Appendix B
Modeling Process and Results

Appendix B

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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.

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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

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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?

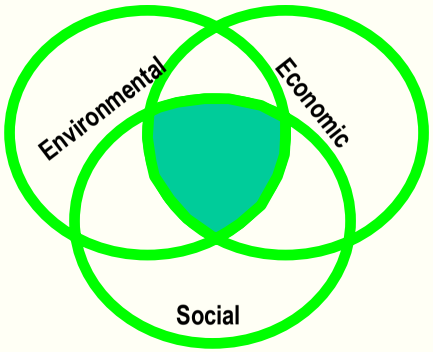
The sustainable harvest level is the amount of timber that can be harvested on average during a decade, assuring that the same amount of trees will be available for harvest each year. This assures that harvests can continue into the future with fairness to all generations of the Trust beneficiaries.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

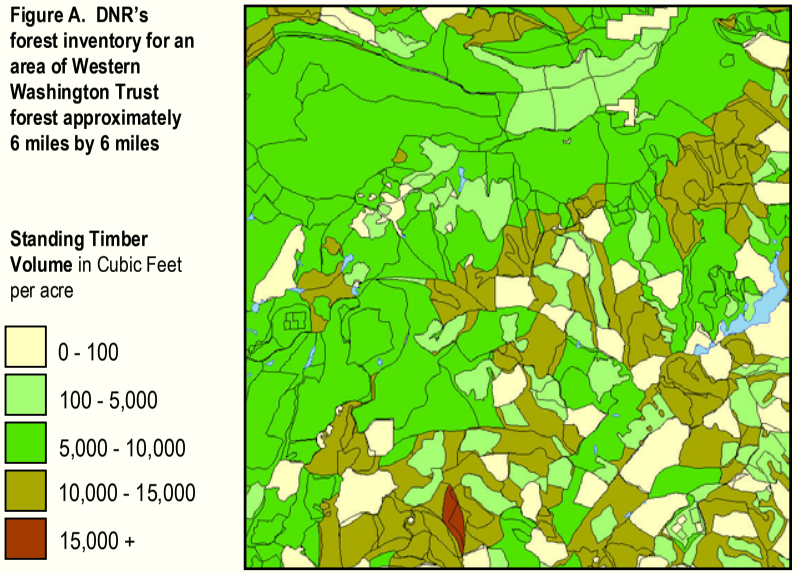
1. Accurately represent the organizational goals and constraints in the model;
2. Use a reliable forest inventory;
3. Develop a appropriate land classification;
4. Ensure a link between the strategic planning process and implementation.

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



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.

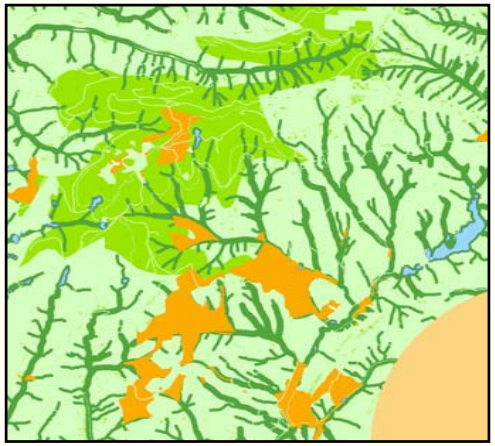


Figure B. Land classification: Riparian (dark green), Uplands with specific objectives (medium green), Uplands with general objectives (light green), long-term deferral (orange) and short-term deferral (light orange).

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.

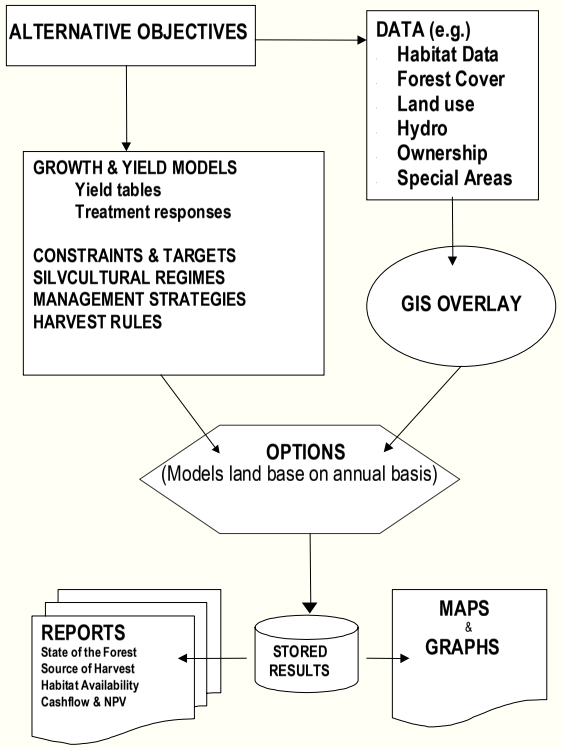


Figure 1. Process used to model the DEIS Alternatives

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.

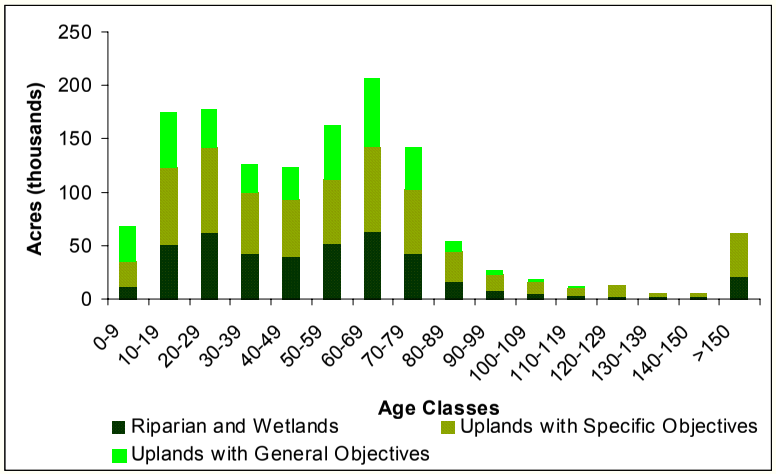


Figure C. Age Class distribution in 2004 for DNR- managed forest lands in Western Washington.

B-11

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)

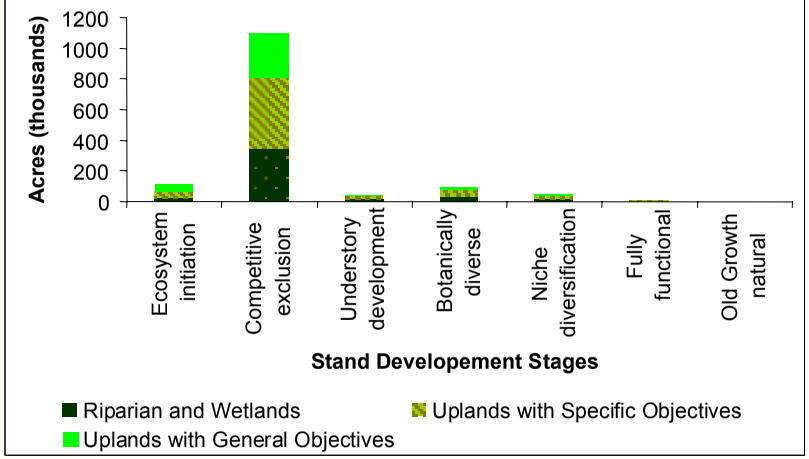


Figure D. Stand Development Stages (SD) in 2004 for the DNR managed forest lands in Western Washington

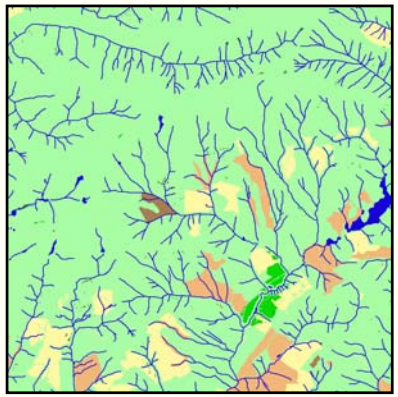
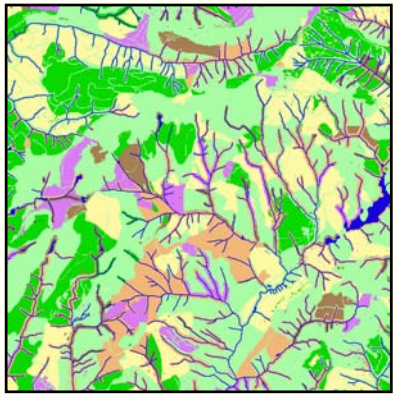


Figure E. Example of data for an area modeled to show stand development stage classification for 2004

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).

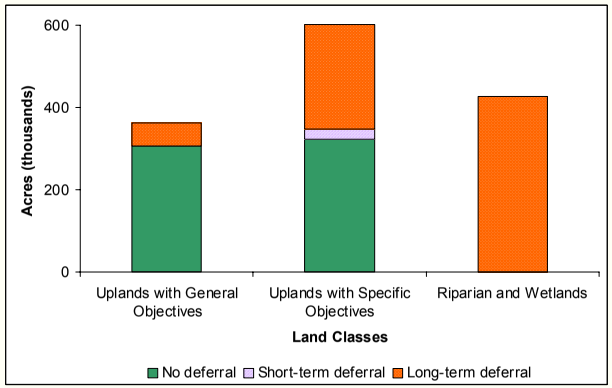


Figure 1. Major land classes and deferrals in 2004

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.

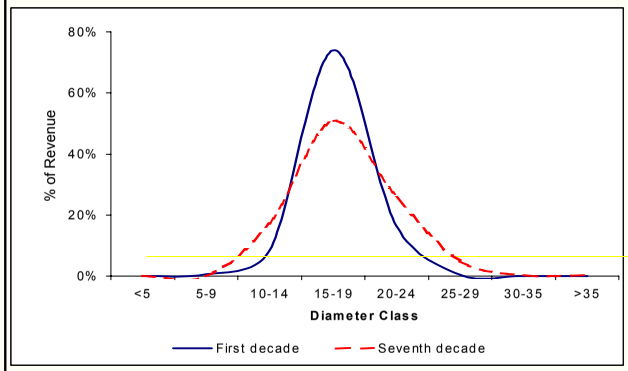


Figure 2. Diameters of harvested stands for selected time periods

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).

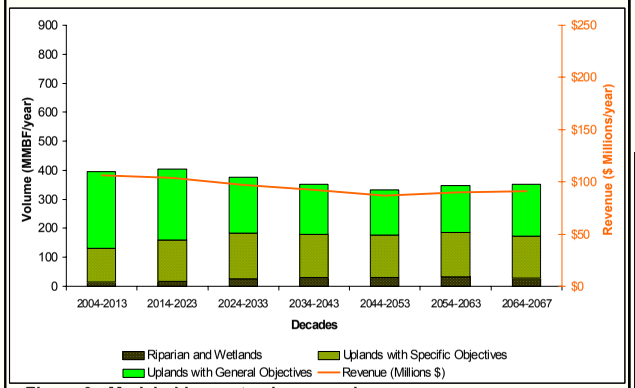


Figure 3. Modeled harvest volumes and revenues

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.

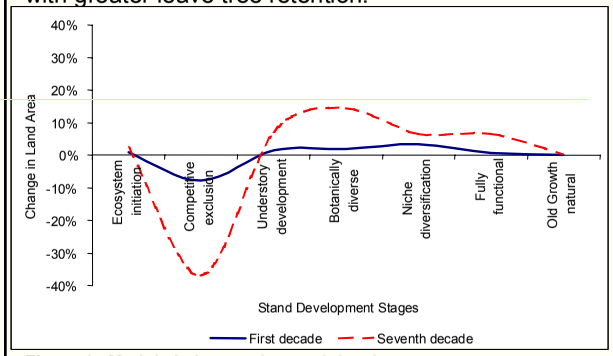


Figure 4. Modeled changes in stand development stages

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.

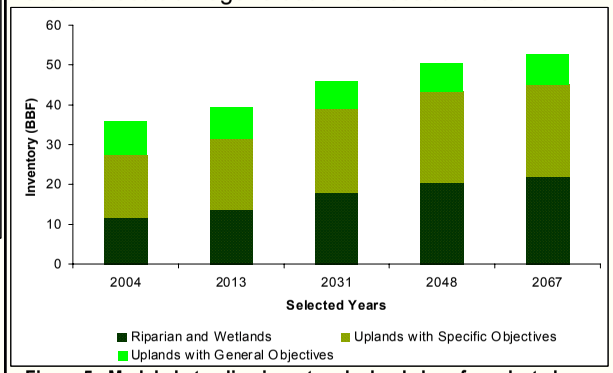


Figure 5. Modeled standing inventory by land class for selected years in billions of board feet.

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)

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

Board of Natural Resources Action

- No policy changes
- Sustainable harvest level adopted

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

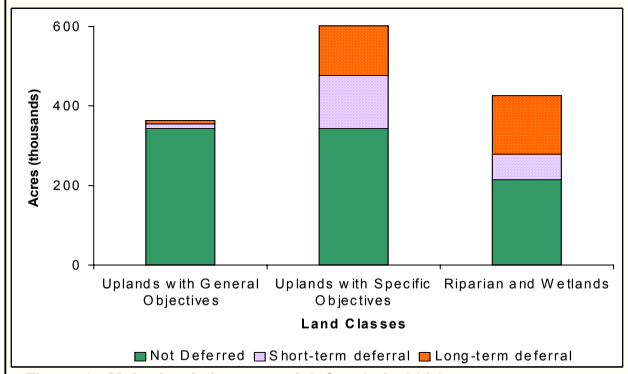


Figure 1. Major land classes and deferrals in 2004

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.

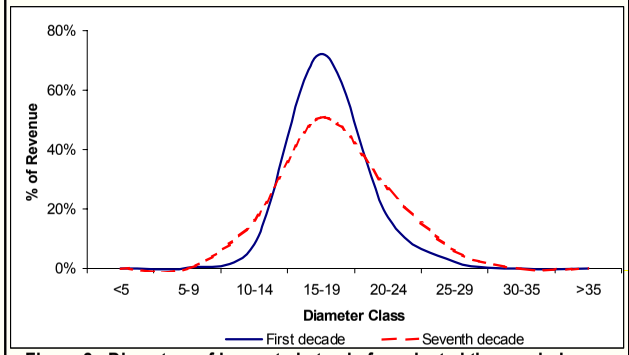


Figure 2. Diameters of harvested stands for selected time periods

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).

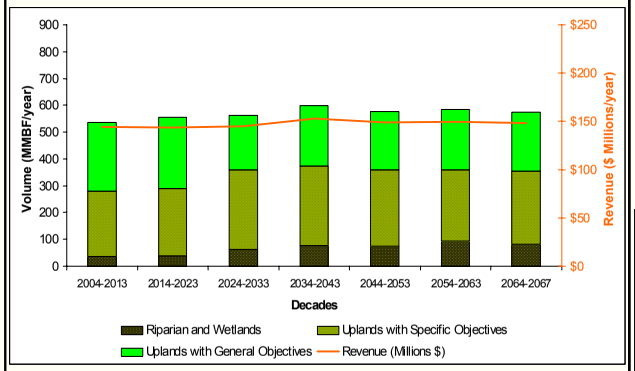


Figure 3. Modeled harvest volumes and revenues

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.

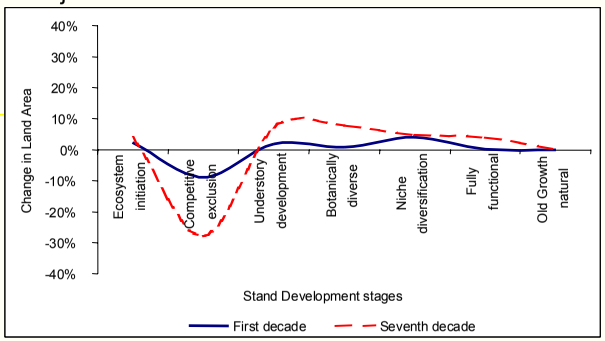


Figure 4. Modeled changes in stand development stages

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.

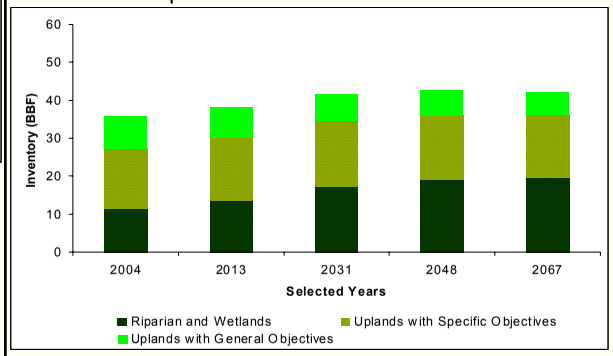


Figure 5. Modeled standing inventory by land class for selected years in billions of board feet

DRAFT – Subject to change

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.

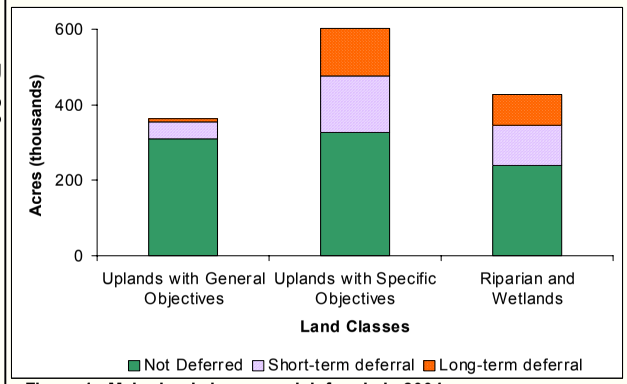


Figure 1. Major land classes and deferrals in 2004

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.

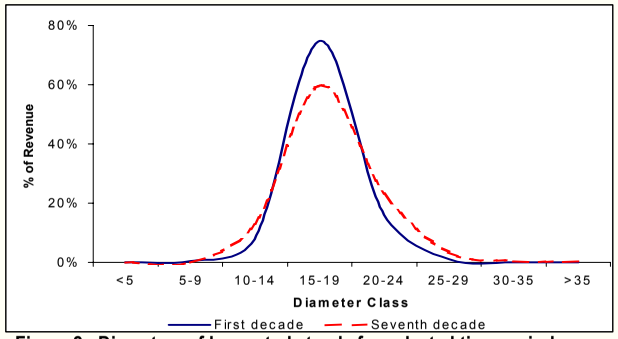


Figure 2. Diameters of harvested stands for selected time periods

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).

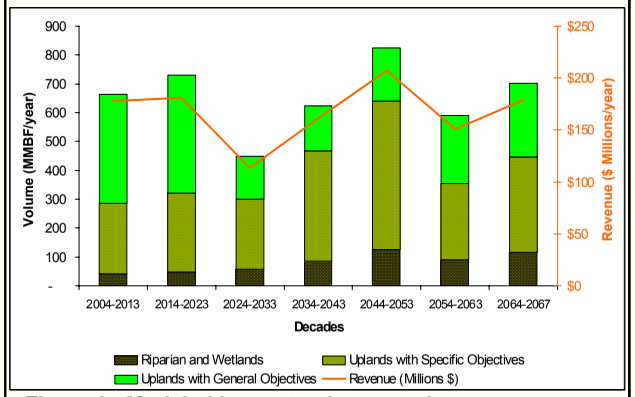


Figure 3. Modeled harvest volumes and revenues

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.

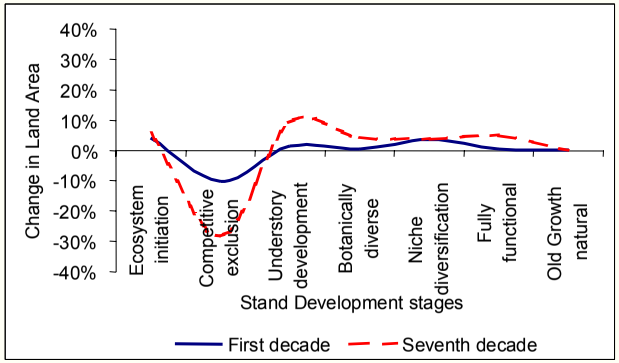


Figure 4. Modeled changes in stand development stages

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.

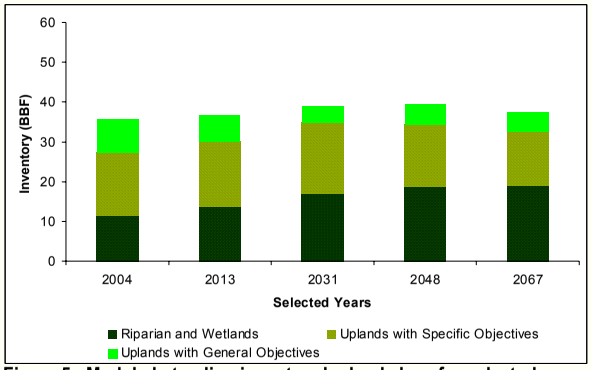


Figure 5. Modeled standing inventory by land class for selected years in billions of board feet

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)

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

Board of Natural Resources Action

- Amend Policy No. 6
- Sustainable harvest level adopted

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

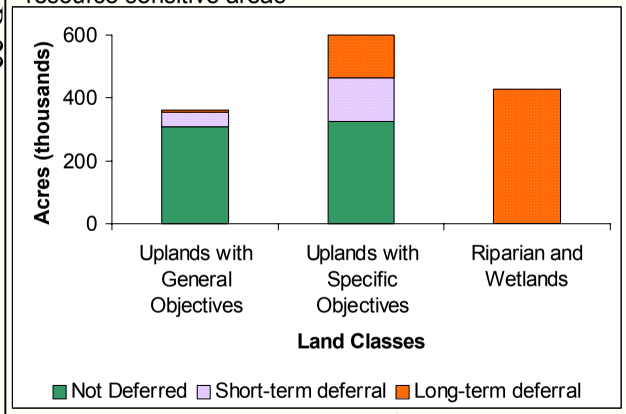


Figure 1. Major land classes and deferrals in 2004

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.

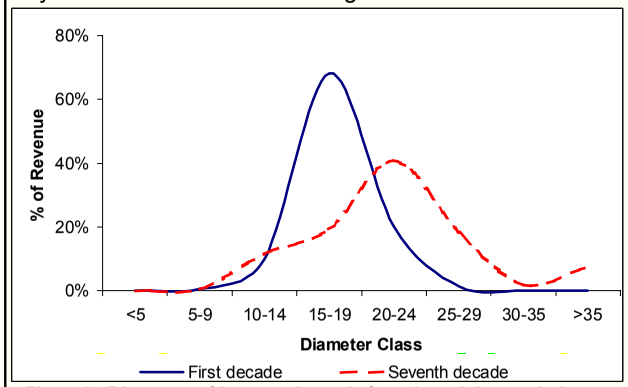


Figure 2. Diameters of harvested stands for selected time periods

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).

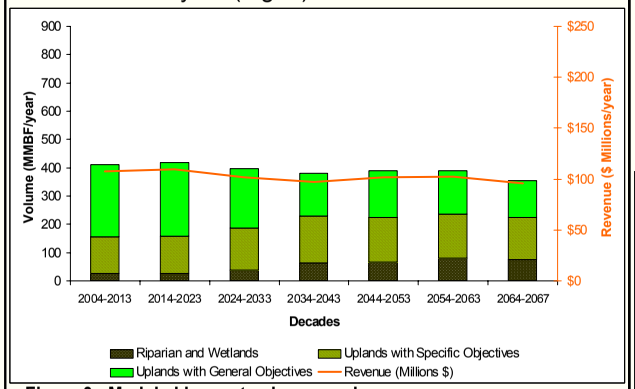


Figure 3. Modeled harvest volumes and revenues

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.

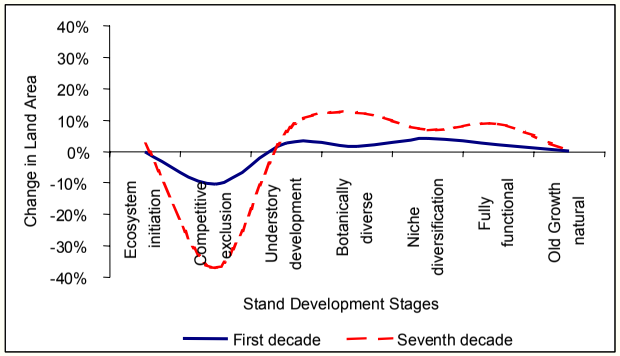


Figure 4. Modeled changes in stand development stages

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.

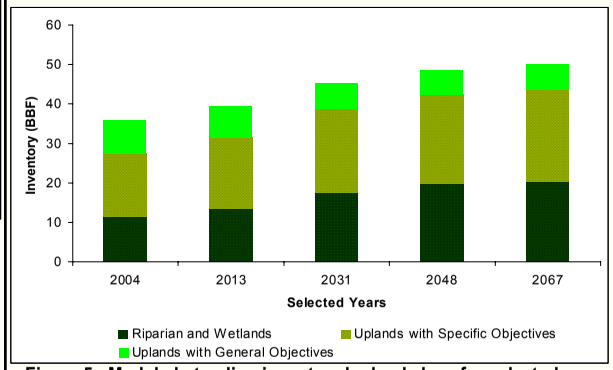


Figure 5. Modeled standing inventory by land class for selected years in billions of board feet

DRAFT – Subject to change

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.

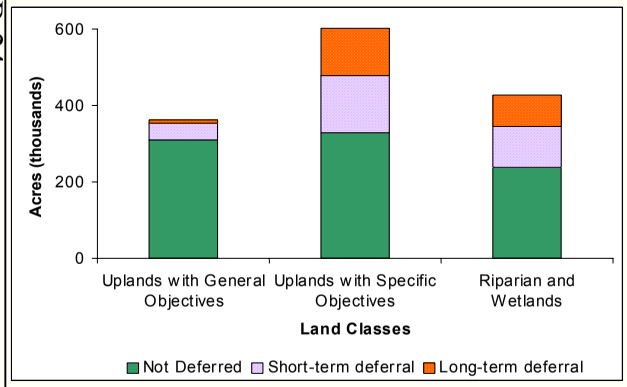


Figure 1. Major land classes and deferrals in 2004

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).

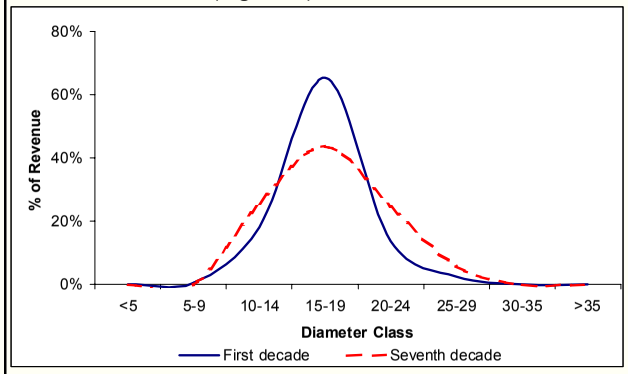


Figure 2. Diameters of harvested stands for selected time periods

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).

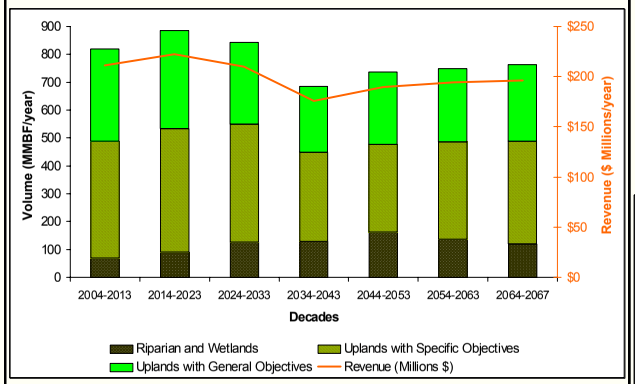


Figure 3. Modeled harvest volumes and revenues

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.

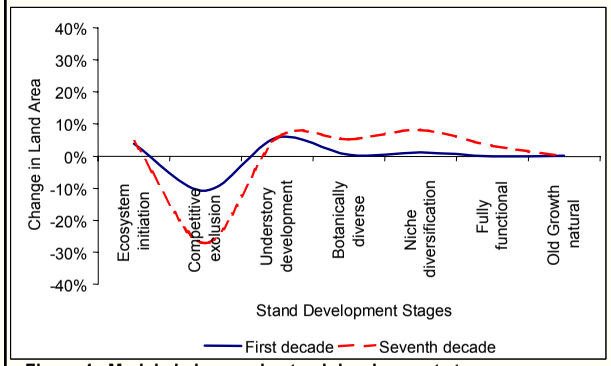


Figure 4. Modeled changes in stand development stages

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.

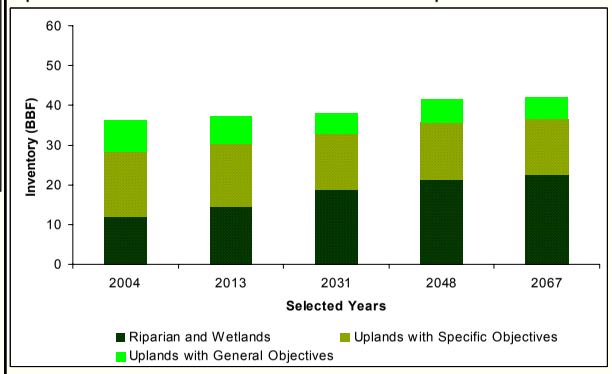


Figure 5. Modeled standing inventory by land class for selected years in billions of board feet

Alternative 5

DRAFT – Subject to change

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.

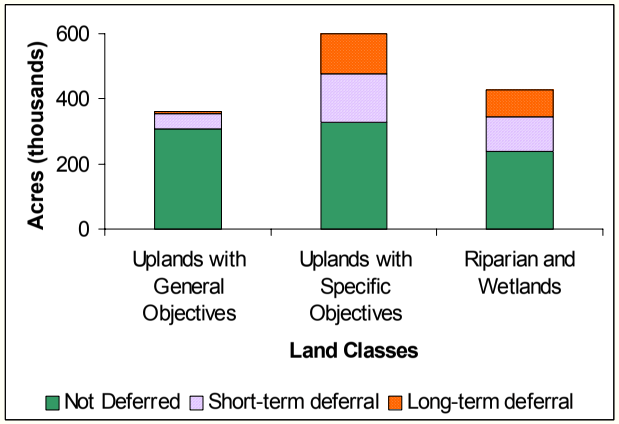


Figure 1. Major land classes and deferrals in 2004

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).

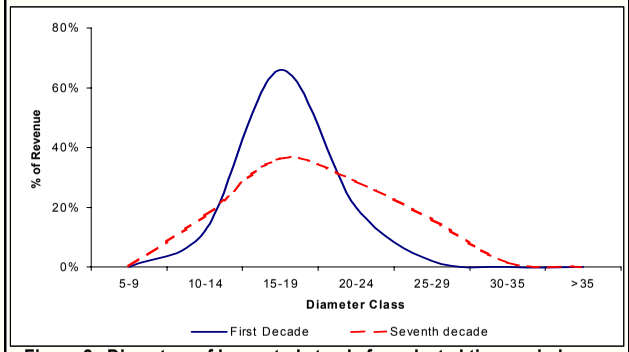


Figure 2. Diameters of harvested stands for selected time periods

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).

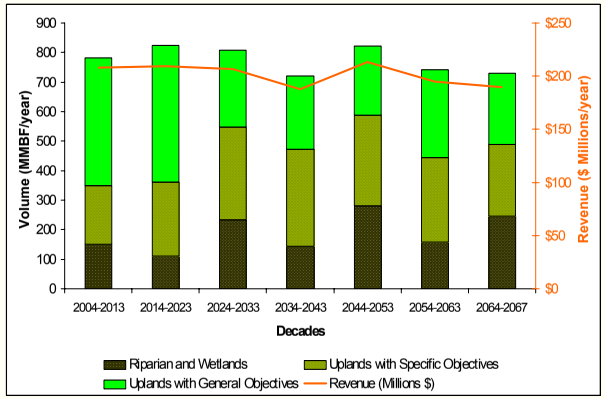


Figure 3. Modeled harvest volumes and revenues

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.

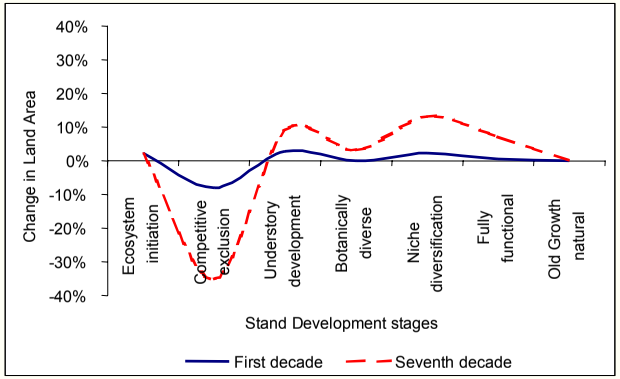


Figure 4. Modeled changes in stand development stages

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.

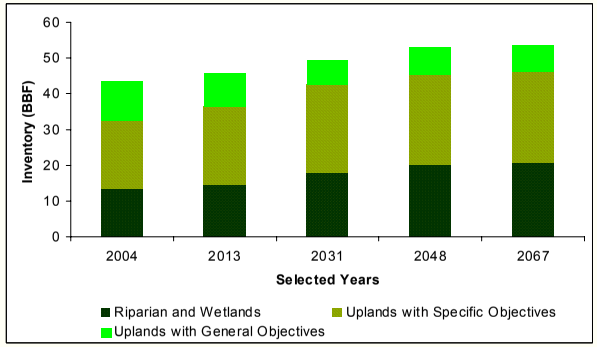


Figure 5. Modeled standing inventory by land class for selected years in billions of board feet

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

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

Board of Natural Resources Action

❖ Amend Policy Nos. 5 and 6, update Nos. 30 and 31

❖ Sustainable harvest level adopted

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.

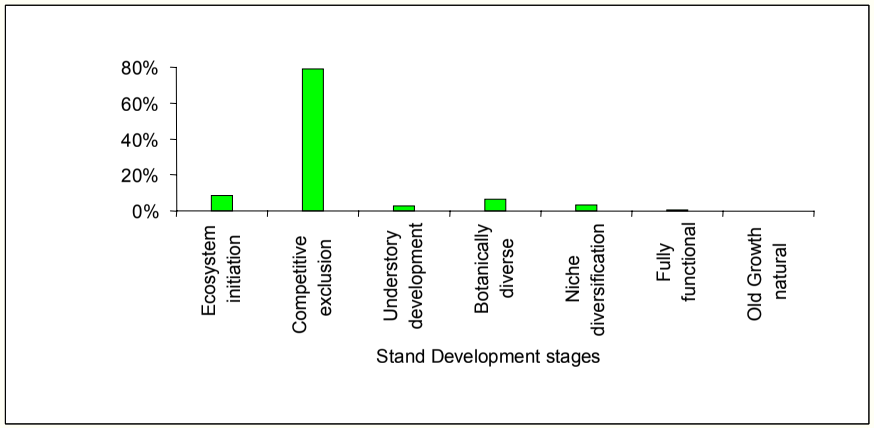


Figure G. Modeled stand development classes in 2004 in Westside Trust forests

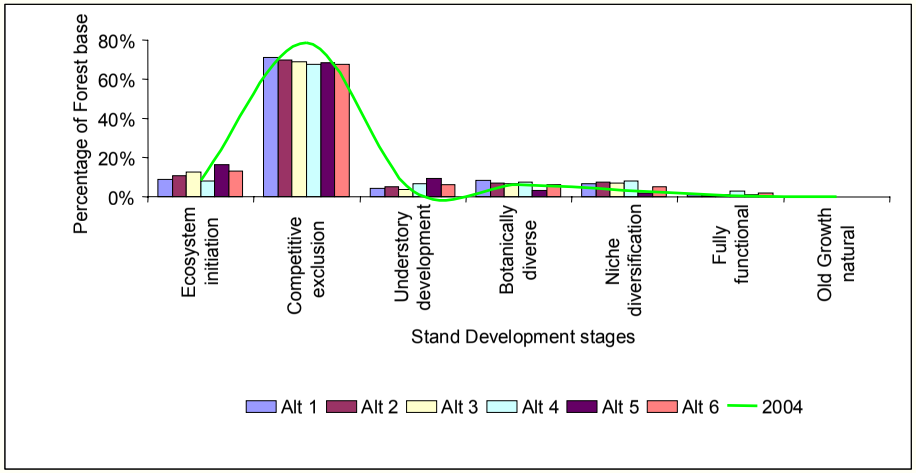


Figure H. Modeled stand development classes in 2013 in Westside Trust forests

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.

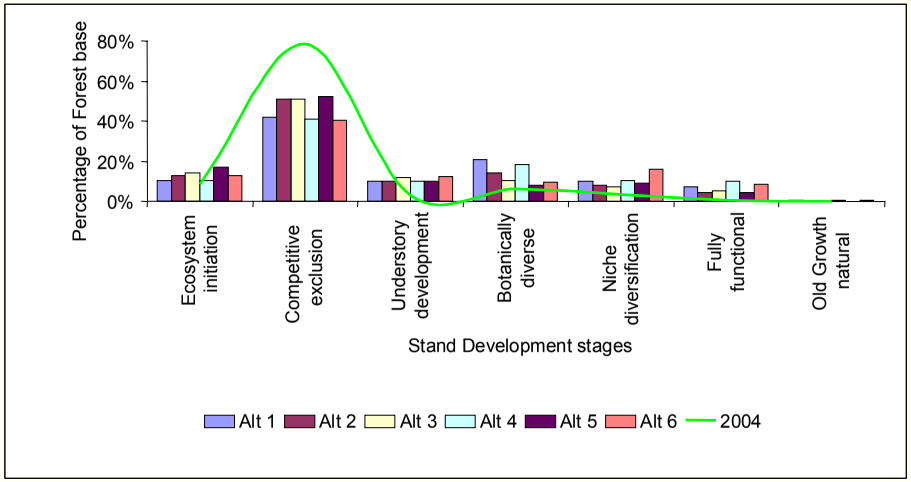


Figure I. Modeled stand development classes in 2067 in Westside Trust forests

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).

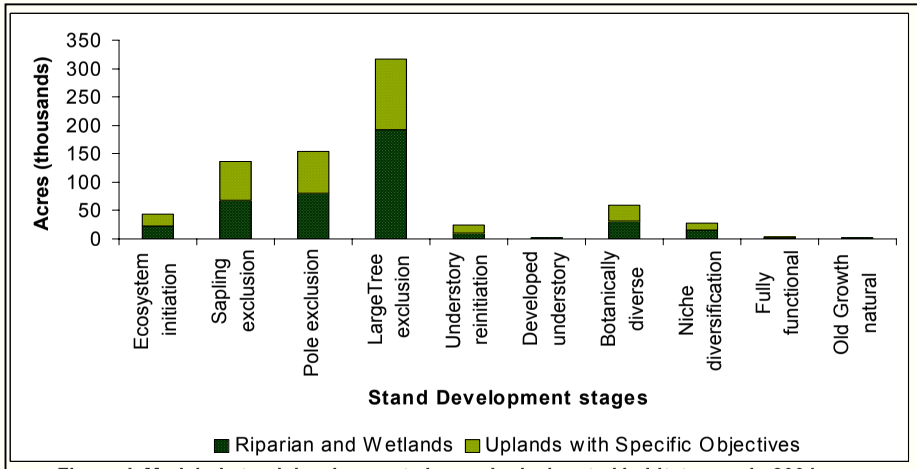


Figure J. Modeled stand development classes in designated habitat areas in 2004

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.

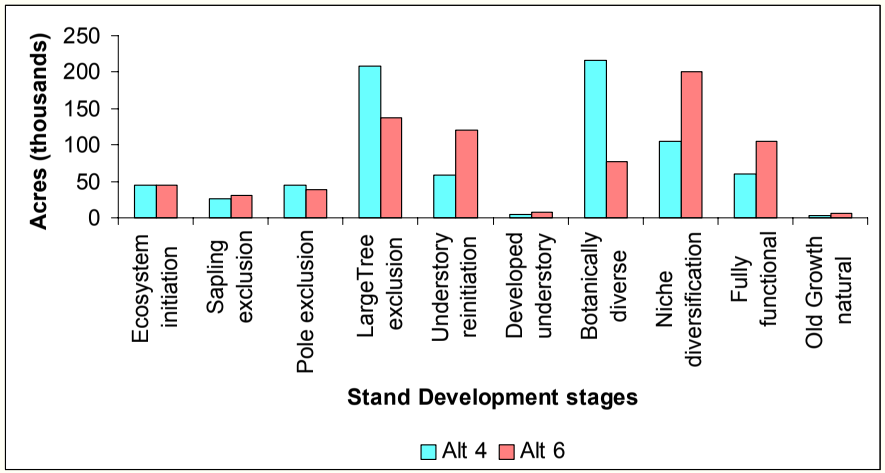


Figure K. Modeled stand development classes in designated habitat areas in 2067

Revenue Generation – A Comparison and Summary

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
	Revenue ($ Millions/year)	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.

B-30

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

County	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
	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.

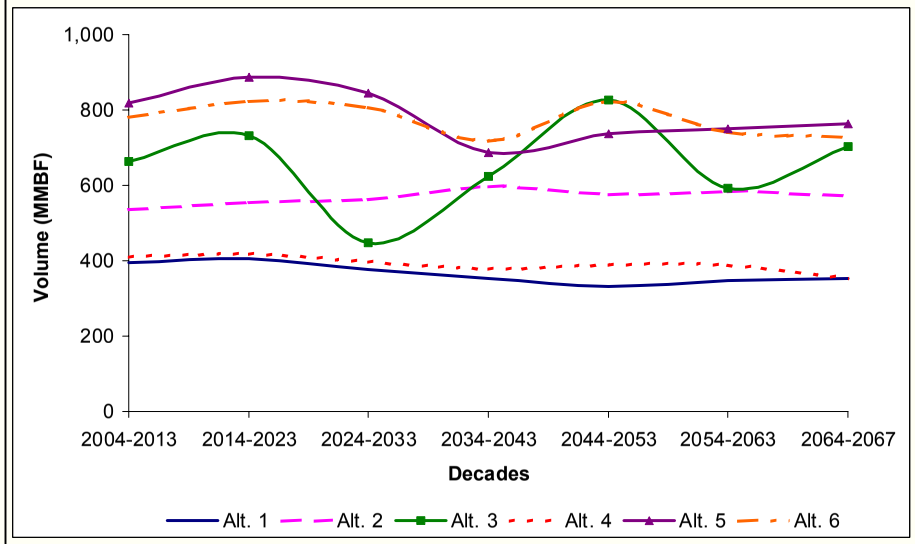


Figure L. Variation in volume over time due to different flow control and management strategies

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

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- The Lands Steward, Bruce Mackey
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- 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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- Mark Perdue

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							Alternative 3							Alternative 4							Alternative 5							Alternative 6						
		1[3]	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Federal Granted Trusts	DNR Central Region	38	44	41	38	39	42	36	58	67	71	71	66	73	74								61	66	64	51	55	60	44															
	DNR Northwest Region	48	42	27	33	32	37	45	60	61	43	61	59	61	55								52	51	49	38	47	49	48															
	DNR Olympic Region	7	7	8	8	7	7	7	17	15	17	14	14	14	12								13	14	13	14	12	14	12															
	DNR South Puget South Region	44	45	43	31	26	25	25	36	36	39	37	36	37	38								26	26	25	27	24	24	22															
	DNR Southwest Region	56	58	55	43	41	42	46	67	60	57	68	66	57	58								59	59	58	47	55	50	49															
	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	38	38	38	34	32	37	34	43	47	41	51	43	44	32								37	36	38	32	36	31	29	44	54	58	51	58	47	46	65	64	66	43	62	64	57
	OESF[4]	19	22	29	30	29	29	30	62	55	101	97	98	95	103								8	7	6	8	10	11	10	170	172	152	138	143	151	147	39	39	61	73	62	49	45
	Clallam County	6	8	8	6	6	7	6	15	28	18	17	17	19	17								15	19	19	18	16	17	17	27	25	30	27	22	24	26	32	33	36	26	24	24	34
	Clark County	11	12	11	11	9	10	6	13	16	9	12	11	13	6								9	9	9	9	8	8	8	16	15	12	12	15	13	13	20	18	18	16	19	17	19
	Cowlitz County	4	4	4	4	4	4	4	6	6	6	5	5	4	4								4	4	5	5	4	4	4	8	6	5	5	5	6	5	8	7	8	5	7	8	6
	Jefferson County	5	5	4	4	3	3	4	6	5	7	5	5	5	5								3	3	4	3	3	3	3	8	7	7	7	6	6	7	9	9	8	6	7	8	7
	King County	10	10	10	8	9	5	4	8	9	9	9	8	8	9								6	6	6	6	6	6	6	14	16	14	6	12	9	12	13	15	14	14	14	10	7
	Kitsap County	3	2	2	2	2	1	1	3	4	2	3	3	3	3								3	3	2	2	2	3	2	3	4	3	3	3	3	3	4	4	4	4	4	4	4
	Lewis County	14	14	14	14	13	13	14	21	19	19	20	19	17	20								17	17	14	18	16	16	15	21	22	30	25	22	20	28	28	28	29	28	29	28	29
	Mason County	9	8	7	7	4	3	3	10	9	8	11	9	10	8								8	8	6	7	7	6	4	12	7	8	11	9	11	12	14	13	12	11	13	13	10
	Pacific County	3	4	4	4	4	4	4	6	8	8	8	8	8	8								6	6	6	7	6	6	5	13	14	8	8	10	8	9	14	14	14	12	13	13	14
	Pierce County	4	4	4	4	4	4	4	4	4	4	5	4	5	4								1	1	1	1	1	1	1	4	8	8	6	5	5	5	1	2	7	7	7	5	4
	Skagit County	32	29	20	27	27	30	32	36	39	31	41	39	41	40								34	32	19	35	33	32	31	50	49	50	42	46	49	54	53	62	55	54	55	51	43
	Skamania County	5	6	7	7	7	6	7	15	11	15	10	13	15	8								3	4	4	4	4	4	5	16	16	18	17	13	18	19	6	5	7	17	19	19	19
	Snohomish County	24	24	23	23	19	22	24	29	32	31	31	29	32	29								28	28	27	28	26	26	19	40	49	40	31	38	35	30	48	49	49	48	49	45	30
	Thurston County	2	3	3	3	3	2	3	6	2	5	2	4	1	2								2	3	3	3	2	3	3	5	5	3	5	5	4	4	6	5	7	6	6	6	5
	Wahkiakum County	4	4	3	3	3	4	4	5	6	6	5	5	6	6								6	6	6	6	5	5	6	11	12	7	8	9	7	11	11	13	9	8	10	9	10
	Whatcom County	10	11	11	9	10	10	10	12	16	15	16	15	14	15								10	13	13	13	11	12	12	22	20	21	15	18	17	17	24	26	26	24	22	23	20
Westside harvest level		396	404	377	352	332	348	353	537	556	562	598	577	585	554	663	731	448	623	825	591	702	411	419	397	380	390	389	354	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

	Alternative 1							Alternative 2							Alternative 3							Alternative 4							Alternative 5							Alternative 6						
Trusts	1[6]	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Agricultural School	9	10	6	6	5	8	6	9	14	13	12	11	12	11	7	19	14	12	21	14	12	12	11	9	6	9	10	11	12	22	26	17	15	17	15	13	20	21	17	21	16	13
Capitol Grant	34	29	22	20	17	19	19	37	33	39	36	28	29	32	46	45	30	37	63	46	47	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	15	11	9	10	6	8	6	15	14	10	10	10	12	12	17	19	7	11	16	10	11	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	2	2	1	2	2	1	3	1	3	1	3	2	1	3	0	4	1	3	2	1	2	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	114	127	121	111	110	109	120	174	166	191	211	209	214	203	179	203	171	227	306	197	320	121	130	125	110	123	130	124	267	301	315	235	268	264	255	259	233	251	214	276	227	259
Escheat	2	1	1	0	2	1	2	2	1	1	1	2	1	2	2	1	1	2	2	1	4	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	32	29	28	24	19	29	31	39	47	34	46	32	36	31	61	52	20	41	40	38	41	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	157	155	144	145	135	139	136	212	225	219	219	213	222	215	300	300	148	233	301	227	221	163	166	151	170	160	158	145	324	310	297	260	272	271	284	307	325	330	313	325	303	278
Normal School	6	5	9	7	6	8	6	12	10	8	16	12	16	10	11	11	11	17	13	15	12	7	5	6	7	7	9	7	14	18	17	18	19	17	14	14	12	17	15	15	14	13
Scientific School	23	25	18	17	14	14	12	22	28	23	26	27	20	21	29	50	22	21	28	22	24	25	25	23	22	21	17	15	33	51	37	21	31	33	37	32	57	40	29	39	40	38
University - Original	1	0	1	1	0	1	1	0	3	1	2	1	1	2	1	2	1	1	2	1	1	1	1	1	0	1	1	1	1	3	1	1	2	2	2	1	1	2	2	2	2	1
University - Transferred	1	10	16	7	15	13	12	13	12	22	17	30	21	12	9	25	21	17	32	20	7	4	8	14	5	4	6	4	21	33	35	29	16	30	25	8	22	24	12	17	12	22
Grand Total	396	404	376	350	331	350	354	536	556	562	599	577	585	554	662	731	447	622	826	592	702	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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