maps/region_hcpunit_map.aml on 24-OCT-2003:08:43:18.00

Map 3: DNR-managed lands and Ownership Groups in Alternative 1



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