"*Stewardship in Forestry*"

Oregon Department of Forestry

# Harvest & Habitat Model Project

## FINAL REPORT

Presented to the Oregon Board of Forestry
March 8, 2006

# *List of Acronyms and Abbreviations*

| | |
|---|---|
| AOP | Annual Operations Plan |
| AT | Astoria district |
| CFM | Coarse Filter Wildlife Matrix |
| CSC | Closed single canopy forest structure |
| DAS | Oregon Department of Administrative Services |
| DFC | Desired future condition |
| FG | Forest Grove district |
| FMP | Forest Management Plan |
| FMP~HCP | Forest Management Plan using a Habitat Conservation Plan alternative |
| FMP~TA | Forest Management Plan using Take Avoidance alternative |
| FPA | Forest Practices Act |
| FPFO | Forestry Program for Oregon |
| GIS | Geographic information system |
| H&H | Harvest and Habitat |
| HCP | Habitat Conservation Plan |
| HLHL | High landslide hazard locations |
| IP | Implementation Plan |
| LMCS | Land Management Classification System |
| LYR | Layered forest structure |
| MBF | Thousand board feet |
| MMBF | Million board feet |
| MSR | Model Solution Review |
| NC | North Cascade district |
| NPV | Net present value |
| NSO | Northern spotted owl |
| ODF | Oregon Department of Forestry |
| ODFW | Oregon Department of Fish and Wildlife |
| OFS | Older forest structure |
| OSU | Oregon State University |
| REG | Regeneration forest structure |
| RMA | Riparian management area |
| SAH | Salmon Anchor Habitat |
| SLI | Stand level inventory |
| SNC | Swiss needle cast disease |
| SW | Southwest Oregon district |
| T&E | Threatened and Endangered (species) |
| TA | Take Avoidance |
| TL | Tillamook district |
| UDS | Understory development forest structure |
| WL | Western Lane district |
| WO | West Oregon district |

# *Abstract*

This report summarizes the findings from the Oregon Department of Forestry's Harvest & Habitat Model Project. Spatial forest scheduling models have been created for seven Oregon Department of Forestry (ODF) districts to provide a component of information for decision-makers to: 1) determine if changes should be made to ODF's *Northwest* and *Southwest Oregon Forest Management Plans* (FMP), 2) decide whether to pursue a Habitat Conservation Plan (HCP), and 3) assist in setting harvest levels for Annual Operation Plans.

Models for four alternatives were created. Two alternatives were modeled for each of seven districts: Astoria, Tillamook Forest Grove, North Cascade, West Oregon, Western Lane, and Southwest Oregon. Both simulated the FMP: one used HCP strategies (FMP~HCP), the other used take avoidance strategies (FMP~TA) for threatened and endangered species (T&E).

Two other alternatives that fell outside the goals and objectives of the FMP were also modeled for three north coast districts: Astoria, Tillamook, and Forest Grove. The Wood Emphasis alternative simulated short rotations and intensive harvesting with Forest Practices Act levels of protection for stream buffers and ODF's take avoidance for T&E species. The Reserve-Based alternative identified approximately 60% of the landscape that had no harvesting or restricted harvesting in areas that included stream buffers and habitat for T&E species.

The report provides an evaluation of the level of confidence in the accuracy of the model to represent the spatial data and simulate policy rules. It also evaluates the districts' ability to implement the model's harvest plan on the ground, with an explanation of district issues. Answers to a list of key questions posed by stakeholders are included.

The results of the modeling are summarized in findings that compare the consequences on harvest and habitat: 1. between the FMP~HCP and the FMP~TA, and 2. between all four alternatives. There are also findings for the results of each of the four alternatives individually with respect to harvest and habitat results.

# *Acknowledgements*

Completing the Harvest &Habitat Model Project has been a team-effort by Oregon Department of Forestry (ODF) field and Salem staff, with invaluable assistance from others in support of ODF's efforts. We would like to acknowledge the contributions made by the following people toward the successful completion of this project.

Oregon State University, College of Forestry
Dr. John Sessions, Professor of Forest Engineering

H&H Executive* and Policy Teams
Steve Thomas, Assistant State Forester, Policy Team Chair*
Lisa DeBruyckere, State Forests Program Director*
Mike Bordelon, Northwest Oregon Area Director*
Dan Shults, Southern Oregon Area Director*
Ross Holloway, (former) State Forests Program Director*
Susan Morgan, State Representative
Tim Josi, Tillamook County Commissioner
Charlie Ringo, State Senator
Susie Jordan, Legislative Budget Analyst
Satish Upadhyay, DAS Budget Analyst
Christina Shearer, (former) DAS Budget Analyst
Steve Purchase, Department of State Lands
John Lilly, (former) Department of State Lands
Dan Doyle, (former) State Representative

Core Team Members**
Wayne Auble, Assistant District Forester, Tillamook
Dan Goody, Management Unit Forester, Astoria
Bob Gustavson, Acting District Forester, Forest Grove
Mark Rasmussen, Mason, Bruce & Girard; County Rep.
Ron Zilli, Assistant District Forester, Astoria
Bill Lecture, (former) Asst. District Forester, Astoria
Vince Pyle, Info. Systems Forester, SW Oregon
Chris Rudd, Management Unit Forester, SW Oregon

Core Team Members (continued)
Erik Marcy, Marketing Unit Forester, Forest Grove
Art McCoy, State Forests Unit Forester, Western Lane
Jerry Chetock, Management Unit Forester, North Cascade
Dan Borg, State Forests Unit Forester, West Oregon
Mary Schmelz, Office Specialist 2, West Oregon
Chuck Hurliman, Tillamook County Commissioner, Alt. Rep.

Other ODF Staff
Mike DeLaune, Senior Application Developer, Salem
Ryan Miller, GIS Coordinator, Salem
Mike Wilson, Wildlife Biologist, Salem
Clint Smith, Wildlife Biologist, Tillamook
Keith Mills, Roads & Harvesting Engineer, Salem
Greg Miller, District Engineering Supervisor, Forest Grove
Carson Hundrup, Road Specialist, Forest Grove
Blake Lettenmaier, District Engineering Supervisor, Tillamook
Bob Teran, Central Unit Forester, Tillamook
Doug Robin, Silviculturalist, Salem
Lisa Zwart, GIS Technician, Salem
Jeff Foreman, Agency Affairs, Salem

H&H Team
Dave Johnson, H&H Project Leader**
Pam Overhulser, H&H Technical Project Leader**
Rob Nall, H&H Assistant Project Leader**
Dave Enck, H&H Model Analyst**
Nancy Hirsch, Integrated Sys. Mgr, State Forests Program**

## ***Acknowledgements*** *(continued)*

Stakeholders
Susan Ash, Portland Audubon
Toby Atterbury, Atterbury Consultants, Inc.
Linc Cannon, Oregon Forest Industries Council (OFIC)
Brent Davies, Ecotrust
Betsy Glenn, The Wildlife Society – Oregon Chapter
Noah Greenwald, Center for Biological Diversity
Lori Hennings, The Wildlife Society – Oregon Chapter
Dave Ivanoff, Hampton Tree Farms
Chris Jarmer, Oregon Forest Industries Council (OFIC)
Mark McCollister, Oregon Trout
John McGhehey, Stimson Lumber Co.
Dave Moskowitz, Wild Salmon Center
Gil Riddell, Association of Oregon Counties
Rex Storm, Associated Oregon Loggers, Inc.
Bob Van Dyk
Ray Wilkeson, Oregon Forest Industries Council (OFIC)
Tom Wolf, Trout Unlimited
Steve Zack, Wildlife Conservation Society

# Table of Contents

# Table of Contents *(continued)*

**Appendices (continued)**

# Executive Summary

New forest models created by the Oregon Department of Forestry's (ODF) Harvest & Habitat Model Project for seven ODF districts are intended to be a component of information for decision-makers. The information will be used to: 1) determine if changes should be made to ODF's *Northwest* and *Southwest Oregon Forest Management Plans* (FMP), 2) decide whether to pursue a Habitat Conservation Plan (HCP), and 3) assist in setting harvest levels for Annual Operation Plans.

Two management alternatives were modeled for the seven districts (Astoria, Tillamook, Forest Grove, North Cascade, West Oregon, Western Lane, and Southwest Oregon) using the current FMP: one with the FMP using an HCP (FMP~HCP), the other with the FMP using Take Avoidance (FMP~TA).

Two other management alternatives, Wood Emphasis and Reserve-Based, were modeled for the three north coast districts of Astoria, Tillamook, and Forest Grove. These model alternatives were viewed to be outside of the FMP.

## Comparison of Management Alternatives

### Seven Districts: Comparison of FMP~HCP and FMP~TA

Across all seven districts, FMP~TA produced more harvest volume (15%) than FMP~HCP in the first decade, and remained higher for the first 30 years, because fewer acres were impacted from northern spotted owls and marbled murrelets. However, FMP~TA produced less volume (14%) over 150 years because of the constraints associated with additional owl and murrelet habitat that appeared over time using the Base Scenario assumptions for northern spotted owl and marbled murrelet populations.

The impact on harvest volume of FMP~HCP versus FMP~TA was not the same on all districts. The four southern districts had a reduction in harvest volume of 3 mmbf/year in the first decade using take avoidance strategies, and the three north coast districts had an increase of 36 mmbf/year.

FMP~HCP and FMP~TA achieved complex structure targets at the same time, but FMP~HCP developed complex structure at an accelerated rate due to more acres being actively managed.

NPV for FMP~TA was 12% higher than FMP~HCP because of higher cash flow in the first 25 years.

### Three North Coast Districts: Comparison of FMP~HCP, FMP~TA, Wood Emphasis, and Reserve-Based Alternatives

In the three north coast districts, FMP~TA produced 20% more harvest volume than FMP~HCP in the first decade, and continues to produce more volume for the first 30 years, because fewer acres were protected for northern spotted owls and marbled murrelets. However, FMP~TA produced 12% less volume over 150 years because of the constraints associated with the additional owl and murrelet habitat that appeared using take avoidance strategies.

For the three north coast districts, Wood Emphasis produced twice the amount of volume of FMP~HCP in the first decade, and almost 40% more volume in 150 years. This additional volume was the result of the goal for 50-year harvest rotations, no goal for complex structure, and fewer acres in owl protection and riparian buffers. It developed about 10% complex structure compared with 50% for FMP~HCP because there was an emphasis on a 50-year rotation age.

For the three north coast districts, Reserve-Based produced about 40% less harvest volume than FMP~HCP because of the acres dedicated to reserves. In 150 years, Reserve-Based developed 60% complex structure compared with 50% in FMP~HCP.

acres dedicated to reserves. In 150 years, Reserve-Based developed 60% complex structure compared with 50% in FMP~HCP.

Active management achieved complex structure at a faster rate for the FMP~HCP alternative than FMP~TA or Reserve-Based.

Wood Emphasis' standing inventory declined by 20% over 150 years due to the goal of harvesting stands older than age 50. After 150 years the standing inventory was approximately 40% lower than FMP~HCP.

Reserve-Based standing inventory tripled in 150 years and was nearly 40% higher than FMP~HCP after 150 years because of the acres in reserves.

NPV was 230% higher for Wood Emphasis than FMP~HCP, Reserve-Based was 40% of FMP~HCP. FMP~TA was 16% higher than FMP~HCP due to the higher volume harvested in the first 30 years.

## Individual Management Alternatives

### Forest Management Plans Using a Habitat Conservation Plan

The harvest volume of all seven districts combined had a non-declining flow pattern increasing from 212 mmbf/year in the first decade to an average of 219 mmbf/year over 150 years. The three north coast districts combined had a non-declining harvest volume flow that increased from 177 mmbf/year in the first decade to an average of 180 mmbf/year over 150 years.

Complex structure of 50% was achieved on all districts between 65 years in Forest Grove and 130 years in Tillamook district.

There was a trade-off between harvest volume goals and complex stand structure goals: higher targets for complex stand structure yielded lower harvest volumes; and conversely, lower targets for complex structure yielded higher harvest volume.

Cash flow levels are closely correlated with harvest volume; however, cash flow was negatively impacted during the early periods due to projected road construction costs.

In a separate analysis, the model indicated that total harvest volume in the first decade could be increased by 15% without falling below baseline levels; however, harvest volume higher than the baseline needs to be analyzed for feasibility and operability.

Ten-year Salmon Anchor Habitat strategies resulted in less than a 0.5% decrease in harvest volume and net revenues compared with no SAH strategies.

From model results, locating the complex structures in the mapped desired future condition (DFC) resulted in reduced harvest volume; however, because of the model's strata-based inventory, there was low confidence in this analysis.

The model achieved and maintained 50% complex structure in patch sizes and frequencies that resembled the landscape design descriptions within the FMP without using a model goal for locating complex structure within the mapped DFC areas.

### Forest Management Plans Using Take Avoidance (Base Scenario)

The harvest volume of all seven districts combined was 245 mmbf/year in the first decade and declined to an average of 193 mmbf/year over 150 years. The three north coast districts combined was 213 mmbf/year in the first decade and declined to an average of 161 mmbf/year over 150 years. The decline was attributed to constraints associated with new owl circles and murrelet habitat that appeared using the Base Scenario of the take avoidance strategies.

# Executive Summary (continued)

When FMP~TA was modeled with a "no complex structure" goal, higher harvest volume was achieved in the first decade goal. With no goal for complex structure, approximately 30% complex structure was achieved at the end of 150 years.

### Wood Emphasis and Reserve-Based Alternatives

For the three north coast districts, the Wood Emphasis alternative's goal of maintaining an average clearcut harvest age of 50, coupled with no goal for complex structure, resulted in a first decade harvest volume of 351 mmbf/year as existing high-volume, older stands were harvested. The average harvest volume was 246 mmbf/year over 150 years.

Despite having no complex structure goal, some complex structure developed, but remained between 2% and 12%, providing enough structure for one new owl circle and about 2,200 acres of new murrelet habitat over 150 years.

For the three north coast districts, the Reserve-Based alternative produced an average of 106 mmbf/year and developed about 60% complex structure in 150 years.

In 150 years, the reserves became mostly older forest structure, while the complex structure outside reserves was more of a balanced mix of older forest structure and layered stands.

### Coarse Filter Wildlife Matrix

The FMP~HCP, FMP~TA, and Reserve-Based alternatives produced similar amounts of habitat for 90% of the 37 wildlife species analyzed. For generalist species, all of the alternatives produced an adequate amount of habitat.

The FMP~HCP alternative appeared to produce greater OFS-based habitat acres than the FMP~TA. These differences may be overestimated, due to the inability of predicting the future distribution of structural components (i.e., snags) across the (9% per year) and over the long-term (9% over 150 years) when compared with results using a 50% complex structure landscape – in all stand types – and the uncertainty of complex structure development for the FMP~TA model.

Species favoring OFS had more habitat acres in the Reserve-Based alternative. In the Wood Emphasis alternative, species favoring REG and CSC types had more habitat; species favoring complex structure had less habitat.

### Levels of Confidence in the Model Results

The districts determined that the model's harvest volume for the FMP~HCP alternative (50% complex structure goal) is achievable on the ground during the first two periods (10 years). Long-term harvest volumes appear to be sustainable because the districts verified the first decade harvest volumes, future harvest volumes do not depart significantly from that level, and growth exceeds harvest levels.

District review of FMP~HCP solutions found the models were consistent with the FMP, HCP and applicable policies that could be modeled. Review of FMP~TA found the model solutions were consistent with the FMP and ODF take avoidance strategies. Wood Emphasis and Reserve-Based data inputs and model rules were verified as being consistent with the modeling assumptions.

The districts need flexibility in deciding the mix of harvest acres (clearcut vs. thinning) in order to implement the harvest volume and mitigate short-term operational issues. Clearcutting in mapped DFC-complex areas is an example of such an issue. FMP~HCP and FMP~TA model results are based on the ability to clearcut in mapped DFC-complex areas.

# Executive Summary (continued)

The districts have low confidence in the FMP~HCP and FMP~TA models' short-term (10-year) location-specific harvest unit decisions, largely due to the strata-based inventory. Note: The models were not intended to provide short-term operational solutions.

Additional analysis is needed to fully understand the relationship between the FMP~HCP and FMP~TA alternatives for districts impacted by many owl circles (North Cascade, West Oregon, Western Lane, and Southwest Oregon).

The districts feel the assumption in FMP~TA, that new owls continue to occupy the same location for the rest of the model's 150-year timeframe, may result in a greater long-term harvest volume reduction than assuming that owls move around on the landscape.

## Modeling Project Strengths and Weaknesses

Strengths: The model integrated the achievement of multiple goals over time and space, displayed the spatial location of the harvest plan and future stand structures, and had many options that allowed the fine-tuning of model goals and constraints. The project utilized updated information to develop model inputs and had extensive involvement by field personnel in every aspect. The model is valuable as a *strategic-tactical* tool.

Weaknesses: The model would benefit from having more measured stands in its inventory, as well as a stand-specific rather than a strata-based inventory approach. Refinement of the stand structure definitions are needed for more accurate prediction of future stand conditions. Lastly, many different model solutions that meet model goals are possible – knowing which solution best meets management objectives requires a significant amount of analysis and field review.

# Introduction & Background

### Modeling for Harvest & Habitat

The Oregon Department of Forestry's Harvest & Habitat Model Project (H&H Project) explores options for optimal timber harvest outputs and specified forest stand structures (habitat) on about 632,000 acres of state-owned forestland.

### Applying Adaptive Management

Results from the project represent some of the information the Board of Forestry will consider in its science-based, adaptive management process to determine:

- If changes should be made to the *Northwest* and *Southwest Oregon Forest Management Plans*.
- Whether or not to pursue a Habitat Conservation Plan (HCP).

The forest management plans, designed to meet the Greatest Permanent Value administrative rule, were approved by the Board of Forestry in 2001. The plans use an integrated approach that seeks a mix of economic, environmental and social benefits.

The State Forester also will use the results for seven districts (Astoria, Tillamook, Forest Grove, North Cascade, West Oregon, Western Lane and Southwest Oregon) under the two forest management plans to:

- Establish timber harvest objectives.

### Four Strategies Analyzed

Four alternatives for these state forests were modeled to provide comparisons of management strategies. Two alternatives followed the goals and strategies of the approved forest management plans:

- ❒ Forest Management Plan (FMP) using an HCP (FMP~HCP)
- ❒ FMP using Take Avoidance – no HCP (FMP~TA)

Two other alternatives that fall outside of the approved forest management plans also were modeled:

- ❒ Wood Emphasis
- ❒ Reserve-Based

### New Modeling Necessary

The H&H Project began in April 2003, one month after the State Forester approved 10-year implementation plans for the seven districts under the two forest management plans (see Appendix A for details of Project Plan).

The implementation plans included a work plan to study harvest and habitat levels. The work plan became necessary after revenue-receiving counties expressed concern over the gap in harvest levels between modeling conducted in 2000 and the levels indicated in the district implementation plans.

Legislative budget notes in 2003 and 2005 also directed the Department of Forestry to carry out the work plan.

### Modeling: 2000 Compared to 2006

The 2000 modeling was done for comparison purposes prior to approval of the NW and SW forest management plans. The H&H Project, completed in early 2006, goes beyond comparisons to provide more accurate forecasting of forest conditions and potential harvest levels.

The H&H Project sought to improve upon many of the shortcomings of the 2000 model. Key elements included:

- Road and access information
- Realistic harvest unit boundaries
- Updated spatial data and landscape design concepts
- Improved forest inventory and Swiss Needle Cast data
- Comprehensive harvest and treatment prescriptions
- Involvement and review by districts for implementability

# Introduction & Background (continued)

The H&H Project created 20 new forest models: one model for each of the seven districts for the FMP~HCP FMP~TA; and one model for each of the three north coast districts (Astoria, Tillamook, and Forest Grove) for both the Wood Emphasis and Reserve-Based alternatives.

The importance of the 2000 modeling should not be diminished by this improved modeling effort. The earlier modeling provided useful comparative information that led to the adoption of a new management approach – a blending of economic, environmental and social values – to be implemented on these state forestlands. Future modeling efforts will certainly improve upon the work done in this project.

**Counties Played Integral Role**

Revenue-receiving counties worked closely with the Oregon Department of Forestry throughout the H&H Project. County commissioners and county representatives played an integral role in the development and creation of the new models.

Counties have an established legal interest in the management of these forestlands. They deeded these lands to the state for rehabilitation and for a future return of revenue from timber sales. The primary beneficiaries of the revenue are the counties, schools and local taxing districts.

**Innovative Modeling**

The H&H models are innovative, state-of-the-art space-and-time forest models that take into account the complex relationships between forest conditions, land classifications and forest management strategies.

The Oregon Department of Forestry cooperated with Oregon State University College of Forestry, and in particular Dr. John Sessions, Professor of Forest Engineering. Dr. Sessions is a world-renowned expert in resource scheduling and played a critical role throughout this modeling project.

These models are capable of integrating the achievement of many model goals over time. They are heuristic models that use a simulated annealing process (i.e., evaluating millions of options) for determining model solutions (see Appendix B for a more thorough description of the model structure).

**Field Review Added Credibility**

These models are intended to be used as tools to help managers make informed decisions. They are intended to be used at the *strategic* and *tactical* level, not at the *operational* level. They will assist in evaluating and possibly adjusting the FMP and Implementation Plans, but they are not intended to be used in isolation to develop specific Annual Operation Plans (AOPs) or related objectives. Operational-level elements have been incorporated into model inputs to the extent possible, in order to achieve realistic and operationally viable model outputs, but on the ground decisions, and the determination of specific AOP objectives, will continue to be made by ODF field foresters and managers.

Field foresters and resource specialists have been involved throughout this project. Districts assisted in the creation of the models and have reviewed results to determine if they can be implemented on-the-ground. Challenges to implementing results have been noted (see Level of Confidence section).

Updated information was used in this project. Enhancements identified during the project but not able to be implemented were noted (see Key Questions section).

We hope the H&H Project provides useful and valuable information in order to make the best decisions possible.

# Introduction & Background (continued)

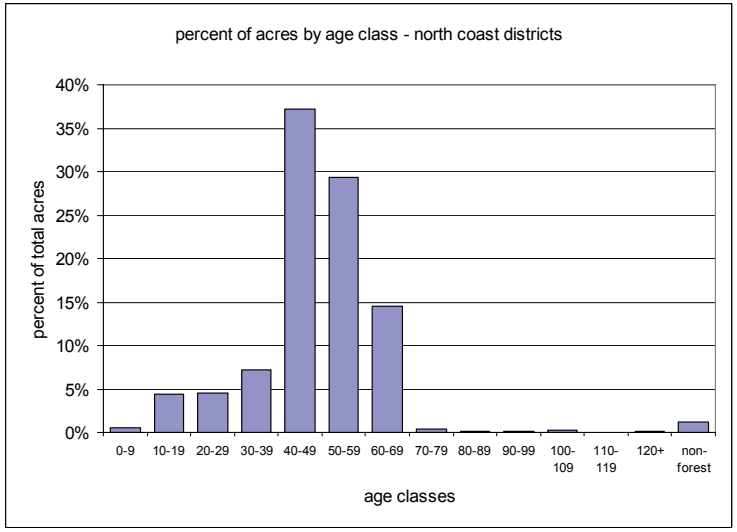
**Young Forest Lacks Diversity**

To understand the forest's future, it is important to understand its past and its current condition. These forests were mostly harvested and burned in the early 1900s. The largest tract was severely impacted by a series of great fires from 1933 to 1945 and became known as the Tillamook Burn.

ODF undertook reforestation and young-growth management activities on these lands, now known as the Clatsop, Tillamook, and Santiam State Forests, as well as on other smaller forest tracts in the Coast Range, in the late 1940s, 1950s and 1960s. Accordingly, these forests are generally young and have similar ages and stand structures. The age of the forest, including its stand structure condition, greatly influence management opportunities.

The following information provides a brief description of the current forest condition (see the Appendix C for a more detailed description, by district).

The age class distribution – for the three north coast districts (Astoria, Tillamook, and Forest Grove) and the seven districts combined – illustrate that the majority of these forests are approximately the same age (40 – 60 years old).



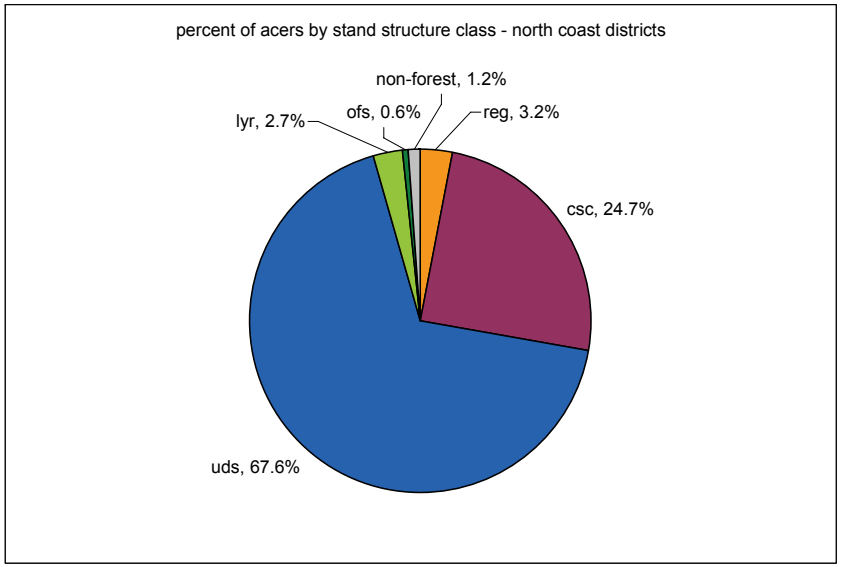

# Introduction & Background (continued)

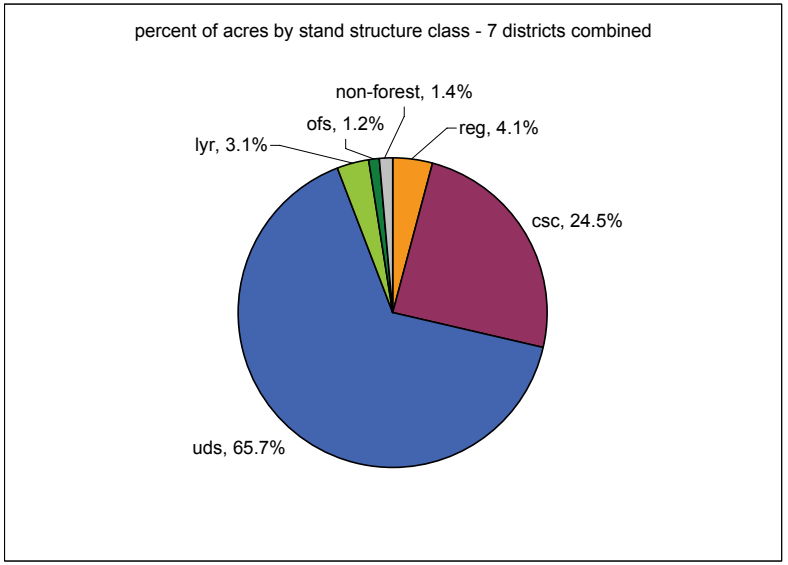
**Young Forest Lacks Diversity** (continued)

The stand structure classification, for the three north coast districts (Astoria, Tillamook, and Forest Grove) and the seven districts combined, illustrate that the vast majority of these forests (~90+%) are in the same two non-complex stand structure classifications: Closed Single Canopy (CSC) and Understory (UDS), with UDS being the predominate stand classification (~65+%).

The complex stand structure classifications of Layered (LYR) and Older Forest Structure (OFS) make-up a relatively small percentage of the forest (~ 4%), as do Regeneration (REG) stands (~4%) and Non-forest types (~1%).

For a description of the stand structure classifications, see Appendix C, Stand Structure Classifications.



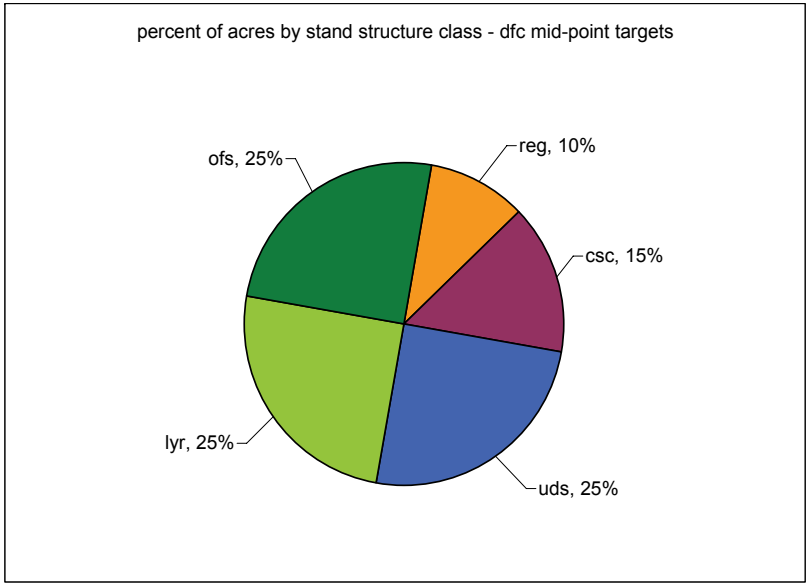



# Introduction & Background (continued)

**Plans Seek Diverse Forests**

The NW and SW FMPs call for a combination of stand structures on each district that includes an average of 50% in complex stands (layered and older forest structures), which is different than the current concentration of non-complex structures (understory and closed single canopy stands). To develop the desired structure mix, the current concentration of age classes (40-70 years) will need to be redistributed and expanded to some older classes. The plans recognize the need for active management and sustainable harvesting to maintain forest health, develop habitat and generate predictable revenue.

The desired future condition of the forest is identified in the plans as a percentage range of the five stand structures. This chart shows the mid-point of each stand structure range. In addition to integrating other goals, the H&H Project seeks to achieve these percentages of layered and older forest structures in the FMP~HCP and FMP~TA alternatives.




**Project Involves Majority of State Forests**

All State Forest lands in Western Oregon, except for the Elliott State Forest, are part of this project. This includes the Clatsop, Tillamook, and Santiam State Forests and other state forest lands. Seven districts manage these state forest lands (see acreage table).

| District | Acres | % |
|---|---|---|
| Astoria | 136,928 | 22% |
| Forest Grove | 114,944 | 18% |
| Tillamook | 250,652 | 40% |
| North Cascade | 47,723 | 8% |
| Southwest Oregon | 18,212 | 3% |
| Western Lane | 25,959 | 4% |
| West Oregon | 37,652 | 6% |
| Total Acres | 632,070 | 100% |

# Description of Model Alternatives

### Forest Management Plan using a Habitat Conservation Plan (FMP~HCP): Seven Districts

This alternative simulated the strategies and policies within the 2001 *Northwest* and *Southwest Oregon Forest Management Plans* (FMPs). These are currently being implemented on state forests along with the strategies within the draft *Western Oregon State Forests Habitat Conservation Plan* (HCP). State Forests Program threatened and endangered species (T&E) take avoidance strategies were used in the first period (5 years), assuming an HCP would be in effect after that.

Model goals: harvest volume, complex stand structure, and net present value. Model goals were integrated to achieve a relatively even flow of harvest volume over 150 years (30, 5-year periods) and the attainment of complex stand structure within a reasonable timeframe while maximizing net present value from future timber revenues.

Salmon Anchor Habitat (SAH) strategies were included. Harvest units were required to have revenues exceed costs.

### Forest Management Plan using Take Avoidance (FMP~TA): Seven Districts

This alternative also used the strategies and policies within the 2001 *Northwest* and *Southwest Oregon Forest Management Plans* (FMPs), but assumed there would be no HCP. State Forests Program T&E take avoidance strategies were used throughout the model's 150-year timeframe.

Because this alternative was based on take avoidance strategies and northern spotted owl (NSO) population trends are uncertain, three different NSO population trend scenarios were modeled. These NSO population trends were identified as the Base Scenario, Continued NSO Decline Scenario, and Improved NSO Recovery Scenario.

Otherwise, this alternative used the same model goals and other assumptions as the FMP~HCP alternative.

### Wood Emphasis: Three North Coast Districts

This alternative emphasized wood production and timber harvest, falling within the Forestry Program for Oregon (FPFO) but not consistent with current FMPs. Oregon Forest Practices Act requirements were used for resource protection. State Forests Program T&E take avoidance strategies were used, and it assumed ODF would continue as the land manager.

Model goals: harvest volume, average age of clearcut unit, net present value and no complex stand structure.

Model assumptions were developed using input from forest industry stakeholders.

### Reserve-Based: Three North Coast Districts

This alternative identified reserves across 56-60% of the landscape (varies by district), falling within the FPFO, but not consistent with current FMPs. Some harvesting is allowed in reserves under specific conditions; FMP strategies are used outside of reserve areas.

The goal inside reserves is to create and maintain old-growth forests in order to provide high quality fish and wildlife habitat and protect other forest resources. Model goals outside of reserves are the same as the FMP~HCP alternative.

Model assumptions were developed using input from conservation group stakeholders.

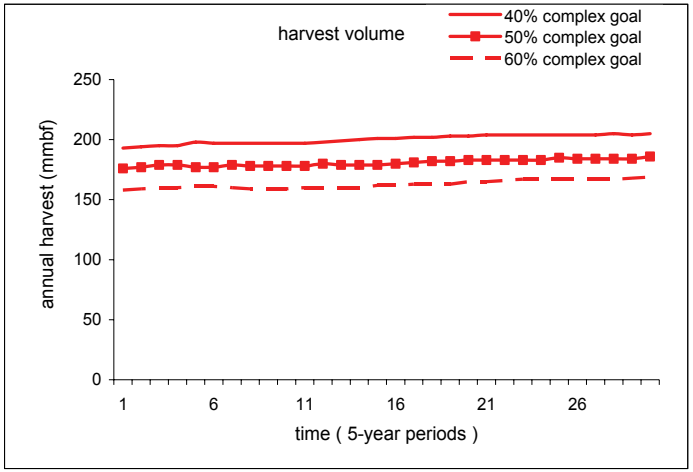
## Results: By Alternative – Forest Management Plan using HCP

# Complex Stand Structure-Volume Analysis: Three North Coast Districts Combined

Average annual harvest volumes and percentage of complex stand structure attained across the landscape are shown over 150 years (30, 5-year periods) using the range of complex stand structure goals identified within the FMP (40% - 60%) with 50% being the mid-point.

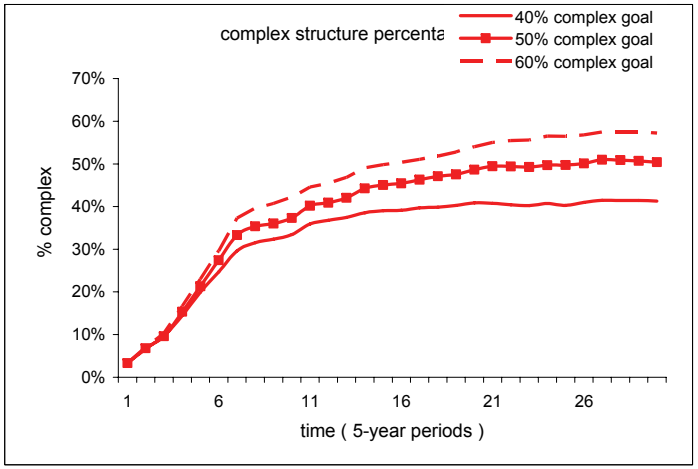
Model goals have been integrated to achieve a relatively even flow of harvest volume and attainment of the specified complex stand structure goals within a realistic timeframe.

### Harvest Volume




First decade average annual volume ranged from 194 mmbf per year (40% complex structure) to 159 mmbf per year (60% complex structure) with 177 mmbf per year generated using the 50% complex structure mid-point (see Appendix G: Table 1: District Summary – FMP~HCP).

### Complex Stand Structure




The 60% target was not quite achieved when the three Districts were combined. Astoria and Forest Grove both would reach 60% complex structure, but Tillamook would only reach a maximum of 55% complex structure in 150 years, due to the district's initial young age classes and Swiss needle cast disease.

### Findings

- There is a trade-off between the achievement of harvest volume and the attainment of complex stand structure: higher targets for complex structure yield lower harvest volumes, and conversely, lower targets for complex structure can yield higher harvest volumes.
- With a 50% complex structure target, harvest volume increases from 177 mmbf/year in the first decade to 180 mmbf/year over 150 years.

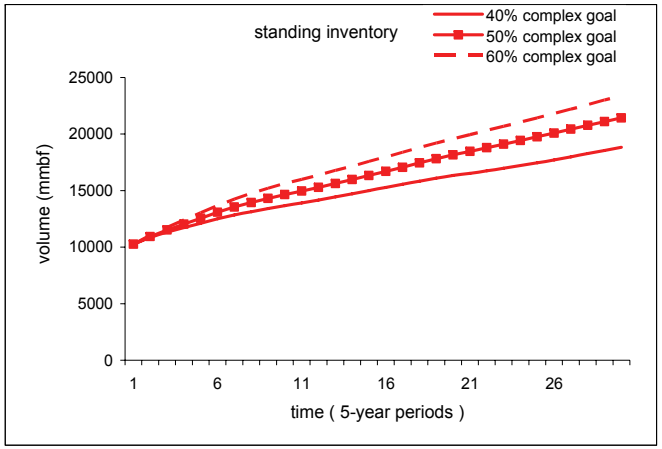
## Results: By Alternative – Forest Management Plan using HCP

# Complex Stand Structure-Volume Analysis: Three North Coast Districts Combined

### Standing Inventory

Standing inventory (the volume of timber in the forest) was shown over 150 years (30, 5-year periods) using the range of complex stand structure goals identified within the FMP (40% - 60%) with 50% being the mid-point.

Standing inventory is an important indicator of long-term harvest sustainability and unrealized timber asset value.



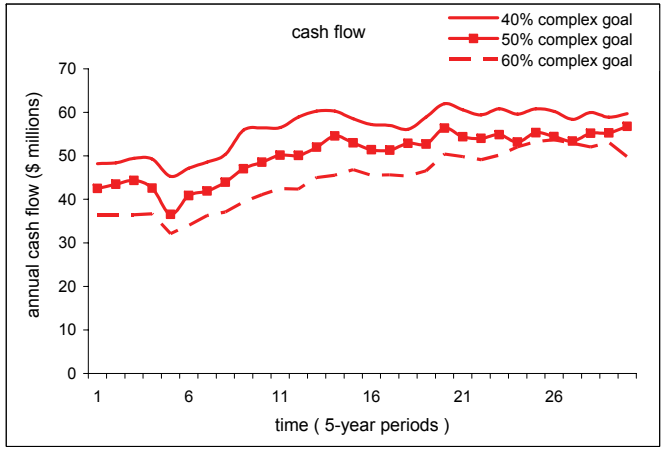

### Economics

Cash Flow is a measure of the net revenue received over time, calculated as the total gross timber revenue minus total costs. Costs include: logging, road construction, improvement, and maintenance, young growth management (planting, etc.), and administrative costs.

Net Present Value (NPV) is a measure of the cash flow of all timber harvested over 150 years, discounted at today's dollars to 4.5%. Short-term income has the greatest influence on NPV.

The economic results shown only pertain to timber-related revenues – other forest values (fish, wildlife, water, air, recreation, etc.) are not reflected in these results.

NPV: 40% Complex Goal = $1.111 billion; 50% Complex Goal = $971 million; and 60% Complex Goal = $823 million.




### Findings

- Standing inventory increases as complex structure goals increase due to less volume being harvested. With 50% complex structure, the standing inventory increases approximately 220% from 10 to 22 billion board feet over 150 years.
- Cash flow levels are closely correlated to harvest volumes; however, cash flow is negatively impacted during early periods due to road construction costs. Road construction is mostly completed within 5 periods (25 years). With 50% complex structure, cash flow increases from $44 million in the first decade to $58 million in 150 years.

## Results: By Alternative – Forest Management Plan using HCP

# Volume Flow Analysis: Three North Coast Districts Combined

The flow of harvest volume for the model runs conducted under the FMP~HCP alternative generally had a pattern of even flow or non-declining flow, meaning the volume from period-to-period was either the same or trended upward over time. There are many reasons why even flow is often chosen for planning purposes. The primary reason is because even flow demonstrates that harvest volume outputs are sustainable over time, providing similar benefits for future generations. Choosing even flow reduces risk because departure projections may not be sustainable or implementable.

However, is even flow a constraint on harvest volume? Since constraints generally reduce volume, is there an opportunity for a short-term increase in harvest today (departure from even flow) without reducing harvests below an even flow level in the future? What are the policy issues that would result from such a departure?

### Analytic Process

For each district a non-declining baseline run was found that had the highest first period harvest volume. The baseline volume was the lowest volume in any period for that model run. (The baseline runs underwent a field review for operational feasibility.) Then, solutions that had higher volumes in the first four periods were found. The run with the highest initial volume that did not fall below the baseline volume, and still achieved the complex structure goals at the same time as the baseline run, was selected as having the greatest opportunity for short-term departure.

### Discussion

This study shows the possibility of additional volume that can be harvested in the first few periods without reducing the long-term volume level below the baseline. From model data, Astoria was able to achieve 3% more volume in the first decade, Forest Grove 6% and Tillamook 36% for a combined harvest volume of 203 mmbf per year for the first decade.

The additional 36% volume in Tillamook in the first two periods deserves a closer look. In the model, some future plantations were 30% to 50% more productive because plantations in the Swiss needle cast (SNC) zone had a smaller component of disease-prone Douglas-fir and had less growth reduction than existing stands. In the high departure runs, more existing stands were clearcut in the first six periods and put into more productive plantations sooner. It appeared this anticipated growth could be offsetting the impacts from this departure. Increased harvest of these existing stands with lower growth rates appeared to make more volume available for harvest in the mid- to long-term.

### Important Limitations and Cautions

First, only the baseline volume level was field verified in each district. Prior district reviews indicated that volumes higher than the baseline level would be difficult to implement. Therefore, a thorough analysis of the choices the model made, such as the mix of harvest types (clearcut vs. thinning), harvest prescriptions, and the location of harvest units would be in order, especially for Tillamook District.

Second, the affect of SNC on future plantations' growth and yield is uncertain. Assumptions made about future yields in infected stands can greatly influence volume flow.

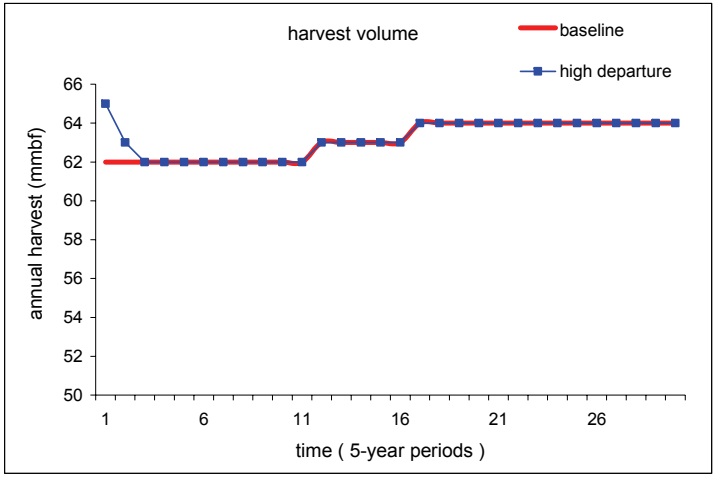
Third, Tillamook's higher volumes have 30% more clearcut acres in the first decade than have been field verified and exceed the district's clearcut range in its Implementation Plan.

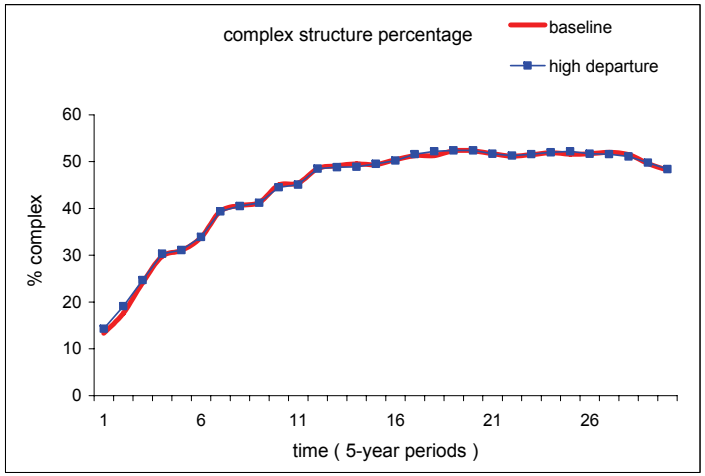
## Results: By Alternative – Forest Management Plan using HCP

# Volume Flow Analysis: Three North Coast Districts Combined

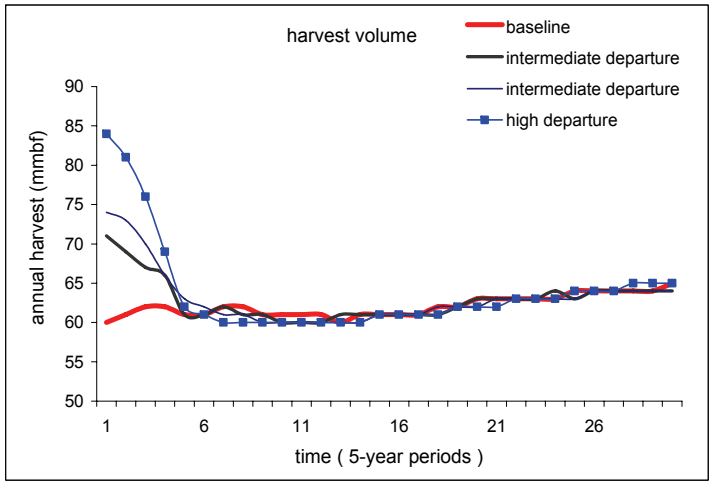
### Harvest Volume and Complex Stand Structure Charts

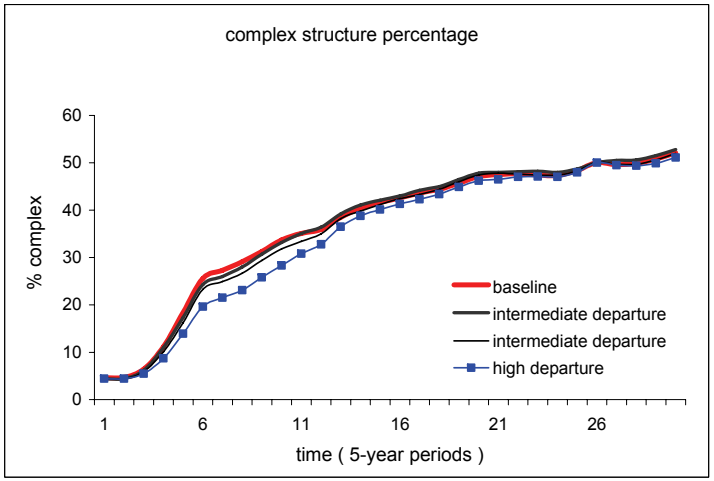
**Astoria District**




**Tillamook District**



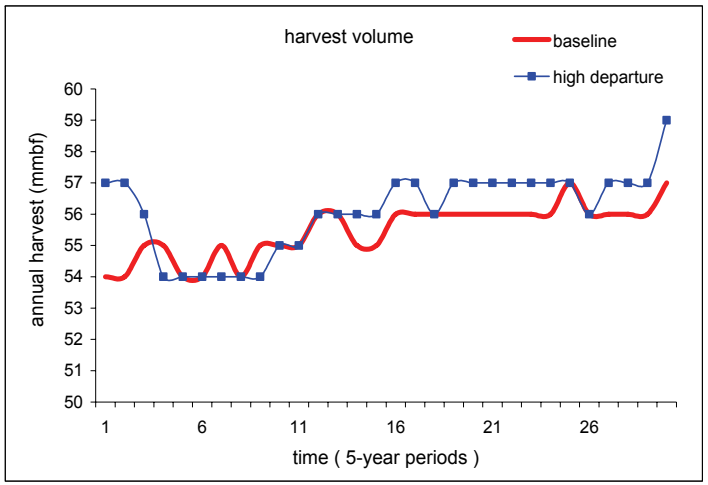



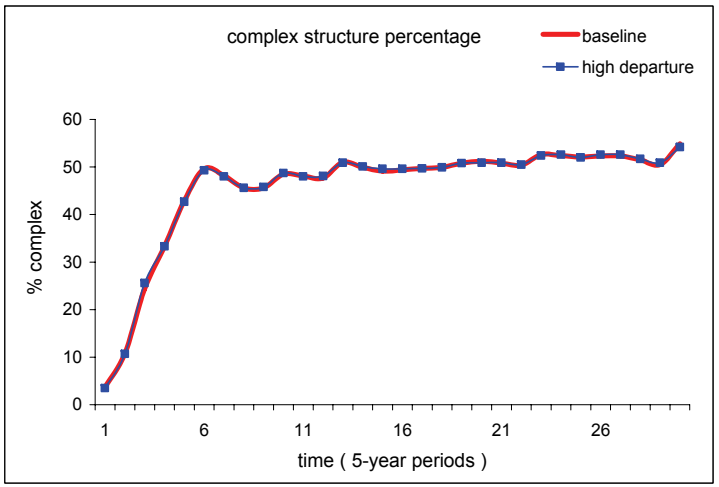
## Results: By Alternative – Forest Management Plan using HCP

# Volume Flow Analysis: Three North Coast Districts Combined

### Harvest Volume and Complex Stand Structure Charts (continued)

**Forest Grove District**




**Findings for Three North Coast Districts Combined**

- The harvest volume of the baseline model run has been field verified as implementable over the first 10 years.
- The Volume Flow Analysis indicates that the total harvest volume in the first decade can be increased by 15% without falling below baseline levels; however, the districts have not verified if this approach can be implemented given the higher volume and clearcut acres above the baseline level.
- In the SNC zone, higher volume in the first 20 years (departure from baseline) depends upon substantially increased productivity in new plantations. While the districts are striving for greater productivity in these plantations, the level of volume increase is uncertain.
- In the high departure runs the clearcut acres are above the high-end of the range in current district Implementation Plans. Such a departure would necessitate a modification in the Implementation Plans.

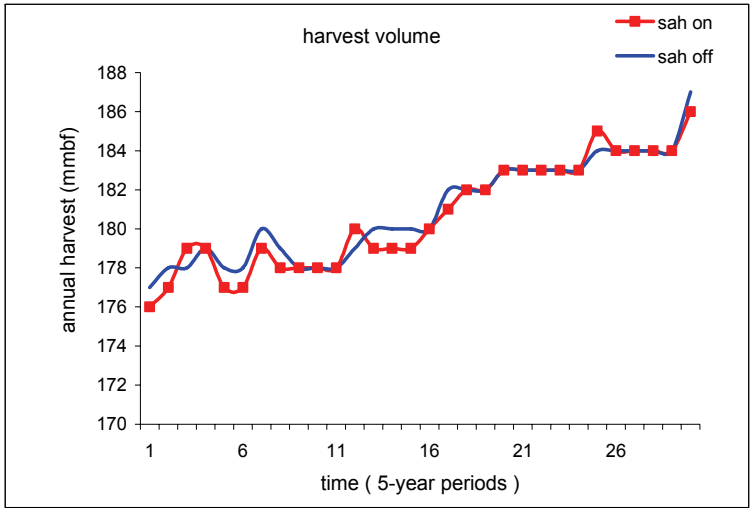
## Results: By Alternative – Forest Management Plan using HCP

# Salmon Anchor Habitat Analysis: Three North Coast Districts Combined

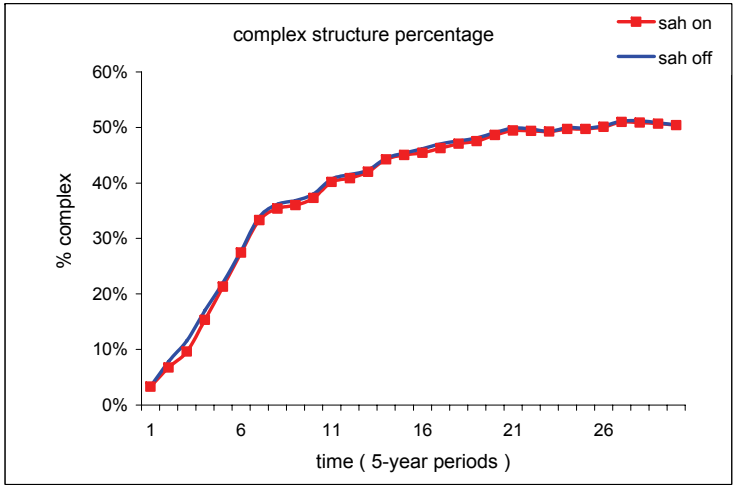
Salmon Anchor Habitat (SAH) strategies apply for 10 years. SAH basins are watersheds, or portions of watersheds, that are important for salmonid spawning and rearing. There are 17 SAHs on State Forest lands within the three north coast districts. Although SAHs are considered important for salmonid species, SAH strategies are not included in the HCP strategies: they are 10-year FMP and Implementation Plan strategies. SAH strategies were switched on in the models for both the FMP~HCP and FMP~TA alternatives; the Wood Emphasis alternative did not use SAH strategies; the Reserve-Based alternative used SAHs as a criteria for identifying reserves (see Appendix J: Salmon Anchor Habitat).

This study showed the effect of management using FMP~HCP with and without SAH strategies for 10 years.

### Harvest Volume




### Complex Stand Structure




### Economics: Net Present Value

- With SAH Strategies: $ 971 million
- Without SAH Strategies: $ 978 million

### Findings

- SAH strategies, applied for the first 10 years, result in less than a 0.5% decrease in harvest volume in the first decade, and less than a 0.1% decrease over 150 years.
- First decade Cash Flow from SAH strategies were slightly lower (no chart shown); total Cash Flow decreased by only 0.5% over 150 years. Model runs without SAH strategies had a similar harvest volume, but with lower costs.
- SAH strategies result in a slight decrease in NPV (approximately 1%).

## Results: By Alternative – Forest Management Plan using HCP

# Landscape Design Analysis: Three North Coast Districts Combined

One of the basic concepts of structure-based management in the FMP is a "landscape design to provide for a functional arrangement of the stand types in terms of habitat values." The FMP includes landscape design strategies that describe the key elements of composition and pattern of stand structure types over the landscape through time. The districts have each mapped the location for their Desired Future Condition (DFC) of the complex stand structures based on the landscape design elements. The mapped DFC was a component of the approved Implementation Plans.

The FMP~HCP model was used for two purposes concerning landscape design:

1. To assess the feasibility and cost of locating complex structures in the DFC.
2. To assess the possibility of a more effective DFC/landscape design that meets the design principles and produces greater harvest volume flow.

The model included two goals for controlling the landscape design to assess these two purposes. The DFC goal was used to direct the model to locate complex structures in DFC mapped areas. The Patch Size Frequency goal directed the model to create various sized complex structure patches in a frequency for each district consistent with landscape design concepts (FMP, Appendix C). Each goal could be turned on or off. Neither goal was used in any of the other alternatives.

Analyses were completed to explore the consequences of using the two goals to compare alternative landscape designs.

**Desired Future Condition Analysis**

An analysis of the impact on harvest volume of having the model locate the Desired Future Condition in the mapped areas was conducted individually for Astoria, Forest Grove, and Tillamook districts for the FMP~HCP alternative. On Astoria and Forest Grove, the model could locate approximately 95% of the complex structure target (i.e., 95% of the 50% district goal) within the DFC mapped locations; however, focusing the attainment of complex structure in the DFC took approximately 50 years longer than achieving 50% complex structure across the entire district.

The consequence on harvest volume was an average reduction of 15% per year in Astoria and 25% in Forest Grove over the 30 periods. The consequence on district-wide complex structure was an attainment of 60% in Astoria and 70% in Forest Grove, concluding that all of the complex structure could not be forced within DFC areas.

On the Tillamook District, the model could place only about 60% of the complex structure target (i.e., 60% of the 50% district goal) within the DFC mapped locations at the end of 150 years. It usually took the model about 130 years to achieve 50% complex structure at the district level. Therefore, it was not unexpected, given the Astoria and Forest Grove example, that it would take Tillamook more than 150 years to locate a high percentage of complex structure within their DFC areas.

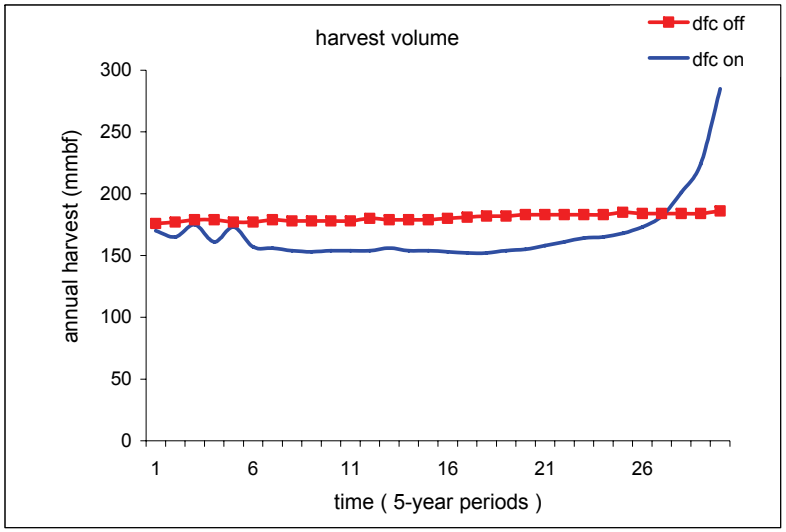
## Results: By Alternative – Forest Management Plan using HCP

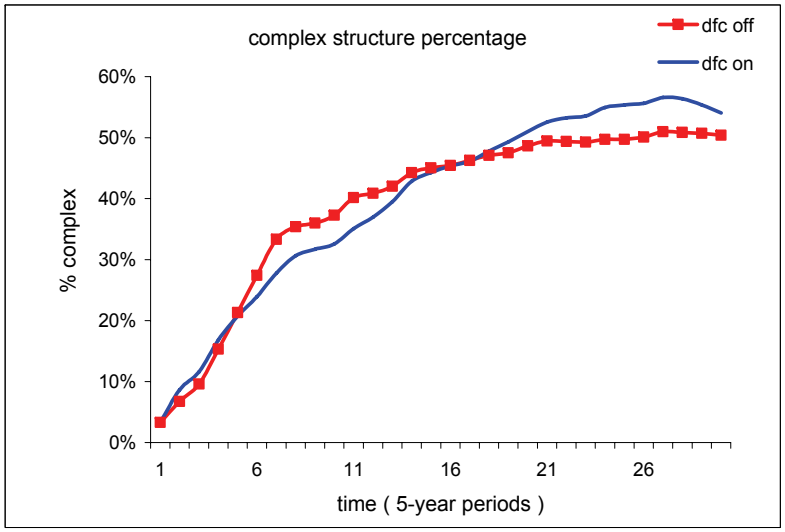
# Landscape Design Analysis: Three North Coast Districts Combined

**Desired Future Condition Analysis (continued)**

Using the model to assess alternatives to the DFC/landscape design, it became clear in the Model Solution Review (MSR) reports that the model's strata-based inventory was not sufficient to make short-term *operational* decisions because it does not have site-specific stand level inventory or stand structure information (see Level of Confidence: MSRs section for details about inventory and structure issues). The model's representation of each stand needs to be more closely aligned with actual stand conditions in order to produce a meaningful model analysis of DFC/landscape design.

**Harvest Volume and Complex Stand Structure: DFC On vs. Off**



## Results: By Alternative – Forest Management Plan using HCP

# Landscape Design Analysis: Three North Coast Districts Combined

### Patch Size Frequency Analysis

A Patch Size Frequency Analysis was done for all seven districts for the FMP~HCP alternative (using a 50% complex structure goal). Analysis showed that, even when the Patch Size Frequency goal was off, once the landscape had developed 50% complex structure, the frequency of the patches in the nine size classes (FMP, page C-31: acres 0-80, 80-120, 120-200, 200-320, 320-520, 520-840, 840-1360, 1360-2180, 2180+) was not far from the distribution described in the FMP. In general, the model solution had more of the 0-80 acre patches than described in the FMP, fewer of the 80-120, close to the number of 120-1360 patches, and more of the 1360-acre and above patches.

When the Patch Size Frequency goal was on, the patch size distribution was very similar to when it was off.

A spatial review of the pattern of these patches showed them distributed across the landscape with connectivity between patches, both within and between basins.

**FMP Patch Size Frequency Goals**

| Patch Size (acres) | Astoria | Tillamook | Forest Grove | North Cascade | West Oregon | Western Lane | Southwest Oregon |
|---|---|---|---|---|---|---|---|
| 0-80 | 34 | 63 | 30 | 12 | 9 | 7 | 5 |
| 80-120 | 70 | 128 | 60 | 24 | 19 | 13 | 9 |
| 120-200 | 46 | 85 | 40 | 16 | 13 | 9 | 6 |
| 200-320 | 37 | 68 | 32 | 13 | 10 | 7 | 5 |
| 320-520 | 22 | 41 | 19 | 8 | 6 | 4 | 3 |
| 520-840 | 10 | 19 | 9 | 4 | 3 | 2 | 2 |
| 840-1360 | 4 | 7 | 3 | 2 | 1 | 1 | 0 |
| 1360-2180 | 1 | 3 | 1 | 0 | 0 | 0 | 0 |
| >2180 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

### Findings

- From model results locating all or most of the complex structure inside the mapped DFC reduces the harvest volume; however because of the model's strata-based inventory, there is not good confidence in this analysis
- Achieving complex structure goals by locating all or most of the complex structure inside the mapped DFC took approximately 50 years longer than achieving 50% complex structure across the entire district.
- Some complex structure develops outside of the mapped DFC without setting any model goal to do so.
- Using the model to find alternatives to DFC/landscape design will be more useful in the future when the model has a good representation of the site-specific stand inventory and more refined stand structure definitions.
- Achieving and maintaining 50% complex structure results in complex patch sizes and frequencies that resemble the landscape design descriptions within the FMP.

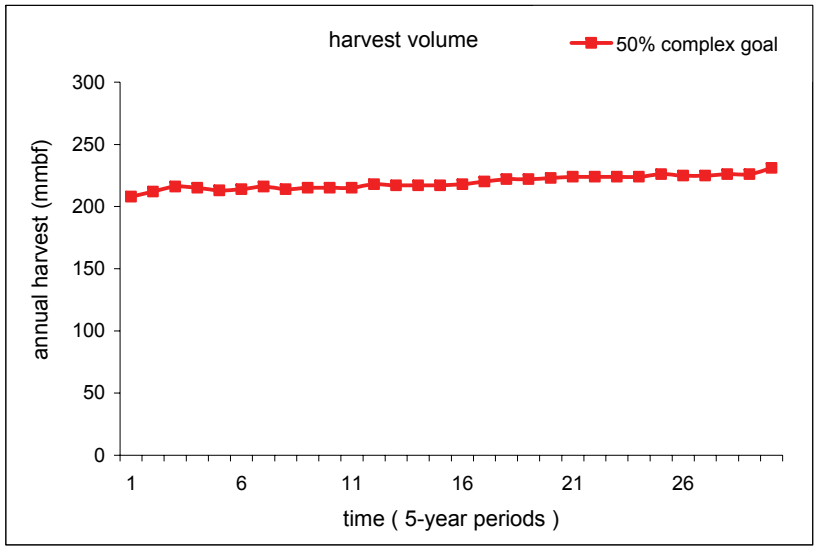
## Results: By Alternative – Forest Management Plan using HCP

# Seven Districts Combined

### Harvest Volume

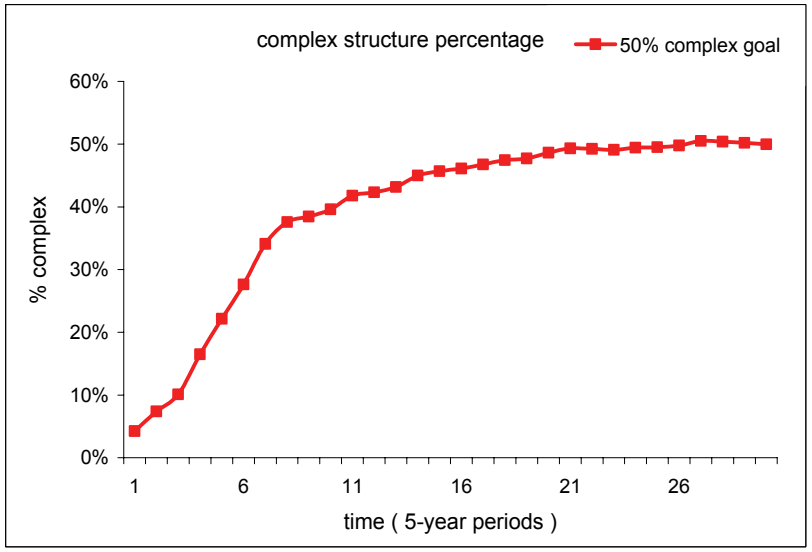
The sum of the average annual harvest volumes and percentage of complex stand structure attained across all seven districts was shown using a complex structure goal of 50% (mid-point of the FMP complex structure range).

Model goals have been integrated to achieve a relatively even flow of harvest volume and attainment of the specified complex stand structure goals within a realistic timeframe.




First decade average annual volume is 213 mmbf per year; average annual volume over 150 years is 222 mmbf per year.

### Complex Stand Structure




The achievement of 50% complex stand structure (with at least 25% in Older Forest Structure) differed on each district, but ranged from as soon as 65 years in Forest Grove District to as long as 130 years in Tillamook District.

### Findings

- Harvest volume has a non-declining flow pattern, increasing about 6% in 150 years from 213 to 225 mmbf/year.
- Complex structure of 50% is achieved on all districts between 65 years in Forest Grove and 130 years in Tillamook District.

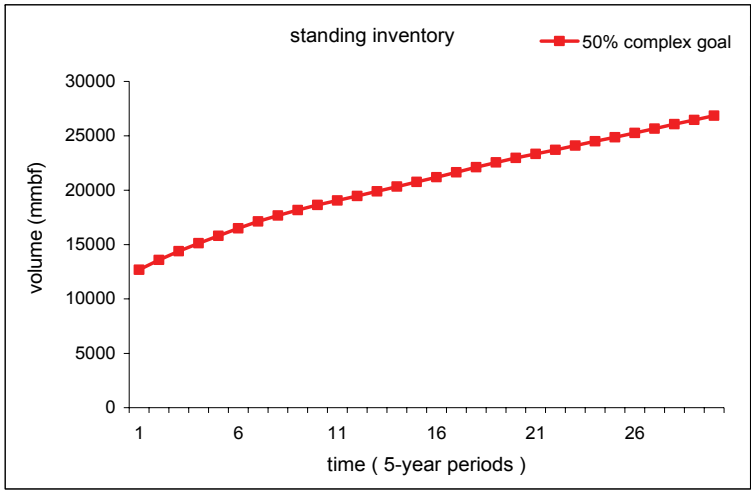
## Results: By Alternative – Forest Management Plan using HCP

# Seven Districts Combined

### Standing Inventory

The sum of the standing inventory (the volume of timber in the forest) is shown for all seven districts using a complex structure goal of 50% (mid-point of the FMP complex structure range).

Standing inventory is an important indicator of long-term harvest sustainability and is a result of growth, mortality and harvest taking place over time.

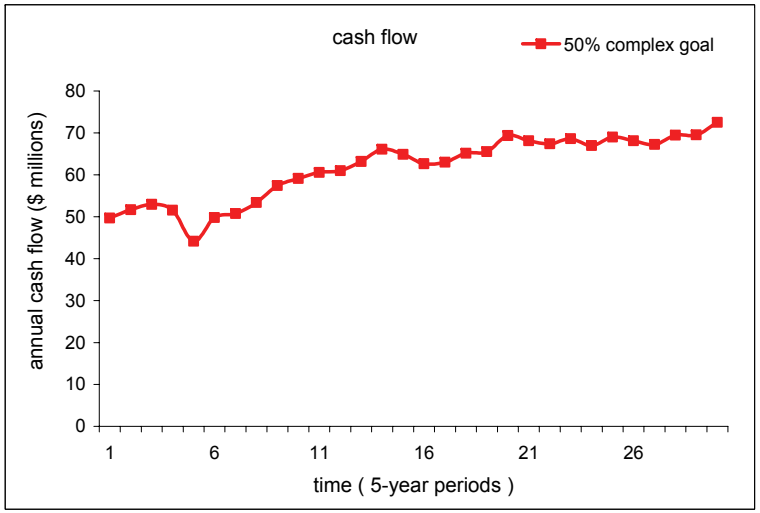



Initial standing inventory was about 13 billion board feet and developed to about 27 billion board feet at the end of 150 years.

### Economics

The economic results shown pertain only to timber-related revenues. Other forest values (fish, wildlife, water, air, recreation, etc.) were not reflected in these results.

Total cash flow increased from about $50 million to about $70 million over 150 years; NPV for all harvests was $1.177 billion.




### Findings

- Standing inventory doubles from 13 billion board feet to about 27 billion board feet in 150 years.
- Cash flow increases by about 40% from $50 million/year to about $70 million/year in 150 years.

## Results: By Alternative – Forest Management Plan using TA

**Description of Model Structure**

The FMP~TA alternative used a different model structure than the FMP~HCP alternative. In order to simulate the likely use of future developing habitat by northern spotted owls and marbled murrelets, the model was run in two phases for the Take Avoidance strategy.

In Phase 1, the model was run knowing the location and harvest restrictions for the existing owl circles and murrelet management areas. Phase 2 was a post-processing step that evaluated the period-by-period complex structure produced in Phase 1 and determined if and where new owl circles and new murrelet management areas would be found. These estimates were based on three population scenarios (see explanation below). The model then subtracted the appropriate harvest volume and acres that would have occurred within these new owl circles and murrelet areas, from that period through the remainder of the 150 years, to arrive at an adjusted total volume.

Based on a set of assumptions, complex structure that develops within new owl circles and murrelet areas was combined with the complex structure achieved outside of those areas to determine a total percentage. The model's complex structure goal in Phase 1 was adjusted to achieve the 50% complex structure goal after Phase 2 in about the same period as the FMP~HCP alternative (using a 50% complex structure goal). Results from these two alternatives could then be compared.

**Northern Spotted Owl and Marbled Murrelet Population Scenarios**

Base Scenario

Northern Spotted Owls: *Astoria, Forest Grove, and Tillamook* – Most of the existing owl circles were assumed to become historic (owls no longer present) during the first 3 periods. New circles with at least a minimum of a specified quality of habitat were assumed to be occupied, based on a defined probability of occupancy.

*North Cascade, West Oregon, Western Lane, and Southwest Oregon* – All of the existing owl circles remained active. New circles with at least a minimum quality habitat were assumed to be occupied based on a defined probability of occupancy.

Marbled Murrelets: In all districts in which murrelets occur, existing murrelets were assumed to stay in their current location for all 30 periods. In the future, OFS in western hemlock stands became murrelet habitat based on a probability of occupancy that differs by proximity to existing murrelet habitat.

Improved Recovery Scenario

Northern Spotted Owls: All districts – All existing owl circles were assumed to retain their current location for all 30 periods. New circles with at least a minimum quality habitat were assumed to be occupied based on a higher probability of occupancy than the Base Scenario.

Marbled Murrelets: Same as the Base Scenario.

Continued Decline Scenario

Northern Spotted Owls: *Astoria, Forest Grove, and Tillamook* – All of the existing owl circles were assumed to become historic (owls no longer present) during the first 10 periods. No new circles were created.

*North Cascade, West Oregon, Western Lane, and Southwest Oregon* – Many existing owl circles were assumed to become historic based on current trends.

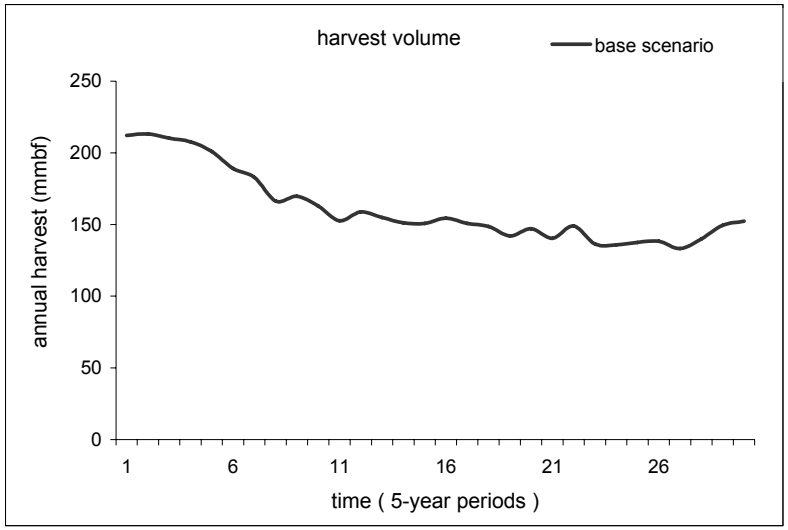
Marbled Murrelets: In all districts in which murrelets occur, existing murrelets were assumed to stay in their current location for all 30 periods. No new murrelet habitat was created.

## Results: By Alternative – Forest Management Plan using TA

# Three North Coast Districts Combined

FMP~TA is reported using the Base Scenario (results from the Improved Recovery and Continued Decline Scenarios are in Appendix H).

**Harvest Volume**

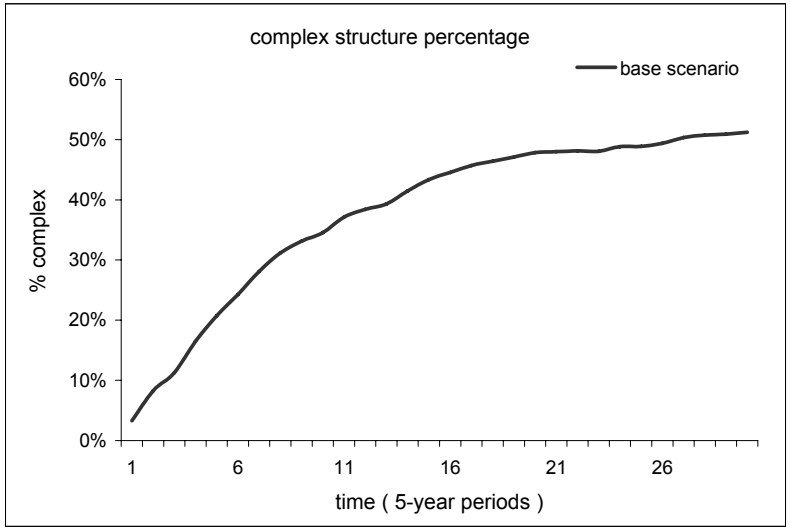



Harvest volume decreased from 213 mmbf/year in the first decade to approximately 150 mmbf/year by period 16 (80 years), largely due to the new owl circles found with the take avoidance strategy. Clearcut acres account for about 45% of all acres harvested (see Appendix G, Table 3 for details).

Overall, 78 new owl circles and about 12,200 acres of new murrelet habitat were found using the Base Scenario. Each owl circle has 2,000 acres (approximately 40%) of habitat patch, where no harvesting occurs from the time it was found through the rest of the 150 years. Most of the owl circles were found in the first 80 years.

**Complex Stand Structure**

Complex structure reached 50% in approximately 130 years in the north coast districts; however, Astoria and Forest Grove reached 50% sooner. Complex structure continued to rise above 50% as new owl habitat matured to become more complex.



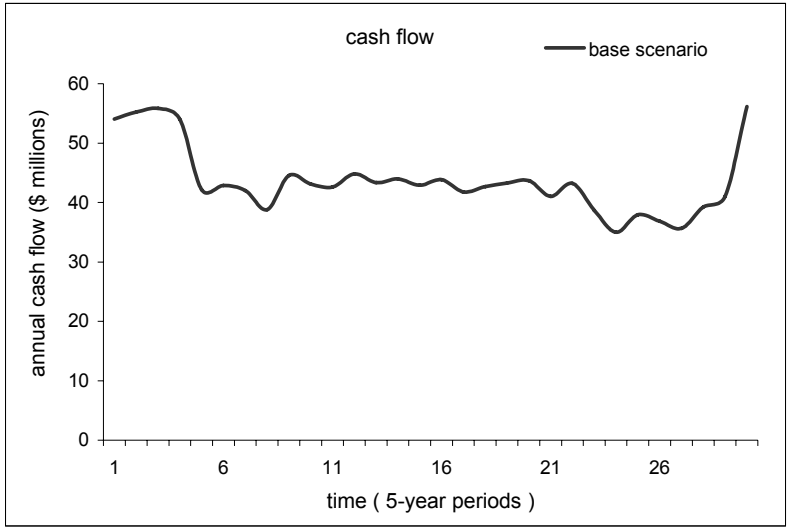
## Results: By Alternative – Forest Management Plan using TA

# Three North Coast Districts Combined

### Standing Inventory

Standing inventory was not shown because of the uncertainty of estimating it with the post-processing model structure.

### Economics




NPV is $1.308 billion.

Cash flow showed a similar trend as harvest volume, but was negatively impacted in the first 30 years because of road construction costs.

### Findings

- The three north coast districts combined harvest volume was 213 mmbf/year in the first decade and declined to an average of 161 mmbf/year over 150 years. The decline was attributed to constraints associated with new owl circles and murrelet habitat that appeared using the Base Scenario of the take avoidance strategies.
- Complex structure reaches 50%, and then climbs higher as the “no harvest” acres in the new owl circles and murrelet areas continue to become more complex.
- Cash flow levels are closely correlated with harvest volume; however, cash flow is negatively impacted during the first five periods (25 years) due to road construction costs, especially in Tillamook.

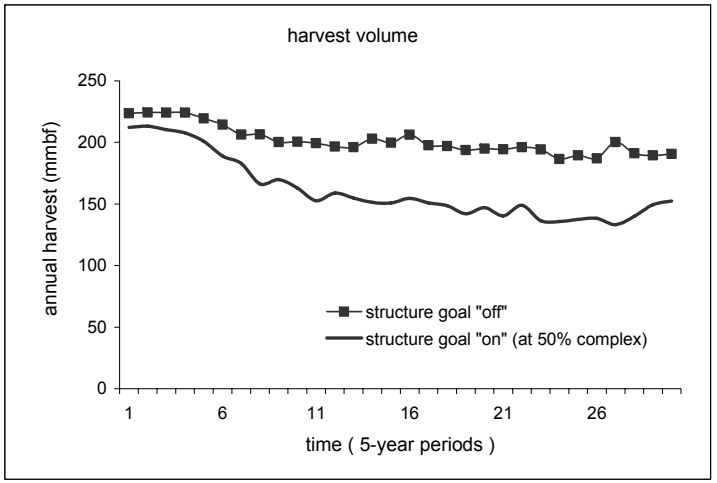
## Results: By Alternative – Forest Management Plan using TA

# No Complex Structure Goal Analysis: Three North Coast Districts Combined

A question arose regarding the FMP~TA alternative about the effect on harvest volume if the complex structure goal was 20% or 30%, instead of 40% - 60% in the FMP.

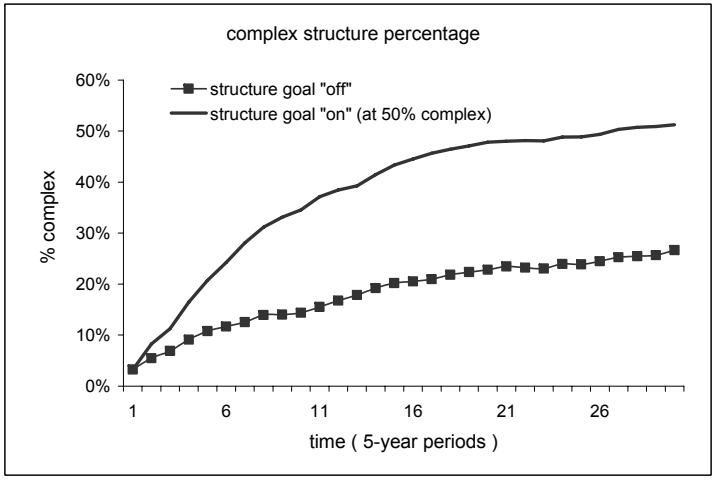
In the model, not enough control of the target for complex structure existed in this alternative to reach and maintain 20% or 30% complex structure because of the two-phased model structure of the FMP~TA alternative. The amount of complex structure could be set in Phase 1 (see above for a description), but new owls and murrelets found in Phase 2 continued to increase the amount of complex structure beyond the attainment of the specified complex structure percent.

So the question was redefined: What is the consequence on harvest volume if there is no specific goal for complex structure? The results were compared with the Base Scenario with a 50% complex structure goal.



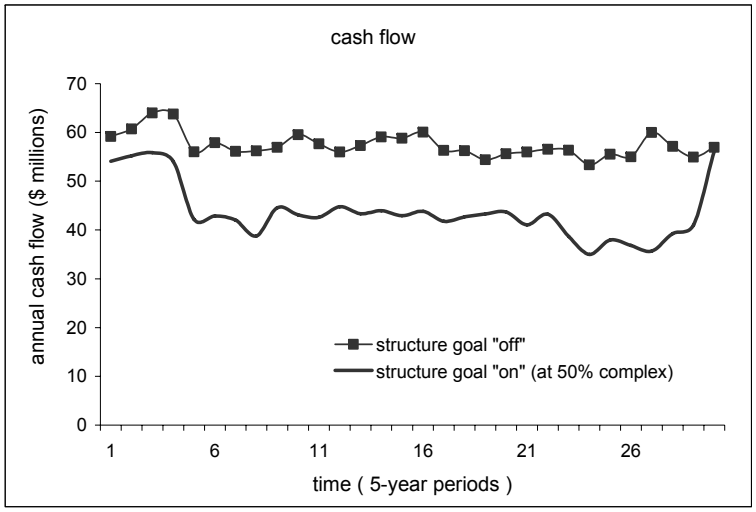

**Analytic Process**

This analysis was completed for the three north coast districts of Astoria, Forest Grove and Tillamook. For each district, a Base Scenario run was found in Phase 1 that had a non-declining flow of harvest volume with the highest first-period volume. The goal for complex structure was set to zero; however, complex structure was not prevented from developing. Phase 2 evaluated each period for new owl circles and murrelet habitat acres and calculated the resulting reduction to harvest volume and increase in complex structure. The analysis was done on each of the three districts, with the results reported for the three north coast districts combined.



## Results: By Alternative – Forest Management Plan using TA

# No Complex Structure Goal Analysis: Three North Coast Districts Combined




**Findings**

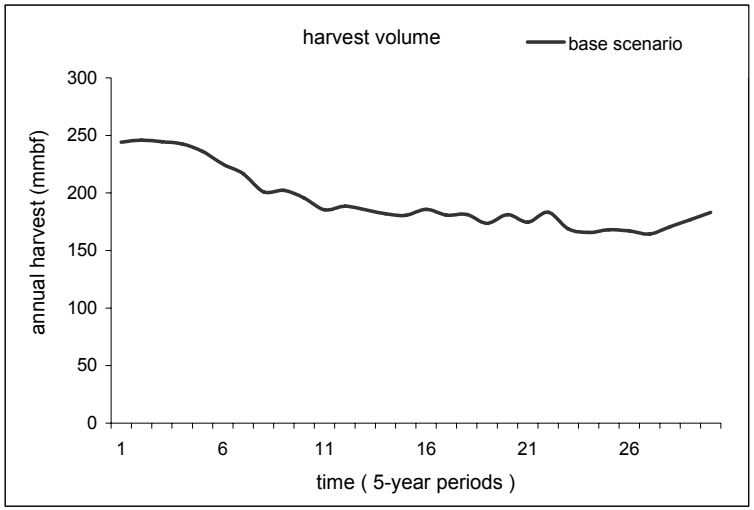
- Compared with the Base Scenario with a 50% complex structure goal, higher harvest volume could be achieved in the first decade (9% per year) and over the long-term (9% over 150 years) when there was no complex structure target.
- Without specifically preventing complex structure, approximately 30% complex structure was achieved.
- Compared with the Base Scenario with a 50% complex structure goal, 22 fewer owl circles (28% fewer circles) and 5,513 fewer murrelet acres (45% fewer acres) were found when there was no complex structure goal on the landscape.

## Results: By Alternative – Forest Management Plan using TA

# Seven Districts Combined

FMP~TA is reported using the Base Scenario (results from the Improved Recovery and Continued Decline Scenarios are in Appendix H).

### Harvest Volume



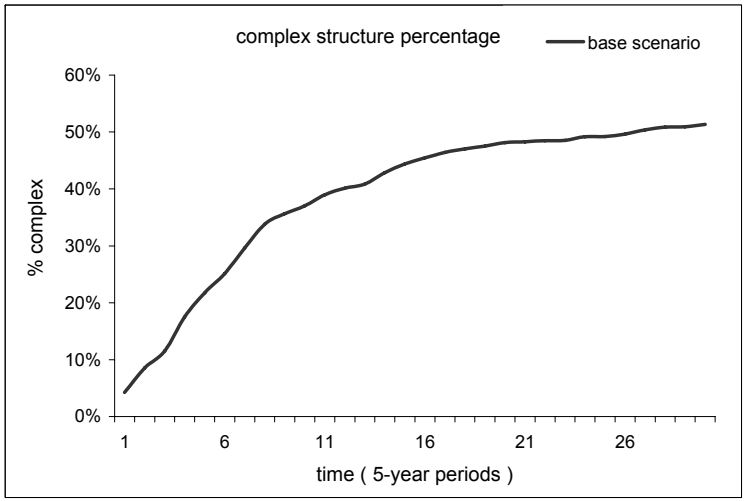

Harvest volume decreased from 245 mmbf/year in the first decade to approximately 180 mmbf/year by period 16 (80 years), largely due to the new owl circles found with the take avoidance strategy. Clearcut acres account for about 44% of all acres harvested (see Appendix F, Table 3 for details).

Across all districts, 92 new owl circles and about 12,300 acres of new murrelet habitat were found using the Base Scenario. Fourteen of the 92 owl circles and 88 acres of new murrelet habitat were found in the southern districts of North Cascade, West Oregon, Western Lane, and Southwest Oregon.

Seventy-nine new circles created 2,000 acres of habitat patch and 13 circles affected 1,200 acres. No harvest was assumed from the time they appeared through the rest of the 150 years. Most of the owl circles appeared in the first 80 years.

### Complex Stand Structure

Complex structure reached 50% in approximately 130 years across all districts.




### Findings

- The harvest volume of all seven districts combined was 245 mmbf/year in the first decade and declined to an average of 193 mmbf/year over 150 years. The decline was attributed to constraints associated with new owl circles and murrelet habitat that appeared using the Base Scenario of the take avoidance strategies.

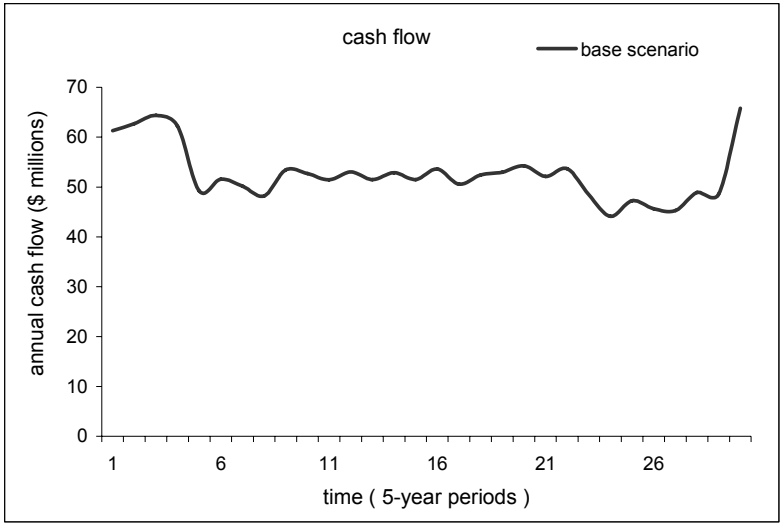
## Results: By Alternative – Forest Management Plan using TA

# Seven Districts Combined

**Economics**

Cash flow showed a trend similar to harvest volume, but was negatively impacted in the first 30 years because of road construction costs.

NPV is $1.308 billion.




**Findings**

- Cash flow declined almost 30% in 30 years. The decline was more rapid than the volume decline because road construction costs were greatest in the first 30 years.

## Results: By Alternative – Wood Emphasis

# Three North Coast Districts

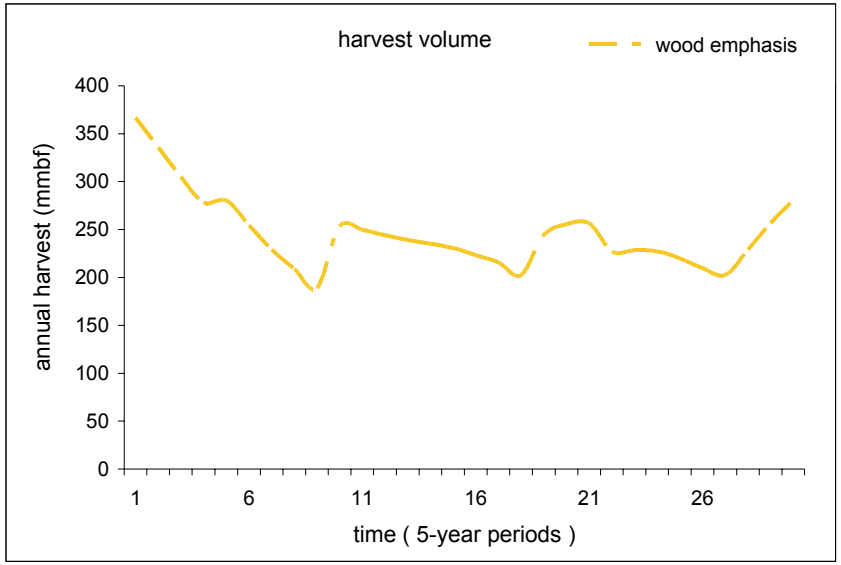
### Description of Model Structure

The Wood Emphasis model used a two-phased approach similar to the FMP~TA model, for estimating the development of structure and its associated effect on threatened species and harvesting. In Phase 1, the model was run knowing the location, protection measures and harvest restrictions for the existing owl circles and murrelet management areas. Phase 2 was a post-processing step that evaluated the period-by-period structure produced in Phase 1 and determined if and where new owl circles and new murrelet management areas would be found, based on the Base Population Scenario (described in FMP~TA section).

Two goals in this alternative allow only a small amount of complex structure to develop: 1) the complex structure goal that guided Phase 1 was set to 0% complex structure; and, 2) the average age of the clearcut stands was 50 years. Thus, few new owl circles and murrelet areas were created in the Phase 2 post-processing procedure. The Wood Emphasis alternative assumed the Base Scenario for northern spotted owl and marbled murrelet population trends.

### Harvest Volume

Harvest volume was 351 mmbf/year in the first decade, declining to a range of 190 to 260 mmbf/year after 40 years. With an average harvest age of 50 years and no complex structure goal, most existing stands older than age 50 were harvested during the first 40 years, resulting in high volume during that period of time. After 40 years, a repeated pattern of peaks and valleys in harvest volume became evident as the clearcut stands grew over age 50 and were cut again. The high volume peaks were correlated with years of high clearcut acres of stands over age 50; the dips occurred during the periods that the clearcut stands were not yet 50 years old, with harvest volume being derived largely from thinning those stands. (See Appendix G, Table 3 for clearcut and thinning acres.) There was more clearcutting than thinning throughout the 150 years; the average ratio of acres clearcut to acres thinned was 6:1.

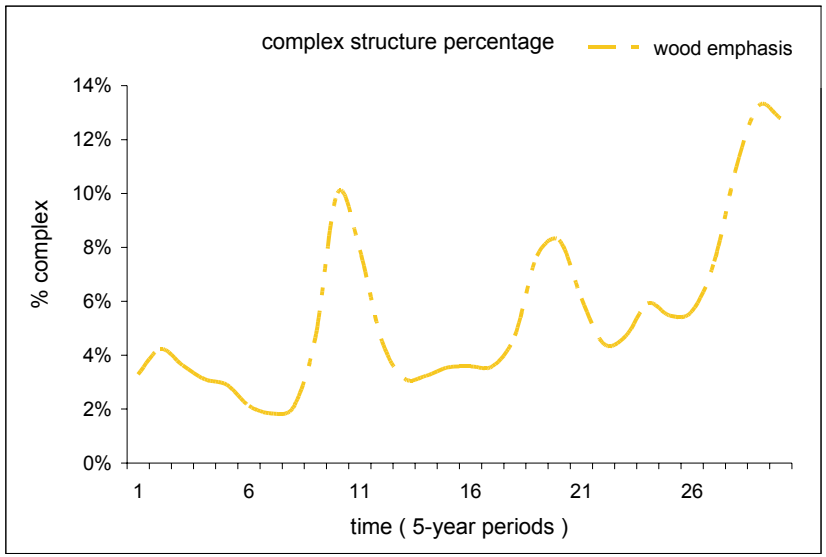


## Results: By Alternative – Wood Emphasis

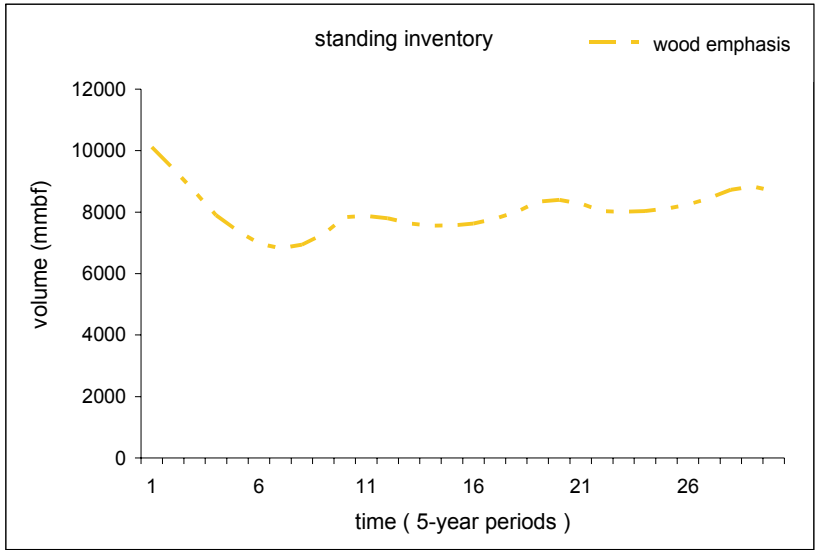
# Three North Coast Districts

### Complex Stand Structure

Complex structure fluctuated between 2% and 12% in a similar pattern as the harvest volume. The complex structure peaked during the periods when greater numbers of stands were not yet eligible for clearcut and were being thinned. Complex structure declined during periods when high acres of clearcut occurred. At these levels of complex structure, one new owl circle and a total of 2,241 acres of new murrelet habitat appeared in all three districts over 150 years.



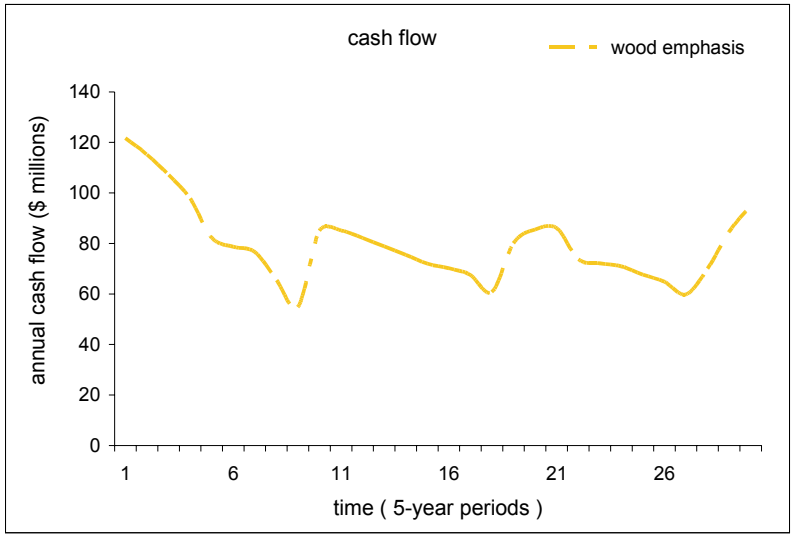

### Standing Inventory



## Results: By Alternative – Wood Emphasis

# Three North Coast Districts

### Economics




NPV was $2.238 billion.

### Findings

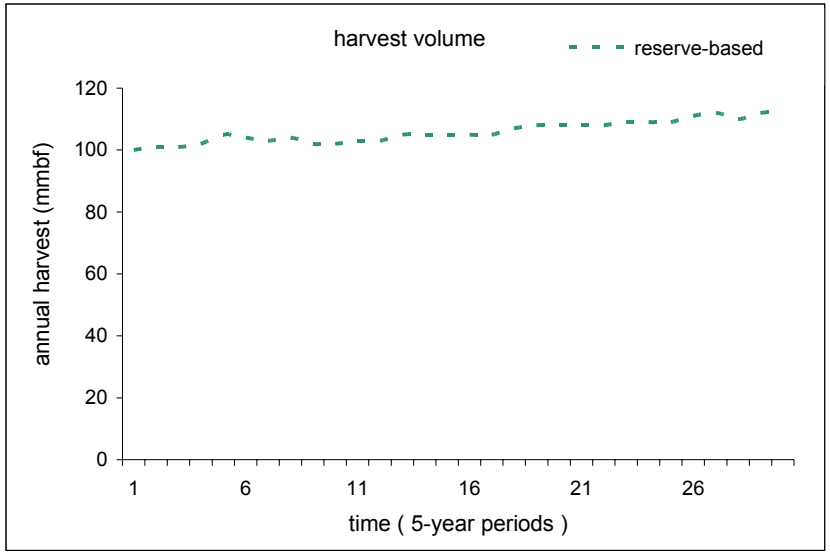
The goal of maintaining an average clearcut harvest age of 50 results in a first decade harvest volume of 351 mmbf/year as existing older stands are harvested with an average harvest volume of 246 mmbf/year over 150 years.

- Complex structure levels range between 2% and 12%
- Existing standing inventory is reduced by 40%, from 10 billion board feet to 6 in the first 30 years, from the harvest of older stands and is maintained thereafter at approximately 8 billion board feet.
- Cash flow levels are closely correlated with harvest volume; however, cash flow is negatively impacted during the first five decades due to road construction costs, especially in Tillamook.

## Results: By Alternative – Reserve-Based

# Three North Coast Districts

Modeling of the Reserve-Based alternative resulted in nearly 60% of the north coast districts in either “no harvest” reserves or reserves limited to thinning with no clearcutting allowed, except in some severe Swiss needle cast areas. The reserves included lands classified as administratively removed (campgrounds, powerlines, deed restrictions, etc.), unharvestable areas, salmon anchor habitats, owl clusters and circles, murrelet management areas, existing older forest structure (OFS) and layered (LYR) stands, expanded riparian buffers, and low road density areas. Outside the reserves FMP strategies were used with a target of 50% complex structure, with at least 25% OFS.




### Harvest volume

Harvest volume was 101 mmbf/year in the first decade, with an average volume of 106 mmbf/year over 150 years. The harvest volume was largely derived from thinning volume with nearly a 2:1 ratio of thinning acres to clearcut acres. (See Appendix G, Table 3 for composition of clearcut and thinning acres.) An average of 5% of the volume came from within reserves and occurred primarily within the first 80 years. The remainder of the volume came from outside the reserves.

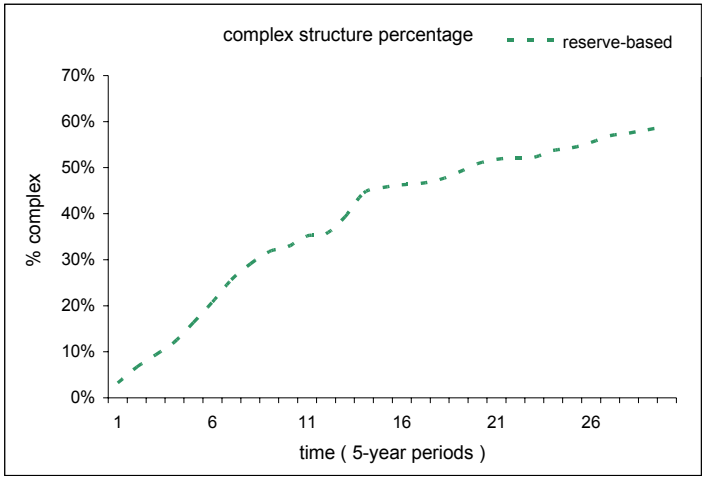
## Results: By Alternative – Reserve-Based

# Three North Coast Districts

### Complex Stand Structure

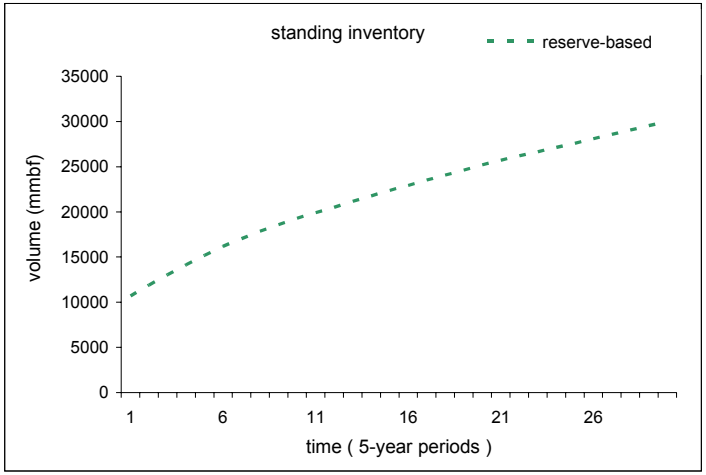
Complex structure continually increased over 150 years to about 60% across the three districts. The complex structure target of 50% applied only to the acres outside the reserves. Therefore, when the complex structure inside the reserves was added, the district percent rose above 50%.

Inside the reserves, the model showed that complex structure developed more slowly than outside, the result of less thinning to promote the development of structure. Eventually, the areas inside the reserves became mostly OFS. Outside the reserves, the complex structure was more balanced between OFS and LYR stands.




### Standing Inventory

The standing inventory tripled in 150 years, rising from about 10 billion board feet to about 30 billion board feet.



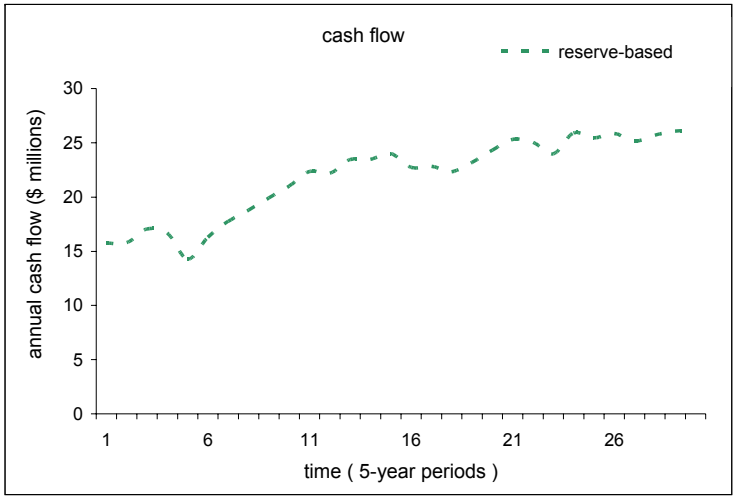
## Results: By Alternative – Reserve-Based

# Three North Coast Districts

### Economics

Cash flow showed a similar trend as volume with a reduction in the first 30 years for road construction costs.

NPV was $376 million.




### Findings

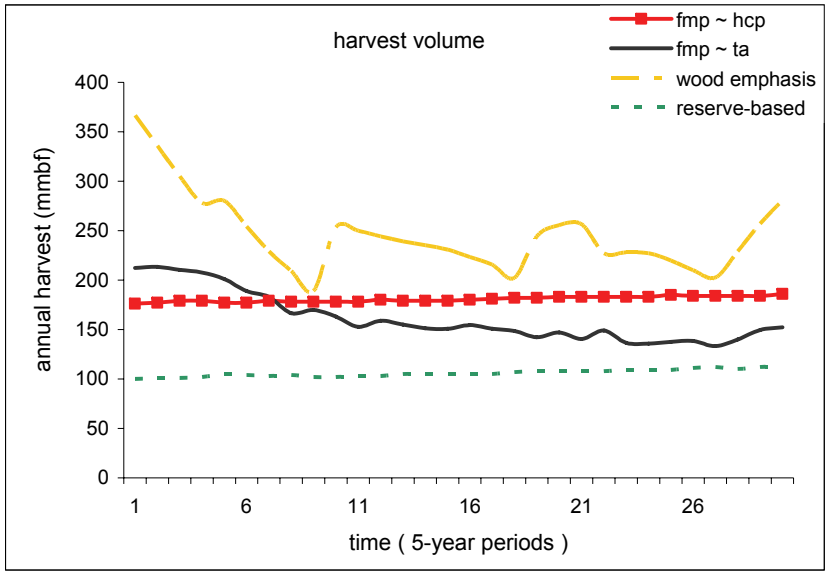
- Harvest volume over 150 years averages 106 mmbf/year and is derived from more thinning acres than clearcut acres in almost a 2:1 ratio.
- In 150 years the north coast districts develop about 60% complex structure, including the structure inside and outside the reserves.
- Nearly 90% of the reserves becomes complex structure in 150 years, but develops more slowly than in the actively managed landscape.
- The reserves become largely OFS, while the complex structure outside reserves is more of a balanced mix of OFS and LYR stands.
- Cash flow levels are closely correlated with harvest volume; however, cash flow is negatively impacted during the first five decades due to road construction costs, especially in Tillamook.

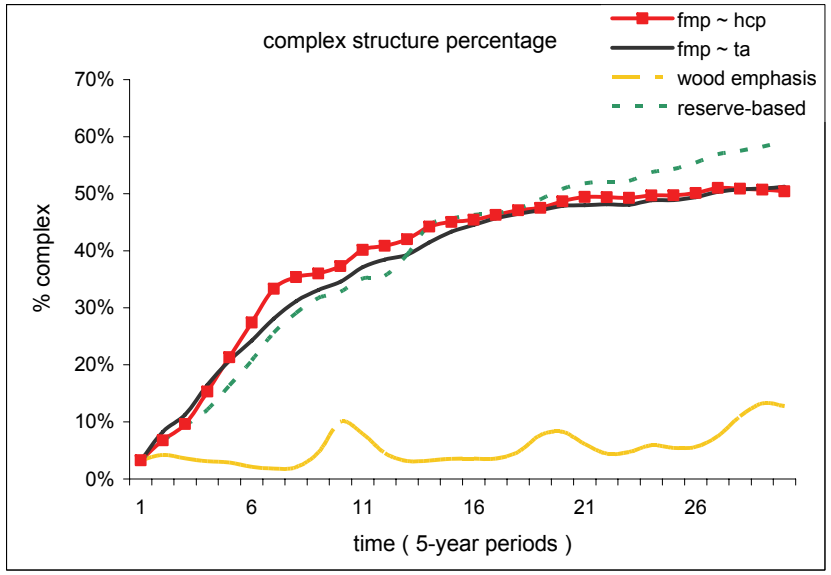
## Results: Comparison of Alternatives

# Three North Coast Districts Combined: All Alternatives

This section shows the results of all four alternatives: FMP~HCP, FMP~TA, Wood Emphasis, and Reserve-Based. The outputs compared appear in "Results: By Alternative."

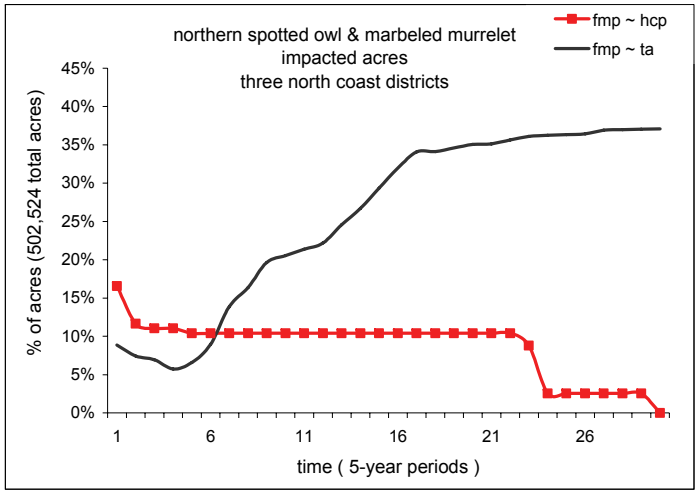
FMP~HCP has a 50% complex structure goal; FMP~TA uses the Base northern spotted owl population scenario with a 50% complex structure goal.



## Results: Comparison of Alternatives

## Three North Coast Districts Combined: All Alternatives (continued)




**Findings**

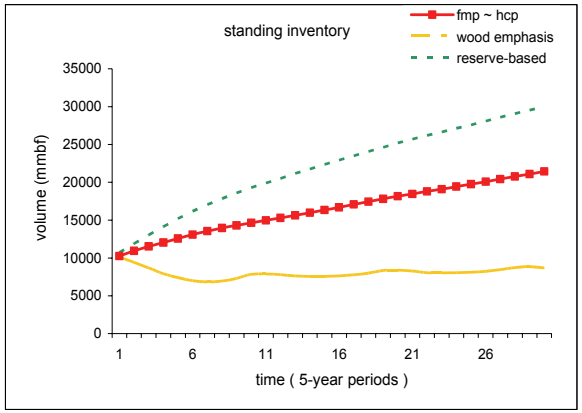
- Compared with FMP~HCP, FMP~TA produces 20% more harvest volume in the first decade, and continues to produce more volume for the first 30 years, because fewer acres are protected for northern spotted owls and marbled murrelets. But FMP~TA produces more than 10% less volume over 150 years because of the additional owl and murrelet habitat found with the take avoidance strategies.
- Wood Emphasis produces twice the amount of volume than FMP~HCP in the first decade and almost 40% more volume in 150 years because of the goal for 50-year harvest rotation, no goal for complex structure, and fewer acres in owl protection and riparian buffers. It develops about 10% complex structure compared with 50% for FMP~HCP because there is an emphasis on a 50-year rotation age.
- Reserve-Based produces about 40% less harvest volume than FMP~HCP because of the acres dedicated to reserves. In 150 years Reserve-Based develops 60% complex structure compared with 50% in FMP~HCP.
- FMP~HCP develops complex structure more quickly than FMP~TA or Reserve-Based because more acres are actively managed.
- The ratio of acres clearcut to acres thinned in all 150 years is similar in the FMP~HCP and Reserve-Based alternatives, each having about 37% of harvest acres being clearcut; FMP~TA alternative has 45%; and Wood Emphasis has 86% of the harvested acres being clearcut (see Appendix G, Table 3).

# Results: Comparison of Alternatives

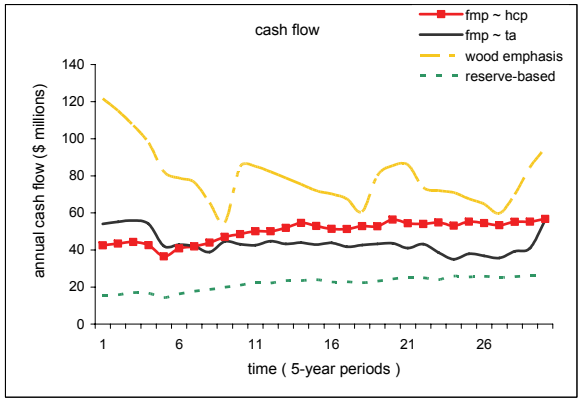
## Three North Coast Districts Combined: All Alternatives (continued)

### Standing Inventory

Standing inventory was not shown for FMP~TA because of the two-phased processing procedure of that alternative (see Results: By Alternative section: FMP~TA).




### Economics




| Alternative | NPV (millions $) |
|---|---|
| FMP ~ HCP | 971 |
| FMP ~ TA | 1124 |
| Wood Emphasis | 2239 |
| Reserve-Based | 376 |

### Findings

- Although standing inventory for FMP~TA is not shown, it would likely result in an inventory greater than FMP~HCP because of the reduced harvesting as new owls and murrelets are found.
- Wood Emphasis standing inventory declines by 20% over 150 years due to the goal of harvesting stands older than age 50. In 150 years the standing inventory is approximately 40% lower than FMP~HCP.
- Reserve-Based standing inventory triples in 150 years and is nearly 40% higher than FMP~HCP in 150 years because of the acres in reserves.
- Cash flow levels in all alternatives are closely correlated with harvest volume; however, cash flow is negatively impacted during the first 5 periods (25 years) due to road construction costs, especially in Tillamook.
- NPV is 230% higher for Wood Emphasis than FMP~HCP, Reserve-Based is 40% of FMP~HCP; and FMP~TA is 16% higher than FMP~HCP. FMP~TA is 16% higher than FMP~HCP due to the higher volume harvested in the first 30 years.

# Coarse Filter Wildlife Matrix: Three North Coast Districts Combined: All Alternatives

## Introduction

The Coarse Filter Wildlife Matrix (CFM) illustrated how a number of different wildlife species might make use of the habitats developed over the modeled timeframe. Information about species use of such habitats was based on review of scientific literature.

The correlation of habitat characteristics with wildlife species is better understood for some species than for others. Based on the literature's description of wildlife habitat, assumptions were made in the H&H model regarding the quantification of size, abundance and other characteristics of the habitat components.

Habitat, in the H&H model, refers to a combination of the five stand classifications used by ODF: Regeneration (REG), Closed Single Canopy (CSC), Understory (UDS), Layered (LYR), and Older Forest Structure (OFS) along with other stand characteristics that could be predicted by modeling such as tree size and diameter, tree species composition, proximity to streams and clearcuts, and time since harvest activity. Estimates of the populations of species or the quality of the habitats were not reported.

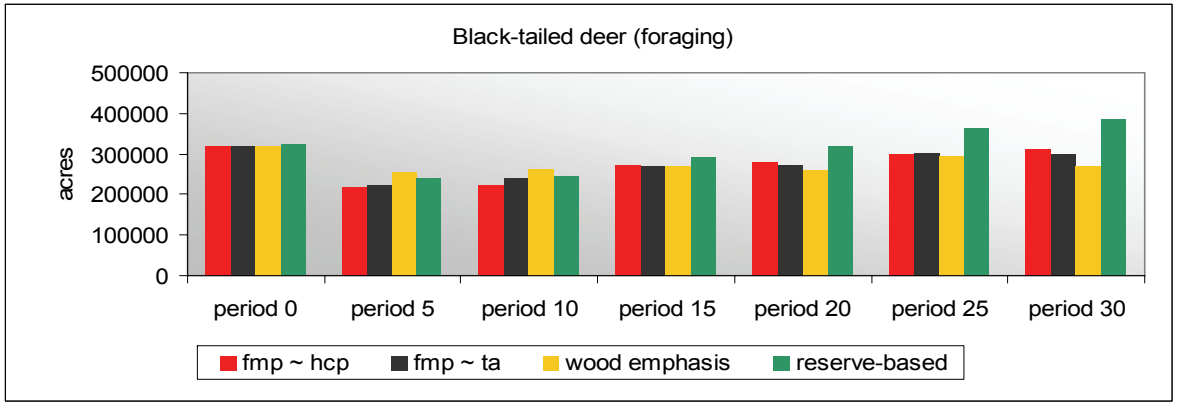
Current and future habitat was estimated for 37 species in the north coast districts. Nine of these species had separate foraging and nesting or cover habitats, resulting in a total of 46 estimated species/habitat combinations. Each species had habitat results specific to each of the four alternatives. Foraging and nesting/cover habitats also had separate habitat results in each of the four alternatives.

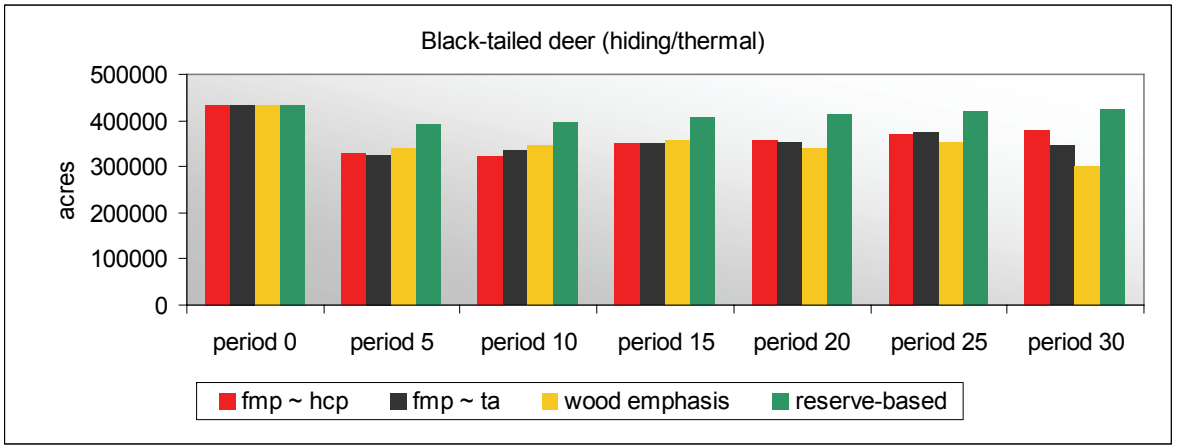
Species have been grouped into three classes: generalist species (multiple stand structures), simple structure species, and complex structure species. For a complete report – listing all species for every district, by alternative – contact ODF.

Note: Downed woody debris, snags, and shrubs were not incorporated into the model because of the limited data and the lack of reliable model results to predict amounts. For species closely tied to snags and downed wood, assumptions were made as to the size and number of snags that would be available in stand structure types.

# Coarse Filter Wildlife Matrix: Three North Coast Districts Combined: All Alternatives (continued)

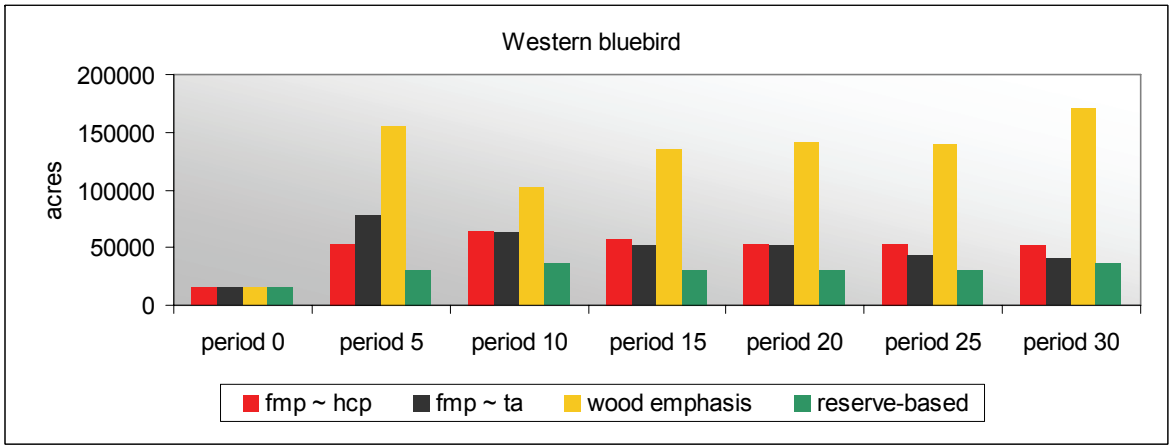
**Generalist (Multiple Structure) Species**: Eleven species/habitat combinations were produced in abundance by all alternatives. The habitat characteristics for these species are fairly common on the modeled landscape, and the species themselves are fairly well distributed (e.g. black-tailed deer).

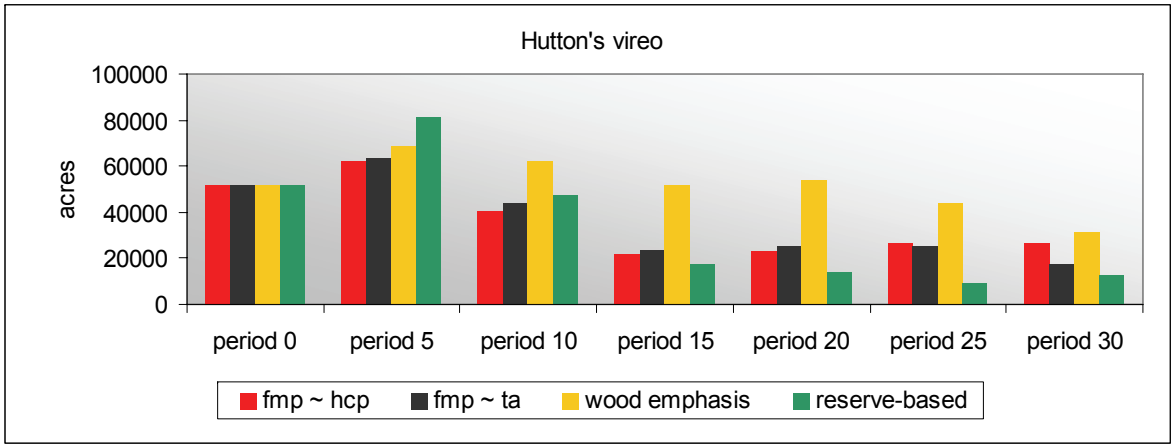


# Coarse Filter Wildlife Matrix: Three North Coast Districts Combined: All Alternatives (continued)

**Simple Structure Species**: These nine species/habitat combinations were produced in greater abundance under Wood Emphasis. These were either open country species associated with low tree density and shrubs (e.g. Western bluebird), or species associated with younger, denser closed single canopy stands (e.g. Hutton's vireo).

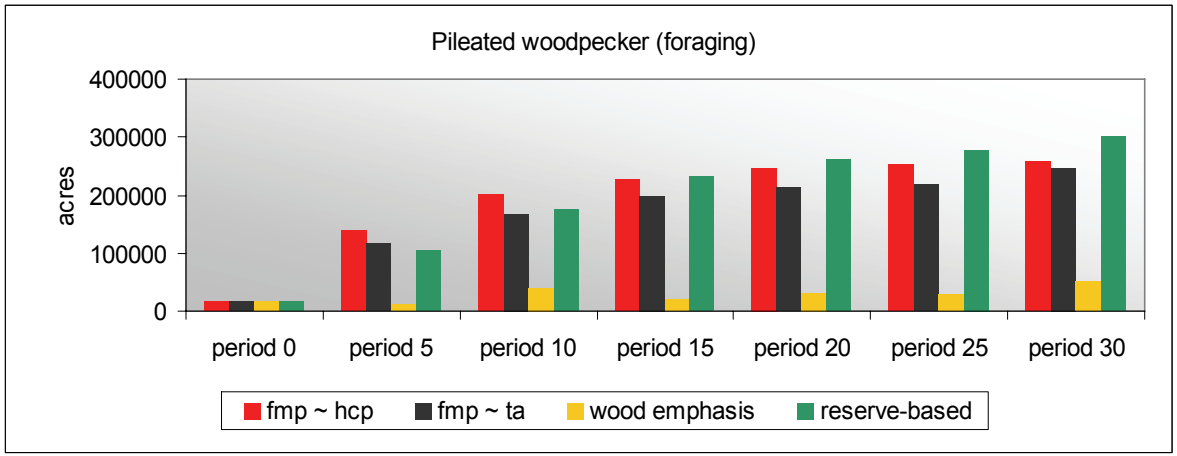


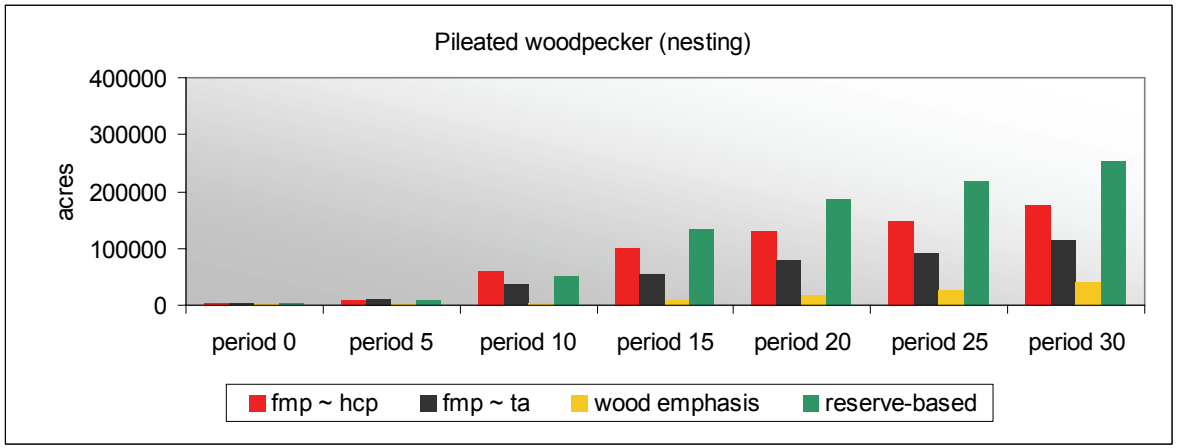



## Results: Comparison of Alternatives

# Coarse Filter Wildlife Matrix: Three North Coast Districts Combined: All Alternatives (continued)

**Complex Structure Species**: These 27 species/habitat combinations were produced in greater abundance by FMP~HCP, FMP~TA and Reserve-Based alternatives (e.g. Pileated woodpecker foraging habitat). The four OFS-based species/habitats were produced in greatest abundance by Reserve-Based (e.g. pileated woodpecker nesting habitat), due to assumptions made regarding available snags of a given size. One species habitat (pacific jumping mouse) was produced in greater abundance by FMP~HCP and FMP~TA.



# Coarse Filter Wildlife Matrix: Three North Coast Districts Combined: All Alternatives (continued)

**Findings**

- The FMP~HCP, FMP~TA, and Reserve-Based alternatives produce similar amounts of habitat for 90% of the 37 species analyzed.
- For generalist species, any of the alternatives produce an adequate amount of habitat.
- Species favoring OFS have more habitat acres in the Reserve-Based alternative.
- In the Wood Emphasis alternative, species favoring REG and CSC types have more habitat; species favoring complex structure have less habitat.
- Due to many unknowns, these results are not precise; they are coarse estimates of potential habitats and the species that use them.

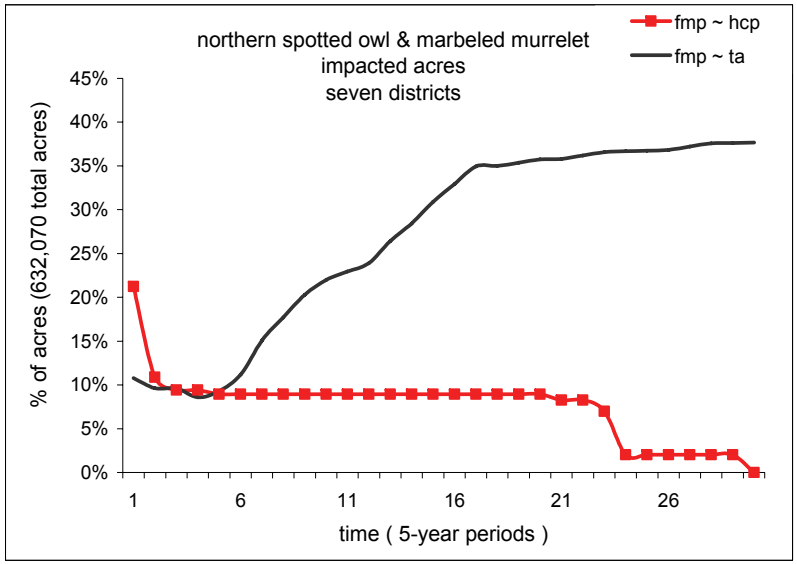
## Results: Comparison of Alternatives

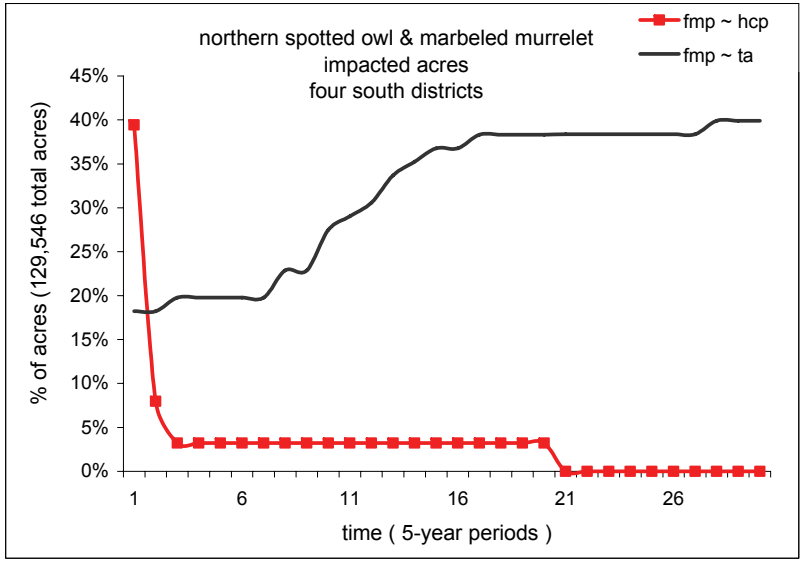
# Seven Districts: Two Alternatives

This section shows the results of FMP~HCP and FMP~TA for all seven districts combined. Both alternatives have a 50% complex structure goal; FMP~TA uses the Base spotted owl population scenario.

FMP~TA had a higher first decade volume and lower total volume than FMP~HCP. This was attributed to a greater number of murrelet- and owl-impacted acres in the first decade and fewer in the future with FMP~HCP.

Differences in impacted acres were apparent, however, between the north coast districts and the southern districts of North Cascade, West Oregon, Western Lane, and Southwest Oregon (see charts below). The southern districts had twice as many acres impacted from owls and murrelets. These differences were obscured when all districts were viewed together (see previous section and Appendix G, Table 2 for separated results).



# Seven Districts: Two Alternatives (continued)

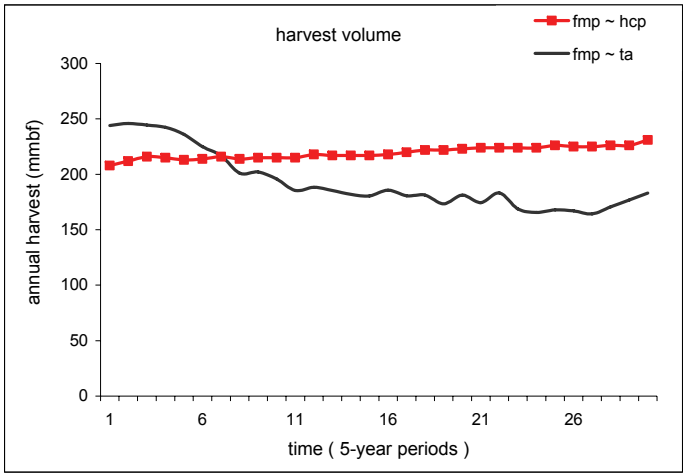
### Harvest Volume

Harvest volume was combined for all seven districts and complex structure percentage was an acre-weighted average of all seven districts (see Appendix H for district-specific information). Results for the seven districts showed a similar trend as the three north coast districts combined, due to the large percentage of acres and harvest in the three districts.

Results for the southern districts showed they had 9% less volume in the first decade and 18% less total volume over 150 years using FMP~TA instead of FMP~HCP. In comparison, the north coast districts had 20% more volume with FMP~TA in the first decade and 9% less over 150 years than the FMP~HCP (see Appendix G, Table 2).

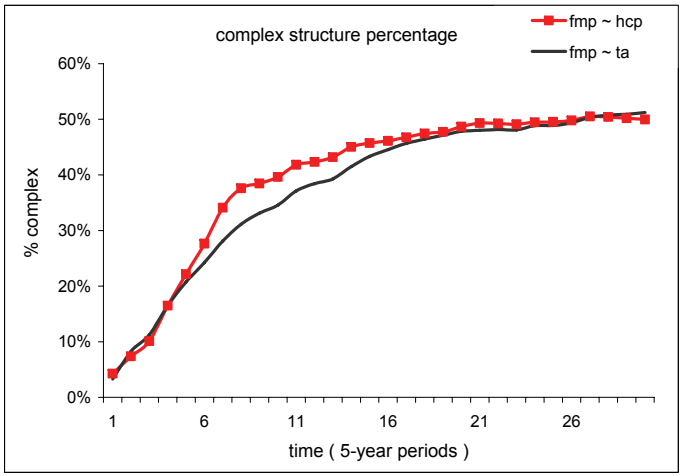
The north coast districts had an initial period in which the take avoidance strategies yielded higher volumes than using HCP strategies, but the southern districts did not.

Over 150 years, the southern districts experienced an 18% reduction in total harvested volume using take avoidance strategies compared to HCP strategies, while north coast districts saw an 11% reduction.




### Complex Structure

By design both alternatives achieved complex structure in a similar timeframe in each district. FMP~HCP developed complex structure at an accelerated rate compared to FMP~TA due to active management occurring on more acres.




### Standing Inventory

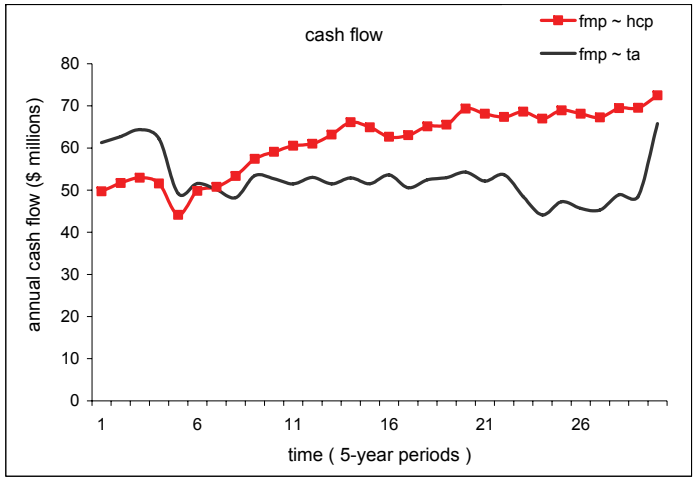
Standing inventory was not shown for FMP~TA because of the two-phase processing procedure of that alternative (see Results: By Alternative section: FMP~TA).

# Results: Comparison of Alternatives

## Seven Districts: Two Alternatives (continued)

### Economics

| All 7 Districts | |
|---|---|
| Alternative | NPV (billions $) |
| FMP ~ HCP | 1.165 |
| FMP ~ TA | 1.308 |




### Findings

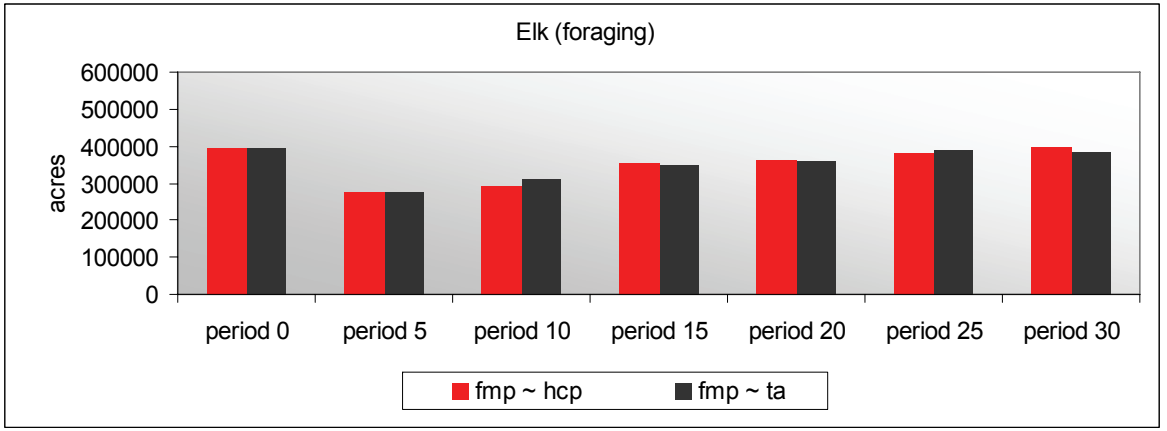
- Across all seven districts, FMP~TA produces more harvest volume (15%) in the first decade, and remained higher for the first 30 years, because fewer acres are impacted from northern spotted owls and marbled murrelets. But FMP~TA produces less volume (14%) over 150 years because of the additional owl and murrelet habitat appeared over time using the Base Scenario.
- The impact on harvest volume of FMP~HCP versus FMP~TA is not the same on all districts. The four southern districts had a reduction in harvest volume of 3 mmbf/year in the first decade using take avoidance strategies, and the three north coast districts had an increase of 36 mmbf/ year.
- Both FMP~HCP and FMP~TA achieve 50% complex structure, but FMP~TA will overachieve 50% in the long-term because 40% of each new owl circle has no harvesting and will develop into complex structure.
- FMP~HCP develops complex structure at an accelerated rate due to more acres being actively managed.
- Cash flow has a similar relationship between FMP~HCP and FMP~TA as harvest volume; however, cash flow is negatively impacted during the first 5 decades due to road construction costs, especially in Tillamook.
- NPV for FMP~TA is higher (12% higher) than FMP~HCP because of the higher cash flow in the first 25 years.

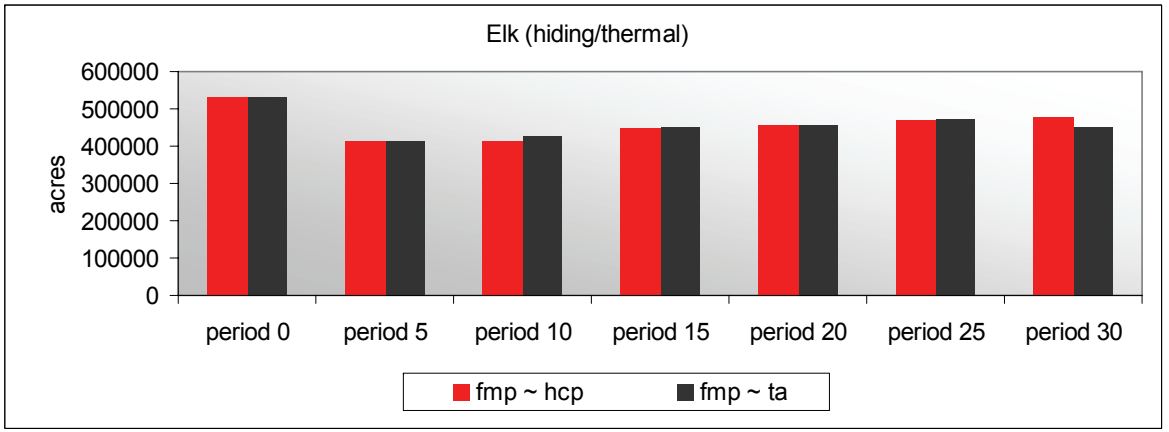
# Coarse Filter Wildlife Matrix: Seven Districts: Two Alternatives

**Coarse Filter Wildlife Matrix**

Habitat acres were estimated for a total of 39 species. Nine of these species had separate foraging and nesting or cover habitats, resulting in a total of 48 species/habitat combinations (see Appendix F).

In FMP~HCP and FMP~TA acres of habitat were similar for all species across all time periods (e.g. elk foraging and hiding/thermal habitat), except the four OFS-based species (northern pygmy owl, pileated woodpecker nesting, red-breasted nuthatch nesting, and red-breasted sapsucker nesting).

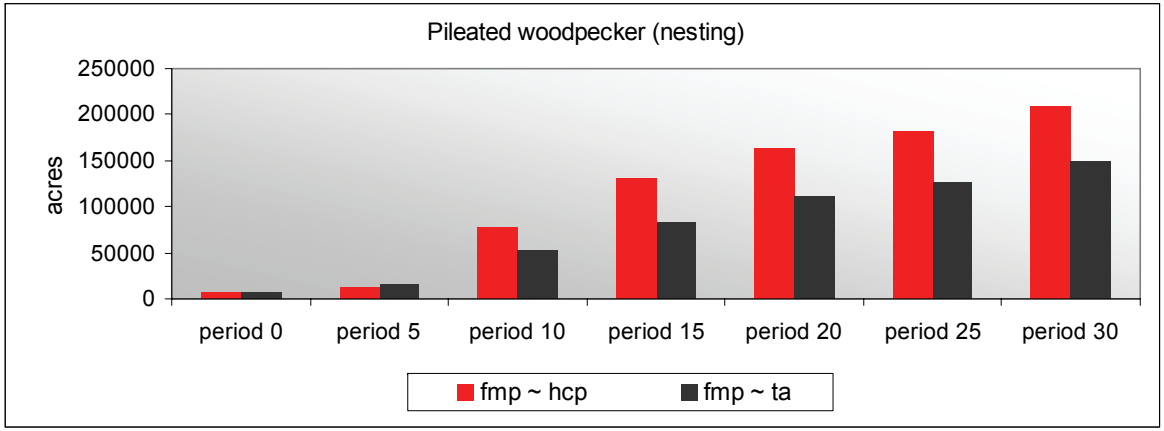


## Results: Comparison of Alternatives

## Coarse Filter Wildlife Matrix: Seven Districts: Two Alternatives (continued)

The FMP~HCP alternative appeared to produce greater habitat levels for the OFS-based species than the FMP~TA (e.g. pileated woodpecker nesting). However, these differences may be overestimated, due to the inability of predicting the future distribution of structural components (i.e., snags) across the landscape – in all stand types – and the uncertainty of complex structure development for the FMP~TA model.




**Findings**

- When comparing FMP~HCP and FMP~TA for all seven districts, acres of habitat for each species appear to be similar for 90% of the species analyzed.
- Model results show an apparent difference in the amount of habitat for the four OFS-based species. These differences may be overestimated, due to the inability of predicting the future distribution of structural components (i.e., snags) across the landscape – in all stand types – and the uncertainty of complex structure development for the FMP~TA model.

# Level of Confidence

The project strived to obtain the highest level of confidence possible in the model results, within the time available. Involvement of district field personnel, who will be asked to achieve harvesting objectives on the ground, has been critical to this process.

The following factors contributed toward achieving a high level of confidence for FMP~HCP model results at the *strategic-tactical* level:

- Extensive district and Salem staff involvement
- District review and approval of spatial information
- Use of the most current stand level inventory information
- Use of the most appropriate growth models
- District validation of growth/yield data
- Operationally-based harvest units
- Ongoing validation of model outputs, using a spreadsheet tool to compare runs and alternatives, a database that analyzes the accuracy of the solution and a GIS tool that checks the accuracy of the spatial data and model rules in the first four periods
- Model Solution Reviews by districts (explained below)
- Hundreds of model runs done to understand the interdependency of the goals and to analyze results
- Assistance from a leading spatial forest modeler, Dr. John Sessions
- Assistance from expert consultants: Mason, Bruce & Girard, Inc. and Logging Engineering International, Inc.

Confidence levels were likewise high for FMP~TA, Wood Emphasis and Reserve-Based models in regards to verifying model input data and rules. Input provided by stakeholders helped clarify and improve model assumptions, especially for the Wood Emphasis and Reserve-Based alternatives. Confidence in model results from these alternatives was lower because less extensive analysis and district review was done for these alternatives.

### Model Solution Review

The Model Solution Review (MSR) was designed to: 1) verify that the model's input data and management rules were constructed correctly, and 2) provide a district review of the ability to implement the model's solution or schedule of harvest on the ground. The MSR was a spatially based review of the model's harvest decisions for the first four periods. It was conducted in two phases: first, project staff checked the model's input data and management rules; then, field foresters reviewed the input data and management rules and analyzed the model solution to assess their ability to implement the model's harvest volume and acres on the ground.

### Process

The MSRs were conducted by providing each district with GIS data showing the spatial location of the thinning and clearcut harvest units for the first four periods of the model solution (20 years). The MSR provided information on the volume and acres harvested for four periods and the costs, revenues, and harvest prescriptions for the first period. The districts were able to document their comments at the harvest unit level.

Each district conducted two or more MSRs for the FMP~HCP alternative and at least one less intensive MSR on each of the other alternatives (information on confidence pending). To improve the model, the districts identified additional corrections to the spatial data inputs and inconsistencies between policy guidance and the model's harvest activities. After completing several MSRs on the FMP~HCP alternative, each district prepared a report of their findings, commenting on the accuracy of the spatial data, interpretation of plans and policies, implementation of model rules, and the district's ability to implement model outputs (FMP~HCP only).

# Level of Confidence (continued)

### Confidence in FMP~HCP Implementation

For the FMP~HCP alternative, all districts reported a high confidence in their ability to implement harvest volume outputs in the first two periods (10 years) for the following reasons:

- The spatial data was essentially correct and no errors existed that would impact implementing the model's scheduled volume during the first two periods.
- The model was consistent with the FMP, HCP and applicable policies, to the extent they could be modeled. Also, any remaining concerns would not have an impact on implementing the volume scheduled by the model during the first two periods.
- The districts could implement the harvest volumes scheduled by the model for the first two periods.

Long-term harvest volumes appear to be sustainable because the districts verified the first decade harvest volumes, future harvest volumes do not depart significantly from that level, and growth exceeds harvest levels.

The districts had a lower confidence in implementing the mix of acres of clearcut and thinning scheduled by the model. A number of factors lowered their confidence, the most important of them being the model's dependence on a strata-based inventory system. All districts believed that FMP goals and the model's volumes could be better achieved through a different mixture of clearcut and thinning harvest acres, especially in the next few years.

### District Implementation Issues

The MSRs identified a number of issues that impact the potential implementation of the model's harvest volume and the mixture of clearcut and thinning acres. The most important of these issues follow:

1. **Model's Strata-Based Inventory** – For each district the model's inventory is based on an average stand for each strata after stratifying the district Stand Level Inventory (SLI) into groups of similar species groups, size classes, and density. Each strata consists of both measured and non-measured stands, and uses a strata-based approach that averages all measured stands within a stratum to estimate the volume (and other stand characteristics) for all stands within the stratum, both measured and non-measured. As a result, the actual conditions within a specific stand may be significantly different than the model data, due to unavoidable within-strata variation. Since the field foresters base their harvest decisions on the actual conditions within a specific stand, their silvicultural decisions may be different than model decisions.

   **Consequence**: Using the model's harvest schedule for short-term *operational* decisions has inherent problems (model solutions are useful for *strategic – tactical* purposes). There needs to be short-term flexibility in the mix of acres (clearcut and thinning) to achieve volume outputs, while still considering the insight that model results provide regarding pathways for achieving longer-term forest management goals.
2. **High Landslide Hazard Locations (HLHL)** – These are potential landslide locations that pose a threat to life or resources that could not be identified during the harvest unit delineation process. HLHL sites generally cannot be clearcut harvested under current policies. On most districts, the impact is insignificant and would not affect harvest outputs (either volume or acres). HLHL areas only occur in significant amounts on the Tillamook District. Their MSR analysis indicates that approximately 7 to 8 percent of the clearcut acres have HLHL sites.

# Level of Confidence (continued)

**Consequence**: No consequence for districts other than Tillamook. Tillamook can achieve their total modeled volume, but may need to use a different mix of clearcut and thinning acres or adjust their harvest volumes, due to HLHL sites.

3. **Desired Future Condition (DFC)** – The model solutions used for the MSRs did not include the goal of developing the complex structures within the DFC-complex mapped areas (included in the district Implementation Plans). Since this was not a goal for these model runs, the model scheduled many clearcuts in the DFC-complex. In practice, within DFC-complex areas districts conduct mostly thinning activities that are designed to create complex structures.

   **Consequence**: Prohibiting clearcut harvest within areas currently identified as DFC-complex will reduce the ability of districts to implement modeled clearcut acres & volume.

   Note: An analysis of the effect of focusing complex structure within district DFC-complex areas vs. across the landscape is discussed in the "Results: By Alternative – FMP using HCP: Landscape Design Analysis" section of this report.

4. **Rate of Harvest** – Constraints related to the rate or pace of harvesting within site-specific geographical areas were not included within model rules (except for Salmon Anchor Habitat areas and owl clusters). The rate of harvesting within specific areas can be a concern, especially in high-use recreational areas, sensitive scenic areas and/or municipal watersheds. The districts manage these concerns by: regulating the rate of clearcut harvest in such areas, conducting more thinnings vs. clearcuts, or both. Model solutions identified more clearcuts and fewer thinnings in some of these geographical areas, over a short period of time, than the district might do *operationally*.

   **Consequence**: Using model solutions for *operational* purposes may cause some operational problems without further rules being added to the model (model solutions are useful for *strategic* – *tactical* purposes). The districts that identified this issue concluded that they could look elsewhere for harvest opportunities in order to manage the harvest rate issue.

5. **FMP~HCP vs. FMP~TA** – It was suspected that, after the first five years, the FMP~TA alternative might show lower short-term harvest volume outputs vs. the FMP~HCP alternative for the four southern districts that currently have many Take Avoidance Owl Circles (Southwest Oregon, Western Lane, North Cascade). While a short-term volume decrease was observed for Western Lane, the four southern districts did not see such a decrease. (All districts did see longer-term volume decreases from using FMP~TA vs. FMP~HCP). Further, FMP~TA harvest volumes appear to be too high for some of these districts to maintain beyond the first decade. These issues raised questions about the take avoidance strategies used in the model and lowered confidence in FMP~TA outputs for these districts.

   There are many possible reasons why these districts are not seeing model results consistent with their expectations. Additional analysis is needed to fully understand the model solutions as they relate to using an HCP vs. using TA.

   Lastly, some districts have been impacted by new Threatened and Endangered species issues since this project began.

   **Consequence**: Additional analysis is needed to fully understand the model results in districts affected by many Owl Circles. Changing owl and murrelet conditions need to be factored into the comparison of FMP~HCP vs. FMP~TA.

# Level of Confidence (continued)

**Findings**

- District review of FMP~HCP solutions found the model was consistent with the FMP, HCP and applicable policies that could be modeled.
- Confidence in implementing short-term (10-year) harvest volume for the FMP~HCP alternative (using a 50% complex structure goal) on the ground is high.
- Long-term harvest volumes appear to be sustainable because the districts verified the first decade harvest volumes, future harvest volumes do not depart significantly from that level, and growth exceeds harvest levels.
- Flexibility in the mix of harvest acres (clearcut vs. thinning) is needed in order to implement the harvest volume and mitigate short-term operational issues.
- The districts have low confidence in the FMP~HCP and FMP~TA models' short-term (10-year) location-specific harvest unit decisions, largely due to the strata-based inventory. Note: The models were not intended to provide short-term operational solutions.
- Additional analysis is needed to fully understand the relationship between the FMP~HCP and FMP~TA alternatives for districts impacted by many owl circles.
- The districts feel the assumption in FMP~TA that new owls continue to occupy the same location for the rest of the model's 150-year timeframe may result in a greater long-term harvest volume reduction than assuming that owls move around on the landscape.

# Key Questions

**The Model**

- ❒ What are the inherent strengths and weaknesses of this model?

  Model strengths: Ability to integrate the achievement of multiple goals over time and space; displays the spatial location of the model's harvest plan; used updated input data; had strong field involvement; has many options that allow fine-tuning the model goals and constraints; is a useful *strategic-tactical* tool.

  Model weaknesses: For the model to be a useful *operational* tool some data inputs and assumptions need to be improved in the future, in particular, the amount of stand-level inventory, the use of strata-based inventory by the model and the model's structure definitions. Further, there are many, different model solutions that meet the goals: knowing which one is best takes a lot of analysis.

**Field verification of the model results**

- ❒ What information exists to demonstrate that model outputs are implementable?

  Districts conducted Model Solution Reviews whereby model rules were confirmed and the spatial location of the model's scheduled harvest was analyzed for the first 20 years. For a discussion about implementing model results and operational limitations, see the Level of Confidence section.

**Coarse Filter Wildlife Matrix (CFM)**

- ❒ What wildlife species were included in the Coarse Filter Wildlife Matrix analysis?

  See Appendix F, Coarse Filter Wildlife Matrix: Species List.

**Harvest Volume Flow Analysis**

- ❒ How do near-term departures from even flow affect overall harvest volumes for the three north coast districts?

  An analysis of this question is presented in this report (Results: By Alternative, Volume Flow Analysis section). The model indicates that the total harvest volume in the first decade can be increased by up to 15% without falling below a minimum threshold, but that districts would need to do an intensive review to verify its feasibility.

**Economics**

- ❒ How do the alternatives compare economically?

  The cash flow and net present value (NPV) are calculated for each alternative and each district and compared in this report (Results: Comparison of Alternatives). Economic results reported in this report are derived from the costs/revenues associated with the overall management of these lands and the sale of timber; economic benefits derived from other forest values (fish, wildlife, water, air, scenic, complex habitat, etc.) are not evaluated in the H&H project.

**Salmon Anchor Habitat (SAH)**

- ❒ How do the 10-year SAH strategies affect harvest levels?

  An analysis of this question is presented in this report (Results: By Alternative, Salmon Anchor Habitat Analysis section). In the combination of the three north coast districts the SAH strategies, developed for the first decade only, resulted in less than a 0.5% decrease in harvest volume in the first decade and less than a 0.1% decrease over 150 years. Modeling confirms ODF's assertion that the affect of SAH strategies is minimal.

# Key Questions (continued)

**Landscape Design and Desired Future Condition (DFC)**

- ❒ How are landscape design strategies being achieved?

  An analysis of the cost and feasibility of locating the complex structures in the mapped DFC is in this report (Results: By Alternative, Landscape Design Analysis section).

**Complex Stand Structure Goals**

- ❒ How does the model integrate complex stand structure goals and harvest volume goals?

  The model is given goals and goal multipliers for harvest volume and complex structure and builds a solution incrementally to try to meet those goals. The goal is the level of harvest or percent of complex structure that you would like the model to strive to achieve. As the model is running it faces decisions that, if accepted, would move the solution closer to one goal but further from the other. The goal multiplier is a factor supplied to the model that tells it how much more important one goal is than another

- ❒ How do different complex stand structure goals affect harvest levels?

  An analysis of the consequence on harvest volume given different complex structure targets is in this report (Results: By Alternative, Complex Stand Structure-Volume Analysis). Analysis shows that there is an inverse relationship between the amount of complex stand structure and harvest volume; higher targets for complex structure yield lower harvest volume, and conversely, lower targets for complex structure can yield higher harvest volume.

**Swiss Needle Cast (SNC)**

- ❒ How is the model treating SNC stands? And is this in accordance with recent SNC scientific findings?

  In keeping with the Board of Forestry's FMP intent statement on managing SNC, the model includes rules which aggressively address this forest disease in the stands that are currently identified with severe SNC. The latest information on how best to manage SNC stands has been incorporated into the model (see Appendix K, "How the Model Addresses Swiss Needle Cast".

**Northern Spotted Owl (NSO) Populations**

- ❒ What does the model predict for habitat that will be available for late seral wildlife species like NSOs?

  The FMP~HCP alternative simulates the protective measures described within the draft HCP, for NSOs and marbled murrelets. As complex stand structures develop, more habitat becomes available for NSOs. Once complex stand structure goals are achieved, it is assumed that adequate habitat will be available across the landscape to provide for viable NSO and murrelet populations, as well as other wildlife species that use complex or late seral habitats.

# Key Questions (continued)

**Northern Spotted Owl (NSO) Populations** (continued)

- ❒ What assumptions about trends in NSO populations are included in the Model? Does the model take into account factors like Barred owls and ocean conditions and their apparent impact on NSOs and marbled murrelets?

  There are differing opinions about what will happen to NSO populations. The FPM~HCP alternative does not have strategies that change with changing NSO or murrelet populations. However the FMP~TA strategies are based upon survey protocols that look for the presence of owls and murrelets. Three different population scenarios were created: Base, Improved Recovery, and Continued Decline (detailed scenario description is in Results: By Alternative, FMP~TA section). The Base Scenario is ODF's best estimate and assumes a decline in owl populations for the first three periods, and then an increase in populations as complex habitat develops.

**Habitat Conservation Plan (HCP) vs. Take Avoidance (TA)**

- ❒ What are the short-term and long-term harvest and habitat implications on the FMP from having an HCP vs. using TA strategies?

  A comparison of the harvest volume and habitat implications is in this report (Results: Comparison of Alternatives). The results are described for the combined three north coast districts, for the combined four southern districts and for the seven districts combined.

**Current and Future Harvest and Habitat Objectives**

- ❒ How do recent harvest levels compare to model volume results for the three north coast districts?

  Per legislative budget note direction, harvest levels for Fiscal Years 2005 and 2006 for the three north coast districts have been set at the high-end of their Implementation Plan ranges: approximately 223 mmbf/year. Harvest levels for FY's 02 through 04 averaged 170 mmbf/year. Model results for these three districts (using FMP~HCP) indicate an average annual harvest volume in the first decade of 177 mmbf/yr.

- ❒ What is the growth rate of the forest under the FMP~HCP and are we harvesting what we are growing?

  The analysis of this question is not in this report. However, for each district, charts showing the average annual board foot volume growth and average volume harvested per acre per year over total district acres have been created (Appendix G). The analysis of these charts will be done by the March 8, 2006 Board of Forestry meeting, at which time this report will be presented.

- ❒ How will this information be used to 1) ensure adequate protection for native wildlife species and 2) establish target harvest objectives?

  An important goal of the FMP is to maintain, protect and enhance native wildlife species. The Board of Forestry will be evaluating information from this report, as well as other information and research in an adaptive management process, to determine if changes should be made to FMP strategies.

  Harvest objectives are established by the State Forester, based on FMP strategies and district Implementation Plans. Information from this report will be used by the State Forester, melded with other information, to establish harvest objectives for FY 2007 and beyond.

# Key Questions (continued)

**Enhancements for the Future**

- What are the most important areas for enhancement for future modeling?
  1. More accurate representation of each stand's inventory. This model uses strata-based data to represent the condition of the stands. Each district puts its stands into one of 105 strata (groups) that have similar stand characteristics. In the model all the stands in each stratum are represented by a single stand description that is the average of all measured stands within the strata. Approximately 33% of the stands in each strata were measured. Individual stand conditions can be made more accurate by measuring more stands and/or changing the strata-based inventory to a stand-based inventory. Improved stand inventory will allow the model to be used for more operational purposes.
  2. Refined stand structure definitions. Current stand structure definitions used by the model were created by modifying the definitions developed for the stand level inventory (SLI) with stand characteristics that can be used in the model. Not all of the SLI stand characteristics are able to be modeled; for example: estimates of down woody debris, snags and non-tree vegetation can not be projected into the future. Further, work remains to fully understand the variety of stand compositions within each stand structure type, i.e. the number of trees required of certain diameters to qualify for a layered classification.
  3. More accurate growth projection of the inventory. An updated inventory and the most appropriate growth model were used for this project. However, the growth functions in the growth model could be calibrated more specifically for each district when ODF's permanent plot inventory has its first remeasurement thereby improving model harvest predictions.
  4. Improved spatial data. Gathering and coordinating the spatial information, including: roads, streams, vegetation layers (inventory), land management classifications, harvest unit boundaries, threatened and endangered species data, etc. was a major challenge. Alignment between the data layers, consistency in data fields and continued data maintenance will improve model accuracy.
  5. Continued field and Salem staff involvement. The importance of involvement in this project by those who will be asked to implement model results is critical. This project made a major effort to involve the district staff in the creation of every aspect of the models from creation to reviewing the outputs. The challenge will be to maintain the district involvement in future model enhancements so the model continues to be an even more valuable tool for forest management planning.

     This project has confirmed Steven Covey's statement "The process is as important as the product" by facilitating field and Salem staff discussion on many topics.

# Summary of Findings

The following is a summary of the Findings from each section of the report, as noted.

## Level of Confidence

- District review of FMP~HCP solutions found the model was consistent with the FMP, HCP and applicable policies that could be modeled.
- Confidence in implementing short-term (10-year) harvest volume for the FMP~HCP alternative (using a 50% complex structure goal) on the ground is high.
- Long-term harvest volumes appear to be sustainable because the districts verified the first decade harvest volumes, future harvest volumes do not depart significantly from that level, and growth exceeds harvest levels.
- Flexibility in the mix of harvest acres (clearcut vs. thinning) is needed in order to implement the harvest volume and mitigate short-term operational issues.
- The districts have low confidence in the FMP~HCP and FMP~TA models' short-term (10-year) location-specific harvest unit decisions, largely due to the strata-based inventory. Note: The models were not intended to provide short-term operational solutions.
- Additional analysis is needed to fully understand the relationship between the FMP~HCP and FMP~TA alternatives for districts impacted by many owl circles.
- The districts feel the assumption in FMP~TA that new owls continue to occupy the same location for the rest of the model's 150-year timeframe may result in a greater long-term harvest volume reduction than assuming that owls move around on the landscape.

## Results: By Alternative – Forest Management Plan using HCP

## Complex Stand Structure-Volume Analysis: Three North Coast Districts Combined

- There is a trade-off between the achievement of harvest volume and the attainment of complex stand structure: higher targets for complex structure yield lower harvest volumes, and conversely, lower targets for complex structure can yield higher harvest volumes.
- With a 50% complex structure target, harvest volume increases from 177 mmbf/year in the first decade to 180 mmbf/year over 150 years.
- Standing inventory increases as complex structure goals increase due to less volume being harvested. With 50% complex structure, the standing inventory increases approximately 220% from 10 to 22 billion board feet over 150 years.
- Cash flow levels are closely correlated to harvest volumes; however, cash flow is negatively impacted during early periods due to road construction costs. Road construction is mostly completed within 5 periods (25 years). With 50% complex structure, cash flow increases from $44 million in the first decade to $58 million in 150 years.

# Summary of Findings (continued)

## Results: By Alternative – Forest Management Plan using HCP
## Volume Flow Analysis: Three North Coast Districts Combined

- The harvest volume of the baseline model run has been field verified as implementable over the first 10 years.
- The Volume Flow Analysis indicates that the total harvest volume in the first decade can be increased by 15% without falling below baseline levels; however, the districts have not verified if this approach can be implemented given the higher volume and clearcut acres above the baseline level.
- In the SNC zone, higher volume in the first 20 years (departure from baseline) depends upon substantially increased productivity in new plantations. While the districts are striving for greater productivity in these plantations, the level of volume increase is uncertain.
- In the high departure runs the clearcut acres are above the high-end of the range in current district Implementation Plans. Such a departure would necessitate a modification in the Implementation Plans.

## Results: By Alternative – Forest Management Plan using HCP
## Salmon Anchor Habitat Analysis: Three North Coast Districts Combined

- SAH strategies, applied for the first 10 years, result in less than a 0.5% decrease in harvest volume in the first decade, and less than a 0.1% decrease over 150 years.
- First decade Cash Flow from SAH strategies were slightly lower (no chart shown); total Cash Flow decreased by only 0.5% over 150 years. Model runs without SAH strategies had a similar harvest volume, but with lower costs.
- SAH strategies result in a slight decrease in NPV (approximately 1%).

# Summary of Findings (continued)

## Results: By Alternative – Forest Management Plan using HCP
## Landscape Design Analysis: Three North Coast Districts Combined

- From model results locating all or most of the complex structure inside the mapped DFC reduces the harvest volume; however because of the model's strata-based inventory, there is not good confidence in this analysis
- Achieving complex structure goals by locating all or most of the complex structure inside the mapped DFC took approximately 50 years longer than achieving 50% complex structure across the entire district.
- Some complex structure develops outside of the mapped DFC without setting any model goal to do so.
- Using the model to find alternatives to DFC/landscape design will be more useful in the future when the model has a good representation of the site-specific stand inventory and more refined stand structure definitions.
- Achieving and maintaining 50% complex structure results in complex patch sizes and frequencies that resemble the landscape design descriptions within the FMP.

## Results: By Alternative – Forest Management Plan using HCP
## Seven Districts Combined

- Harvest volume has a non-declining flow pattern, increasing about 6% in 150 years from 213 to 225 mmbf/year.
- Complex structure of 50% is achieved on all districts between 65 years in Forest Grove and 130 years in Tillamook District.
- Standing inventory doubles from 13 billion board feet to about 27 billion board feet in 150 years.
- Cash flow increases by about 40% from $50 million/year to about $70 million/year in 150 years.

# Summary of Findings (continued)

## Results: By Alternative – Forest Management Plan using TA
## Three North Coast Districts Combined

- The three north coast districts combined harvest volume was 213 mmbf/year in the first decade and declined to an average of 161 mmbf/year over 150 years. The decline was attributed to constraints associated with new owl circles and murrelet habitat that appeared using the Base Scenario of the take avoidance strategies.
- Complex structure reaches 50%, and then climbs higher as the "no harvest" acres in the new owl circles and murrelet areas continue to become more complex.
- Cash flow levels are closely correlated with harvest volume; however, cash flow is negatively impacted during the first five periods (25 years) due to road construction costs, especially in Tillamook.

## Results: By Alternative – Forest Management Plan using TA
## No-Complex Structure Goal Analysis: Three North Coast Districts Combined

- Compared with the Base Scenario with a 50% complex structure goal, higher harvest volume could be achieved in the first decade (9% per year) and over the long-term (9% over 150 years) when there was no complex structure target.
- Without specifically preventing complex structure, approximately 30% complex structure was achieved.
- Compared with the Base Scenario with a 50% complex structure goal, 22 fewer owl circles (28% fewer circles) and 5,513 fewer murrelet acres (45% fewer acres) were found when there was no complex structure goal on the landscape.

## Results: By Alternative – Forest Management Plan using TA
## Seven Districts Combined

- The harvest volume of all seven districts combined was 245 mmbf/year in the first decade and declined to an average of 193 mmbf/year over 150 years. The decline was attributed to constraints associated with new owl circles and murrelet habitat that appeared using the Base Scenario of the take avoidance strategies.
- Cash flow declined almost 30% in 30 years. The decline was more rapid than the volume decline because road construction costs were greatest in the first 30 years.

# Summary of Findings (continued)

## Results: By Alternative – Wood Emphasis
## Three North Coast Districts Combined

- The goal of maintaining an average clearcut harvest age of 50 results in a first decade harvest volume of 351 mmbf/year as existing older stands are harvested with an average harvest volume of 246 mmbf/year over 150 years.
- Complex structure levels range between 2% and 12%
- Existing standing inventory is reduced by 40%, from 10 billion board feet to 6 in the first 30 years, from the harvest of older stands and is maintained thereafter at approximately 8 billion board feet.
- Cash flow levels are closely correlated with harvest volume; however, cash flow is negatively impacted during the first five decades due to road construction costs, especially in Tillamook.

## Results: By Alternative – Reserve-Based
## Three North Coast Districts Combined

- Harvest volume over 150 years averages 106 mmbf/year and is derived from more thinning acres than clearcut acres in almost a 2:1 ratio.
- In 150 years the north coast districts develop about 60% complex structure, including the structure inside and outside the reserves.
- Nearly 90% of the reserves becomes complex structure in 150 years, but develops more slowly than in the actively managed landscape.
- The reserves become largely OFS, while the complex structure outside reserves is more of a balanced mix of OFS and LYR stands.
- Cash flow levels are closely correlated with harvest volume; however, cash flow is negatively impacted during the first five decades due to road construction costs, especially in Tillamook.

# Summary of Findings (continued)

## Results: Comparison of Alternatives
## Three North Coast Districts Combined

- Compared with FMP~HCP, FMP~TA produces 20% more harvest volume in the first decade, and continues to produce more volume for the first 30 years, because fewer acres are protected for northern spotted owls and marbled murrelets. But FMP~TA produces more than 10% less volume over 150 years because of the additional owl and murrelet habitat found with the take avoidance strategies.
- Wood Emphasis produces twice the amount of volume than FMP~HCP in the first decade and almost 40% more volume in 150 years because of the goal for 50-year harvest rotation, no goal for complex structure, and fewer acres in owl protection and riparian buffers. It develops about 10% complex structure compared with 50% for FMP~HCP because there is an emphasis on a 50-year rotation age.
- Reserve-Based produces about 40% less harvest volume than FMP~HCP because of the acres dedicated to reserves. In 150 years Reserve-Based develops 60% complex structure compared with 50% in FMP~HCP.
- FMP~HCP develops complex structure more quickly than FMP~TA or Reserve-Based because more acres are actively managed.
- The ratio of acres clearcut to acres thinned in all 150 years is similar in the FMP~HCP and Reserve-Based alternatives, each having about 37% of harvest acres being clearcut; FMP~TA alternative has 45%; and Wood Emphasis has 86% of the harvested acres being clearcut (see Appendix G, Table 3).
- Although standing inventory for FMP~TA is not shown, it would likely result in an inventory greater than FMP~HCP because of the reduced harvesting as new owls and murrelets are found.
- Wood Emphasis standing inventory declines by 20% over 150 years due to the goal of harvesting stands older than age 50. In 150 years the standing inventory is approximately 40% lower than FMP~HCP.
- Reserve-Based standing inventory triples in 150 years and is nearly 40% higher than FMP~HCP in 150 years because of the acres in reserves.
- Cash flow levels in all alternatives are closely correlated with harvest volume; however, cash flow is negatively impacted during the first 5 periods (25 years) due to road construction costs, especially in Tillamook.
- NPV is 230% higher for Wood Emphasis than FMP~HCP, Reserve-Based is 40% of FMP~HCP; and FMP~TA is 16% higher than FMP~HCP. FMP~TA is 16% higher than FMP~HCP due to the higher volume harvested in the first 30 years.
- The FMP~HCP, FMP~TA, and Reserve-Based alternatives produce similar amounts of habitat for 90% of the 37 species analyzed.
- For generalist species, any of the alternatives produce an adequate amount of habitat.
- Species favoring OFS have more habitat acres in the Reserve-Based alternative.

# Summary of Findings (continued)

## Results: Comparison of Alternatives
## Three North Coast Districts Combined (continued)

- In the Wood Emphasis alternative, species favoring REG and CSC types have more habitat; species favoring complex structure have less habitat.
- Due to many unknowns, these results are not precise; they are coarse estimates of potential habitats and the species that use them.

## Results: Comparison of Alternatives
## Seven Districts

- Across all seven districts, FMP~TA produces more harvest volume (15%) in the first decade, and remained higher for the first 30 years, because fewer acres are impacted from northern spotted owls and marbled murrelets. But FMP~TA produces less volume (14%) over 150 years because of the additional owl and murrelet habitat appeared over time using the Base Scenario.
- The impact on harvest volume of FMP~HCP versus FMP~TA is not the same on all districts. The four southern districts had a reduction in harvest volume of 3 mmbf/year in the first decade using take avoidance strategies, and the three north coast districts had an increase of 36 mmbf/year.
- Both FMP~HCP and FMP~TA achieve 50% complex structure, but FMP~TA will overachieve 50% in the long-term because 40% of each new owl circle has no harvesting and will develop into complex structure.
- FMP~HCP develops complex structure at an accelerated rate due to more acres being actively managed.
- Cash flow has a similar relationship between FMP~HCP and FMP~TA as harvest volume; however, cash flow is negatively impacted during the first 5 decades due to road construction costs, especially in Tillamook.
- NPV for FMP~TA is higher (12% higher) than FMP~HCP because of the higher cash flow in the first 25 years.
- When comparing FMP~HCP and FMP~TA for all seven districts, acres of habitat for each species appear to be similar for 90% of the species analyzed.
- Model results show an apparent difference in the amount of habitat for the four OFS-based species. These differences may be overestimated, due to the inability of predicting the future distribution of structural components (i.e., snags) across the landscape – in all stand types – and the uncertainty of complex structure development for the FMP~TA model.

# Appendix A
# Project Plan: Goals, Objectives & Expectations

*Oregon Department of Forestry*

## Creating a New Harvest & Habitat Model
## Project Plan

April 24, 2003 (Updated: 4/12/04; Introduction Reformatted for Final Report 1/16/06)

The Board of Forestry approved the *Northwest Oregon Forest Management Plan* in January of 2001. In March of 2003, the State Forester approved District Implementation Plans (IPs). A condition of approving the IPs was a Work Plan which included the creation of a new harvest model (see the attached *"Work Plan to Address Harvest Schedule Modeling and Sustainable Harvest Levels in the District Implementation Plans"*).[1]

The below Project Plan, in the context of achieving the Greatest Permanent Value through the implementation of the Forest Management Plan, captures the goals and objectives of creating a new Harvest & Habitat Model, key expectations, an organizational structure for this project, updated project timelines, possible budget items, and identifies key communication links with internal and external stakeholders.

[1] The *Northwest Oregon Forest Management Plan* and *District Implementation Plans* also provide management direction for Common School Forest Lands in the project area. These plans are acknowledged as being consistent with the agreement established between the State Forester and the State Land Board (consistent with the State Land Board's asset management plan and Admission Act trust obligations).

**Project Goals, Objectives, and Expectations**

- Goals and Objectives
  - Develop a process for determining optimum timber harvest and habitat outputs, consistent with the goals of the Forest Management Plan, based on a model that reflects (as closely as possible) current and future forest conditions and activities, and a review by the on-the-ground managers of the real-life opportunities and constraints.
  - Create a model which will…
    - Use the Forest Management Plan (FMP) as the foundation for creating a timber harvest and habitat model and related outputs.
    - Provide timber harvest scheduling outputs that can be confidently and systematically "ground-truthed" to arrive at revised harvest levels for

the following District Implementation Plans (IPs): Tillamook, Astoria, Forest Grove, West Oregon, Cascade, West Lane, and Southwest Oregon.

- Identify possible opportunities and constraints for modifying harvest levels identified with the IPs.
- Describe the achievement of various stand types/stand attributes over time in a manner that can be used to evaluate the quality and quantity of wildlife habitats over time and across the landscape.
- Provide opportunities for evaluating various Landscape Design strategies over time (i.e., arrangement of Desired Future Condition stand types).
- Utilize inputs that reflect the best information we currently have.
- Provide an analytical tool for evaluating various HCP strategies.

- Key Expectations
  - The intent is for the Harvest & Habitat Model to be a tool to help ODF improve the implementation of the FMP by exploring options to determine optimal timber harvest and habitat outputs, consistent with the goals of the FMP.
  - Field and staff will be actively involved in the process, which will provide an opportunity to talk about various technical choices, management options, and information about implementing the FMP.
  - There will be strong involvement from field personnel in the development of model inputs to ensure understanding, acceptance, and support of the model outputs.
  - To the greatest extent possible, the model will incorporate on-the-ground implementation strategies and opportunities, as well as real-life operability constraints.
  - This will be an iterative process between the model, its inputs, outputs, and review by field and staff personnel.
  - The model's first decade "solution" will be reviewed by the on-the-ground managers to verify opportunities and constraints, then the model will be re-run to test long-term consequences of revisions made by field managers.
  - Harvest objectives will be established for each district and outputs will be reported by district and by county.
  - This project will be completed by the spring of 2005. It is understood that updated Stand Level Inventory information and Growth and Yield Tables are critical for having accurate model outputs. It will be necessary to re-run the model incorporating new information as it becomes available.

# Appendix B
# The Model: Its Use and Construction

### Model Structure

The structure of the harvest scheduling model is classified as Model II (Johnson and Scheurman 1977). That is, stands that are harvested can switch prescriptions at regeneration time, and that the length of the rotation can also vary from rotation to rotation. Since the decision variables are integers, the resulting problem is a large integer programming problem. The Tillamook district has the largest model consisting of about 150,000 parcels or 1.35 million integer decision variables.

### Solution Procedure

To solve this problem, simulated annealing (Kirkpatrick et al. 1983), one of a family of well known modern heuristics to solve combinatorial optimization problems, is used (Reeves 1993, Glover and Kochenberger 2003). Simulated annealing is a stochastic, neighborhood search technique that builds up a solution incrementally by randomly selecting harvest units, prescriptions, and regeneration times for the parcels within the harvest unit. The algorithm includes rules to escape from local minima. The first application of simulated annealing to spatial harvest scheduling appears to have been done by Lockwood and Moore (1993). Since that time, simulated annealing has been applied to a number of harvest scheduling problems (Nelson and Liu 1994, Murray and Church 1995, Ohman and Eriksson 1998, Boston and Bettinger 1999, Van Deusen 1999, and Sessions et al. 2000).

In this application, the multiple goals are expressed as a goal programming problem objective function structure. Goal programming objective functions have been found useful in multi-criteria problems where feasible solutions may not exist in the sense of being able to meet all constraints. In order to evaluate the contribution to net present value, harvest and road costs are calculated based on the vegetation condition and spatial location of the harvest unit and its position on the transportation tree similar to the procedure used by Murray and Church (1995). Roads are constructed or reconstructed as necessary to support the harvest scheduling choices. For each move, spatial feasibility, i.e., clearcut size is checked before evaluation of the objective function. If a move survives the spatial feasibility test, its contribution to the objective function is calculated.

Solution time depends upon the number of polygons, but a "good" solution can be achieved within one hour on a 3.4 gigahertz computer with 1 gigabyte of RAM. Usually a number of runs must be made in order to fine tune the penalty functions being used in the goal programming objective function. Since the simulated annealing heuristic is stochastic, i.e., random numbers are used during the search process, multiple runs are made to identify dominant solutions for a given set of goals and goal multipliers.

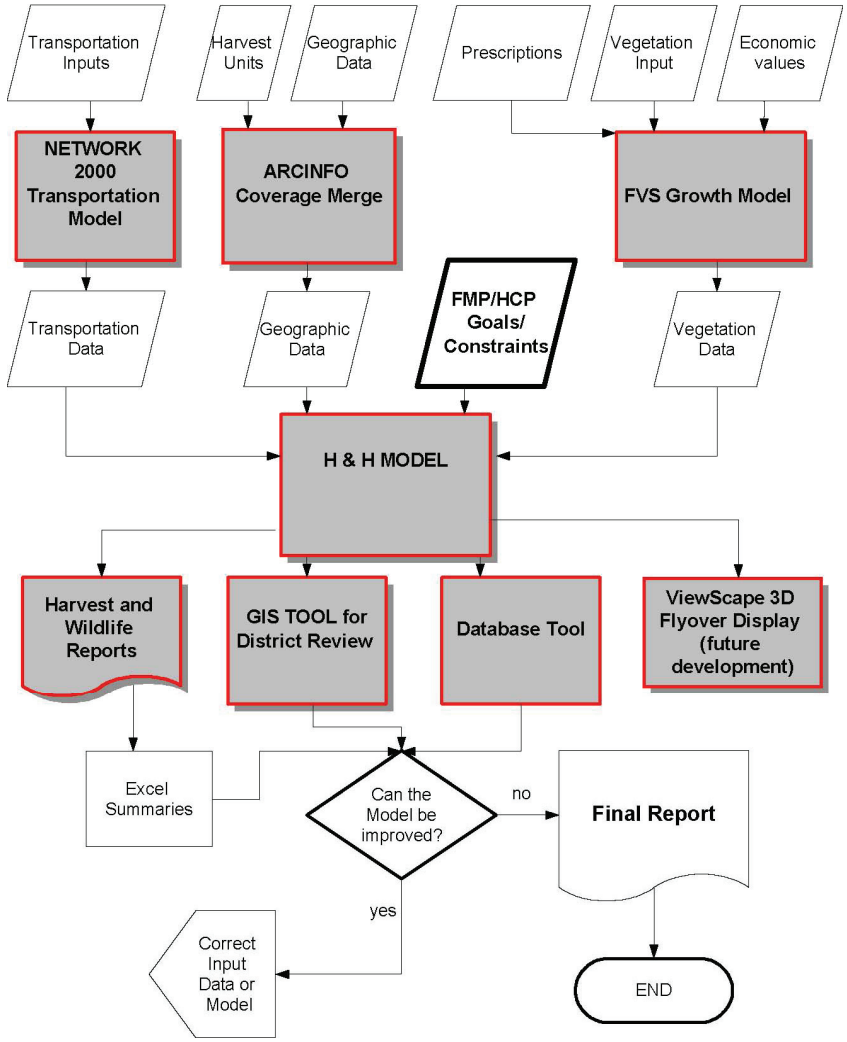
See the next page for a brief description of this project and a System Design chart that illustrates the project's complexity.

## A Complex Project

The H&H Project can be described as a complex process to gather and create data inputs, identify and quantify model rules (constraints), and integrate model goals within a spatial forest harvest scheduling model that includes field verification of the results. Below is a system design chart that identifies the types of inputs and processes that were used to create the final report.

Network 2000, ArcInfo, and FVS growth model are 3 of the prominent software products that assisted in the processing of data to create model inputs. The H&H model produces reports that summarize the harvest plan for reporting purposes and creates files for the GIS tool for the district feasibility/operability review and files that summarize acres of habitat for a variety of wildlife species. There are plans to produce a 3-dimensional fly-over display in a sample of the planning area.

**Harvest and Habitat Model System Design Chart**



# Appendix C
# Stand Structure Classifications

**Stand Structure Classifications in the H&H Model**

Stand structure in the H&H model is classified from stand characteristics that are derived from growing an initial stand table for 30 five-year intervals using the Forest Vegetation Simulator (FVS) growth model (USDA Forest Service). The H&H structure definition is based on the stand level inventory (SLI) algorithm; however, some of the SLI criteria could not be grown forward in a growth model; i.e. snags, downed wood, and shrub/herbs/grass. Therefore, modifications to the SLI algorithm were made for the H&H model. The model's initial stand structure distribution varies from the districts' Implementation Plans because of the strata-based representation of the ODF inventory.

The H&H structure classification system was developed by a team of ODF professionals and a county representative from Mason, Bruce, and Girard, Inc. To create criteria that best simulated observed forest structure development, the team used SLI stands and management prescriptions used in the H&H model. The trees per acre (TPA) and diameter breast height (DBH) criteria from the SLI algorithm were used; stand density index (SDI) was used in place of SLI's relative density (RD) criteria. Age was added to the H&H criteria to classify regeneration structure. The diameter diversity index (DDI) criteria required more modification than the other stand characteristics. The DDI value from SLI was reduced from 6.5 for several reasons: 1. the H&H model did not have values for snags, downed wood, and shrub/herbs/grass criteria, 2. each thinned stand did not have a stand-specific prescription but used generalized prescriptions making it more difficult to prescribe the right number of trees in each of the four DDI diameter classes, 3. the DDI criteria that applied to stands before the first thinning was calibrated by the districts so that initial stand structure classifications would more closely reflect current structure amounts.

The H&H model structure definition used the following stand characteristics:

- Age
- DBH
- TPA
- SDI
- DDI

The H&H stand structure classification criteria are:

- REG: Age < 15
- CSC: Age >= 15; SDI > 55; not OFS or LYR
- UDS: Age >= 15; SDI <= 55; not OFS or LYR
- LYR: Age >= 15; >= 30 TPA >= 18" DBH;
- OFS: Age >= 15; >= 30 TPA >= 18" DBH; >= 8 TPA >= 32" DBH;
- Before the first thinning the DDI for LYR or OFS is listed below for each district.
  - FG is 6.5
  - AT is 6.0
  - TL is 6.2
  - WO is 6.27
  - WL is 6.18
  - NC is 6.1
  - SW is 6.0
- After the first thinning the DDI for LYR or OFS is 5.0.

# Stand Structure Classifications (continued)

**Stand Structure Classification in SLI**

Stand structure type definitions in the FMP (FMP Appendix C pp. 2-15) have been translated into criteria for use in the ODF SLI system that are referred to as the SLI structure algorithm. The criteria are used to classify the stand structure of newly inventoried stands.

The SLI structure classification criteria include the following stand characteristics:

- DBH
- tree height
- TPA
- RD
- DDI
- snags
- downed wood
- shrub/herbs/grass/trees <= 15'
- shrub/herb/grass - number of species

| Structural Component | OFS | LYR | UDS | CSC | REG |
|---|---|---|---|---|---|
| Tree DBH | >= 8 TPA, 32"+ DBH; and (>= 30 TPA that are 18"+ DBH, **or** Stand 5.6"+ QMD >= 18" DBH) | >= 30 TPA that are 18"+ DBH, **or** Stand 5.6"+ QMD >= 18" DBH | | | < 8" DBH of all trees. |
| Tree Height | 18"+ DBH trees are >= 100' tall | 18"+ DBH trees are >= 100' tall | 30 TPA are >= 40' Tall | | |
| Trees per acre | | | | | >= 50 |
| RD (trees >= 2" DBH) | >= 25 | >= 25 | >= 15 | >= 25 | <=35 |
| Layered[6] | Diameter Diversity Index >= 6.5 | Diameter Diversity Index >= 6.5 | | | |
| Snags | >= 2 snags, 24"+ DBH and >= 4 snags, 12"+ DBH | | | | |
| Downed Wood | 600 $ft^3$ in Decay Classes 1 & 2 **or** 3000 $ft^3$ in Decay Classes 1 - 5 | | | | |
| SHGT[3] Amount | | | >= 40% coverage | | |
| SHG[3] Species | | | >= 2 species | | |

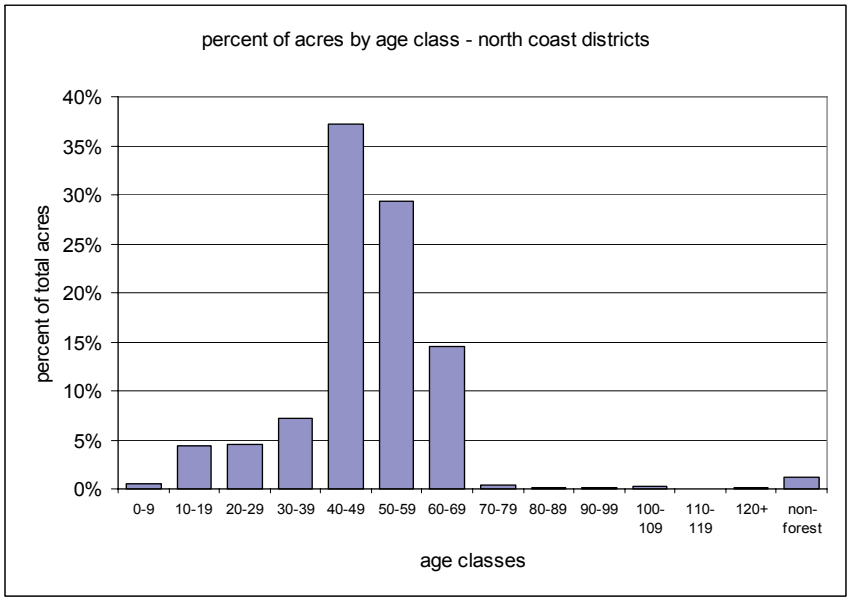
# Stand Structure Classifications (continued)

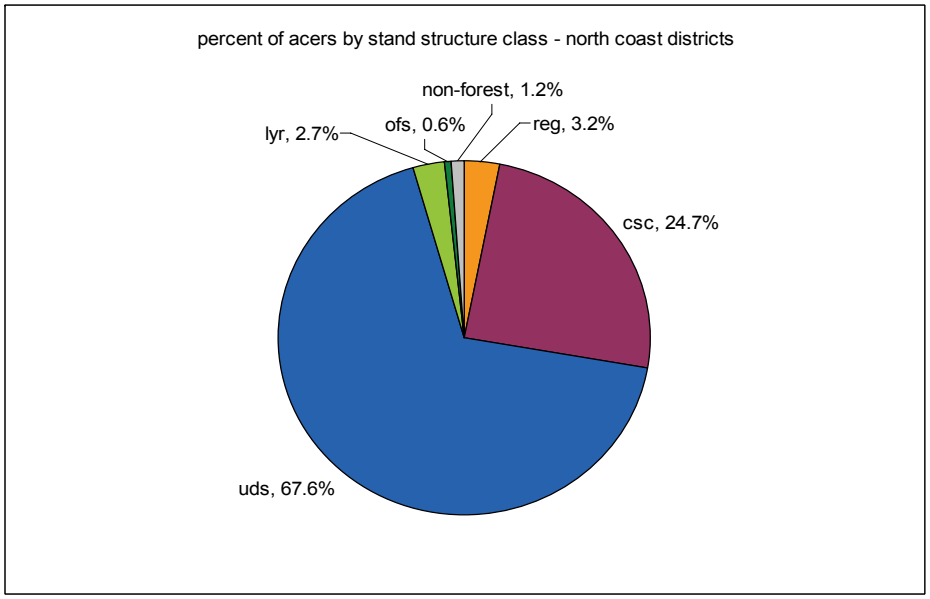
1. Cross-hatched cells in the table above indicate that the structural component is not required or specified for the structure category.
2. The classification process for a stand begins by checking to see if the stand meets all of the criteria for OFS. If so, then the stand is assigned to OFS and the process ends. If not, then the stand is checked to see if it meets all of the criteria for LYR and so on until a category is found for which the stand meets all of the criteria. The process then stops and assigns the stand to that category.
3. SHG means shrubs, herbs, and grasses. SHGT means all shrubs, herbs, and grasses, and trees that are <= 15' high.
4. Stands with less than 10 TPA are classified as NON (non-forest).
5. Stands that do not meet all of the criteria of any of the categories (including non-forest) are classified as UNK (unknown). These stands should be reviewed and assigned a structure category based on "best fit" with the categories described in the Northwest Forest Management Plan.
6. Diameter Diversity Index (DDI) was developed by Tom Spies to describe the relative similarity of a given stand to an old growth stand in terms of the number of trees per acre in each of 4 diameter classes. Stands can range from a DDI of almost 0 up to a maximum of 10. A stand with a "10" would have the same number of trees per acre (or more) than the average old growth stand in each of the 4 diameter classes. Spies found that old growth stands have DDIs ranging from 7.5 to 10. Based on observations of stands in North Cascade and Astoria districts, a DDI of 6.5 was selected as the threshold for computer-classifying a stand as having multiple canopy layers.

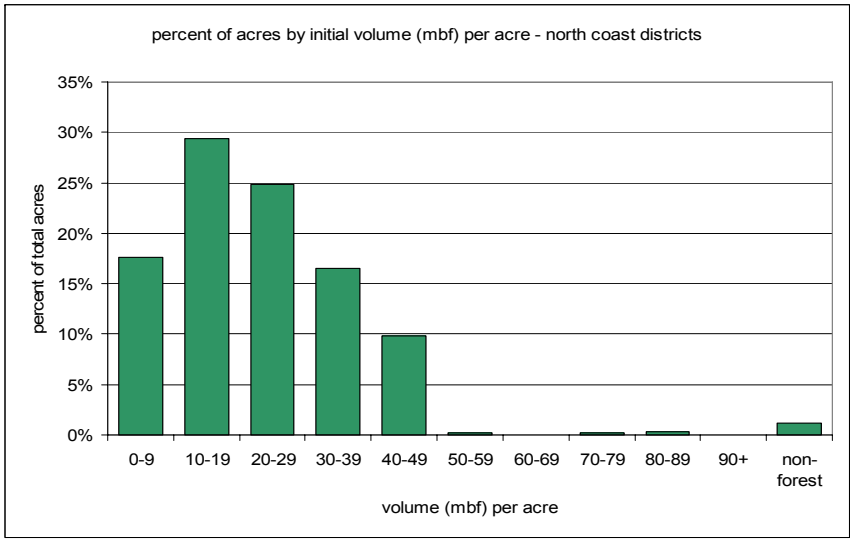
*This page left intentially blank*

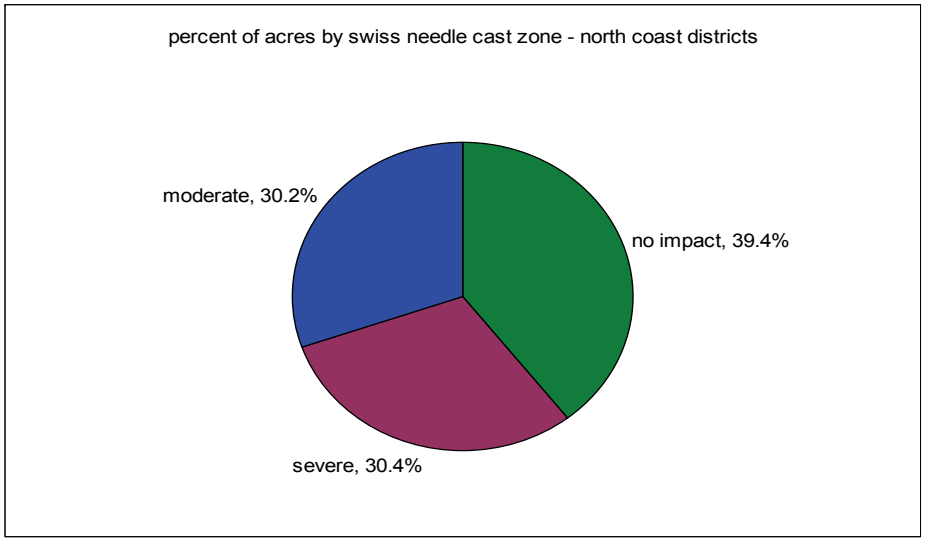
# Appendix D

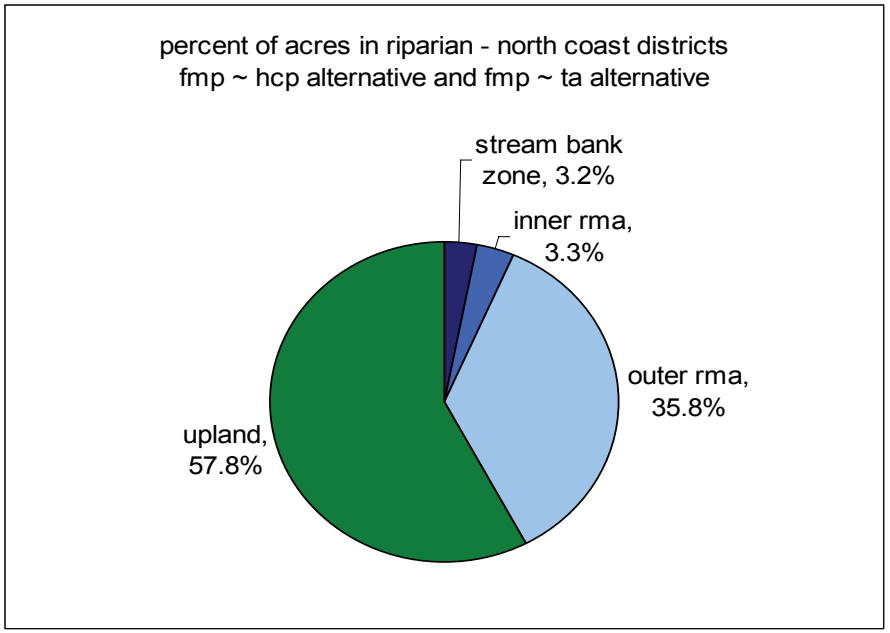
## Current Forest Condition: North Coast Districts (Astoria, Tillamook, and Forest Grove)

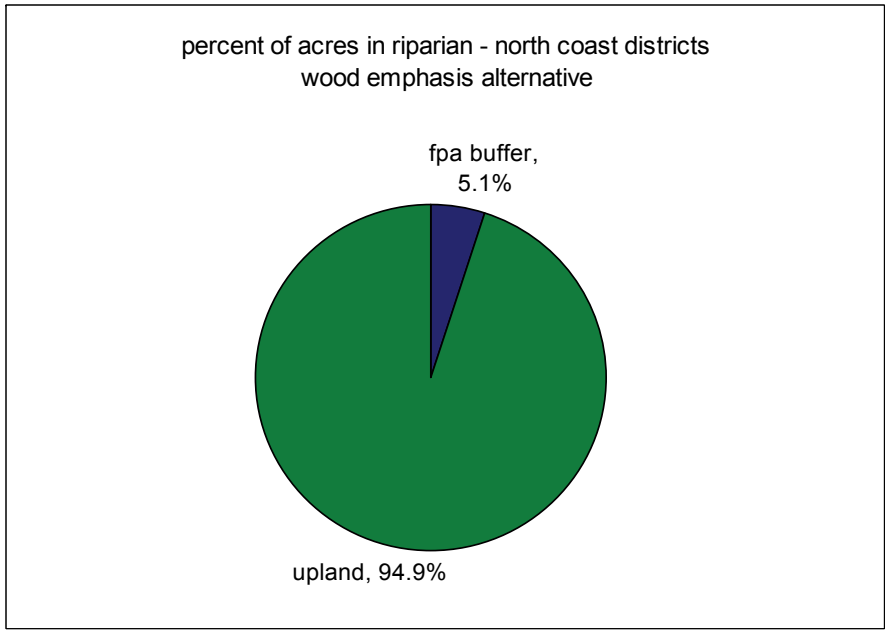


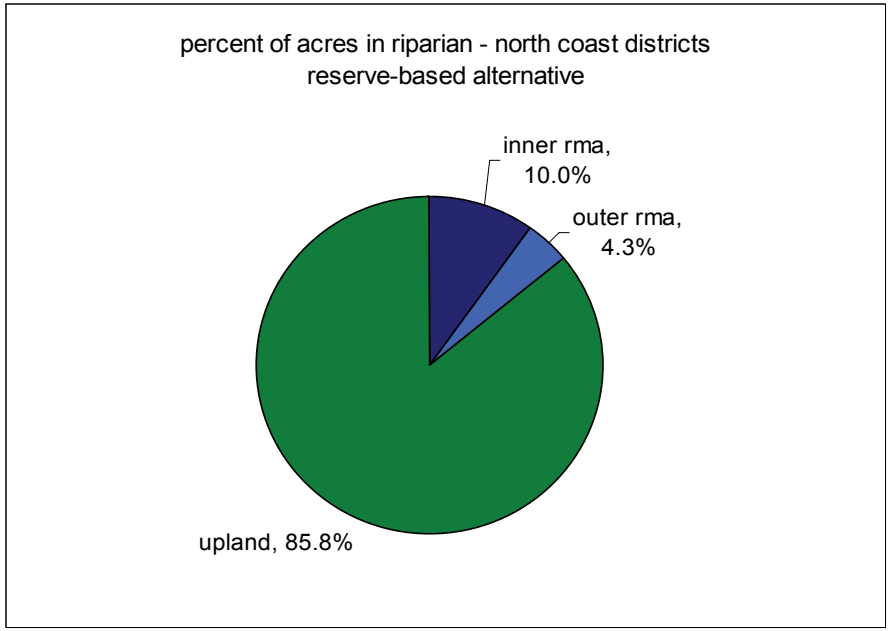



| FMP ~ HCP or TA | AT Acres | FG Acres | TL Acres | Totals | Percent |
|---|---|---|---|---|---|
| Stream Bank Zone | 3,074 | 3,424 | 9,479 | 15,976 | 3.2% |
| Inner RMA | 4,168 | 5,295 | 6,983 | 16,447 | 3.3% |
| Outer RMA | 42,979 | 28,722 | 107,990 | 179,691 | 35.8% |
| Upland | 86,707 | 77,503 | 126,200 | 290,410 | 57.8% |
| Totals | 136,928 | 114,944 | 250,652 | 502,524 | 100% |

| Wood Emphasis | AT Acres | FG Acres | TL Acres | Totals | Percent |
|---|---|---|---|---|---|
| FPA Buffer | 5,876 | 7,041 | 12,578 | 25,495 | 5.1% |
| Upland | 131,052 | 107,903 | 238,074 | 477,029 | 94.9% |
| Totals | 136,928 | 114,944 | 250,652 | 502,524 | 100% |

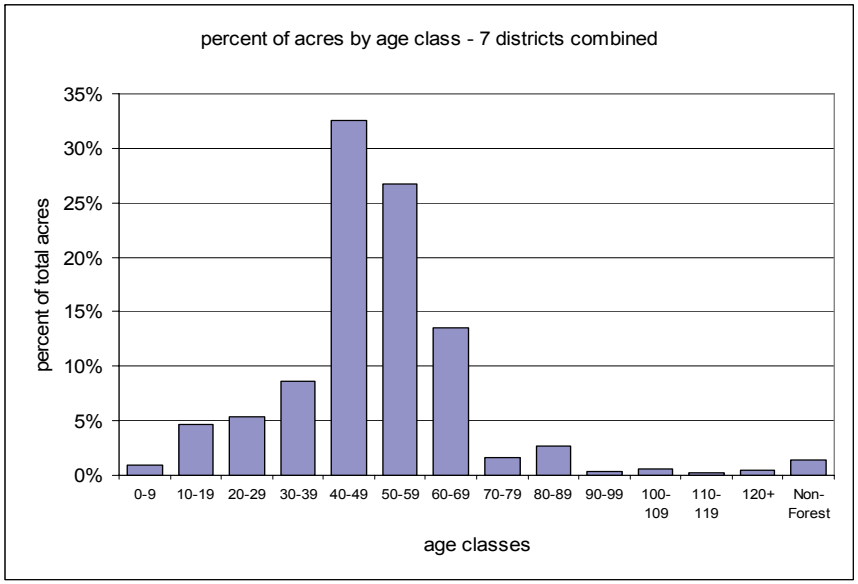
| Reserve-Based | AT Acres | FG Acres | TL Acres | Totals | Percent |
|---|---|---|---|---|---|
| Inner RMA | 13,179 | 12,688 | 24,140 | 50,007 | 10.0% |
| Outer RMA | 5,094 | 6,120 | 10,305 | 21,519 | 4.3% |
| Upland | 118,656 | 96,136 | 216,207 | 430,999 | 85.8% |
| Totals | 136,928 | 114,944 | 250,652 | 502,524 | 100% |

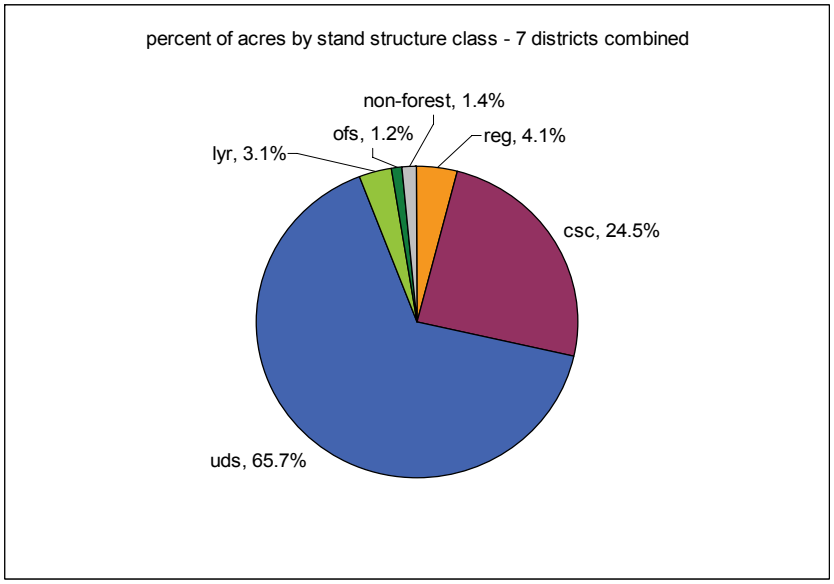


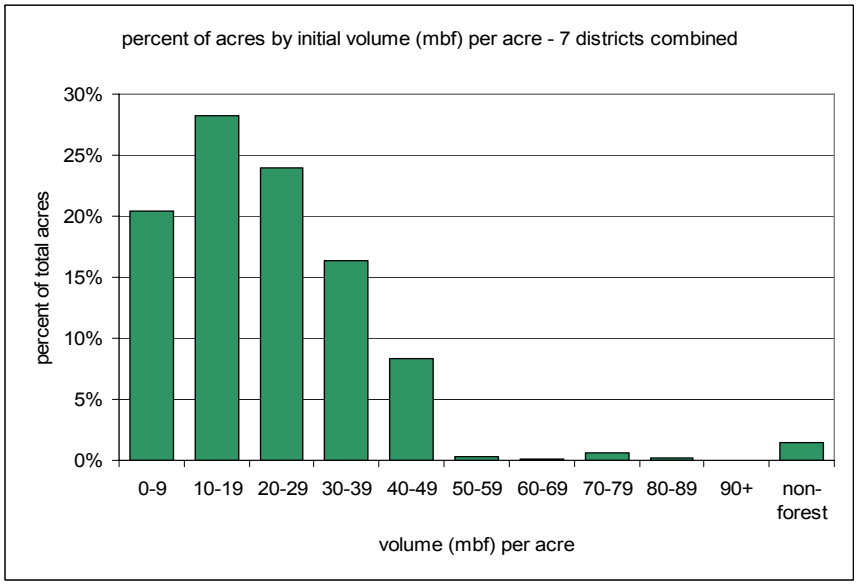

Initial Inventory Volume (MMBF)

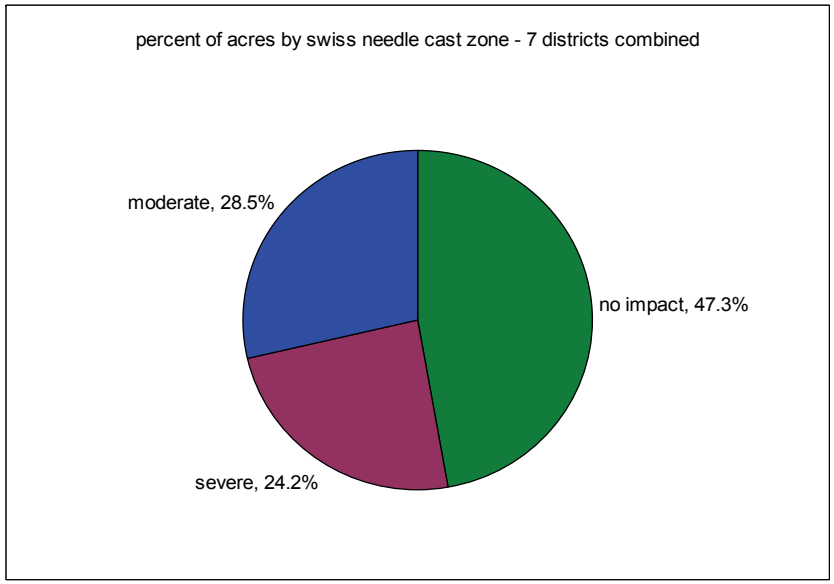
| | AT | FG | TL | Total |
|---|---|---|---|---|
| MMBF | 3,080 | 2,995 | 4,776 | 10,850 |

# Current Forest Condition: All 7 Districts

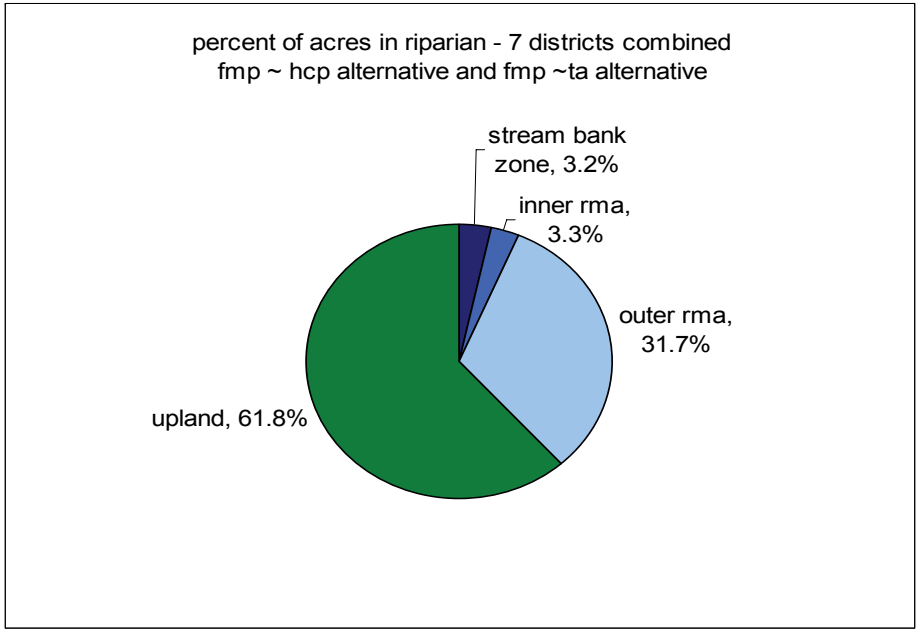


# Current Forest Condition: All 7 Districts (continued)

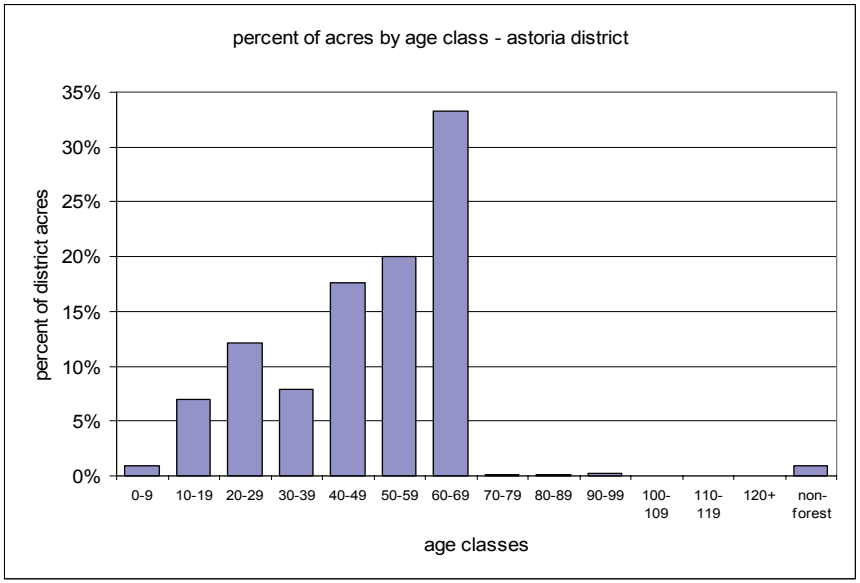


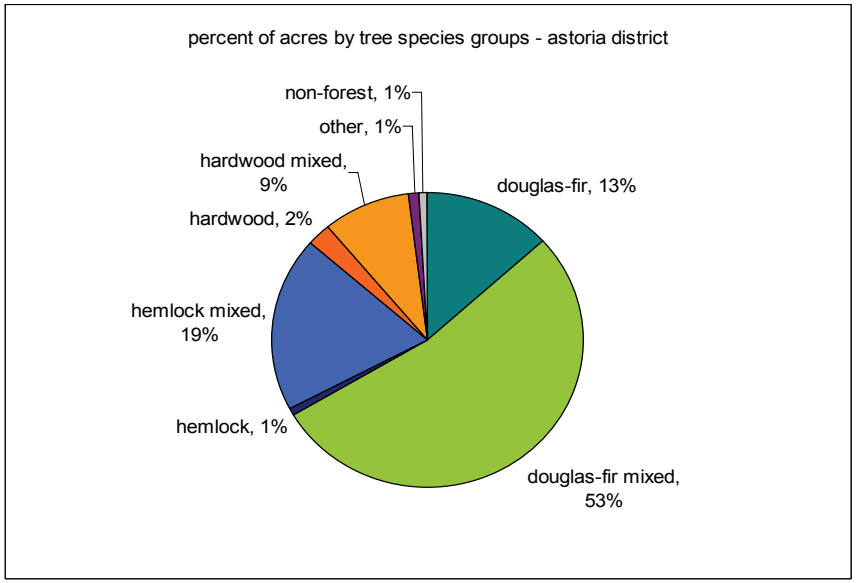

| FMP ~ HCP or TA | AT Acres | FG Acres | TL Acres | NC Acres | SW Acres | WL Acres | WO Acres | Totals | Percent |
|---|---|---|---|---|---|---|---|---|---|
| Stream Bank Zone | 3,074 | 3,424 | 9,479 | 1,722 | 473 | 1,149 | 1,001 | 20,321 | 3.2% |
| Inner RMA | 4,168 | 5,295 | 6,983 | 1,783 | 248 | 622 | 1,596 | 20,696 | 3.3% |
| Outer RMA | 42,979 | 28,722 | 107,990 | 6,687 | 3,780 | 2,701 | 7,669 | 200,528 | 31.7% |
| Upland | 86,707 | 77,503 | 126,200 | 37,531 | 13,711 | 21,487 | 27,386 | 390,526 | 61.8% |
| Totals | 136,928 | 114,944 | 250,652 | 47,723 | 18,212 | 25,959 | 37,652 | 632,070 | 100% |

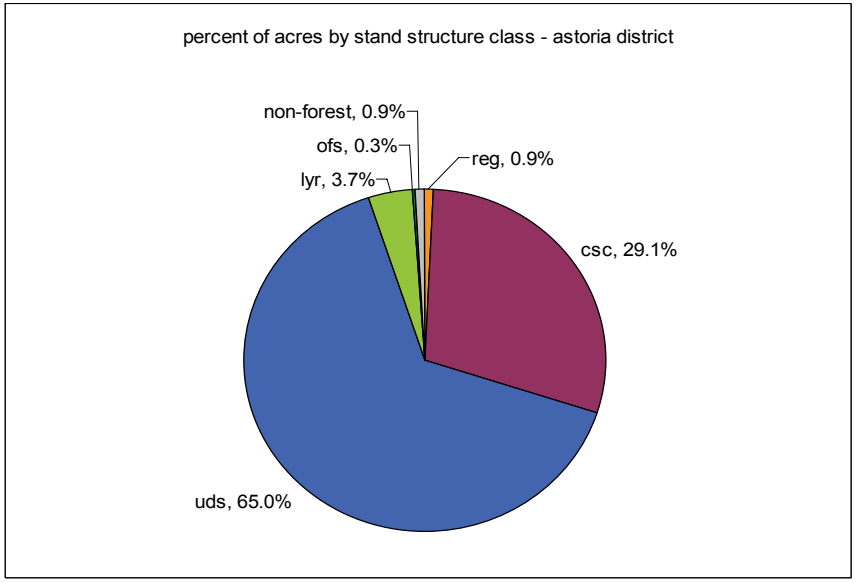
Initial Inventory Volume(MMBF)

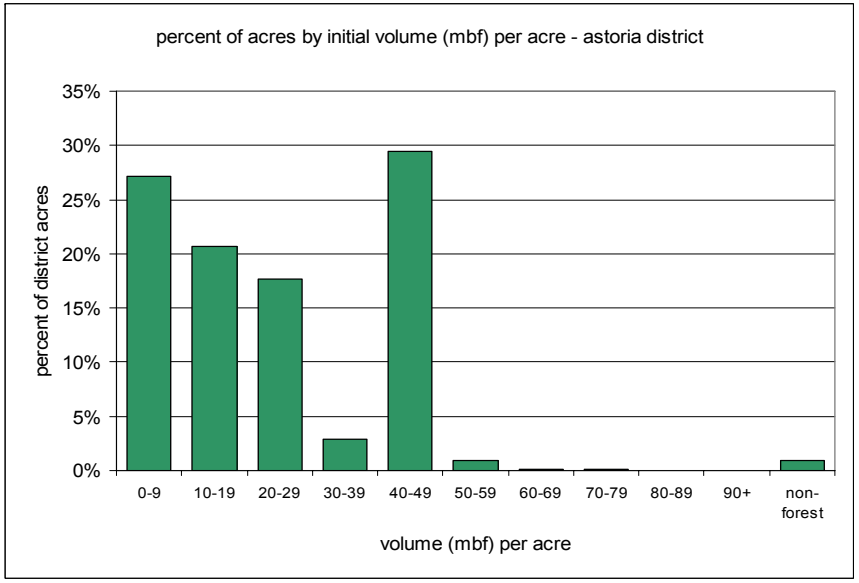
| | AT | FG | TL | NC | SW | WL | WO | Total |
|---|---|---|---|---|---|---|---|---|
| MMBF | 3,080 | 2,995 | 4,776 | 1,007 | 254 | 536 | 628 | 13,274 |

# Current Forest Condition: Astoria District

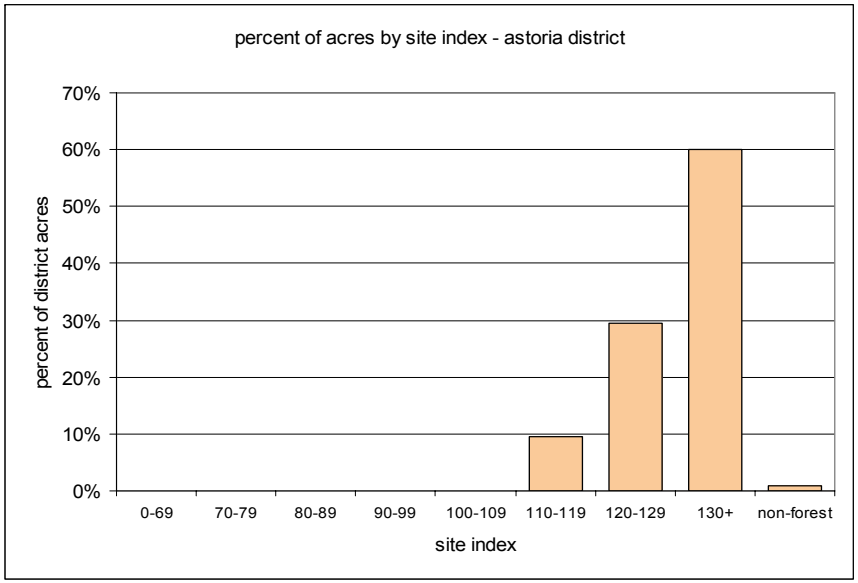


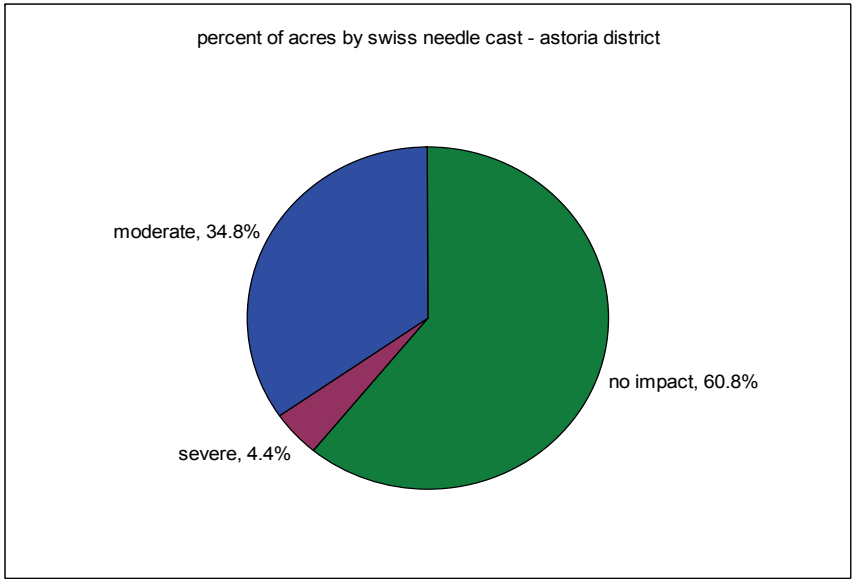



# Current Forest Condition: Astoria District (continued)



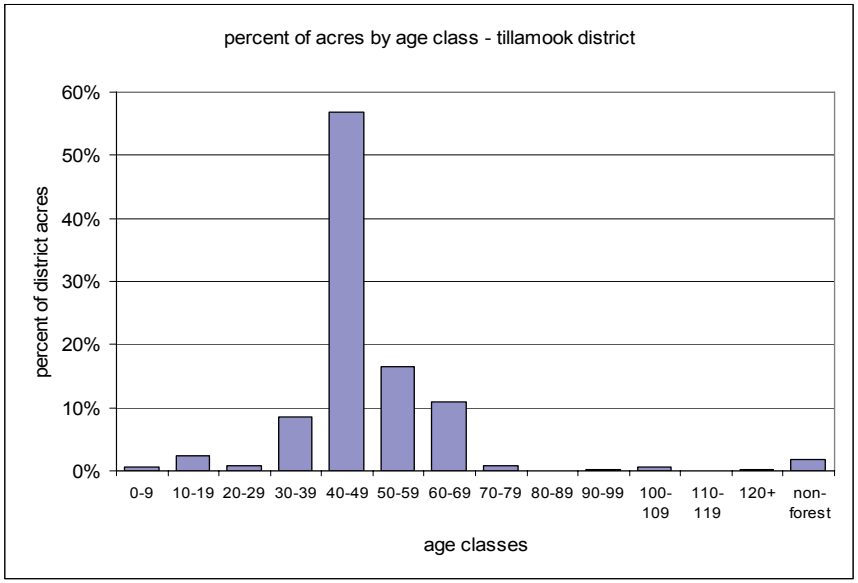

| Harvest Availability Class - FMP ~ HCP and FMP ~ TA Alternatives | Acres | Percent of District Acres |
|---|---|---|
| Road right-of-way | 3,704 | 2.7% |
| Administratively removed | 784 | 0.6% |
| Non-loggable | 2,623 | 1.9% |
| Deed restrictions | 0 | 0.0% |
| Old-growth designated | 0 | 0.0% |
| FPA critical wildlife species site | 176 | 0.1% |
| No-Harvest, Riparian | 5,294 | 3.9% |
| Non-Harvestable Subtotal (includes overlap) | 12,581 | 9.2% |
| | | |
| Harvestable | 124,928 | 91.2% |
| Non-Harvestable (no overlap) | 12,000 | 8.8% |
| Total | 136,928 | 100% |

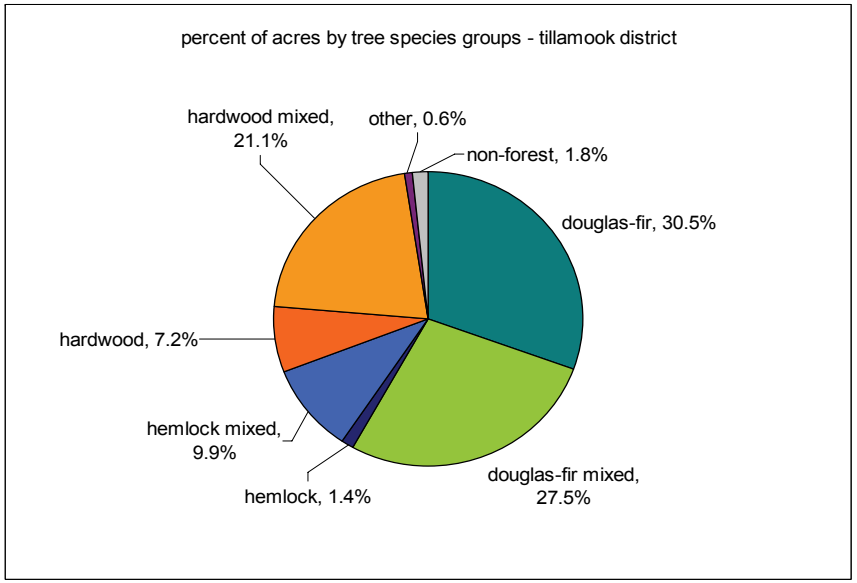
| Fund | Acres | Percent of District Acres |
|---|---|---|
| 51 | 134,866 | 98.5% |
| 52 | 1,968 | 1.4% |
| 54 | 94 | 0.1% |
| Total | 136,928 | 100% |

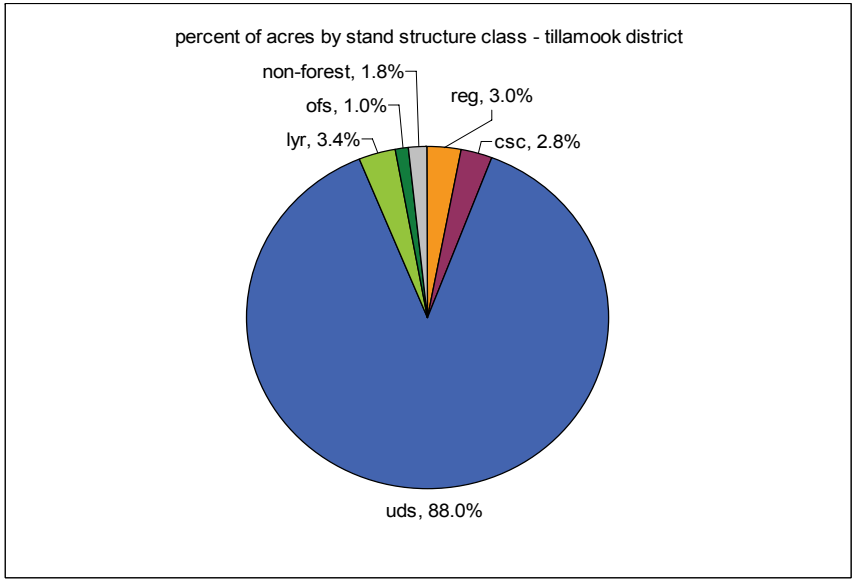
| County | Acres | Percent of District Acres |
|---|---|---|
| Clatsop | 135,744 | 99.2% |
| Columbia | 23 | 0.0% |
| Tillamook | 1,161 | 0.8% |
| Total | 136,928 | 100% |

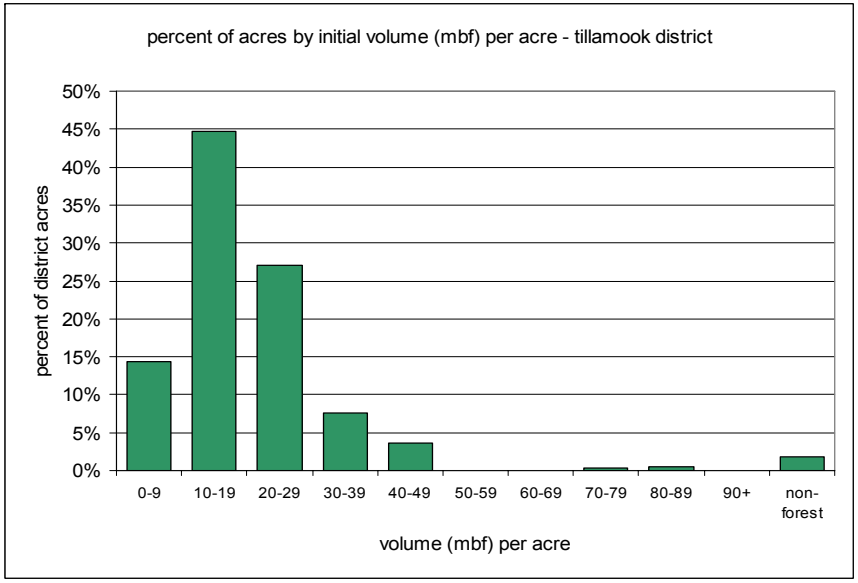
| Initial Inventory Volume (MMBF) |
|---|
| 3,080 |

# Current Forest Condition: Tillamook District

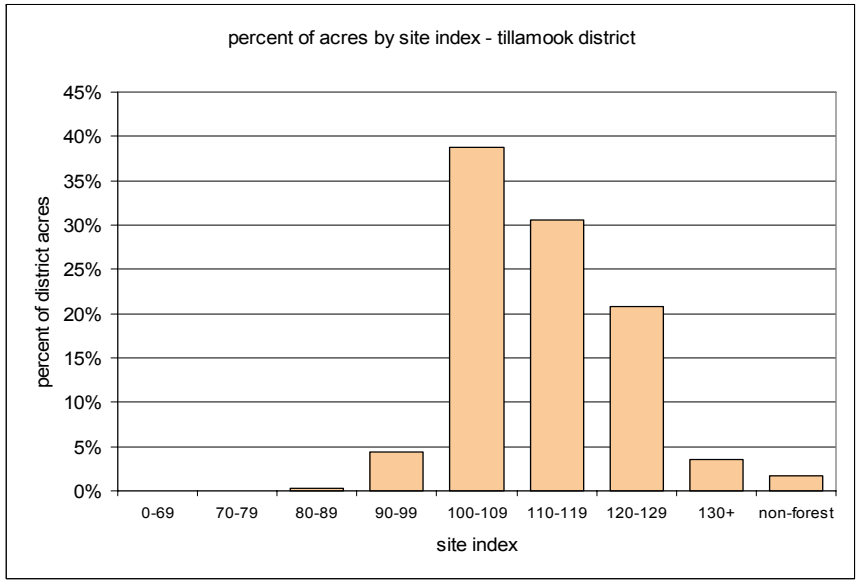


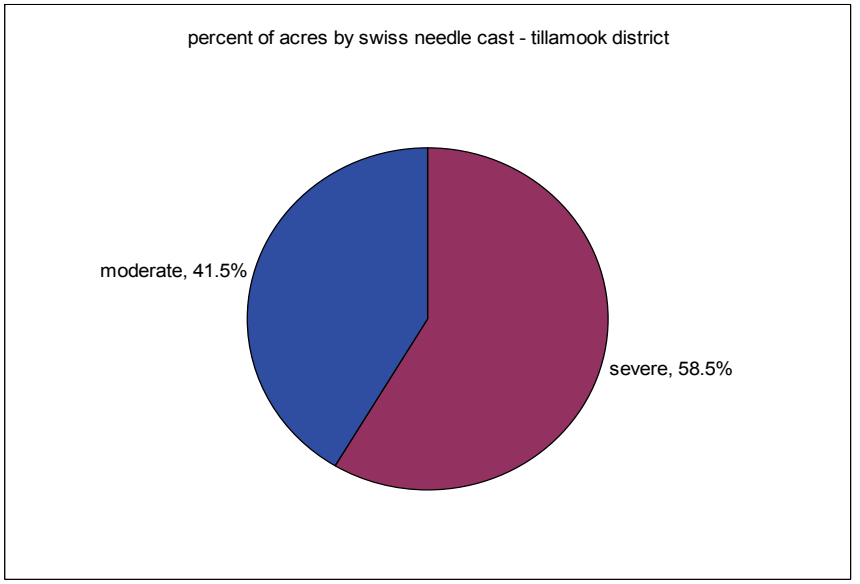



# Current Forest Condition: Tillamook District (continued)



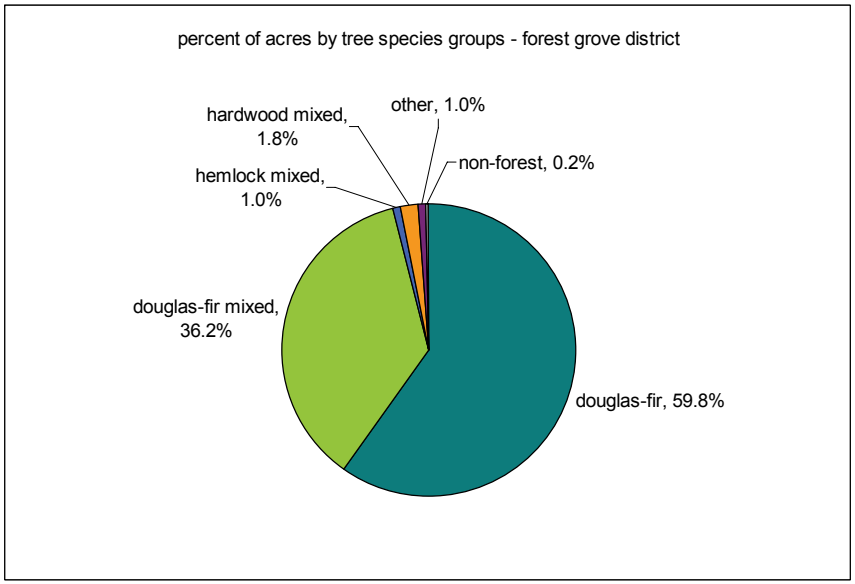

| Harvest Availability Class - FMP ~ HCP and FMP ~ TA Alternatives | Acres | Percent of District Acres |
|---|---|---|
| Road right-of-way | 5,956 | 2.4% |
| Administratively removed | 2,529 | 1.0% |
| Non-loggable | 30,349 | 12.1% |
| Deed restrictions | 2,707 | 1.1% |
| Old-growth designated | 55 | 0.0% |
| FPA critical wildlife species site | 153 | 0.1% |
| No-Harvest, Riparian | 9,369 | 3.7% |
| Non-Harvestable Subtotal (includes overlap) | 51,119 | 20.4% |
| | | |
| Harvestable | 206,017 | 82.2% |
| Non-Harvestable (no overlap) | 44,635 | 17.8% |
| Total | 250,652 | 100% |

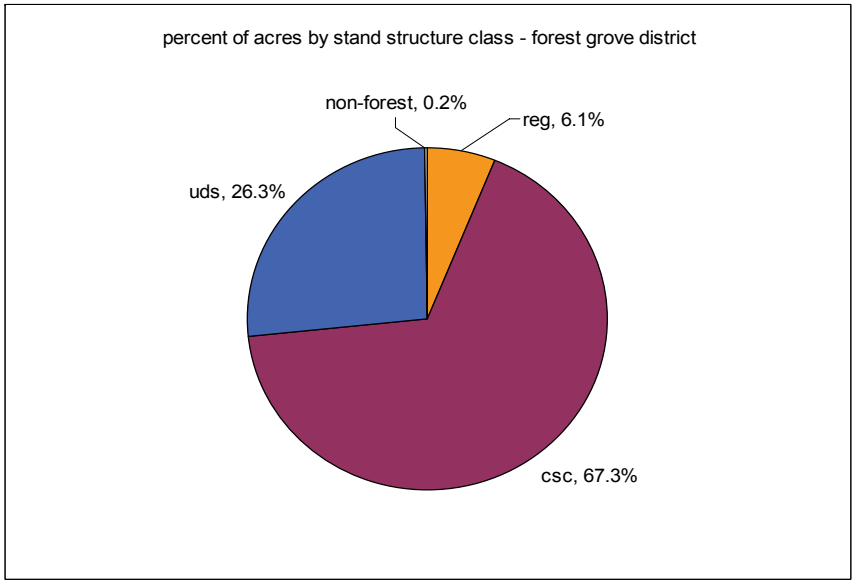
| Fund | Acres | Percent of District Acres |
|---|---|---|
| 51 | 233,358 | 93.1% |
| 52 | 5,124 | 2.0% |
| 54 | 7,636 | 3.0% |
| 55 | 1,521 | 0.6% |
| 56 | 1,045 | 0.4% |
| 57 | 218 | 0.1% |
| 75 | 1,750 | 0.7% |
| Total | 250,652 | 100% |

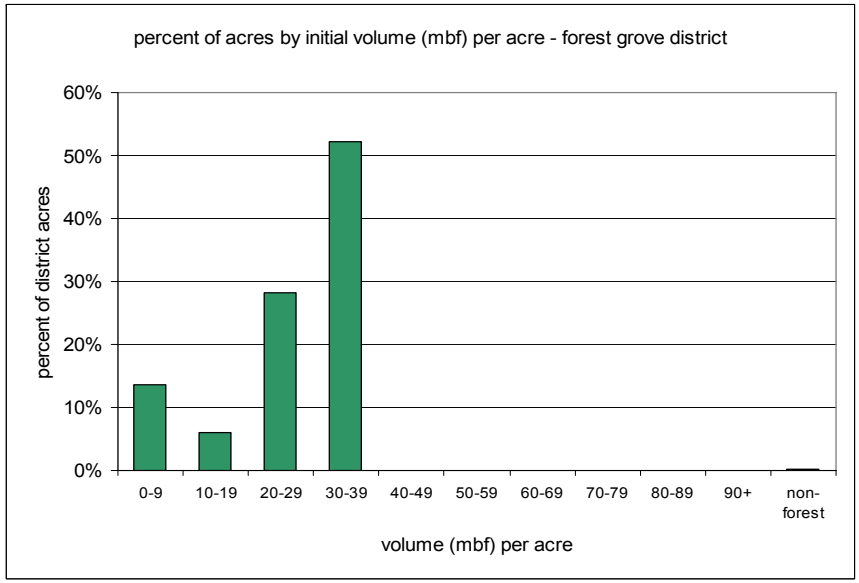
| County | Acres | Percent of District Acres |
|---|---|---|
| Clatsop | 2,532 | 1.0% |
| Tillamook | 247,066 | 98.6% |
| Washington | 1,055 | 0.4% |
| Total | 250,652 | 100% |

| Initial Inventory Volume (MMBF) |
|---|
| 4,776 |

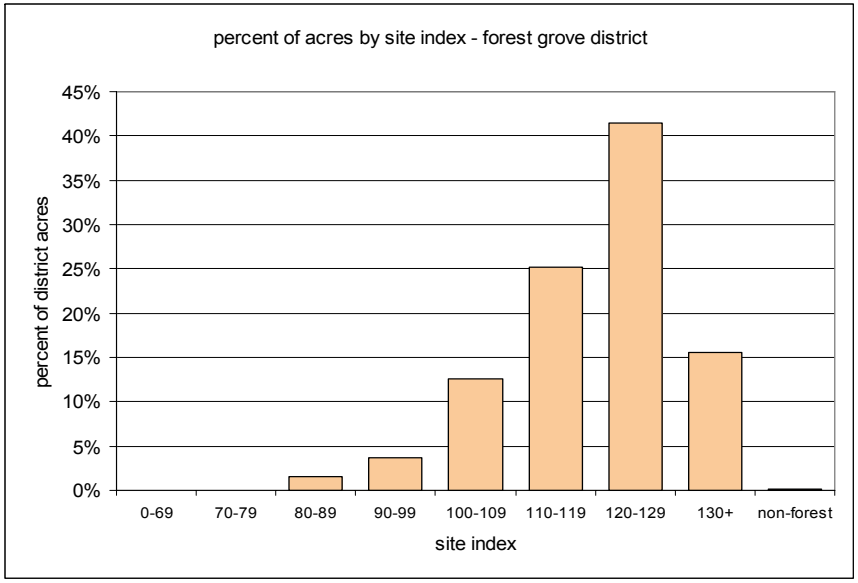
# Current Forest Condition: Forest Grove District

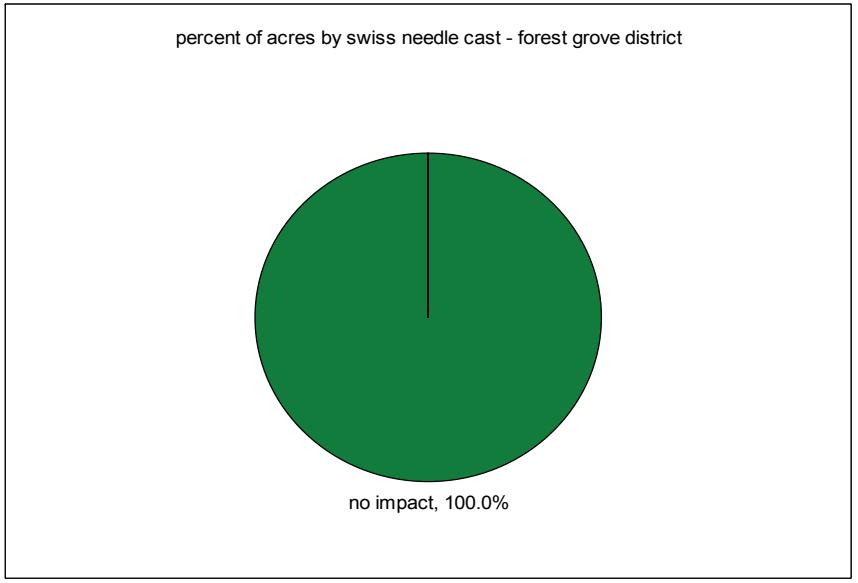



# Current Forest Condition: Forest Grove District (continued)



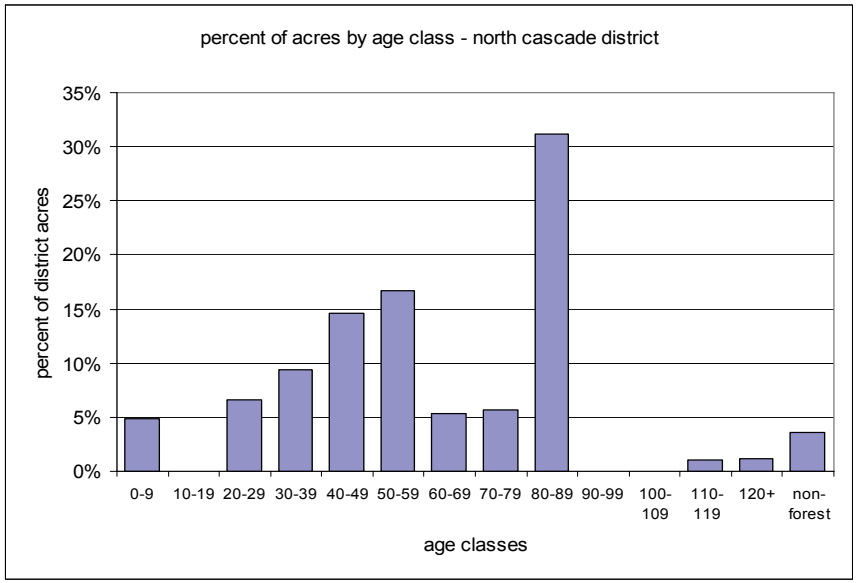

| Harvest Availability Class - FMP ~ HCP and FMP ~ TA Alternatives | Acres | Percent |
|---|---|---|
| Road right-of-way | 2,842 | 2.5% |
| Administratively removed | 435 | 0.4% |
| Non-loggable | 11,846 | 10.3% |
| Deed restrictions | 38 | 0.0% |
| Old-growth designated | 131 | 0.1% |
| FPA critical wildlife species site | 0 | 0.0% |
| No-Harvest, Riparian | 4,518 | 3.9% |
| Non-Harvestable Subtotal (includes overlap) | 16,968 | 17.2% |
| | | |
| Harvestable | 96,333 | 83.8% |
| Non-Harvestable (no overlap) | 18,611 | 16.2% |
| Total | 114,944 | 100% |

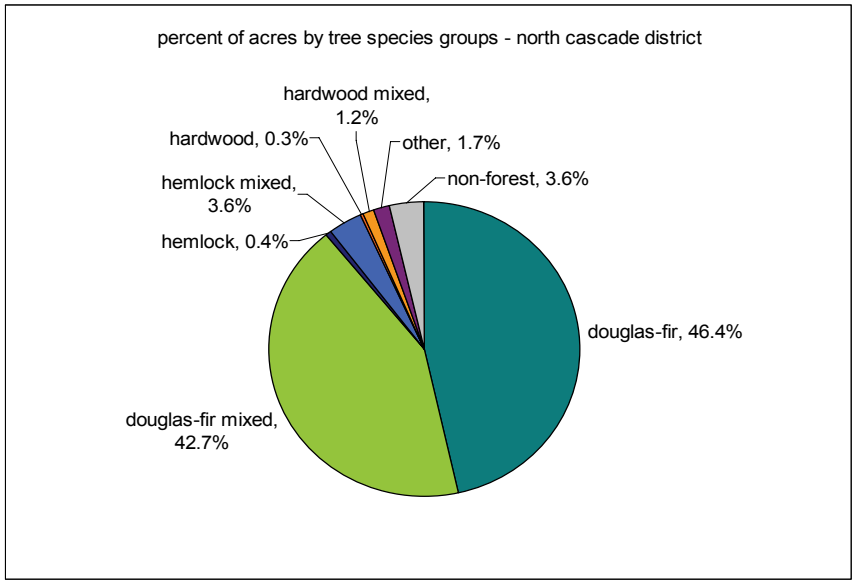
| Fund | Acres | Percent of District Acres |
|---|---|---|
| 51 | 114,253 | 99.4% |
| 52 | 653 | 0.6% |
| 58 | 21 | 0.0% |
| 62 | 17 | 0.0% |
| Total | 114,944 | 100% |

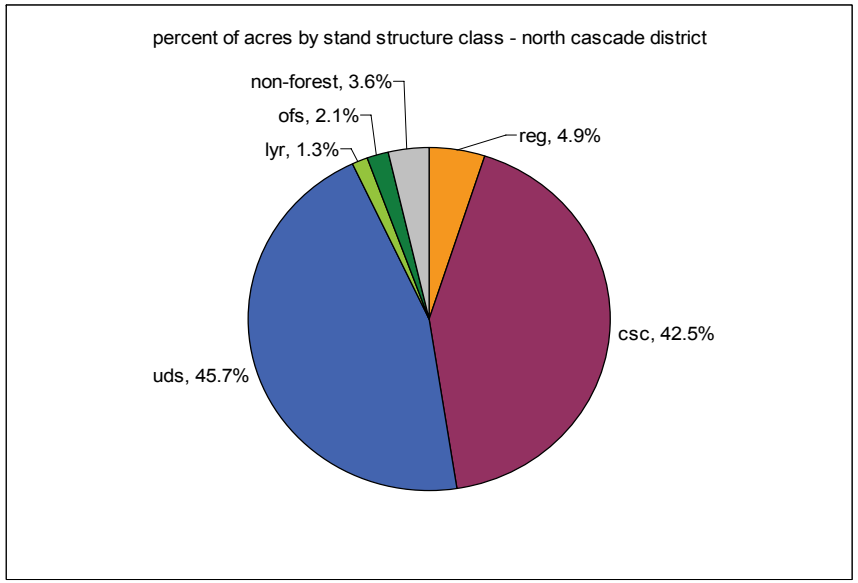
| County | Acres | Percent of District Acres |
|---|---|---|
| Clatsop | 8,552 | 7.4% |
| Columbia | 6,379 | 5.5% |
| Tillamook | 54,533 | 47.4% |
| Washington | 45,402 | 39.5% |
| Yamhill | 79 | 0.1% |
| Total | 114,944 | 100% |

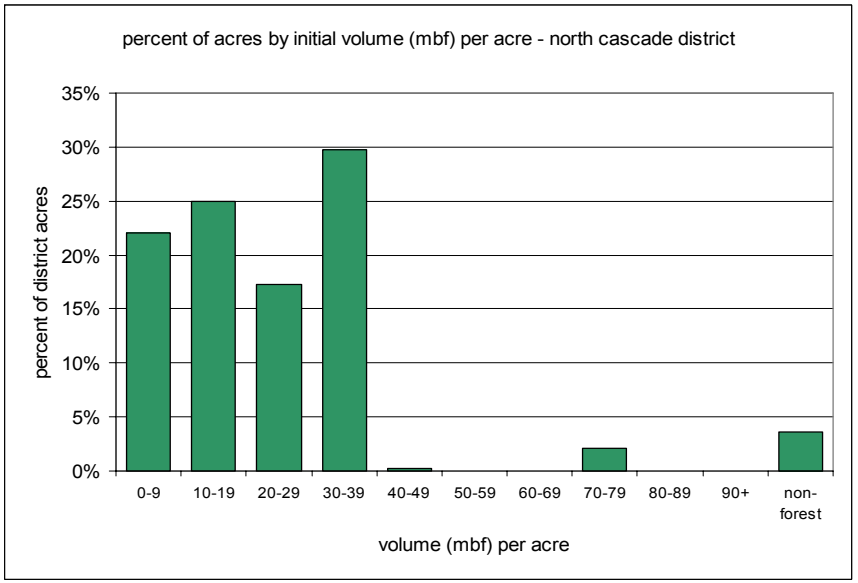
| Initial Inventory Volume (MMBF) |
|---|
| 2,995 |

# Current Forest Condition: North Cascade District

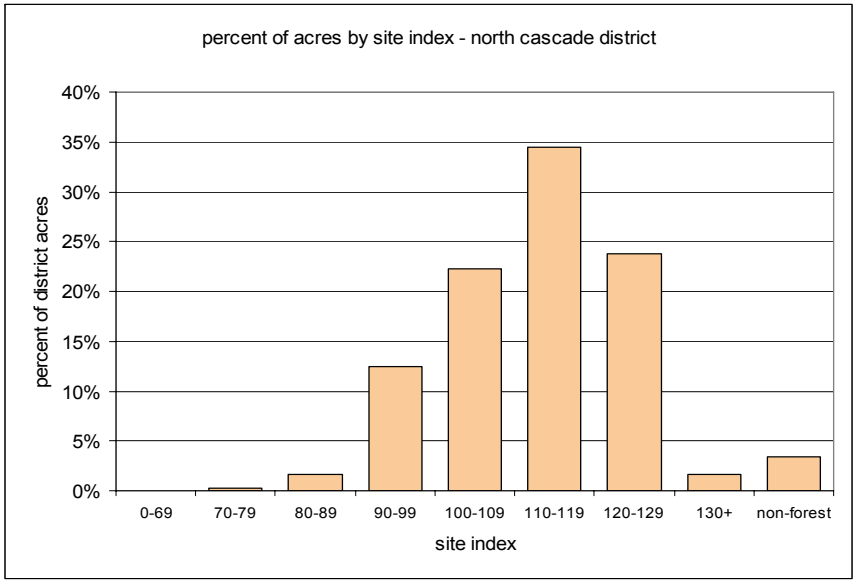


# Current Forest Condition: North Cascade District (continued)



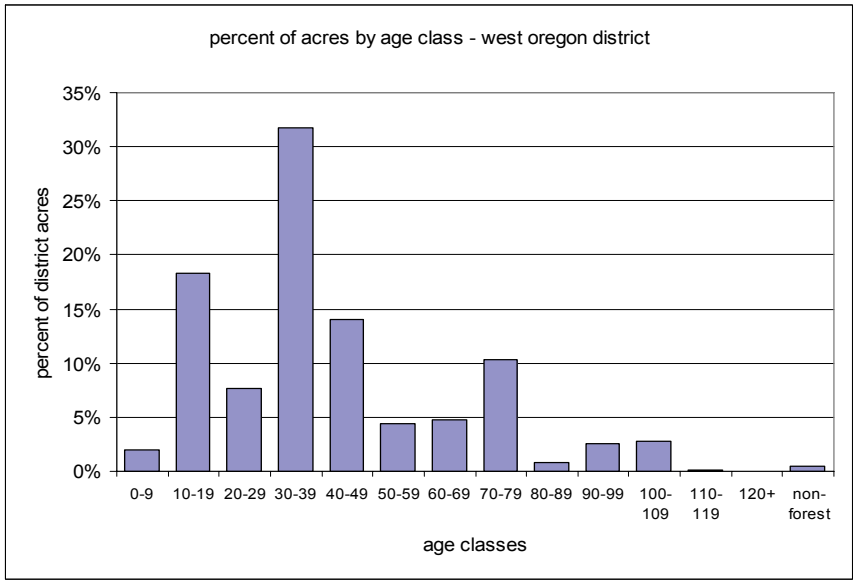

| Harvest Availability Class - FMP ~ HCP and FMP ~ TA Alternatives | Acres | Percent of District Acres |
|---|---|---|
| Road right-of-way | 1,300 | 2.7% |
| Administratively removed | 805 | 1.7% |
| Non-loggable | 2,740 | 5.7% |
| Deed restrictions | 0 | 0.0% |
| Old-growth designated | 133 | 0.3% |
| FPA critical wildlife species site | 0 | 0.0% |
| No-Harvest, Riparian | 1,722 | 3.6% |
| Non-Harvestable Subtotal (includes overlap) | 6,700 | 14.0% |
| | | |
| Harvestable | 41,426 | 86.8% |
| Non-Harvestable (no overlap) | 6,297 | 13.2% |
| Total | 47,723 | 100% |

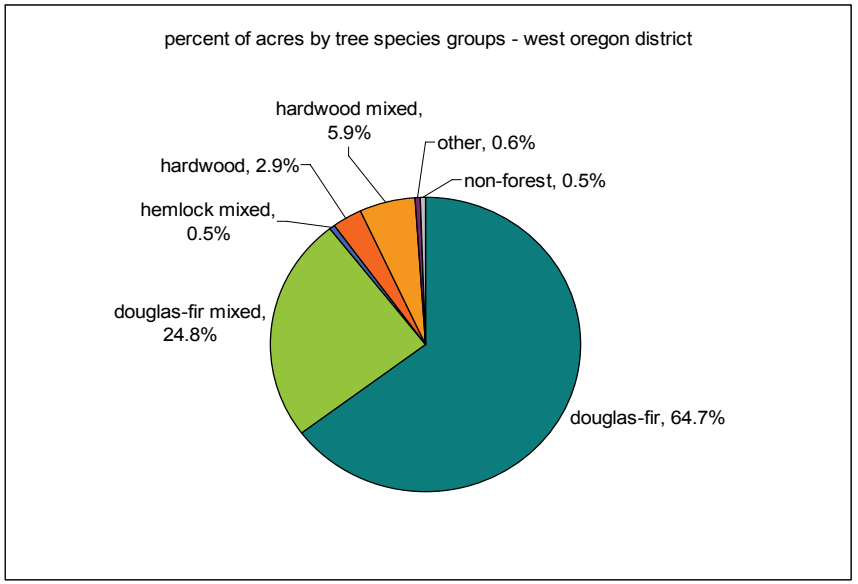
| Fund | Acres | Percent of District Acres |
|---|---|---|
| 51 | 46,796 | 98.1% |
| 52 | 927 | 1.9% |
| Total | 47,723 | 100% |

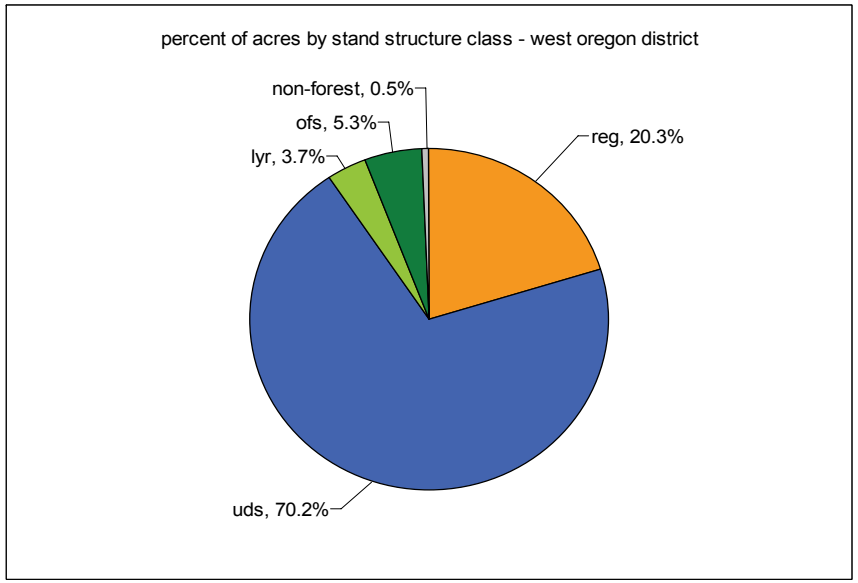
| County | Acres | Percent of District Acres |
|---|---|---|
| Clackamas | 7,214 | 15.1% |
| Linn | 21,356 | 44.7% |
| Marion | 19,154 | 40.1% |
| Total | 47,723 | 100% |

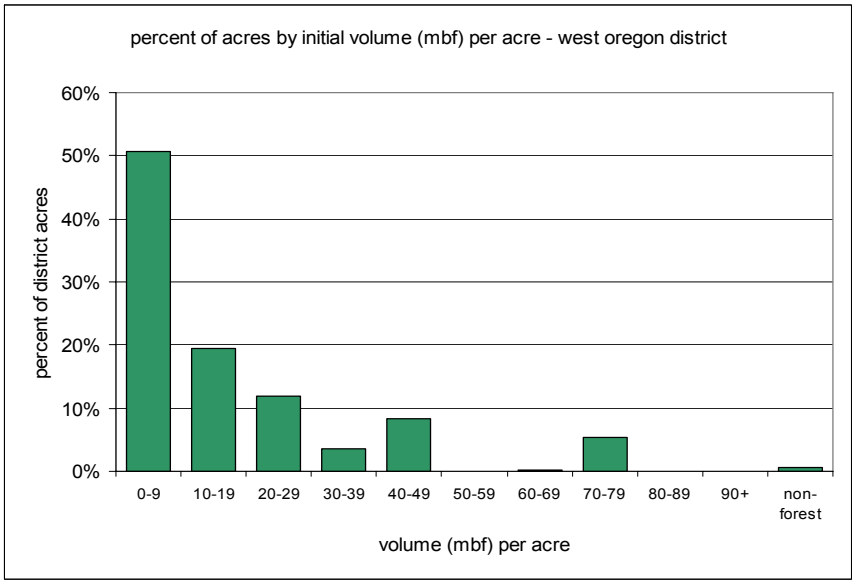
| Initial Inventory Volume (MMBF) |
|---|
| 1,007 |

# Current Forest Condition: West Oregon District

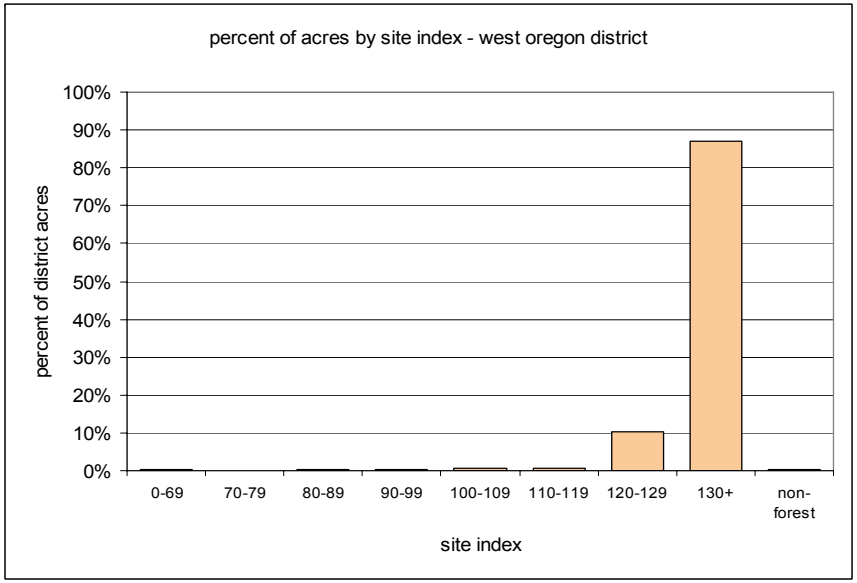


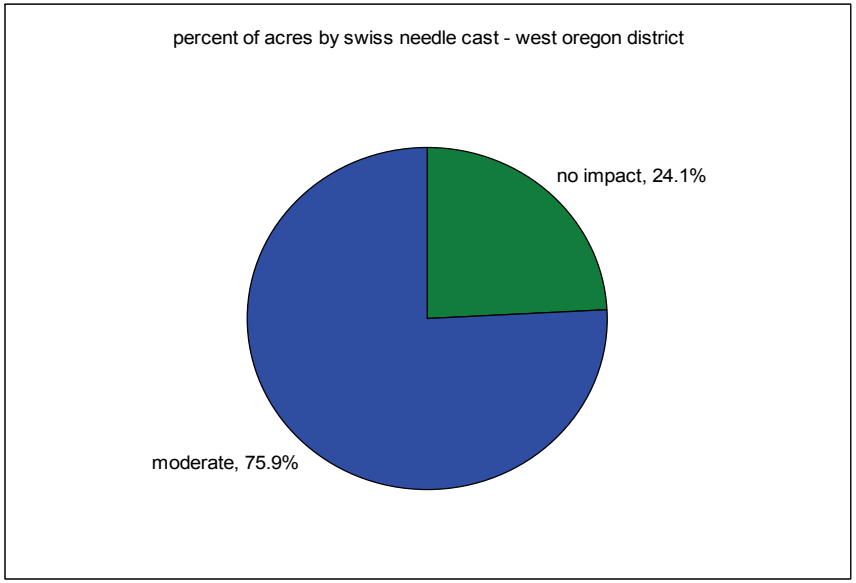



# Current Forest Condition: West Oregon District (continued)



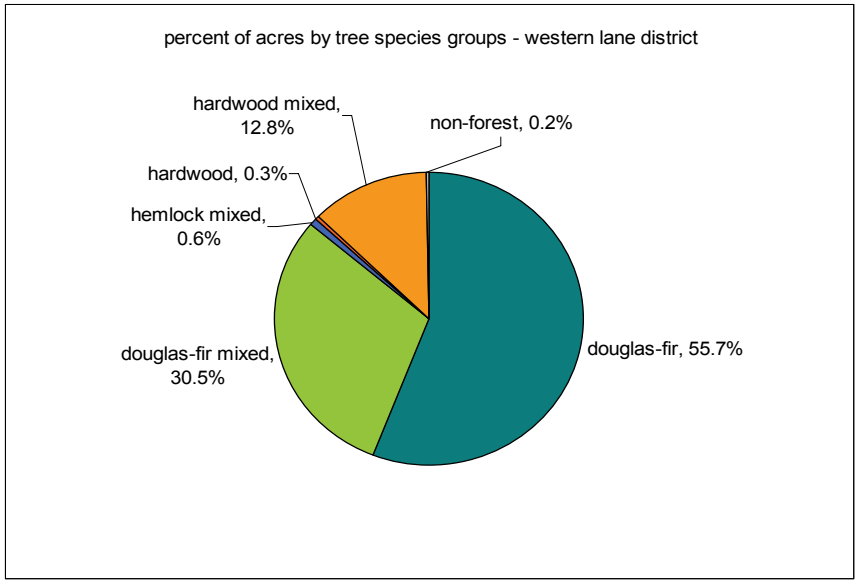

| Harvest Availability Class - FMP ~ HCP and FMP ~ TA Alternatives | Acres | Percent |
|---|---|---|
| Road right-of-way | 1,162 | 3.1% |
| Administratively removed | 208 | 0.6% |
| Non-loggable | 327 | 0.9% |
| Deed restrictions | 0 | 0.0% |
| Old-growth designated | 0 | 0.0% |
| FPA critical wildlife species site | 0 | 0.0% |
| No-Harvest, Riparian | 990 | 2.6% |
| Non-Harvestable Subtotal (includes overlap) | 2,687 | 7.2% |
| | | |
| Harvestable | 35,075 | 93.2% |
| Non-Harvestable (no overlap) | 2,577 | 6.8% |
| Total | 37,652 | 100% |

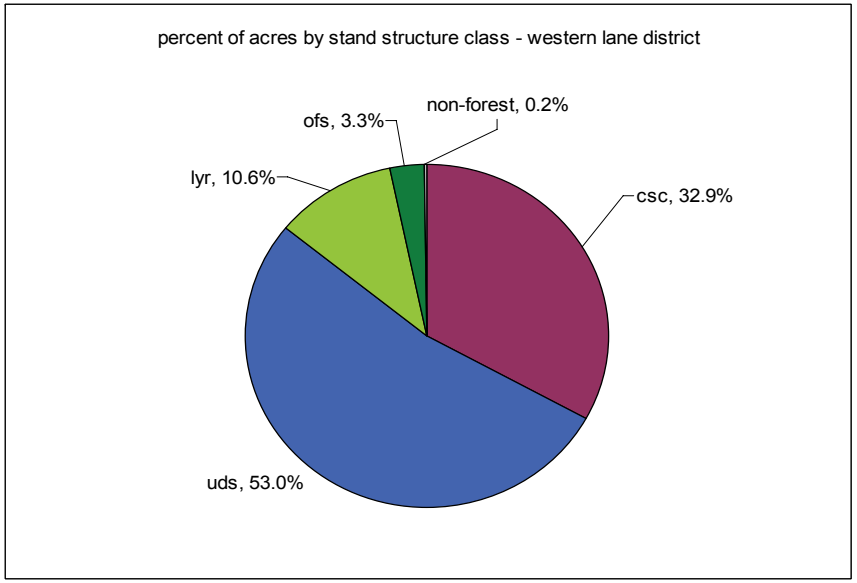
| Fund | Acres | Percent of District Acres |
|---|---|---|
| 51 | 29,666 | 78.8% |
| 52 | 7,986 | 21.2% |
| Total | 37,652 | 100% |

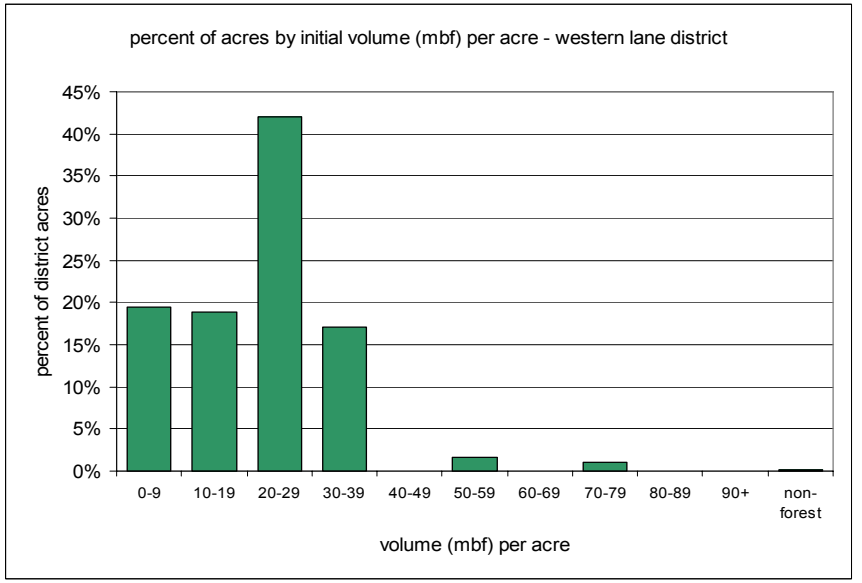
| County | Acres | Percent of District Acres |
|---|---|---|
| Benton | 8,829 | 23.5% |
| Lincoln | 21,066 | 55.9% |
| Polk | 7,757 | 20.6% |
| Total | 37,652 | 100% |

| Initial Inventory Volume (MMBF) |
|---|
| 628 |

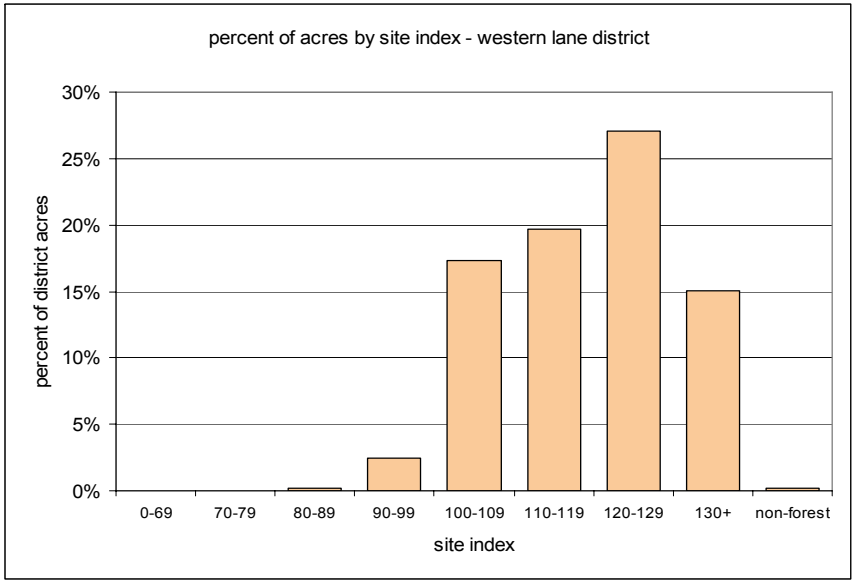
# Current Forest Condition: Western Lane District

# Current Forest Condition: Western Lane District (continued)



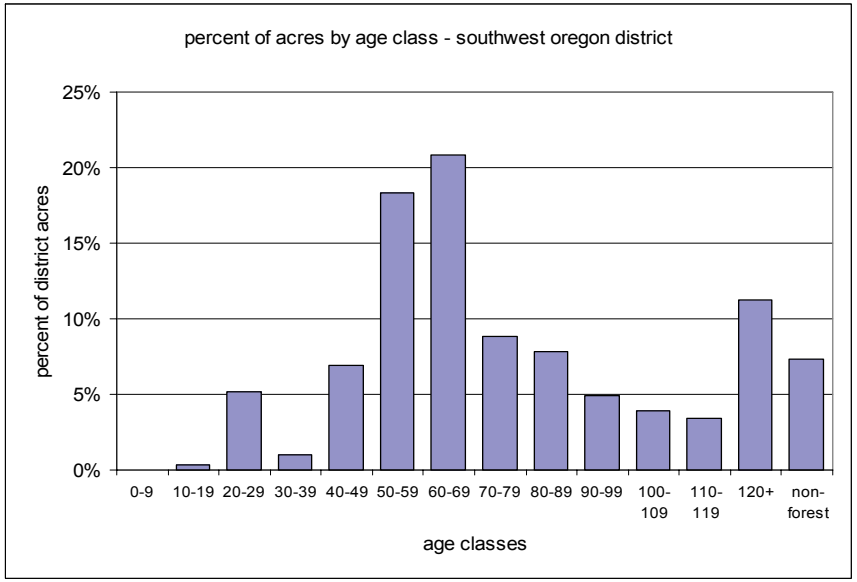

| Harvest Availability Class - FMP ~ HCP and FMP ~ TA Alternatives | Acres | Percent of District Acres |
|---|---|---|
| Road right-of-way | 1,046 | 4.0% |
| Administratively removed | 205 | 0.8% |
| Non-loggable | 467 | 1.8% |
| Deed restrictions | 0 | 0.0% |
| Old-growth designated | 1,446 | 5.6% |
| FPA critical wildlife species site | 0 | 0.0% |
| No-Harvest, Riparian | 1,131 | 4.4% |
| Non-Harvestable Subtotal (includes overlap) | 4,295 | 16.5% |
| | | |
| Harvestable | 21,895 | 84.3% |
| Non-Harvestable (no overlap) | 4,064 | 15.7% |
| Total | 25,959 | 100% |

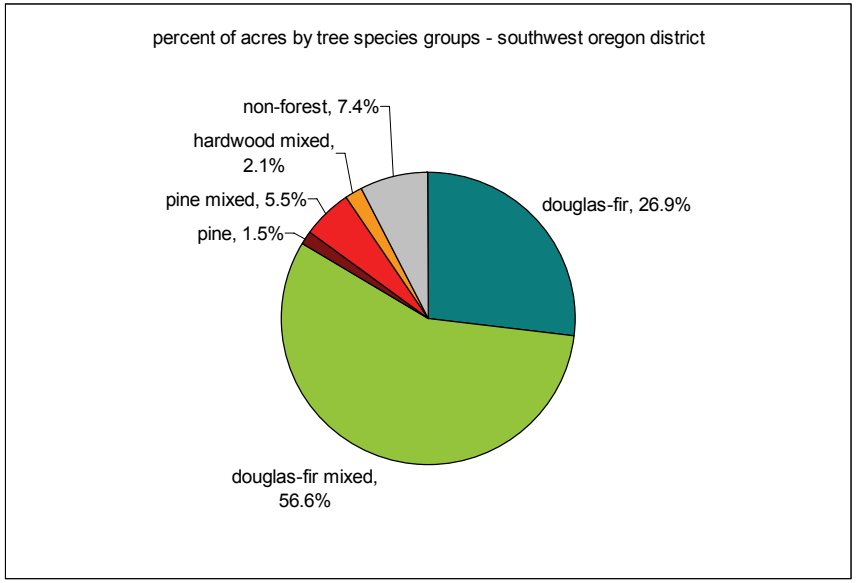
| Fund | Acres | Percent of District Acres |
|---|---|---|
| 51 | 24,215 | 93.3% |
| 52 | 1,744 | 6.7% |
| Total | 25,959 | 100% |

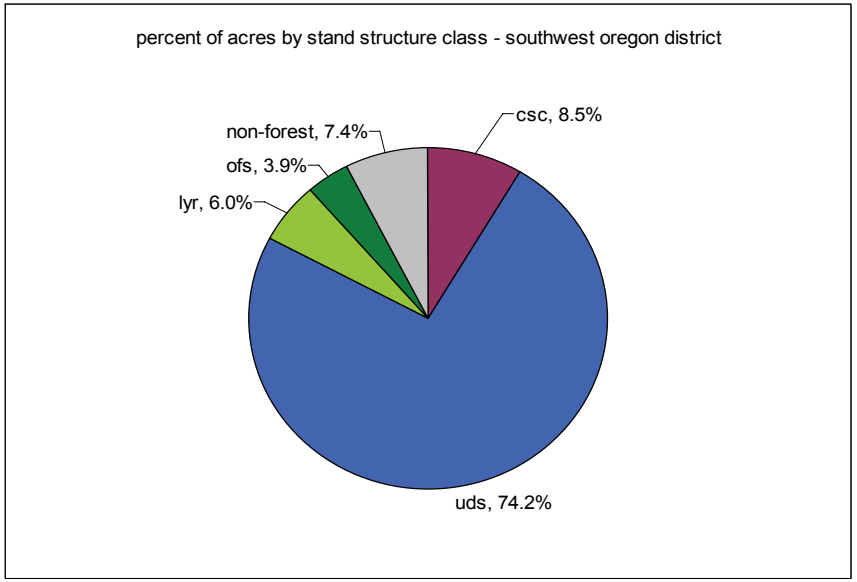
| County | Acres | Percent of District Acres |
|---|---|---|
| Lane | 25,959 | 100% |

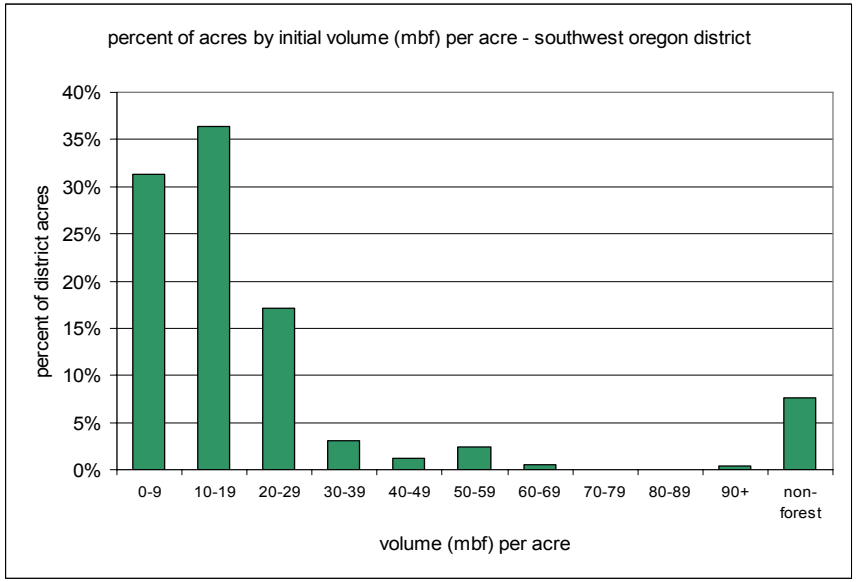
| Initial Inventory Volume (MMBF) |
|---|
| 536 |

# Current Forest Condition: Southwest Oregon District

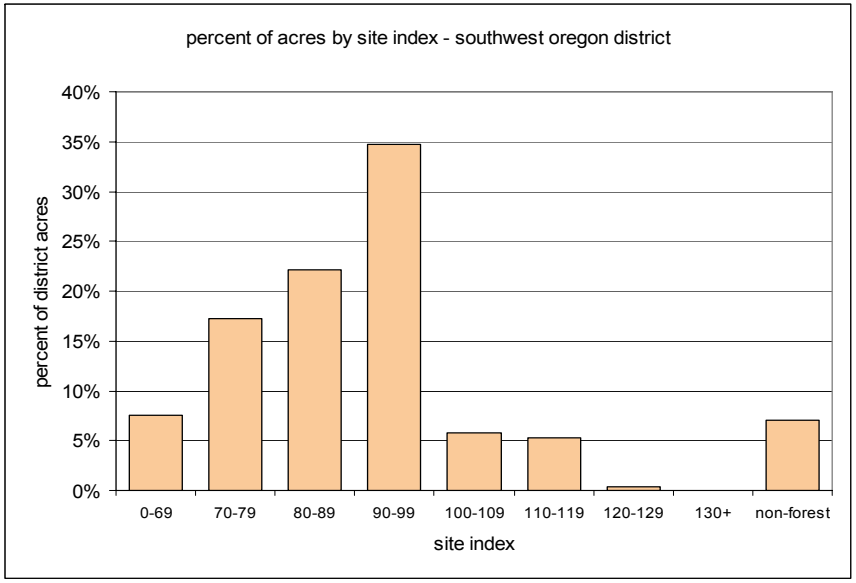


# Current Forest Condition: Southwest Oregon District (continued)




| Harvest Availability Class - FMP ~ HCP and FMP ~ TA Alternatives | Acres | Percent of District Acres |
|---|---|---|
| Road right-of-way | 569 | 3.1% |
| Administratively removed | 358 | 2.0% |
| Non-loggable | 1,692 | 9.3% |
| Deed restrictions | 0 | 0.0% |
| Old-growth designated | 1,603 | 8.8% |
| FPA critical wildlife species site | 73 | 0.4% |
| No-Harvest, Riparian | 462 | 2.5% |
| Non-Harvestable Subtotal (includes overlap) | 4,757 | 26.1% |
| | | |
| Harvestable | 14,028 | 77.0% |
| Non-Harvestable (no overlap) | 4,183 | 23.0% |
| Total | 18,212 | 100% |

| Fund | Acres | Percent of District Acres |
|---|---|---|
| 51 | 9,385 | 51.5% |
| 52 | 8,826 | 48.5% |
| Total | 18,212 | 100% |

| County | Acres | Percent of District Acres |
|---|---|---|
| Curry | 604 | 3.3% |
| Douglas | 8,181 | 44.9% |
| Jackson | 2,049 | 11.3% |
| Josephine | 7,378 | 40.5% |
| Total | 18,212 | 100% |

| Initial Inventory Volume (MMBF) |
|---|
| 254 |

# Appendix E

# Model Solution Reviews: District Level of Confidence

Confirmation that model results reflect the forest's Land Management Classification System and FMP strategies, and that outputs are implementable, are discussed in district Model Solution Review Reports. Below is a brief summary of these reports for the FMP~HCP alternative (50% complex structure goal) and how model results compare to recent harvest levels.

Specific district MSR reports are available upon request.

***Note**: Model numbers (shown below), on which district MSR reports were based, are slightly different than the numbers reported in the Final Report (see Appendix G). Minor adjustments were made to the models after the districts prepared their MSR reports, causing these differences. These minor differences should not affect district MSR reports.

## Astoria District

- The district can achieve the model volume, which is within the IP volume range.
- The model volume is 20 percent below the 2005 AOP.
- The model volume is 3 percent above the IP mid-point.

| | IP mid-points | AOP 05 | Model* |
|---|---|---|---|
| 1st Decade Average Annual Volume mmbf/yr. | 58.9 | 76.4 | 60.5 |
| Clearcut acres/yr. | 750 | 1,007 | 1,677 |
| Thinning acres/yr. | 2,750 | 2,362 | 771 |

## Tillamook District

- Tillamook can achieve their total modeled volume (this is within the IP volume range) but may need to use a different mix of clearcut and thinning acres or adjust their harvest volumes, due to HLHL sites.
- The model volume is 24 percent below the 2005 AOP.

| | IP mid-points | AOP 05 | Model* |
|---|---|---|---|
| 1st Decade Average Annual Volume mmbf/yr. | 63.9 | 78.6 | 59.5 |
| Clearcut acres/yr. | 4,850 | 5,654 | 3,194 |
| Thinning acres/yr. | 1,200 | 1,249 | 330 |

## Forest Grove District

- The district can achieve the model volume, which is within the IP volume range.
- The model volume is 22 percent below the 2005 AOP.
- The model volume is slightly below the IP mid-point.

| | IP mid-points | AOP 05 | Model* |
|---|---|---|---|
| 1st Decade Average Annual Volume mmbf/yr. | 53.2 | 67.1 | 52.5 |
| Clearcut acres/yr. | 422 | 877 | 1,029 |
| Thinning acres/yr. | 2,956 | 3,041 | 1,329 |

## North Cascade District

- The district can achieve the model volume, however this volume is 22 percent below the lower limit of the IP volume range.
- The district has historically harvested more volume per acre than the model is predicting (46 percent more on clearcuts and 25 percent more on thinning). Therefore, achieving both the acre and volume targets is not likely:
    - If the district focused on achieving the model volume, it could do so solely by thinning 1,000 acres per year (based on its historic thinning per acre volume)
    - If the district focused on achieving the model acres, it would be harvesting 20.9 mmbf (the volume mid point of the State Forester approved IP).
- The model volume is 42 percent below the 2005 AOP.
- The model volume is 38 percent below the IP mid-point.

| | IP mid-points | AOP 05 | Model* |
|---|---|---|---|
| 1st Decade Average Annual Volume mmbf/yr. | 20.9 | 22.4 | 13.0 |
| Clearcut acres/yr. | 225 | 255 | 371 |
| Thinning acres/yr. | 1,000 | 1,387 | 591 |

## West Oregon District

- The district can achieve the model volume; this is within the IP volume range.
- The district has historically harvested more volume per acre than the model is predicting (47 percent more on clearcuts, but not significantly different on thinning). Therefore, achieving both the acre and volume targets is not likely:
    - If the district focused solely on achieving the model acres, it would be harvesting 16.2 mmbf (30 percent above the volume range of the State Forester approved IP).
    - There are probably numerous mixes of acres that could achieve the model volume.
- The model volume is 16 percent above the 2005 AOP.
- The model volume is 14 percent above the IP mid-point.

| | IP mid-points | AOP 05 | Model* |
|---|---|---|---|
| 1st Decade Average Annual Volume mmbf/yr. | 10.1 | 9.9 | 11.5 |
| Clearcut acres/yr. | 90 | 82 | 239 |
| Thinning acres/yr. | 900 | 920 | 615 |

## Western Lane District

- The district can achieve the model volume; however this is 3 percent above the top end of the IP volume range.
- The model volume is 19 percent above the 2005 AOP.
- The model volume is 11 percent above the IP mid-point.

| | IP mid-points | AOP 05 | Model* |
|---|---|---|---|
| 1st Decade Average Annual Volume mmbf/yr. | 7.2 | 6.7 | 8.0 |
| Clearcut acres/yr. | 140 | 82 | 250 |
| Thinning acres/yr. | 250 | 331 | 331 |

## Southwest Oregon District

- The district can achieve the model volume, however it is 15 percent above the top end of the IP volume range.
- The model volume is slightly above the 2005 AOP and IP mid-point.

| | IP mid-points | AOP 05 | Model* |
|---|---|---|---|
| 1st Decade Average Annual Volume mmbf/yr. | 1.8 | 1.7 | 2.3 |
| Clearcut acres/yr. | 0 | 0 | 116 |
| Thinning acres/yr. | 225 | 277 | 110 |

*This page left intentially blank*

# Appendix F

# Coarse Filter Wildlife Matrix: Species List

Habitat assessment for the 39 identified wildlife species listed below are reported by the model via the application of the Coarse Filter Wildlife Matrix (CFM) criteria. The criteria included: stand structure classification, tree species groups, proximity to streams and clearcuts, tree diameters, number of trees per acre, clearcut size, stand age, and time since harvest activity. The total acres of suitable habitat for each species is reported for each of the 30, five-year periods modeled, by district, by alternative (specific information is available upon request). For some species, separate characterizations of acres are made for distinct uses such as nesting, foraging, or hiding habitat.

Species are grouped based on the stand structure habitat with which they are most associated; generalists use multiple stand structures, simple structure species prefer REG and CSC; and complex structure species prefer LYR and OFS. Species that prefer OFS only are noted.

**Generalist Species (Multiple Structure)**

Black-tailed deer (foraging)
Black-tailed deer (hiding/thermal)
Douglas' squirrel
Elk (foraging)
Elk (hiding/thermal)
Hairy woodpecker (foraging)
Montane Shrew
Northern flicker (foraging)
Orange-crowned warbler
Rufous hummingbird (foraging)
Spotted towhee

**Simple Structure Species (REG, CSC)**

Chipping Sparrow[2]
Creeping vole
Fox sparrow
Hutton's vireo
Long-tailed vole
Macgillivray's warbler
Mountain quail
Western bluebird
Western fence lizard
Willow flycatcher

[2] Southwest Oregon District only.

# Coarse Filter Wildlife Matrix: Species List (continued)

**Complex Structure Species (LYR, OFS)**

Band-tailed pigeon (foraging)
Band-tailed pigeon (nesting)
Brown creeper
Chestnut-backed chickadee
Dark-eyed junco
Evening grosbeak
Golden-crowned kinglet
Great gray owl[3]
Hairy woodpecker (nesting)
Hammond's flycatcher
Hermit warbler
Northern flicker (nesting)
Northern pygmy owl[4]
Pacific jumping mouse
Pacific-slope flycatcher
Pileated woodpecker (foraging)
Pileated woodpecker (nesting)[3]
Red crossbill
Red-breasted nuthatch (foraging)
Red-breasted nuthatch (nesting)[3]
Red-breasted sapsucker (foraging)
Red-breasted sapsucker (nesting)[3]
Rufous hummingbird (nesting)
Townsend's solitaire
Varied thrush
Western red-backed vole
Western tanage

[3] North Cascade District only.

[4] OFS-based

# Appendix G
# Model Results: Summary Data

| Table 1: FMP~HCP Complex Stand Structure Analysis* | 1st Decade Avg. Annual Harvest Volume | | | 1st Decade Avg. An. Clearcut Acres/Year | | | 1st Decade Avg. An. Thinning Acres/Year | | | NPV ($millions) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **District** | **40%** | **50%** | **60%** | **40%** | **50%** | **60%** | **40%** | **50%** | **60%** | **40%** | **50%** | **60%** |
| Astoria | 66 | 62 | 54 | 1873 | 1719 | 1445 | 614 | 766 | 811 | 416 | 374 | 310 |
| Tillamook | 68 | 61 | 56 | 3601 | 3241 | 3021 | 442 | 330 | 347 | 254 | 206 | 172 |
| Forest Grove | 60 | 54 | 49 | 1183 | 1154 | 1027 | 1495 | 1225 | 1183 | 441 | 391 | 341 |
| **Three North Coast Districts Sub-Total:** | **194** | **177** | **159** | **6657** | **6114** | **5493** | **2551** | **2321** | **2341** | **1111** | **971** | **823** |
| North Cascade | | 12 | | | 375 | | | 455 | | | 71 | |
| West Oregon | | 12 | | | 228 | | | 664 | | | 78 | |
| Western Lane | | 9 | | | 234 | | | 254 | | | 43 | |
| Southwest Oregon | | 2 | | | 117 | | | 110 | | | 2 | |
| **Four South Districts Sub-Total:** | | **35** | | | **954** | | | **1483** | | | **194** | |
| **Grand Total:** | | **212** | | | **7068** | | | **3804** | | | **1165** | |

* 50% Complex Stand Structure Goal for All Seven Districts; 40%, 50%, and 60% Complex Stand Structure Goals for the Three North Coast Districts

| Table 2: District Summary of All Alternatives: Harvest Volume, NPV, and Complex Structure | | Astoria | Tillamook | Forest Grove | 3 NC SUB-TOTAL | North Cascade | West Oregon | Western Lane | Southwest Oregon | 4 SOUTH SUB-TOTAL | GRAND TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **FMP using HCP** | Annual Volume 1st Dec[1] | 62 | 61 | 54 | **177** | 12 | 12 | 9 | 2 | **35** | **212** |
| | Annual Volume 150 yrs[1] | 63 | 62 | 55 | **180** | 13 | 14 | 10 | 2 | **39** | **219** |
| | NPV (millions $ @ 4.5%) | 374 | 206 | 391 | **971** | 71 | 78 | 43 | 2 | **194** | **1165** |
| | Total Structure Attained[2] | 52% | 50% | 51% | -- | 51% | 50% | 50% | 37% | -- | -- |
| | Years to Attain Structure[2] | 95 | 130 | 65 | -- | 90 | 70 | 75 | 85 | -- | -- |
| **FMP using TA** | Annual Volume 1st Dec[1] | 76 | 73 | 64 | **213** | 12 | 12 | 6 | 2 | **32** | **245** |
| | Annual Volume 150 yrs[1] | 58 | 57 | 46 | **161** | 11 | 12 | 7 | 2 | **32** | **193** |
| | NPV (millions $ @ 4.5%) | 432 | 277 | 415 | **1124** | 74 | 83 | 24 | 3 | **184** | **1308** |
| | Total Structure Attained[2] | 50% | 50% | 50% | -- | 50% | 51% | 50% | 38% | -- | -- |
| | Years to Attain Structure[2] | 80 | 130 | 70 | -- | 105 | 65 | 65 | 90 | -- | -- |
| **Wood Emphasis** | Annual Volume 1st Dec[1] | 134 | 113 | 104 | **351** | | | | | | |
| | Annual Volume 150 yrs[1] | 91 | 92 | 63 | **246** | | | | | | |
| | NPV (millions $ @ 4.5%) | 825 | 644 | 770 | **2239** | | | | | | |
| | Max~Avg Struct. Attained[3] | 20~8% | 12~5% | 14~5% | -- | | | | | | |
| **Reserve-Based** | Annual Volume 1st Dec[1] | 29 | 39 | 33 | **101** | | | | | | |
| | Annual Volume 150 yrs[1] | 32 | 41 | 33 | **106** | | | | | | |
| | NPV (millions $ @ 4.5%) | 105 | 76 | 195 | **376** | | | | | | |
| | Total Structure Attained[4] | 61% | 51% | 51% | -- | | | | | | |
| | Years to Attain Structure[4] | 60 | 150 | 70 | -- | | | | | | |

**Footnotes**

[1] Average annual harvest volume in 1st decade and over 150 years, in millions of board feet (mmbf).

[2] FMP w/HCP, FMP w/TA, and Reserve-Based Structure Goals (except SW) = **50%** LYR+OFS w/ a minimum of 25% OFS. SW = 35% LYR+OFS w/ a minimum of 20% OFS.

[3] Wood Emphasis has no Structure Goals; average % attained over 150 years is reported. See charts for reporting of structure attained by period.

[4] Reserve-Based Structure Goals apply to acres outside of "Reserves;" structure is reported across the total landscape.

| Table 3: District Summary of All Alternatives: Clearcut and Thinning Acres | | Astoria | Tillamook | Forest Grove | 3 NC SUB-TOTAL | North Cascade | West Oregon | Western Lane | Southwest Oregon | 4 SOUTH SUB-TOTAL | GRAND TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **FMP using HCP** | Clearcut Acres 1st Dec[1] | 1719 | 3241 | 1154 | **6114** | 375 | 228 | 234 | 117 | **954** | **7068** |
| | Thinning Acres 1st Dec[1] | 766 | 330 | 1225 | **2321** | 455 | 664 | 254 | 110 | **1483** | **3804** |
| | Clearcut Acres 150 yrs[1] | 1233 | 1420 | 829 | **3482** | 260 | 247 | 185 | 98 | **790** | **4272** |
| | Thinning Acres 150 yrs[1] | 1539 | 2351 | 1733 | **5623** | 411 | 420 | 268 | 57 | **1156** | **6779** |
| **FMP using TA** | Clearcut Acres 1st Dec[1] | 2107 | 3828 | 1462 | **7397** | 395 | 323 | 122 | 121 | **961** | **8358** |
| | Thinning Acres 1st Dec[1] | 890 | 267 | 1179 | **2336** | 406 | 578 | 262 | 85 | **1331** | **3667** |
| | Clearcut Acres 150 yrs[1] | 1249 | 1497 | 795 | **3541** | 233 | 231 | 132 | 100 | **696** | **4237** |
| | Thinning Acres 150 yrs[1] | 1322 | 1915 | 1126 | **4363** | 367 | 348 | 169 | 49 | **933** | **5296** |
| **Wood Emphasis** | Clearcut Acres 1st Dec[1] | 4721 | 6265 | 3371 | **14357** | | | | | | |
| | Thinning Acres 1st Dec[1] | 9 | 32 | 0 | **41** | | | | | | |
| | Clearcut Acres 150 yrs[1] | 2787 | 4097 | 2061 | **8945** | | | | | | |
| | Thinning Acres 150 yrs[1] | 633 | 566 | 238 | **1437** | | | | | | |
| **Reserve-Based** | Clearcut Acres 1st Dec[1] | 695 | 2056 | 569 | **3320** | | | | | | |
| | Thinning Acres 1st Dec[1] | 978 | 569 | 1125 | **2672** | | | | | | |
| | Clearcut Acres 150 yrs[1] | 602 | 889 | 533 | **2024** | | | | | | |
| | Thinning Acres 150 yrs[1] | 889 | 1710 | 941 | **3540** | | | | | | |

**Footnotes**

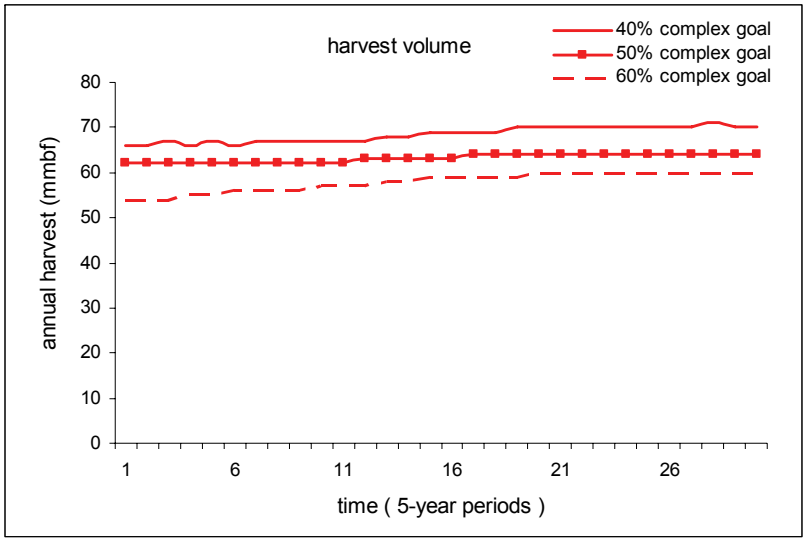
[1] Average annual harvest acres in 1st decade and over 150 years.

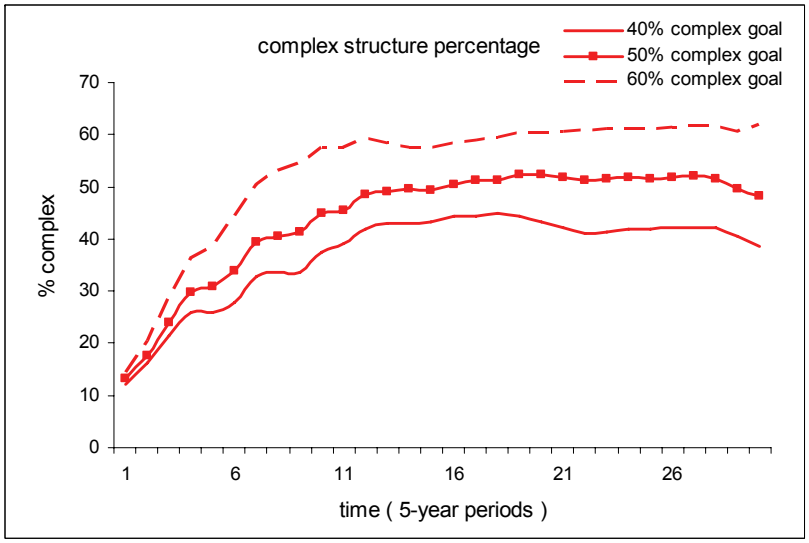
*This page left intentially blank*

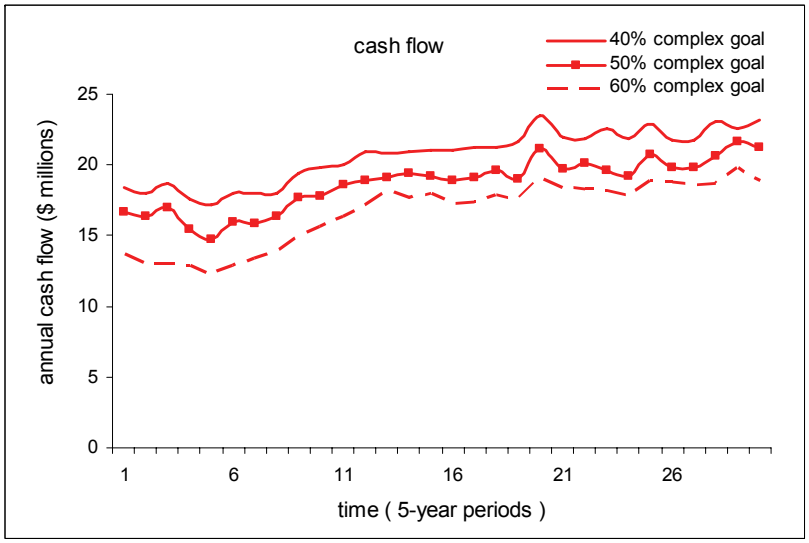
# Appendix H

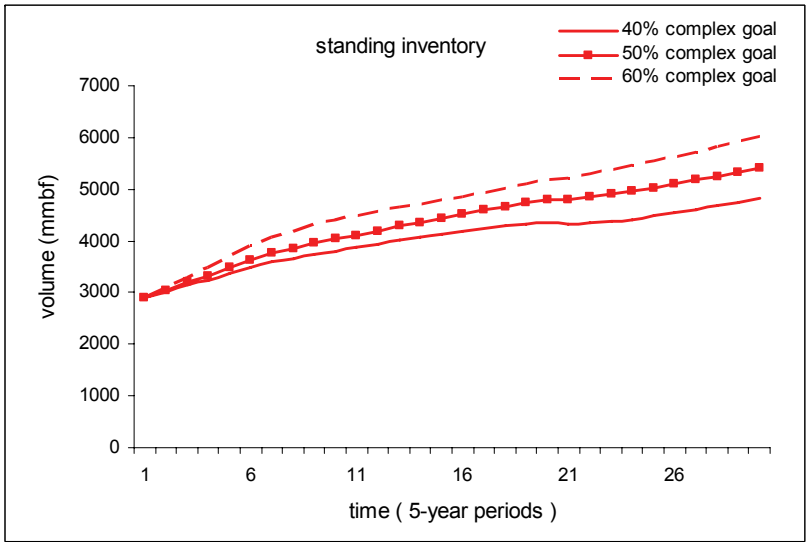
## Model Results: District Detail by Alternative

### Astoria District – FMP using HCP Alternative – 40%, 50% and 60% complex structure goals

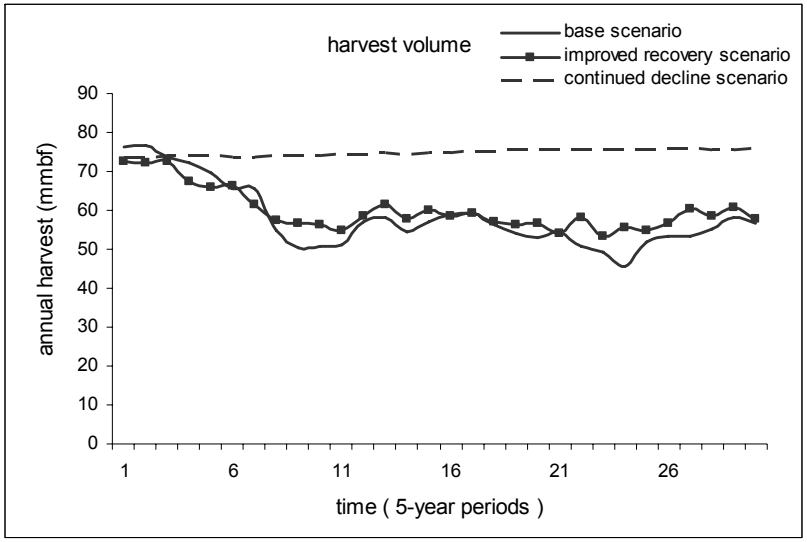


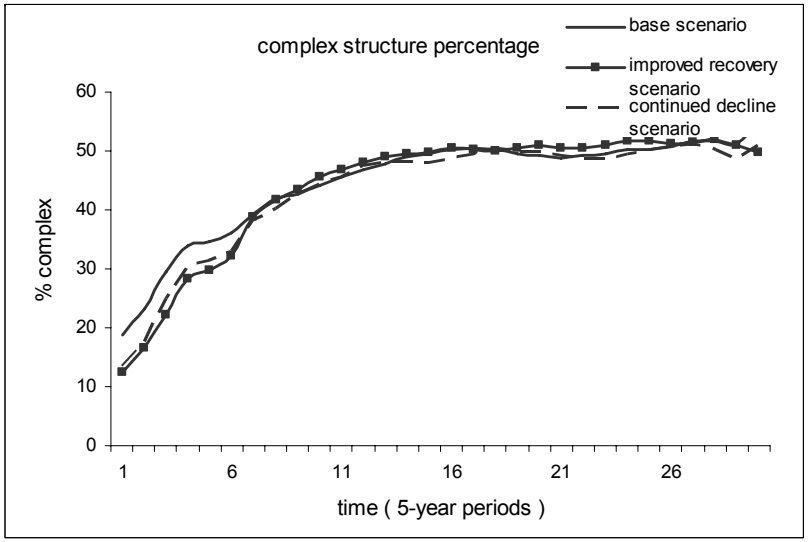



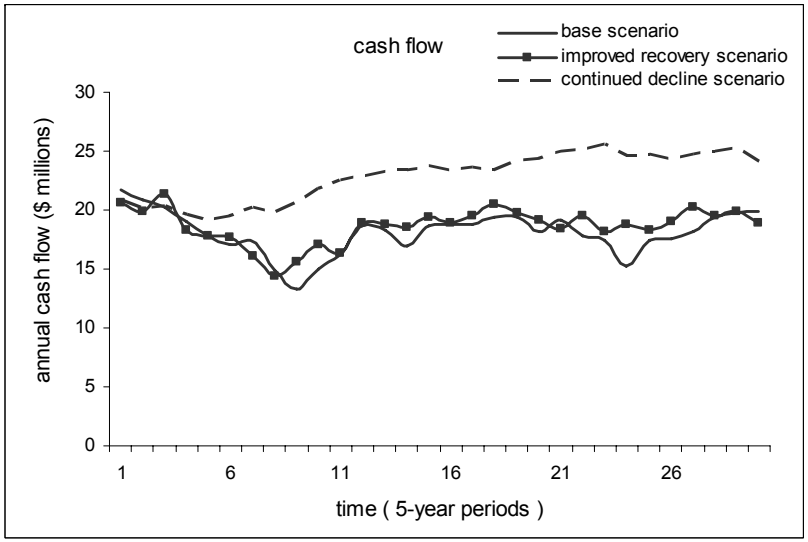



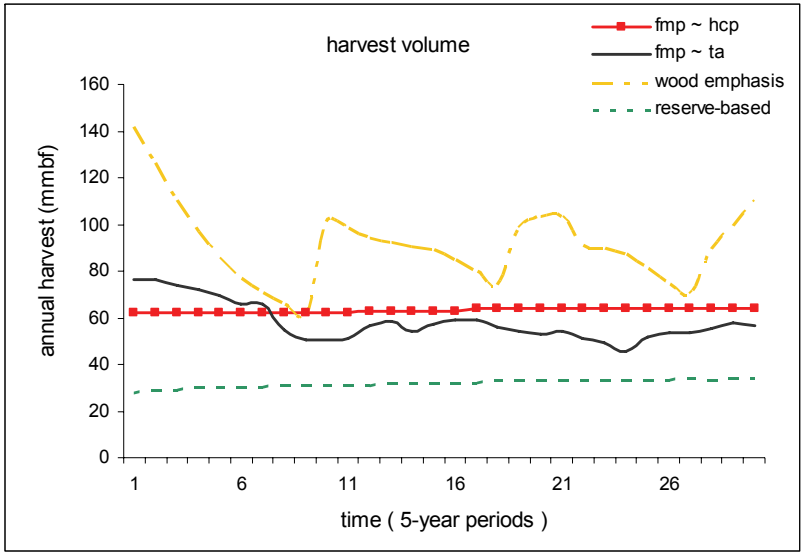
# Astoria District – FMP using TA Alternative – Three NSO Population Trend Scenarios

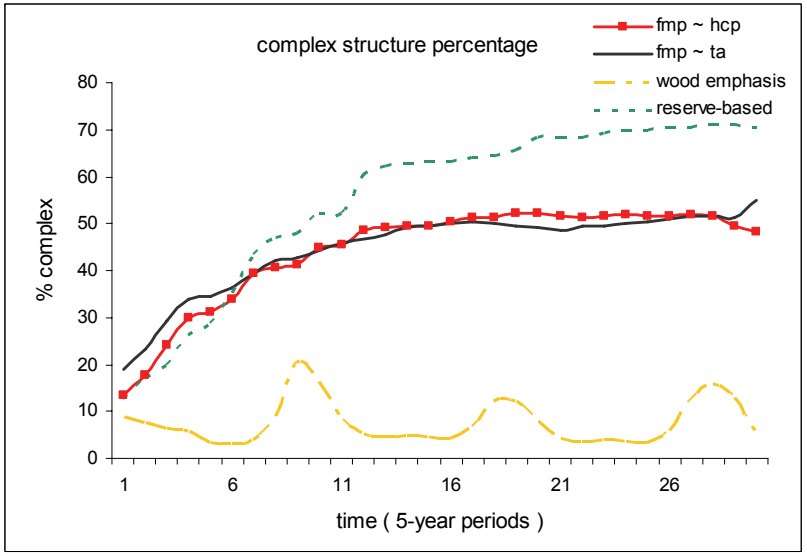


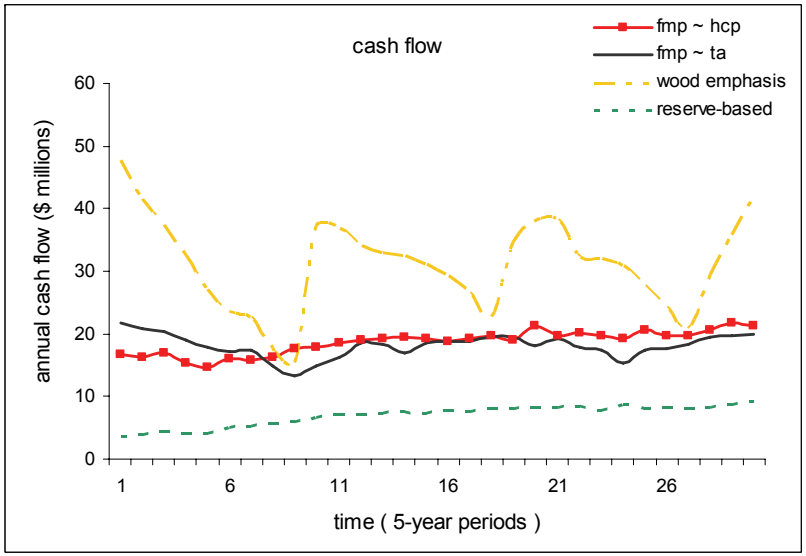



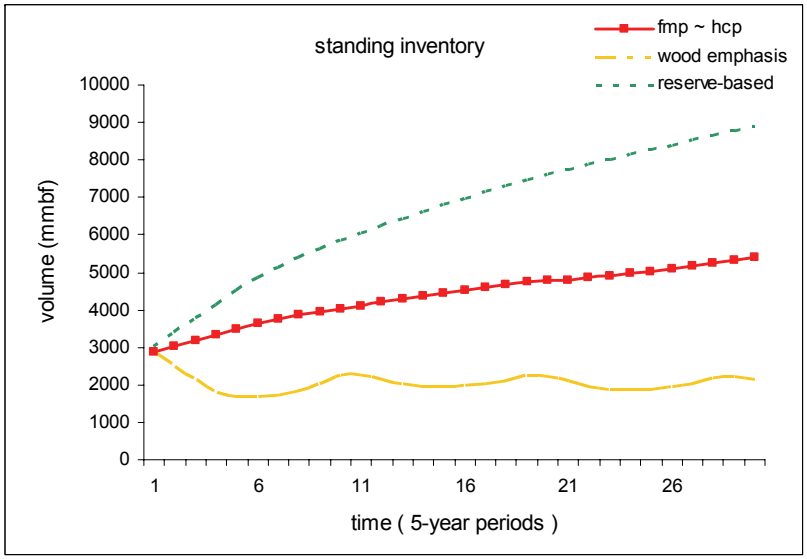



# Astoria District – Comparison of All Four Alternatives

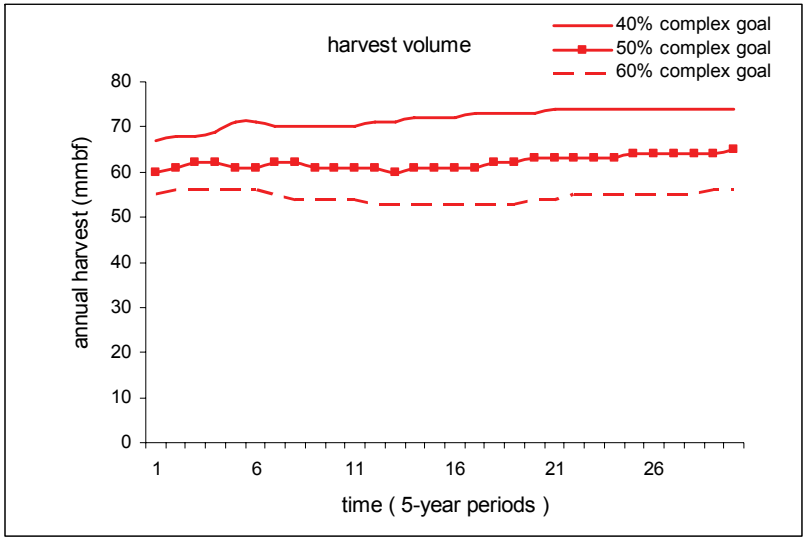


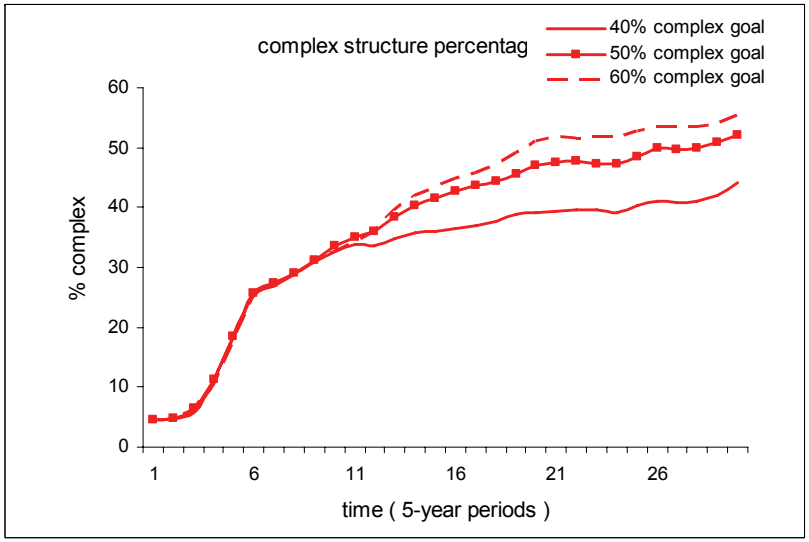



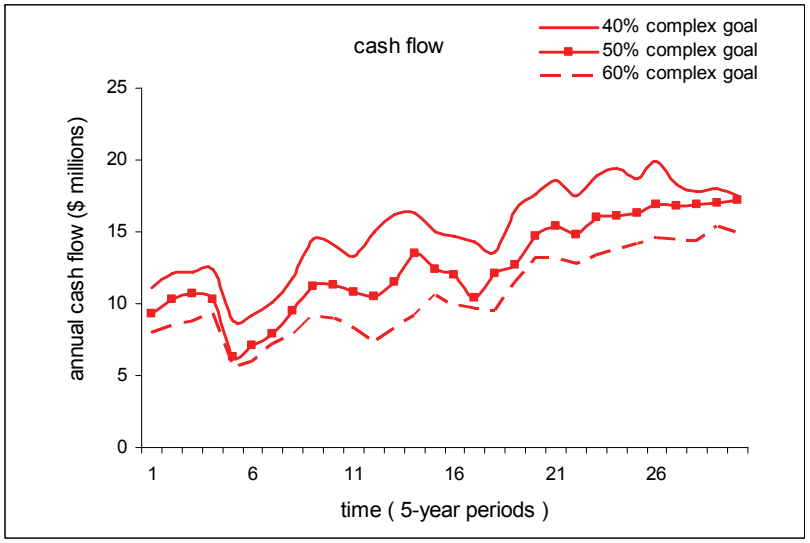



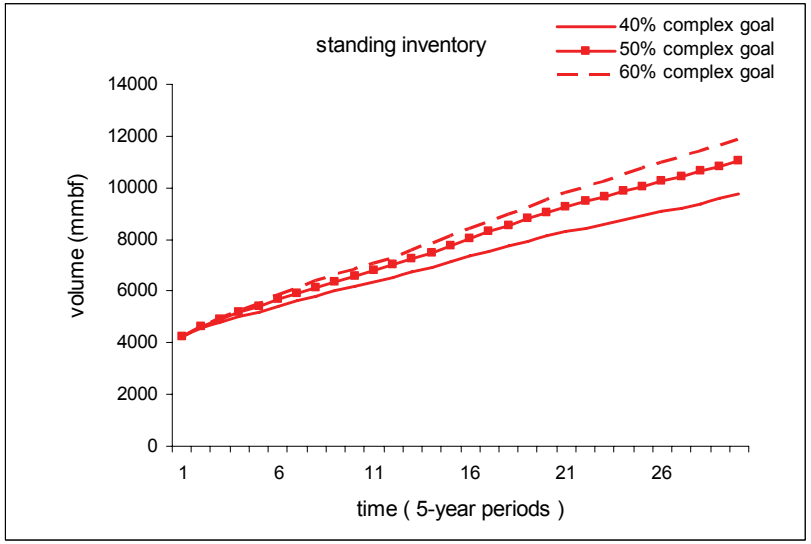



# Tillamook District – FMP using HCP Alternative – 40%, 50% and 60% complex structure goals

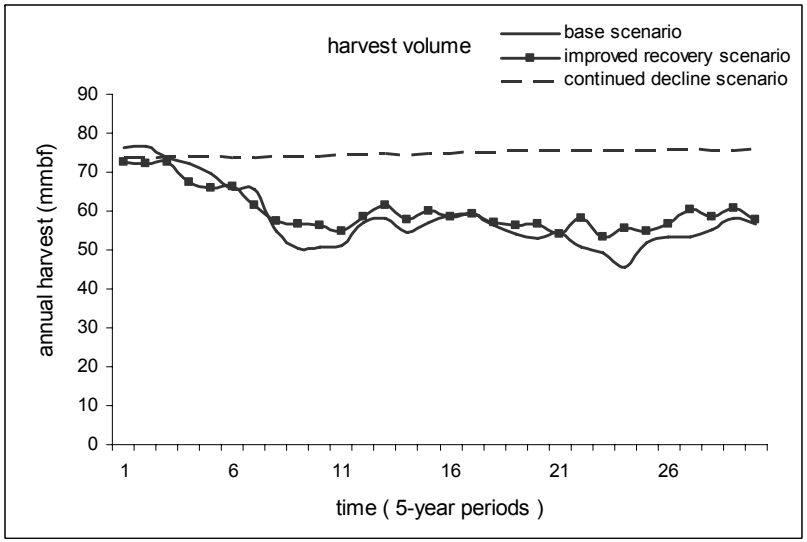


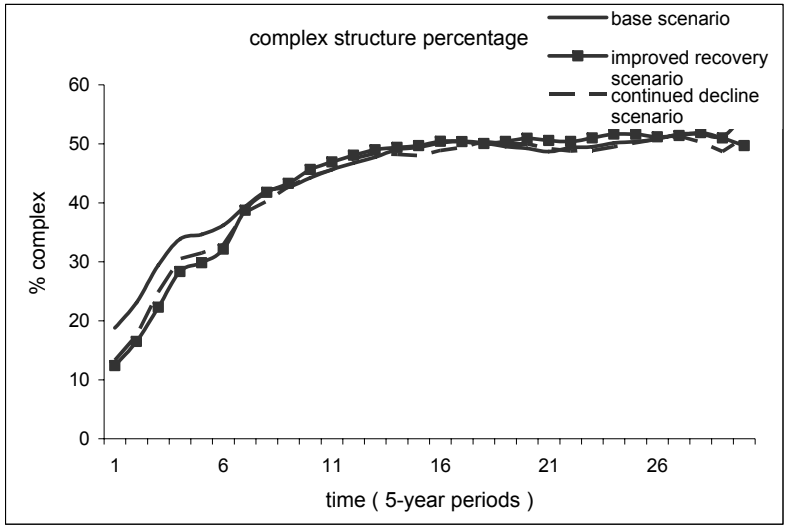



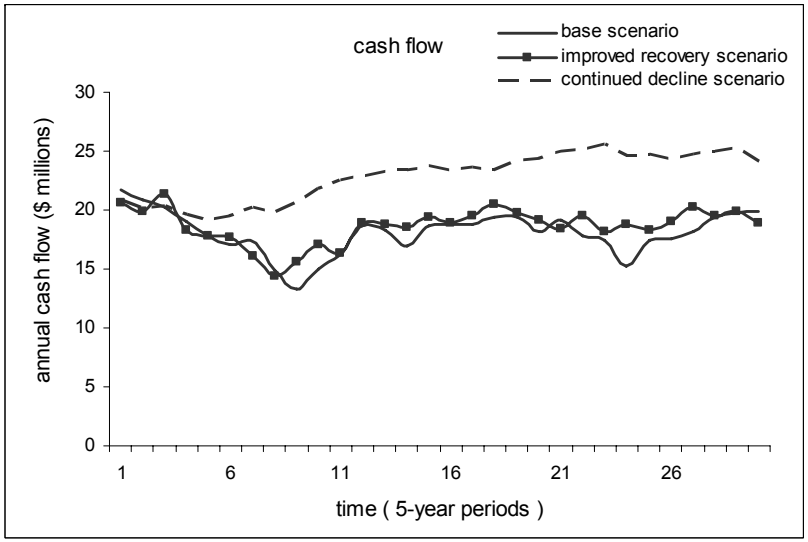



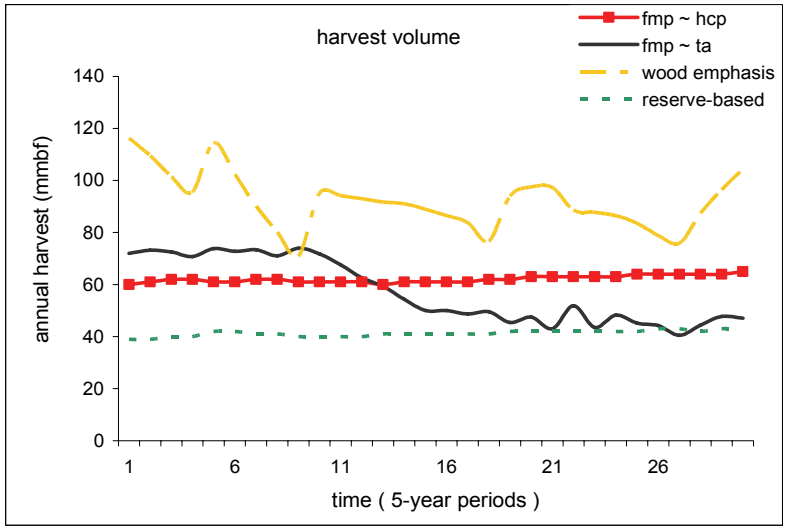
## Tillamook District – FMP using TA Alternative – Three NSO Population Trend Scenarios

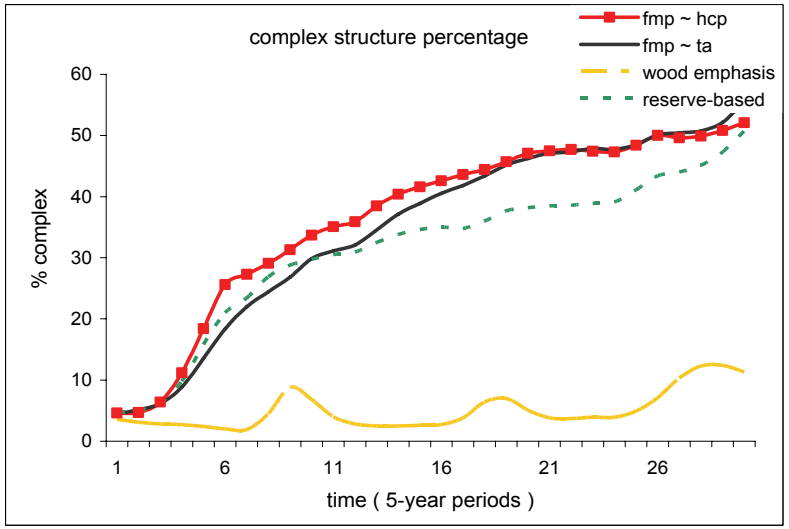


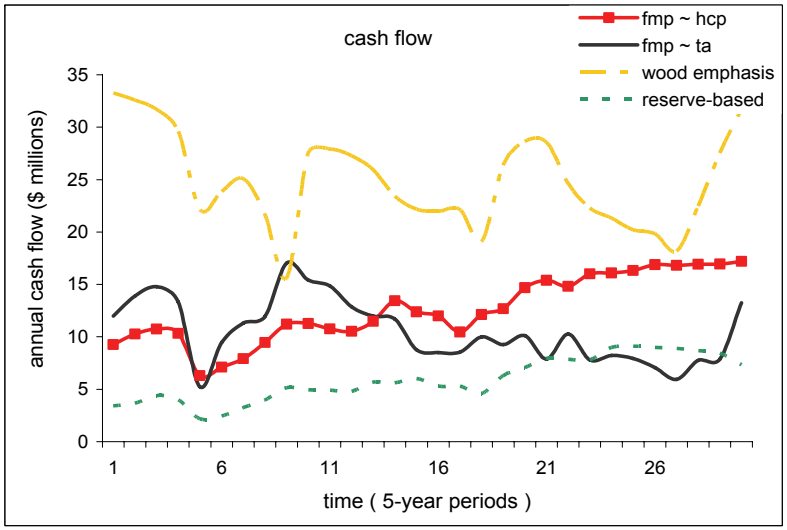



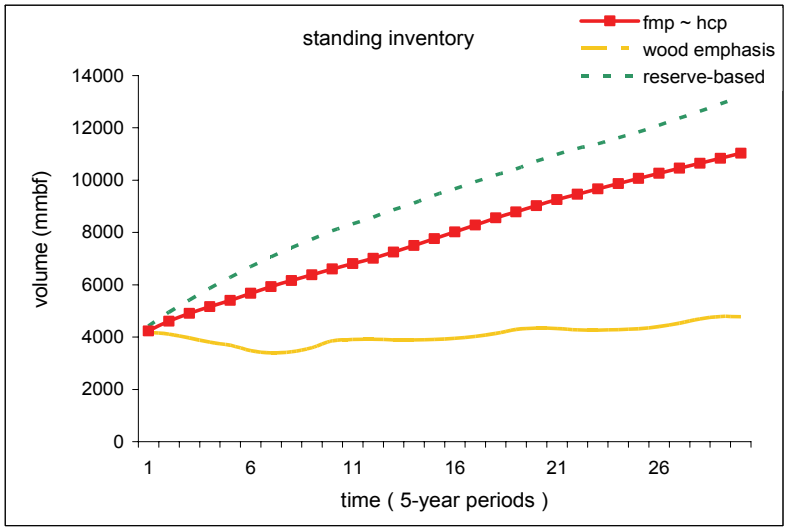



# Tillamook District – Comparison of All Four Alternatives

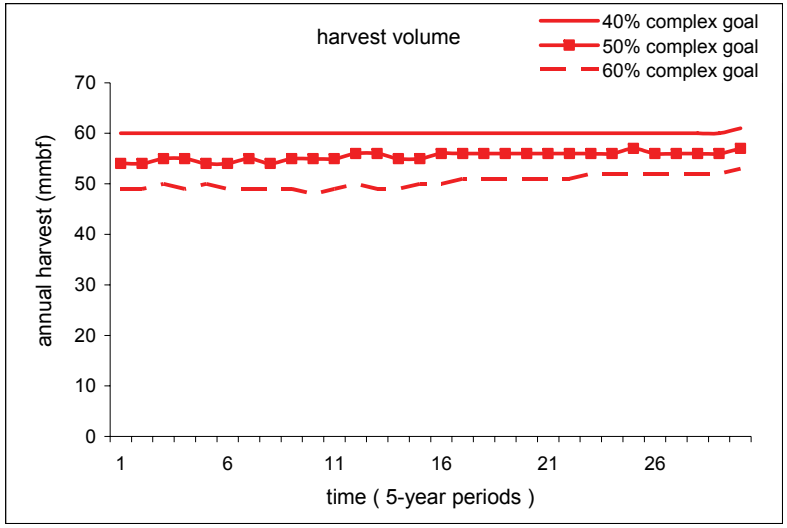


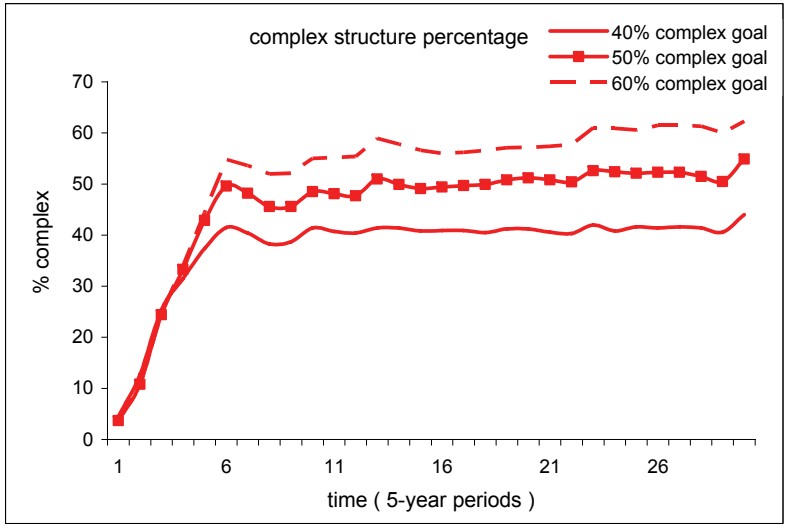



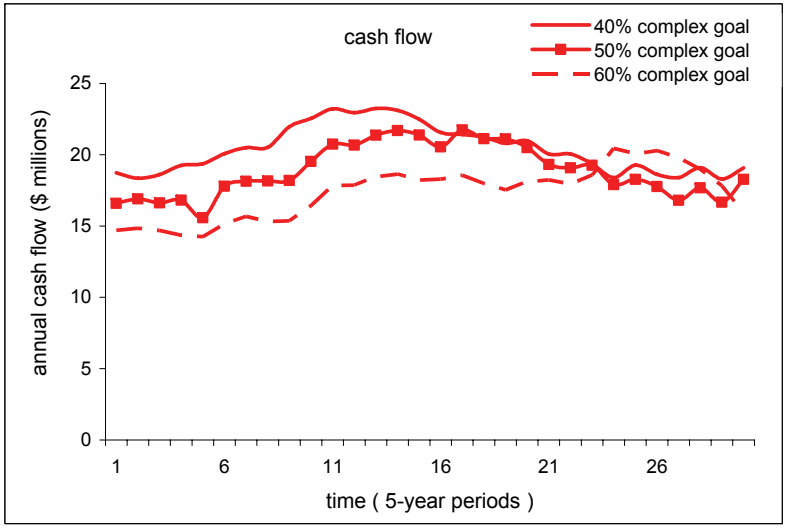



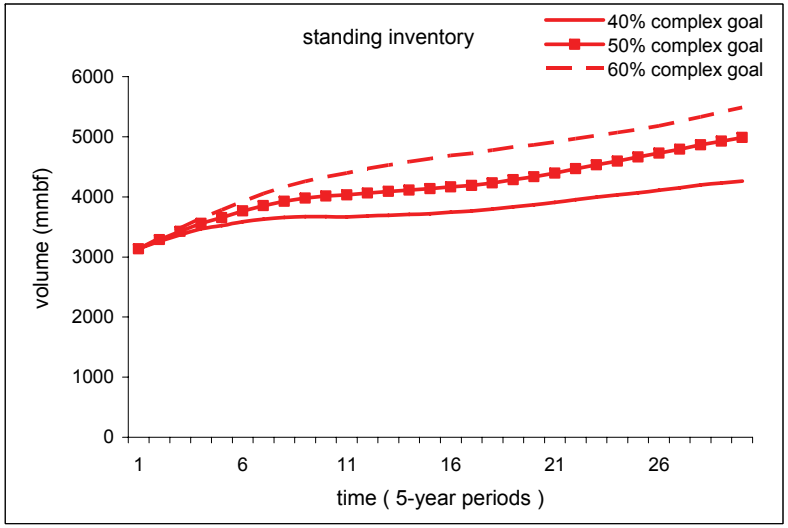



# Forest Grove District – FMP using HCP Alternative
# 40%, 50% and 60% complex structure goals

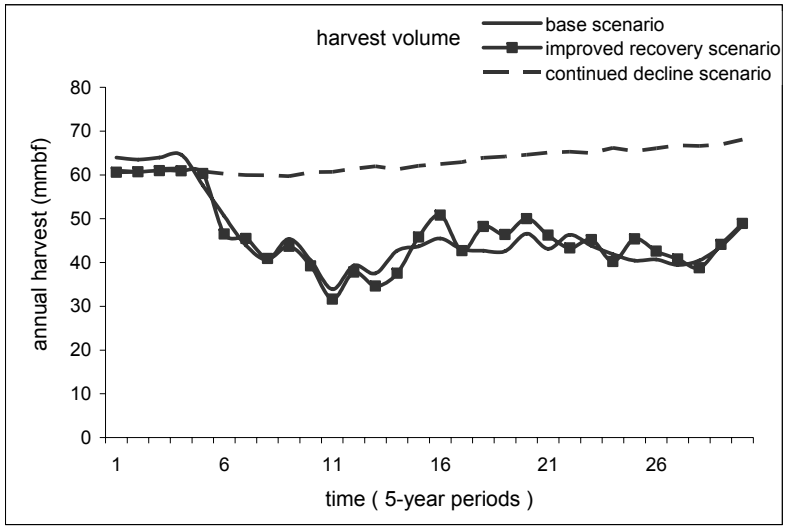


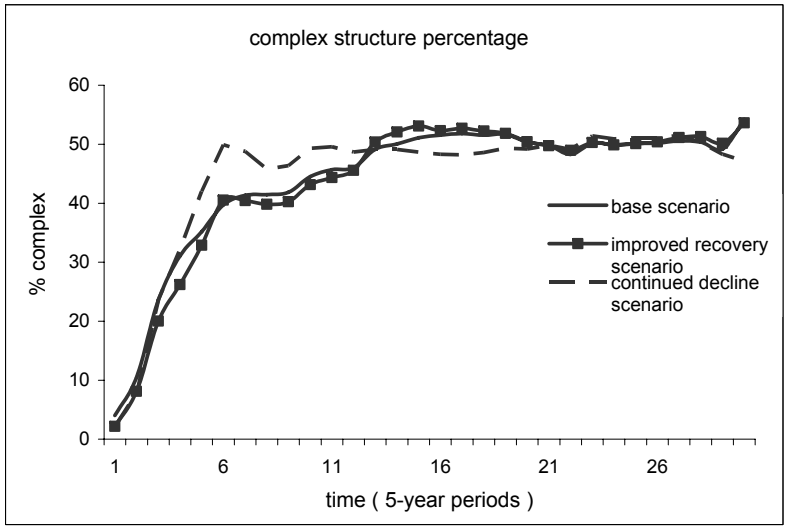



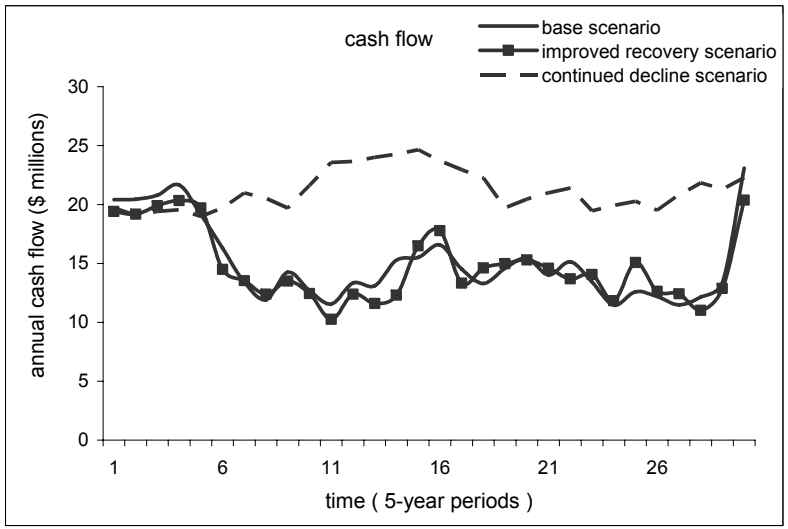



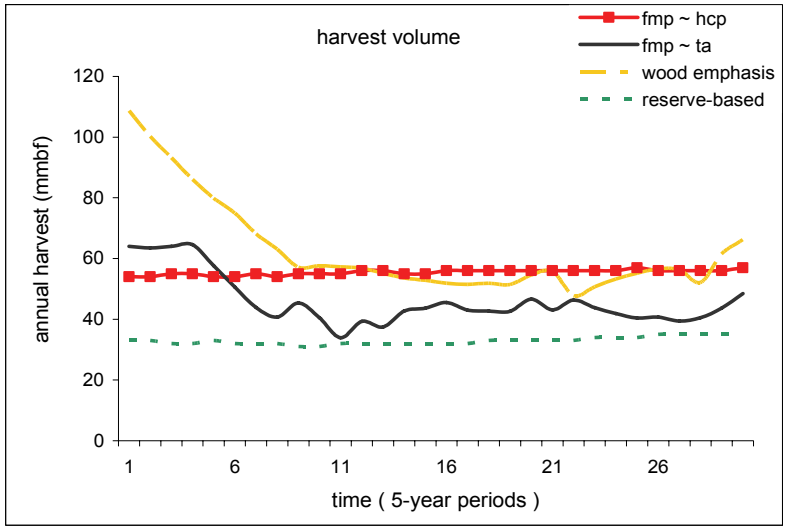
# Forest Grove District – FMP using TA Alternative – Three NSO Population Trend Scenarios

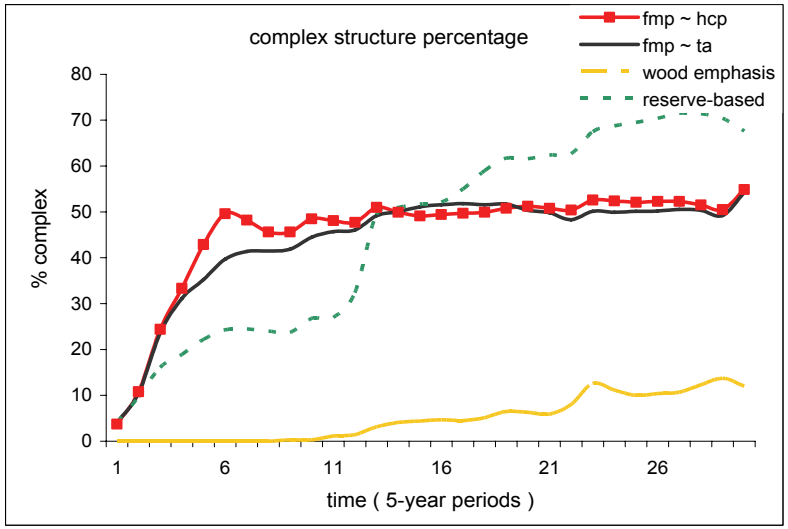


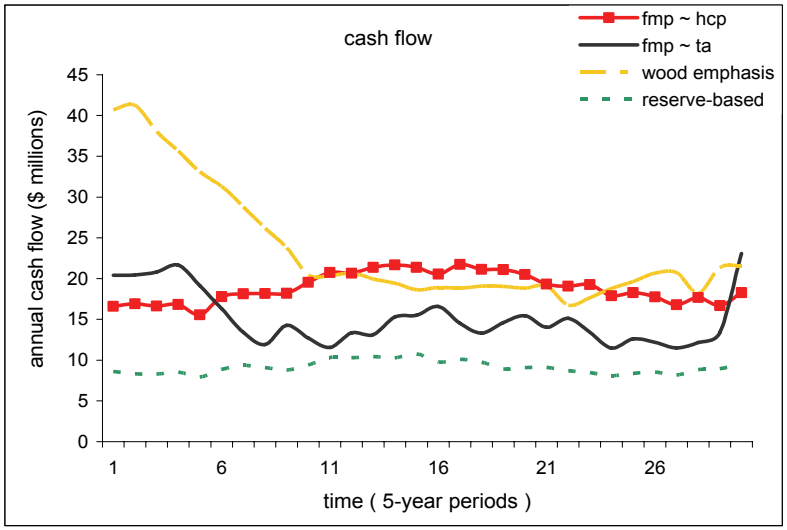



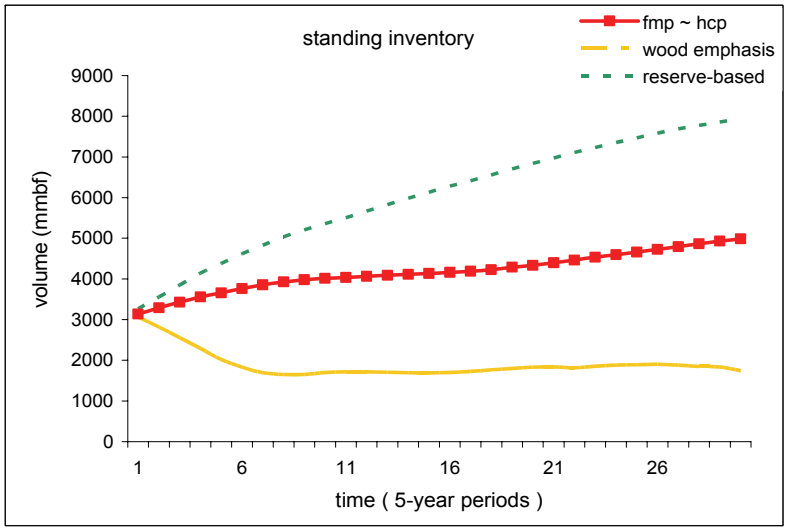



# Forest Grove District – Comparison of All Four Alternatives

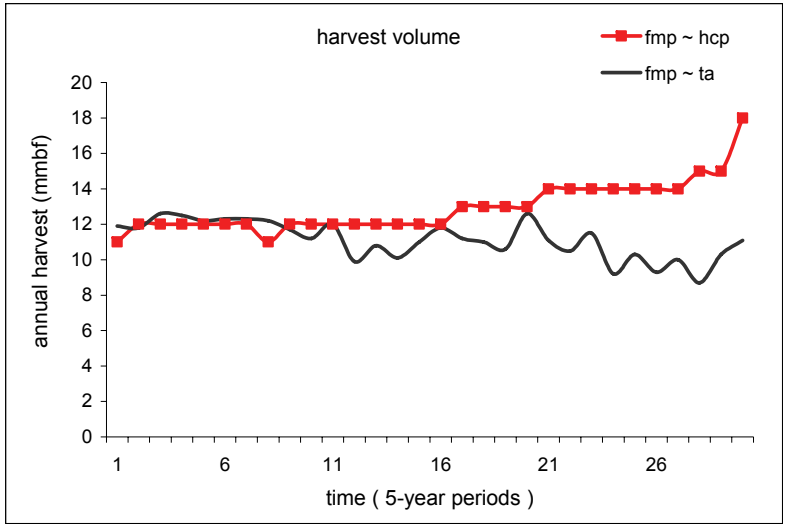


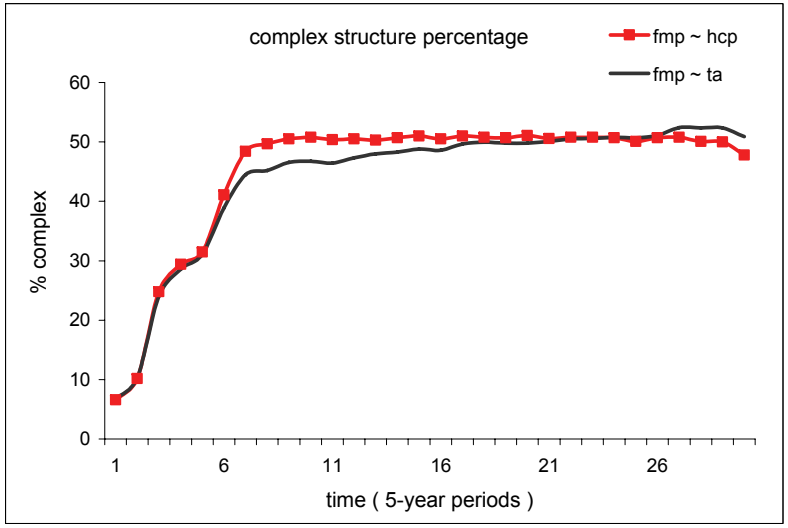



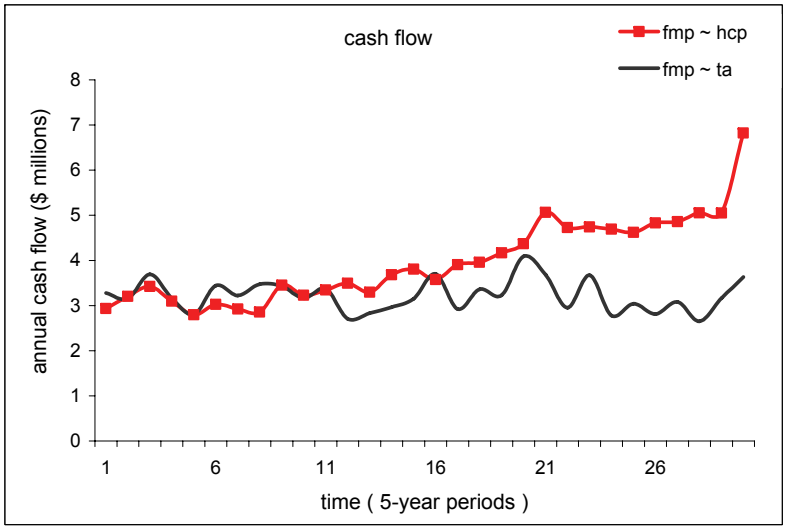



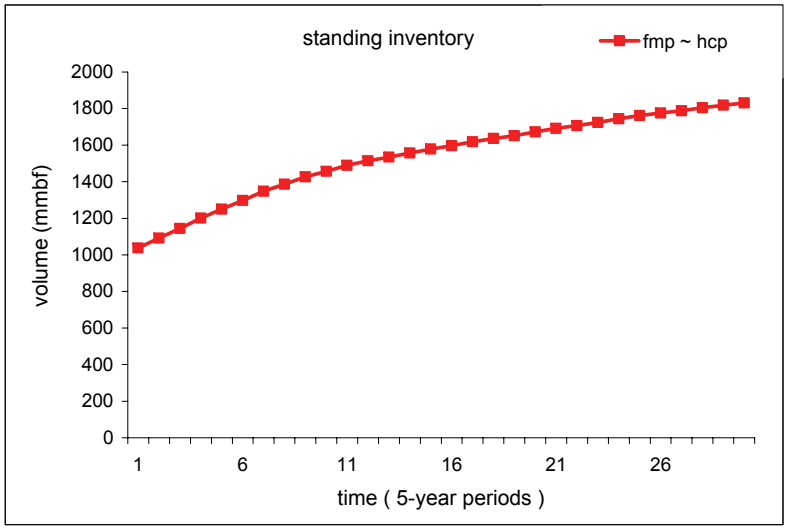



# North Cascade District
## Comparison of FMP using HCP Alternative and FMP using TA Alternative

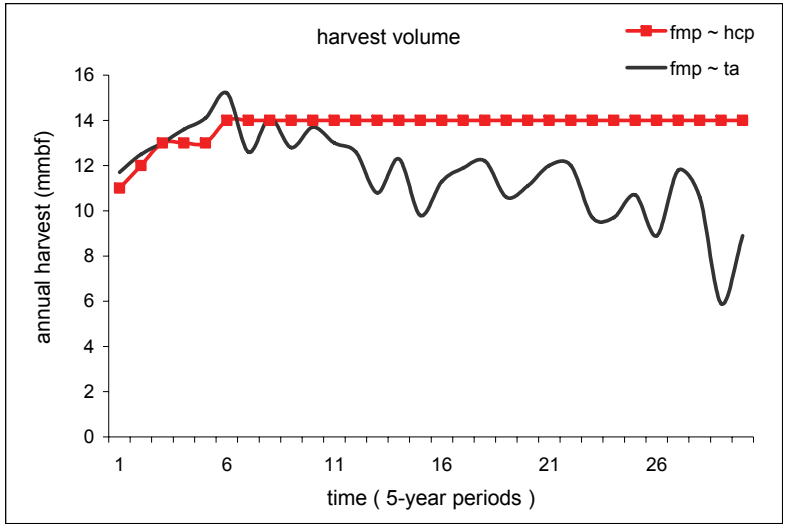


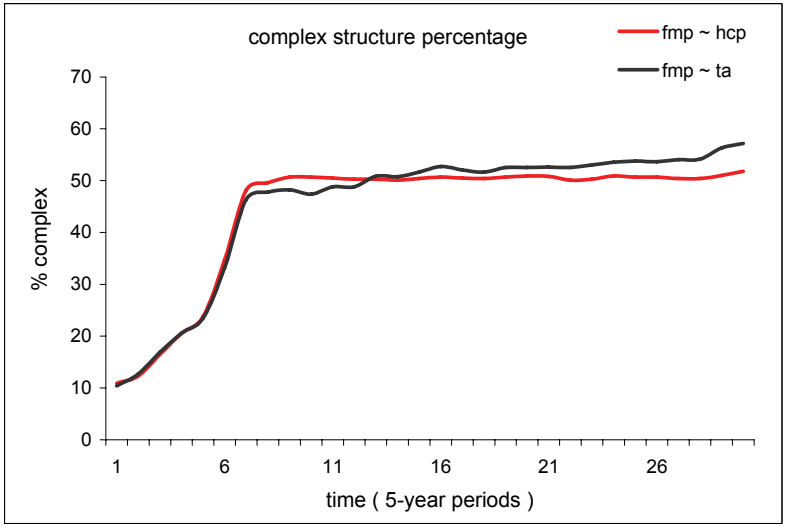



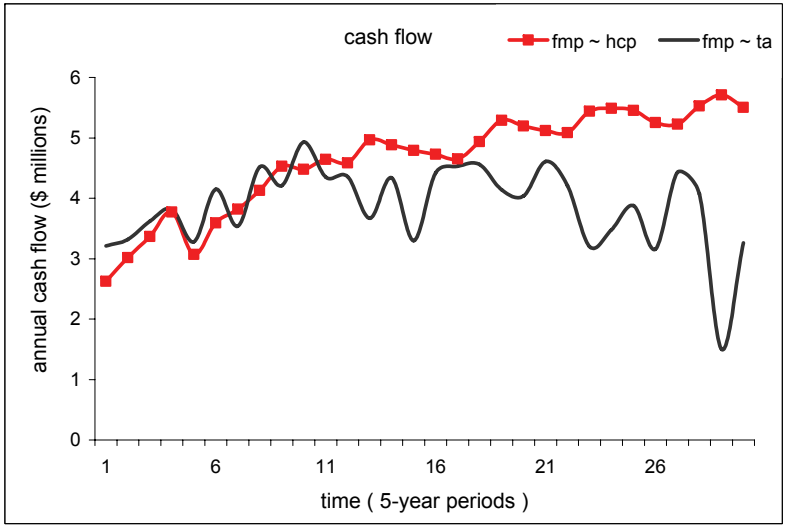



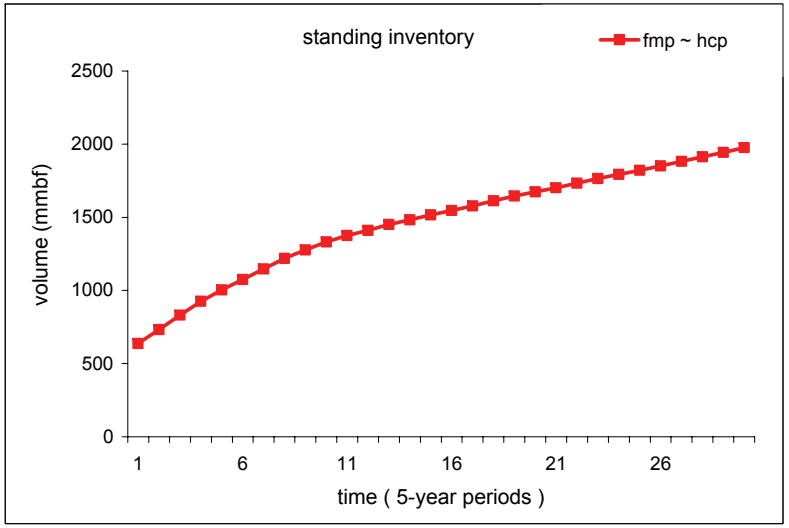



# West Oregon District
## Comparison of FMP using HCP Alternative and FMP using TA Alternative

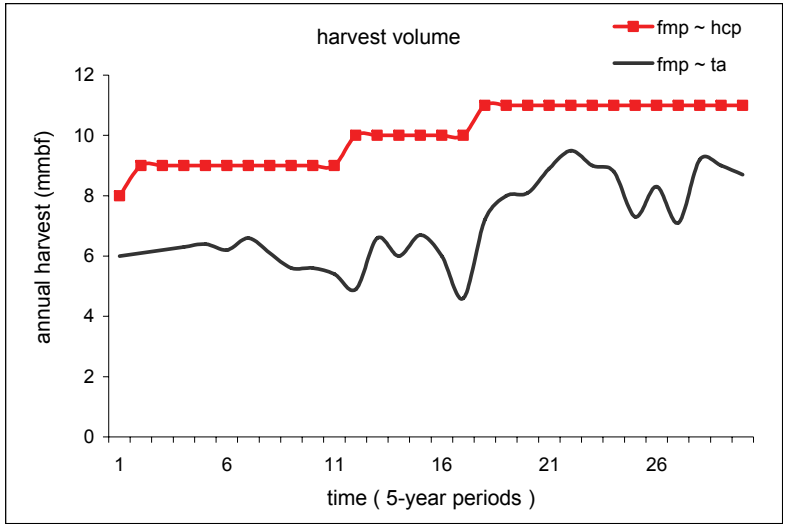


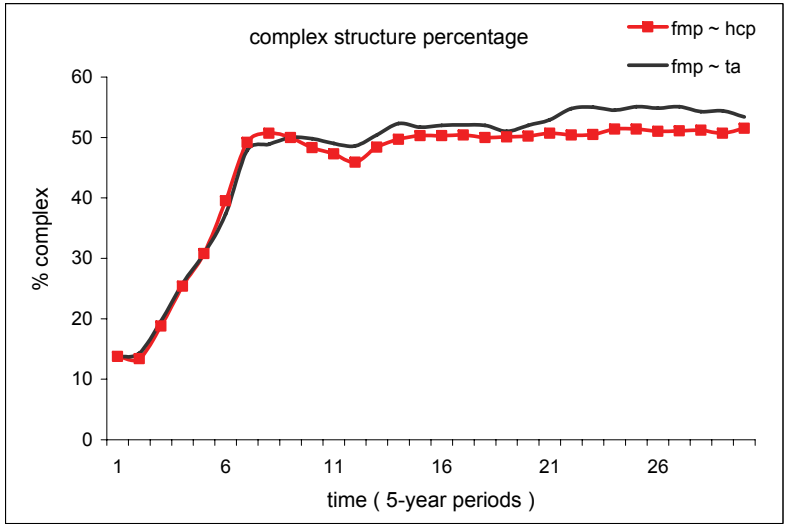



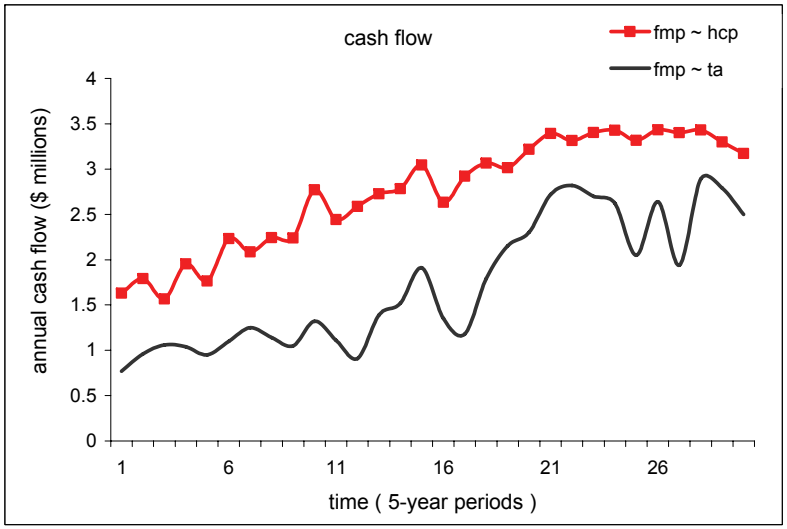



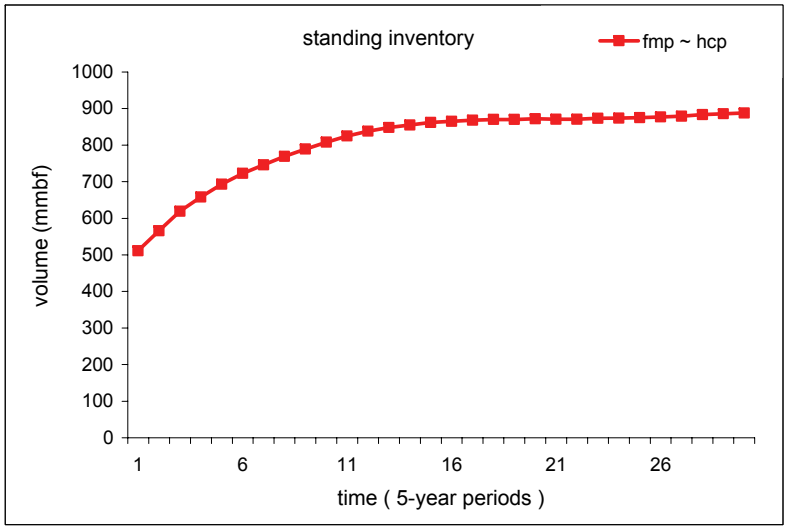



# Western Lane District
## Comparison of FMP using HCP Alternative and FMP using TA Alternative

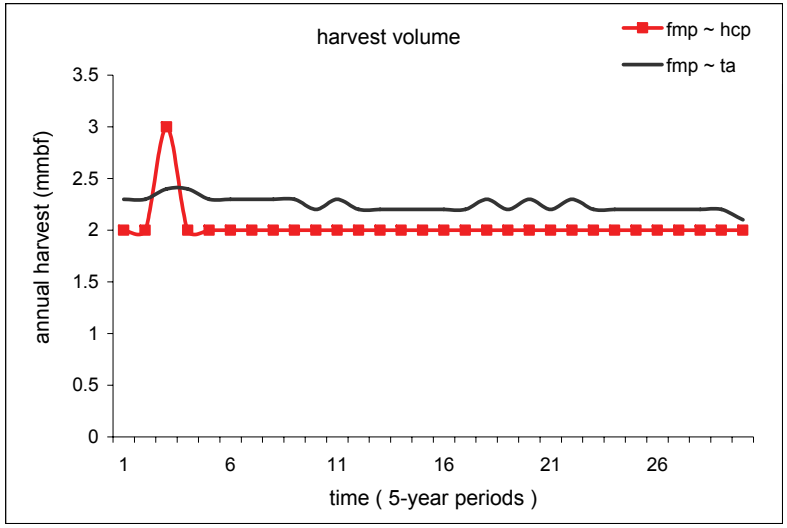


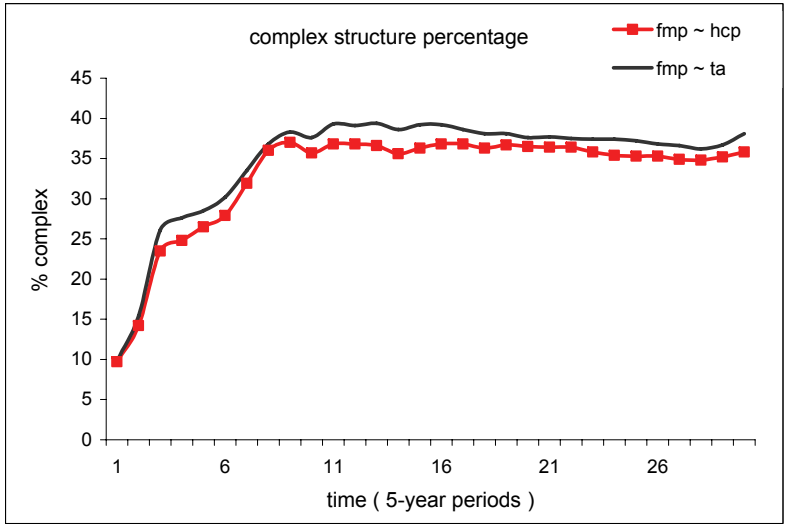



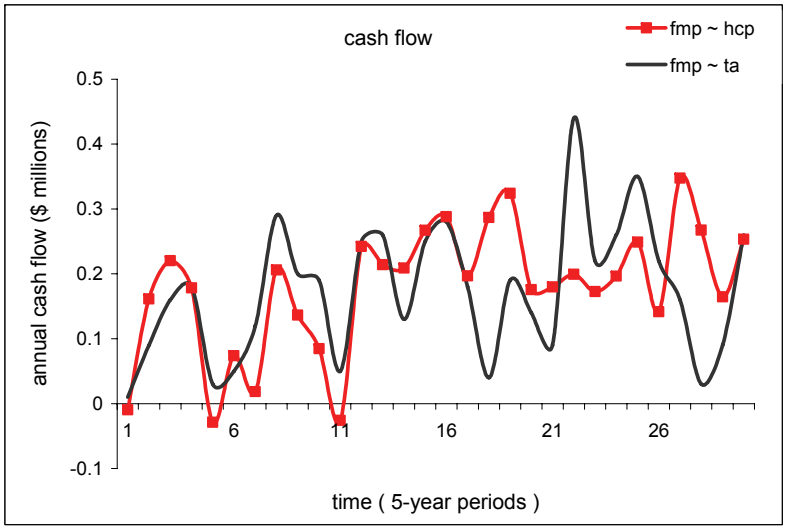



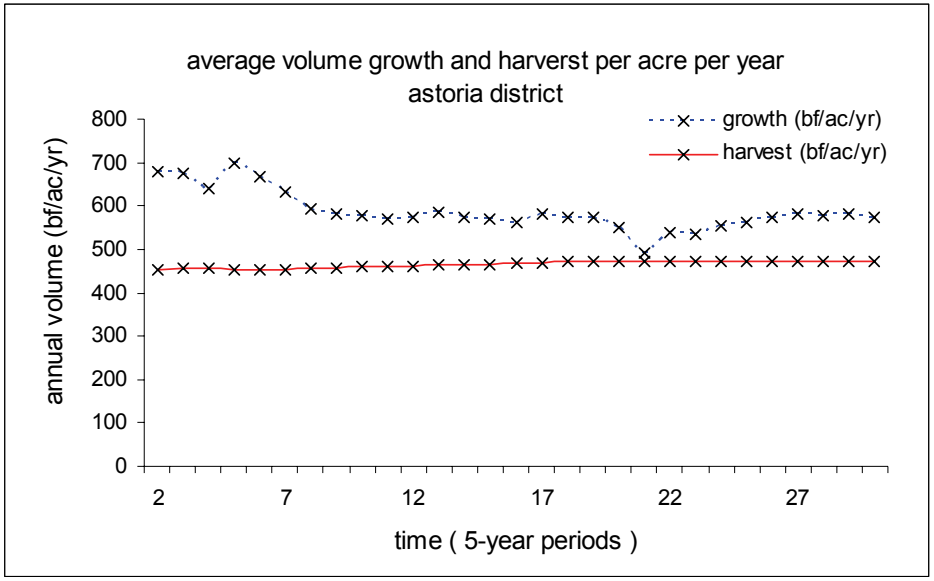
# Southwest Oregon District
## Comparison of FMP using HCP Alternative and FMP using TA Alternative

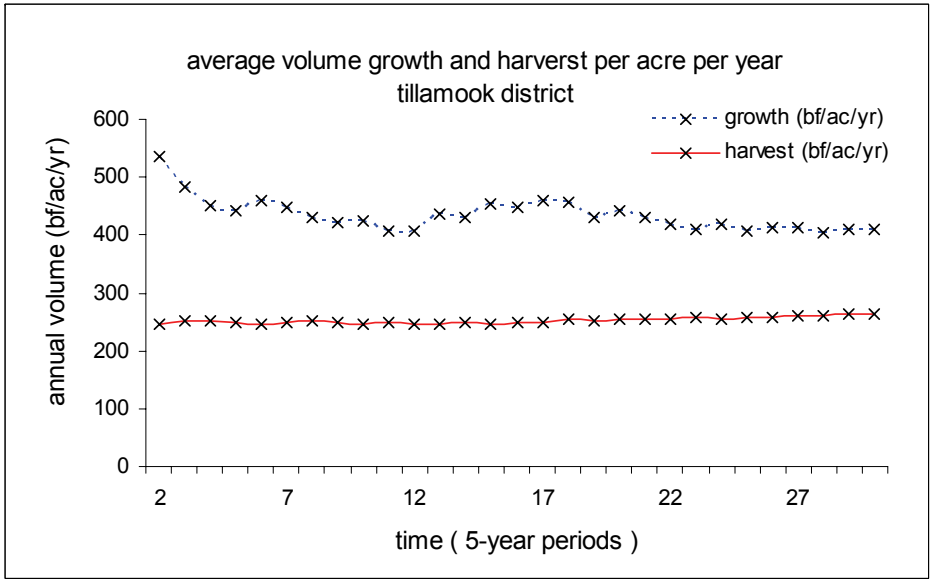


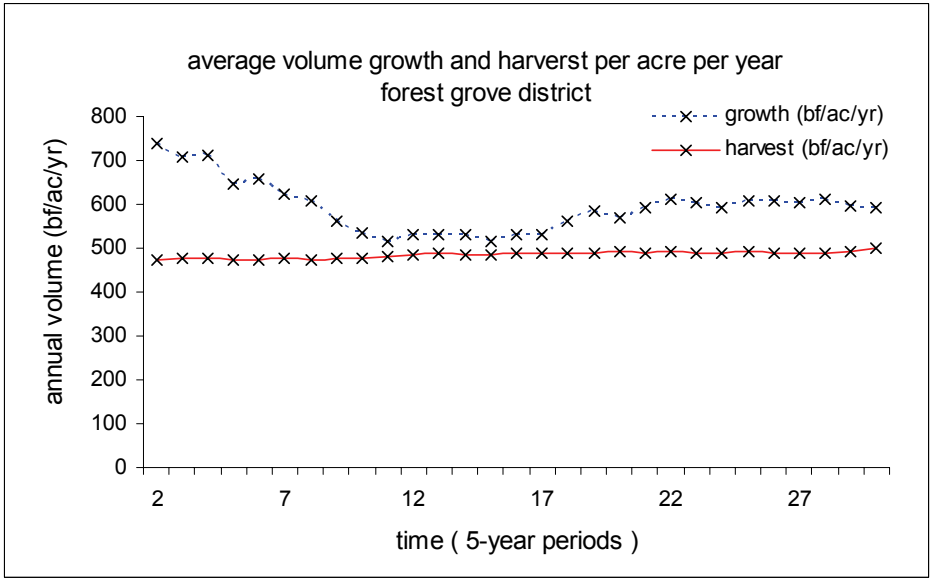



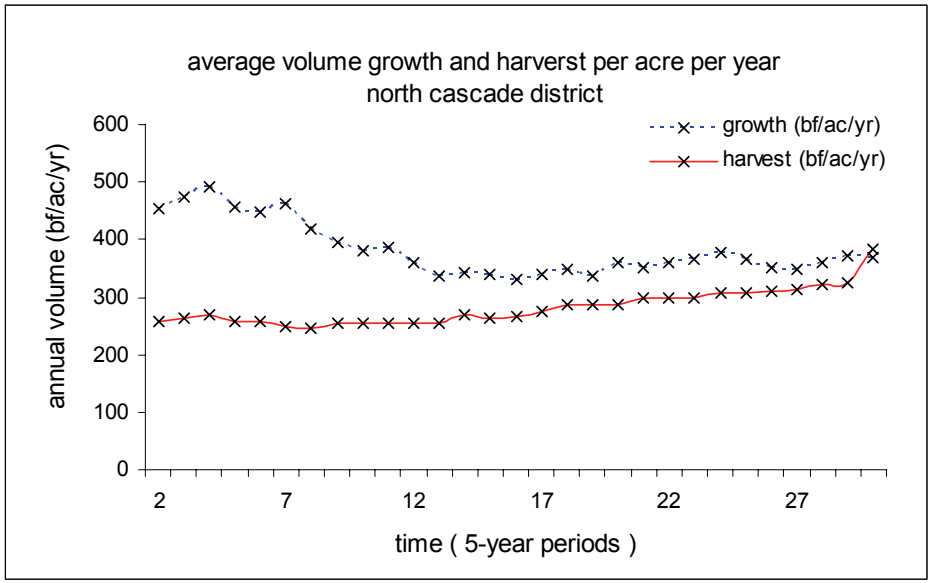




# FMP using HCP Alternative – Average Growth and Harvest

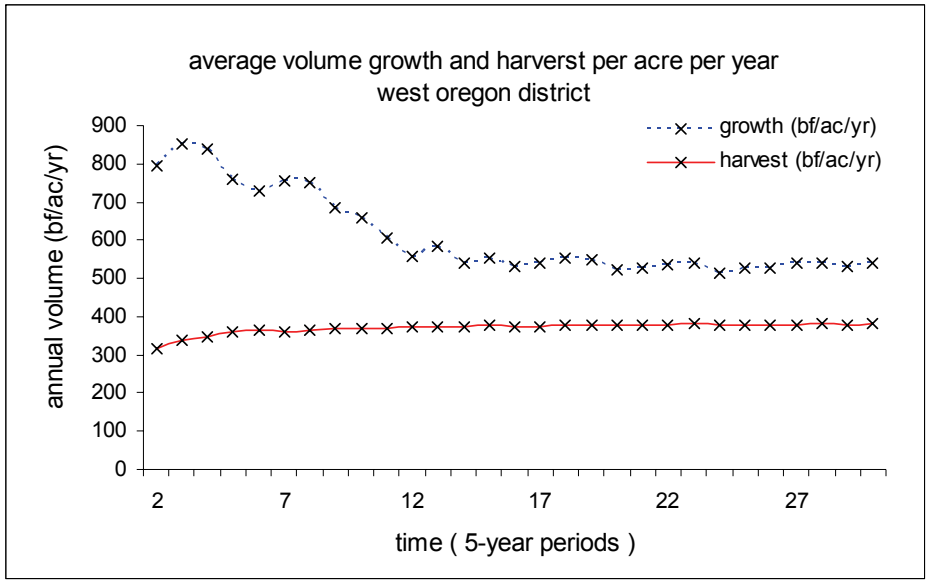


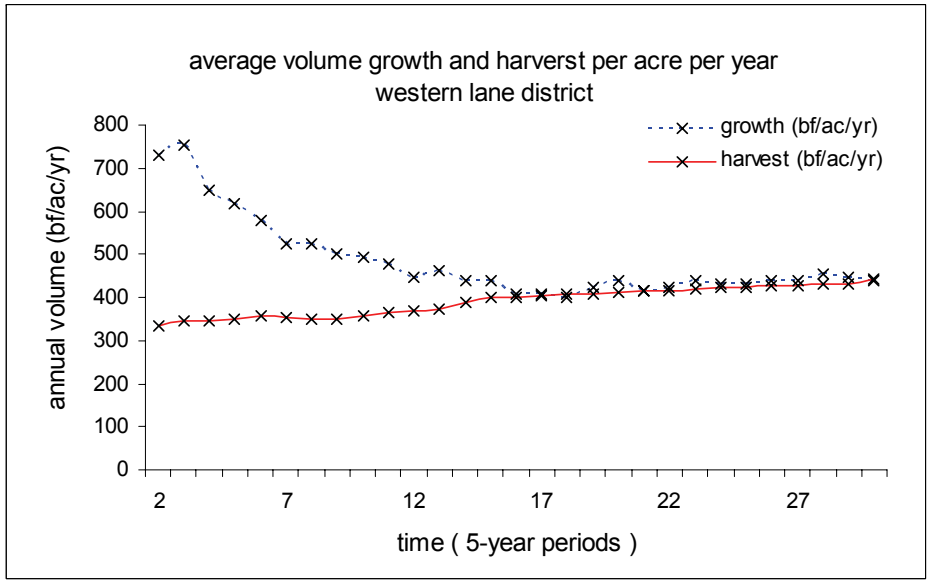



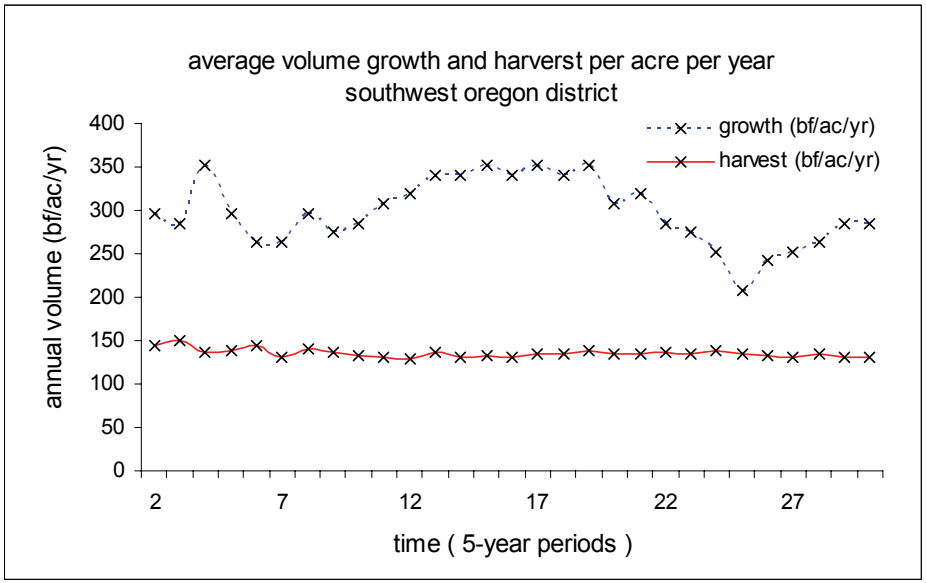



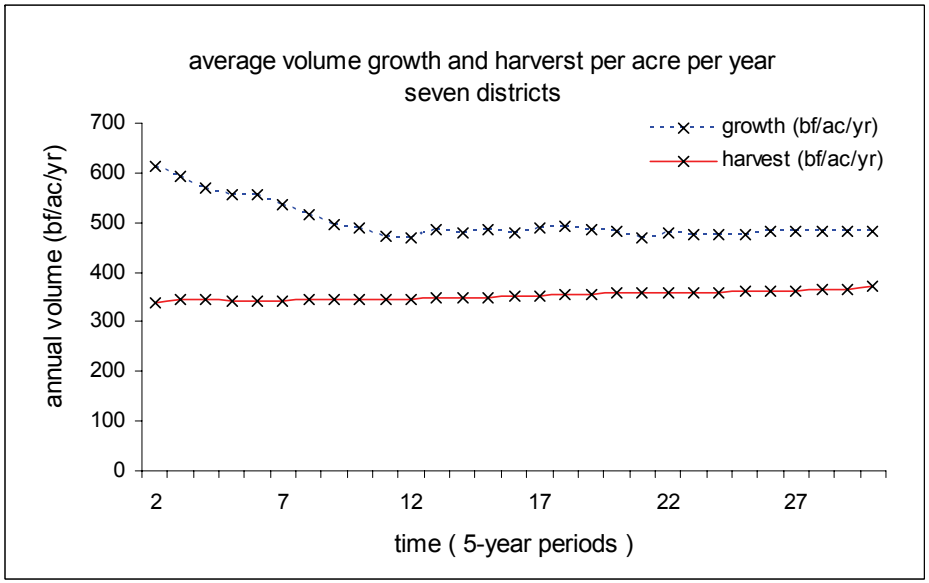



# FMP using HCP Alternative – Average Growth and Harvest (continued)



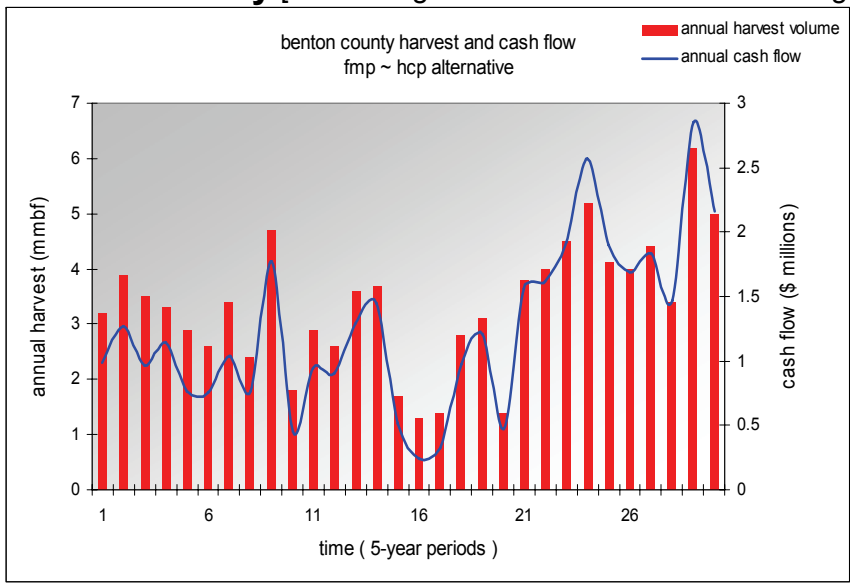



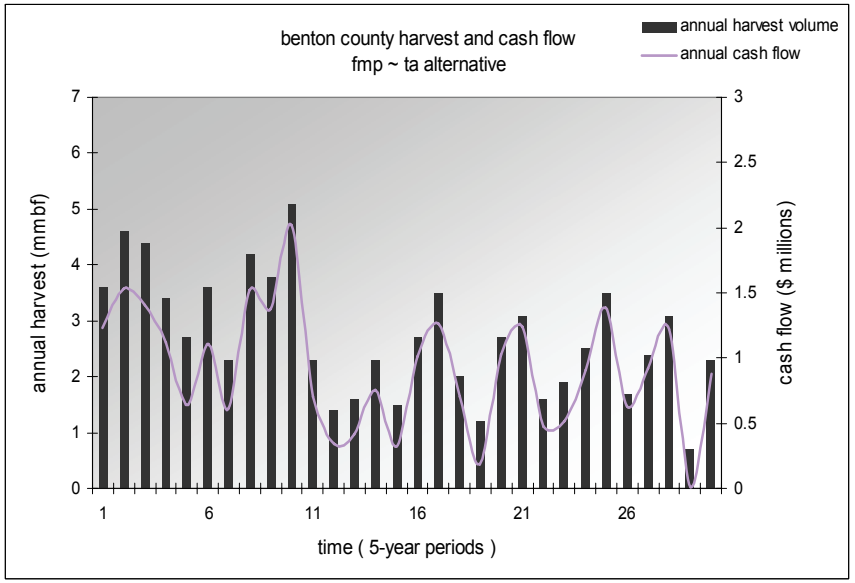



*This page left intentially blank*

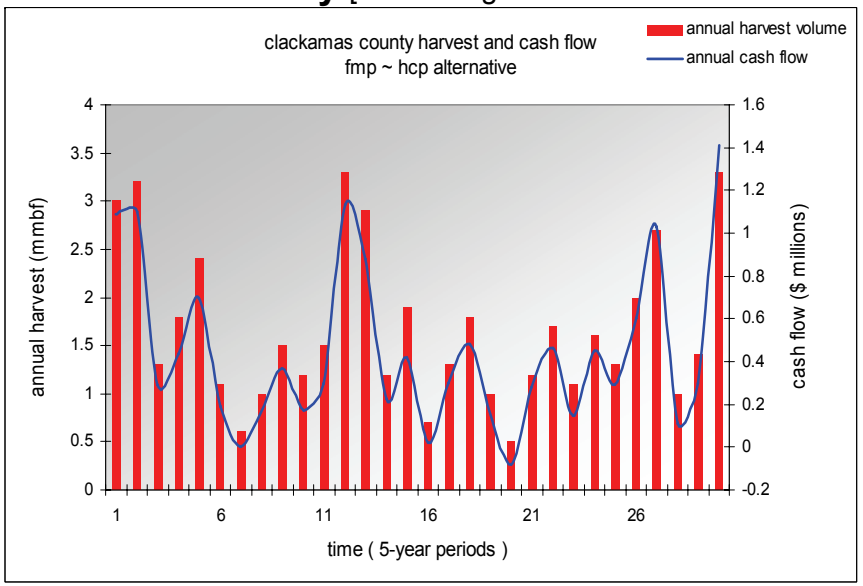
# Appendix I
# Model Results: Volume and Cash Flow by County

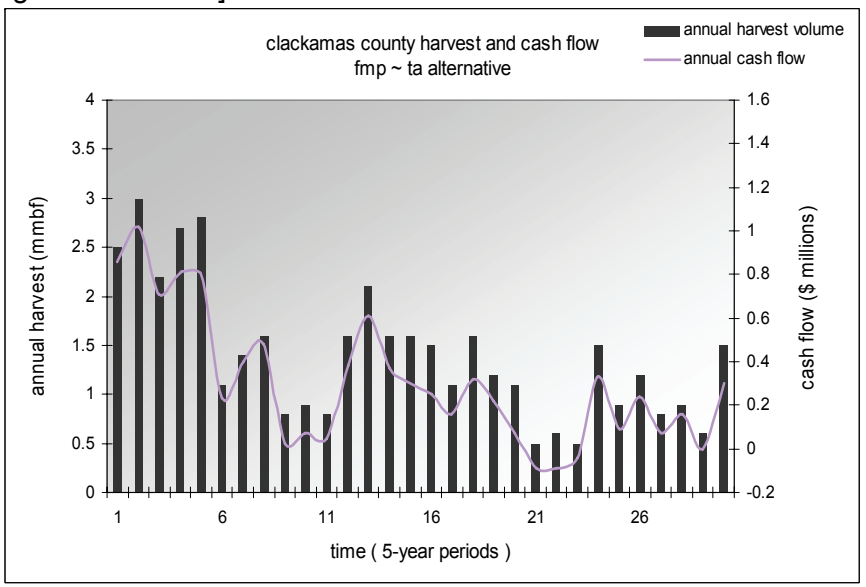
## Benton County [FMP using HCP alternative and FMP using TA alternative]



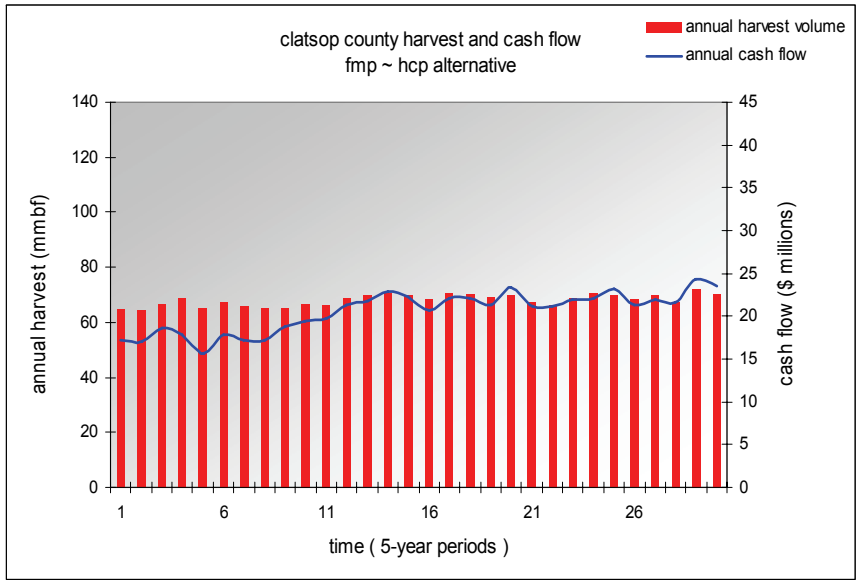



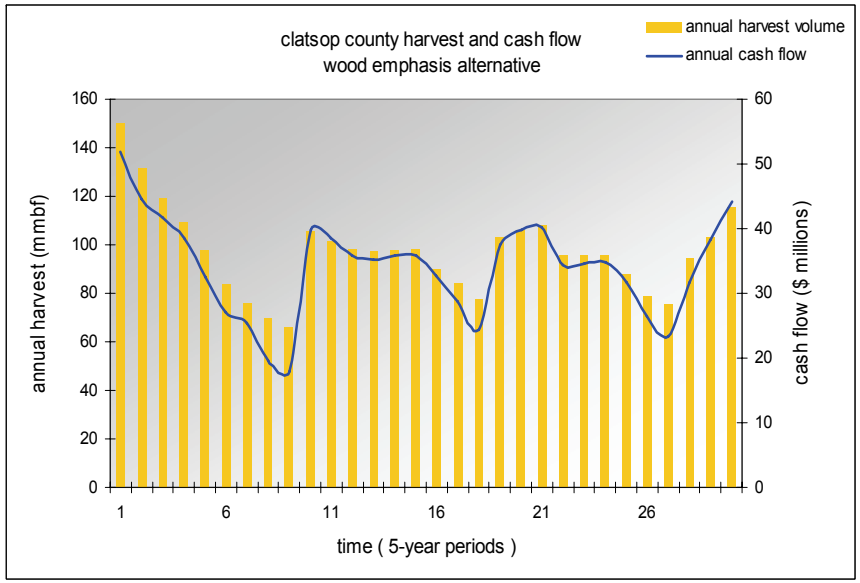

## Clackamas County [FMP using HCP alternative and FMP using TA alternative]

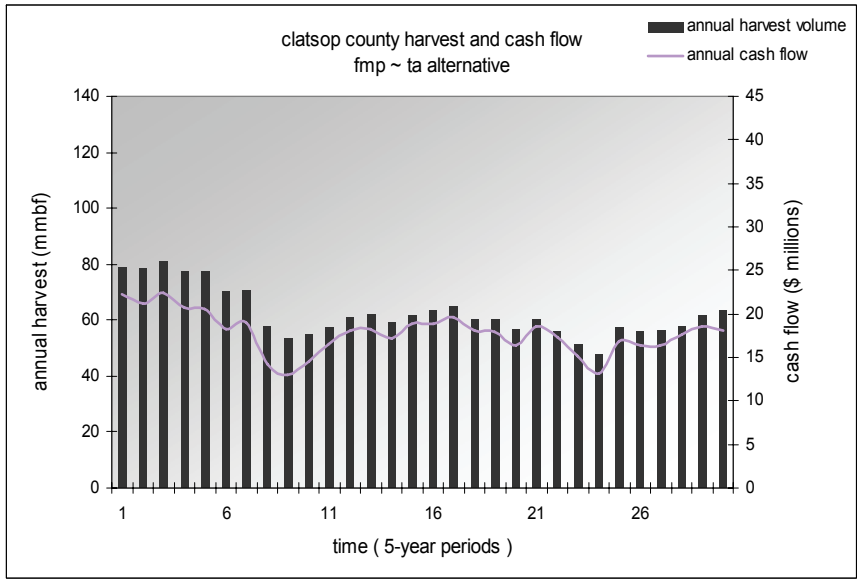


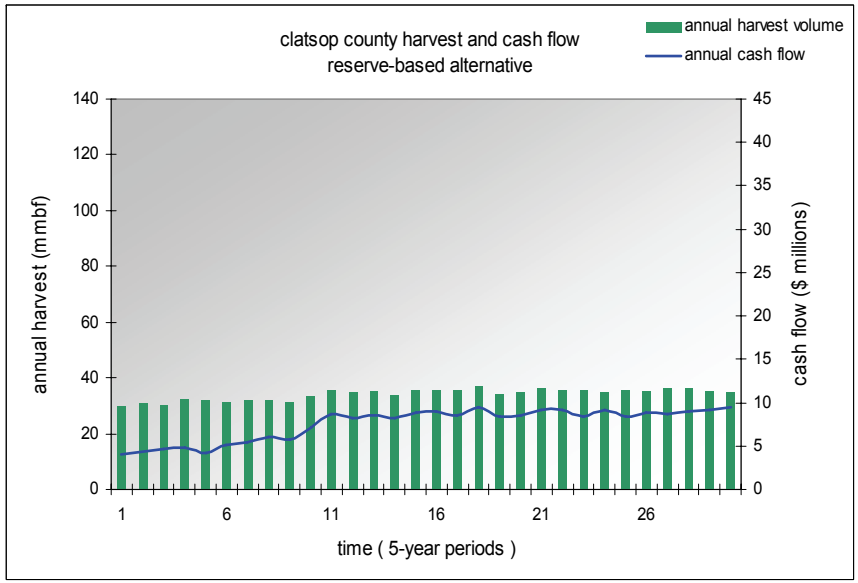



## **Clatsop County** [all four alternatives]

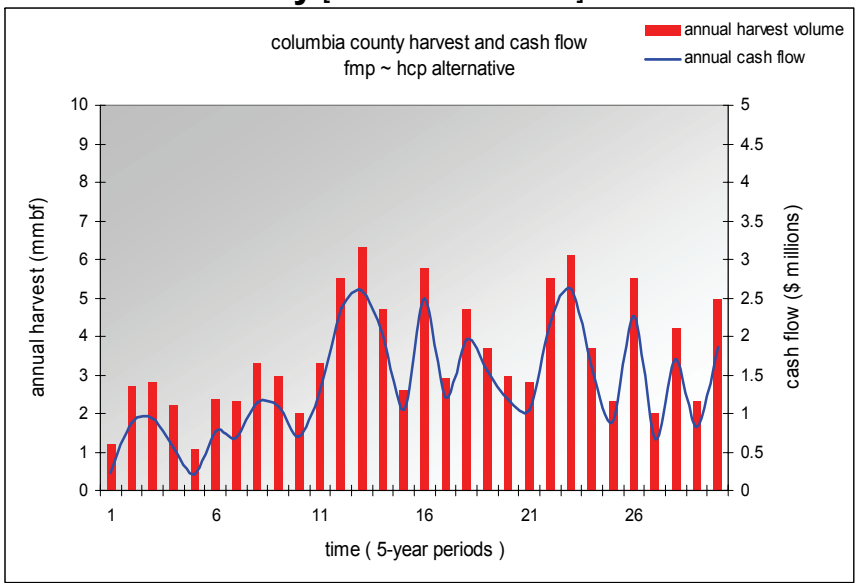


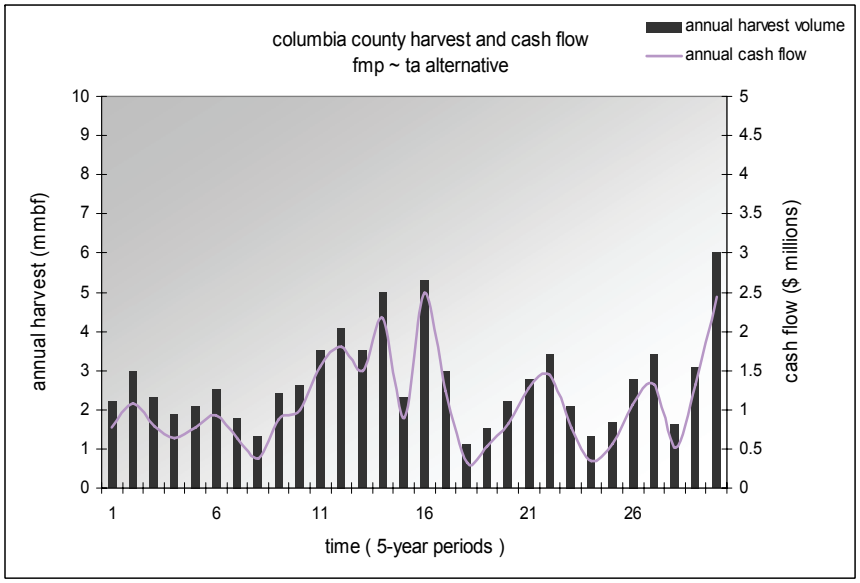



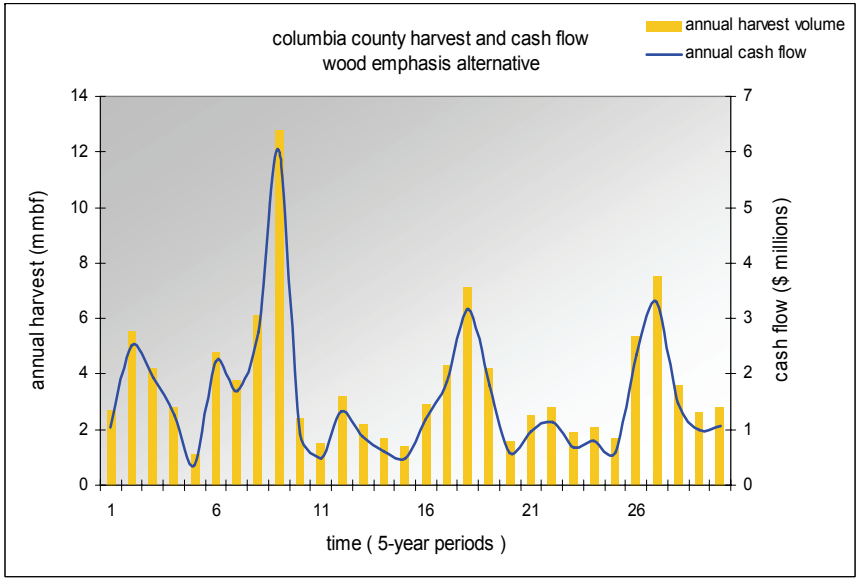



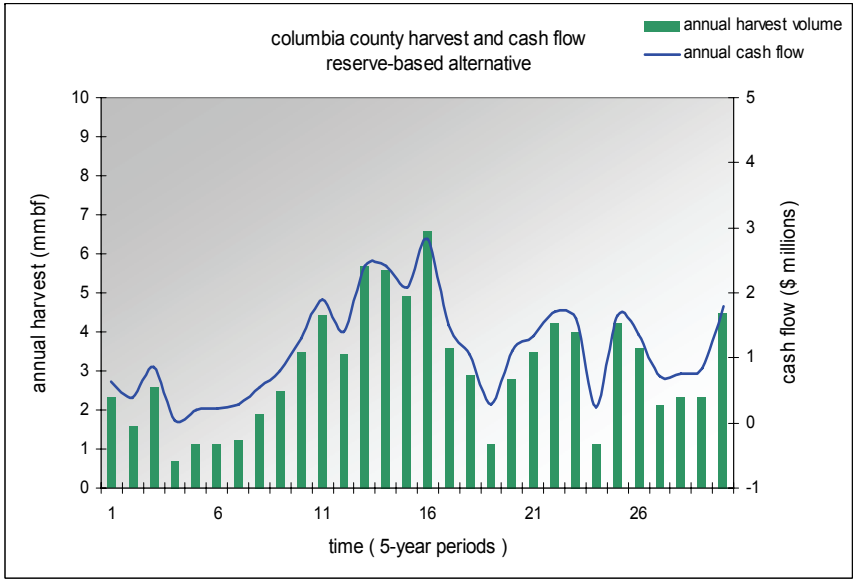



## **Columbia County** [all four alternatives]

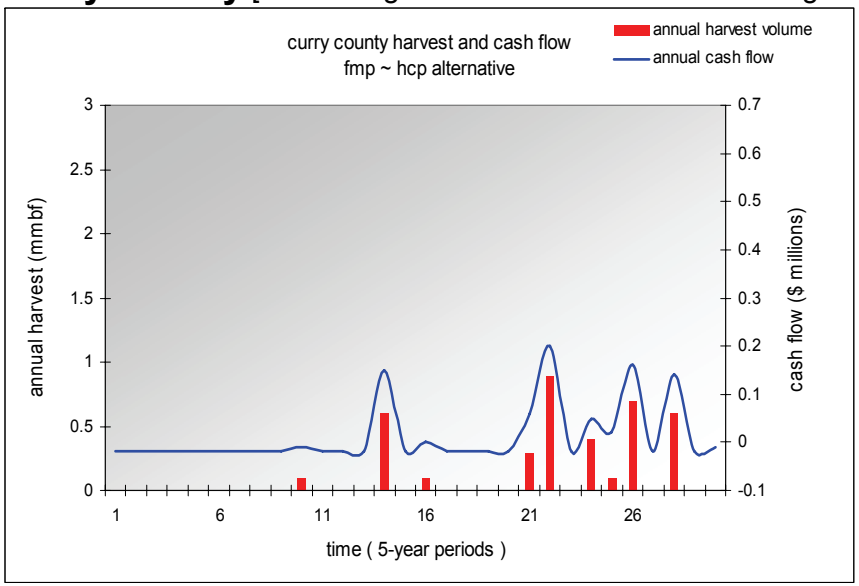


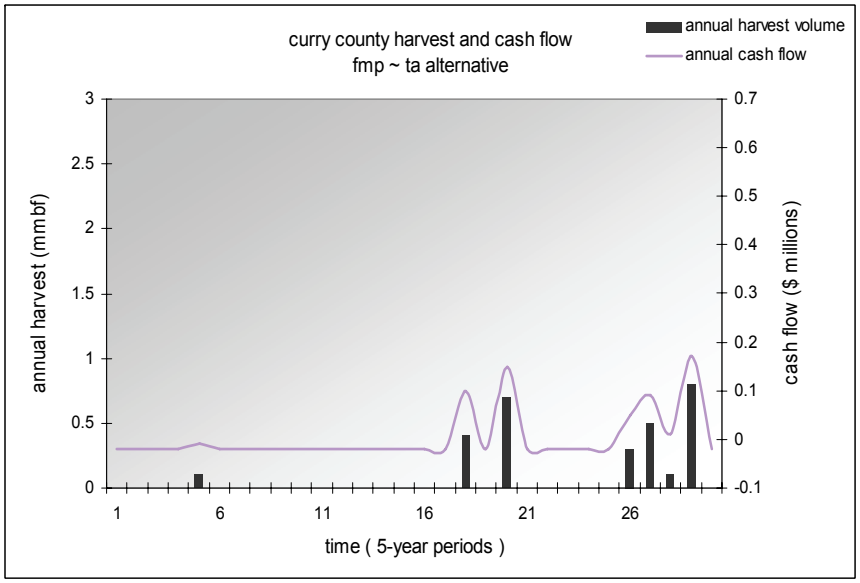



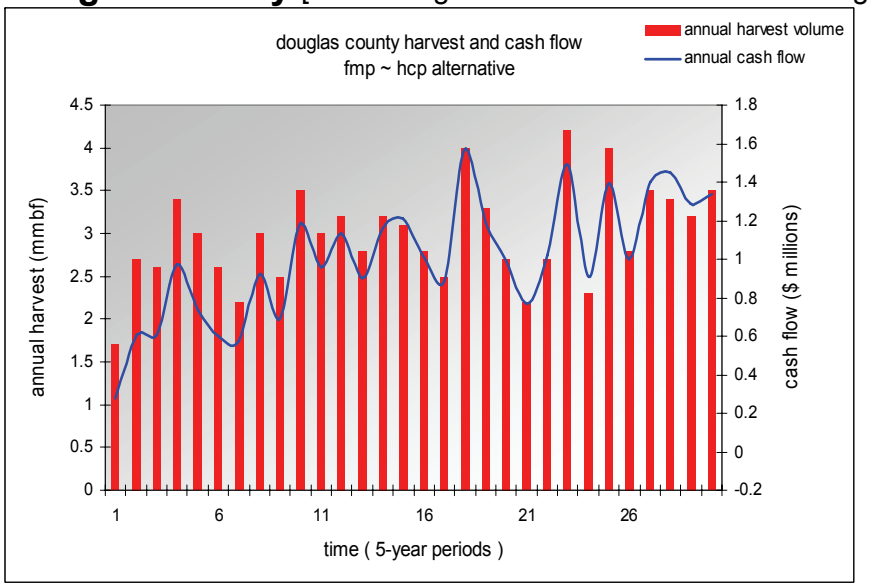



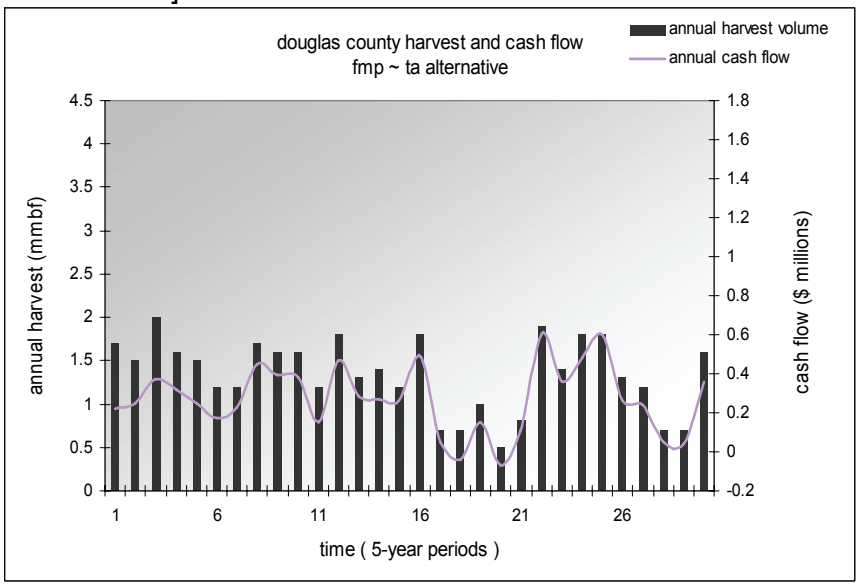
## **Curry County** [FMP using HCP alternative and FMP using TA alternative]



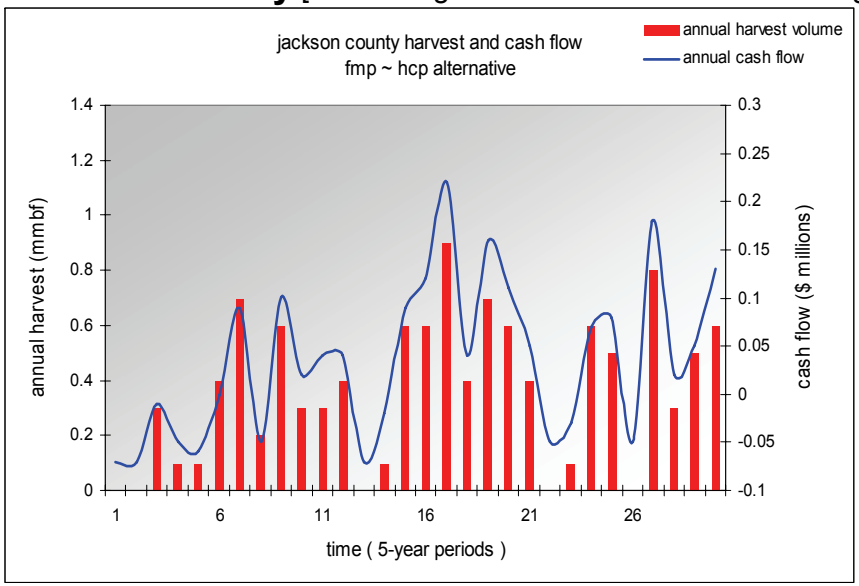



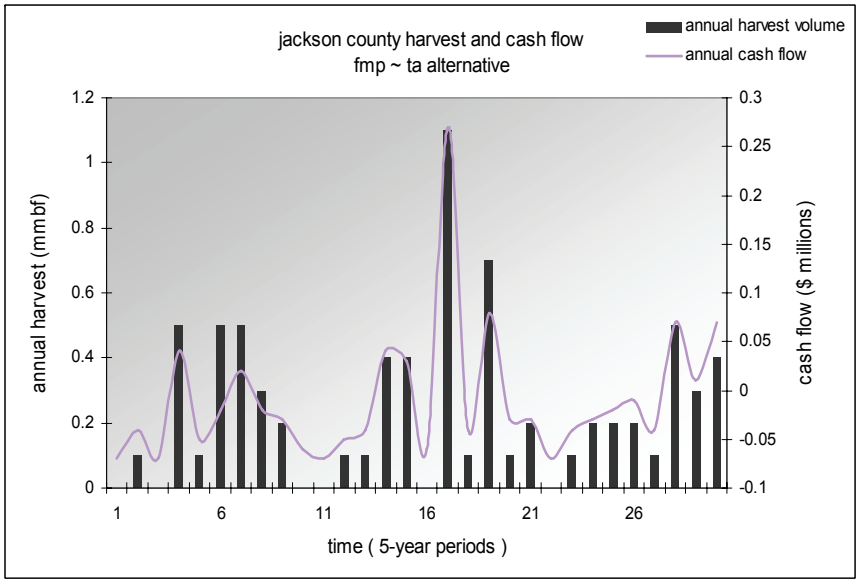

## **Douglas County** [FMP using HCP alternative and FMP using TA alternative]



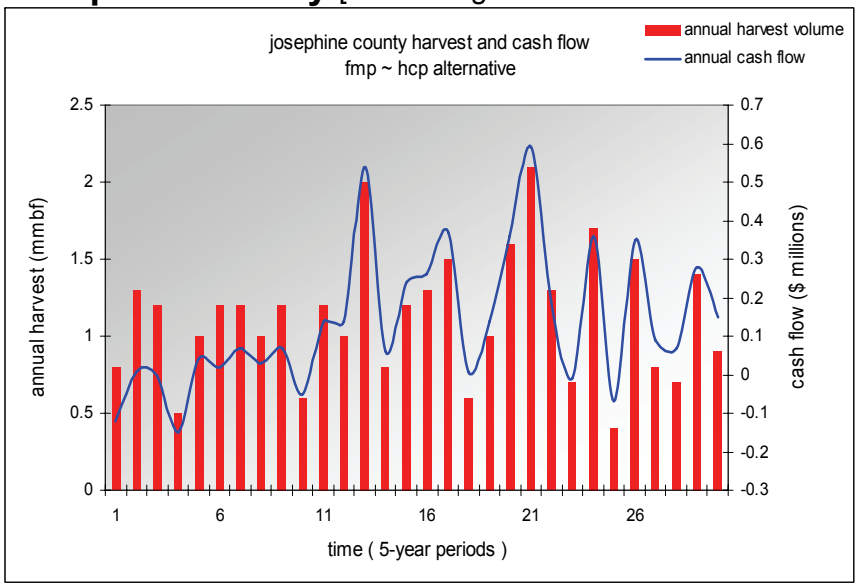



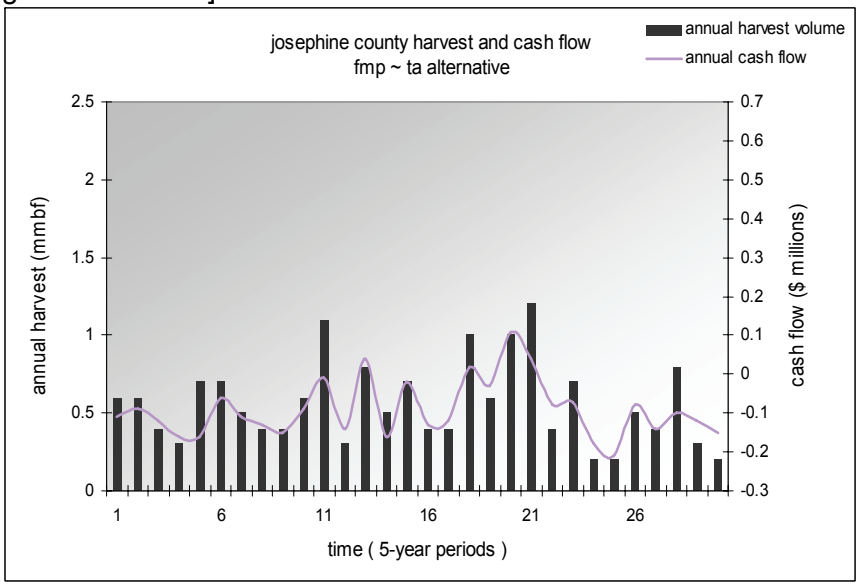
## **Jackson County** [FMP using HCP alternative and FMP using TA alternative]



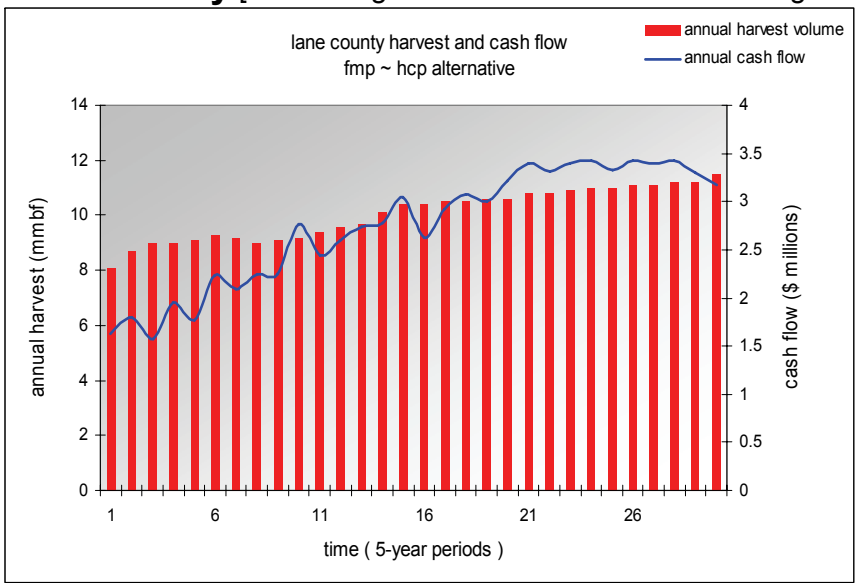



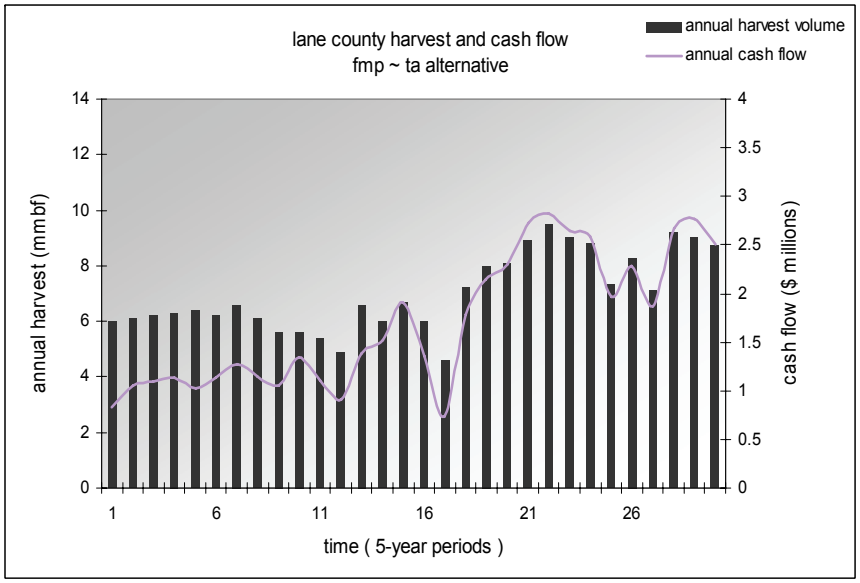

## **Josephine County** [FMP using HCP alternative and FMP using TA alternative]



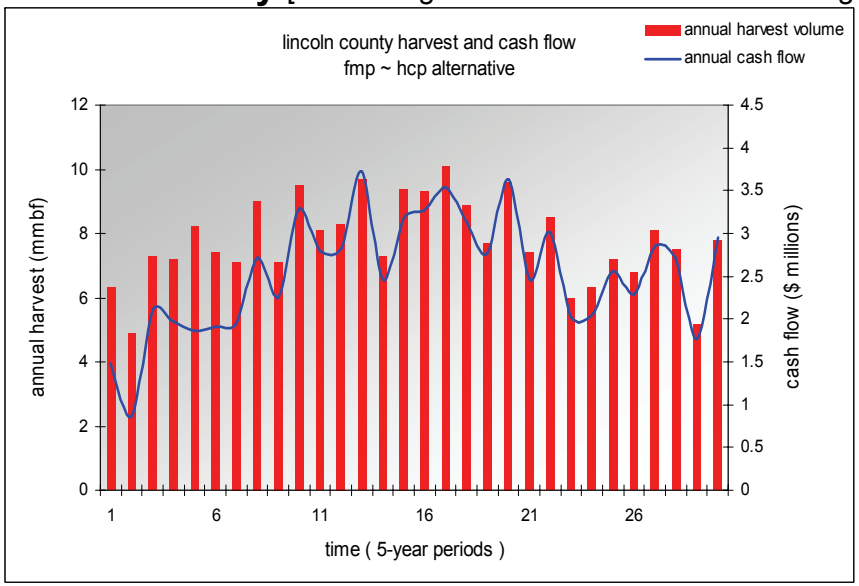



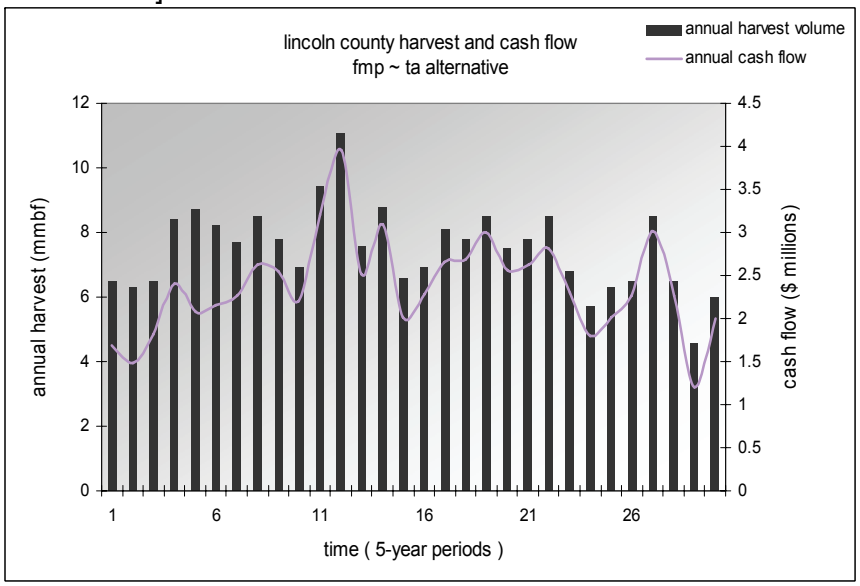
## **Lane County** [FMP using HCP alternative and FMP using TA alternative]



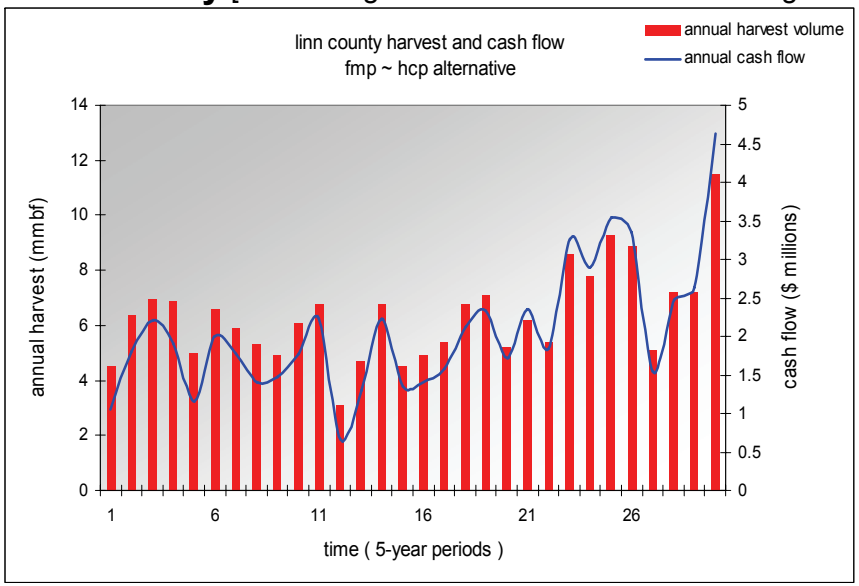



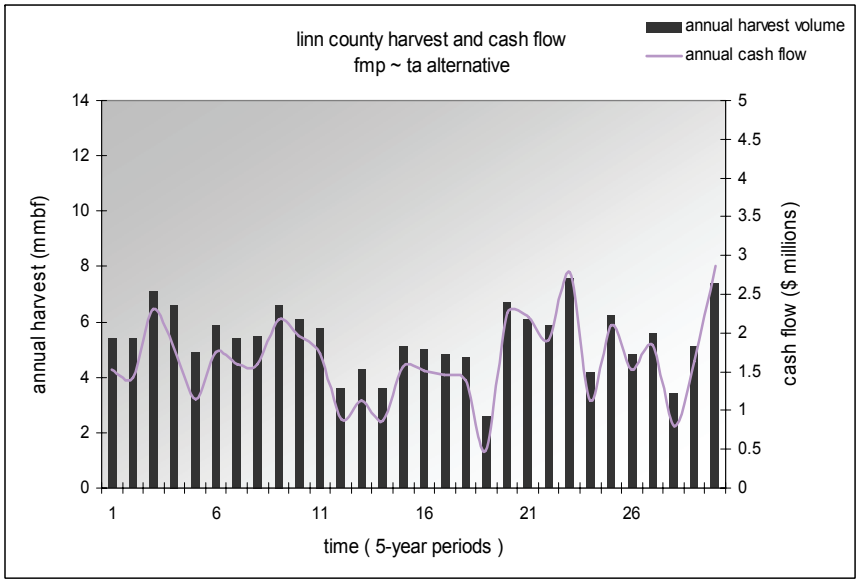

## **Lincoln County** [FMP using HCP alternative and FMP using TA alternative]



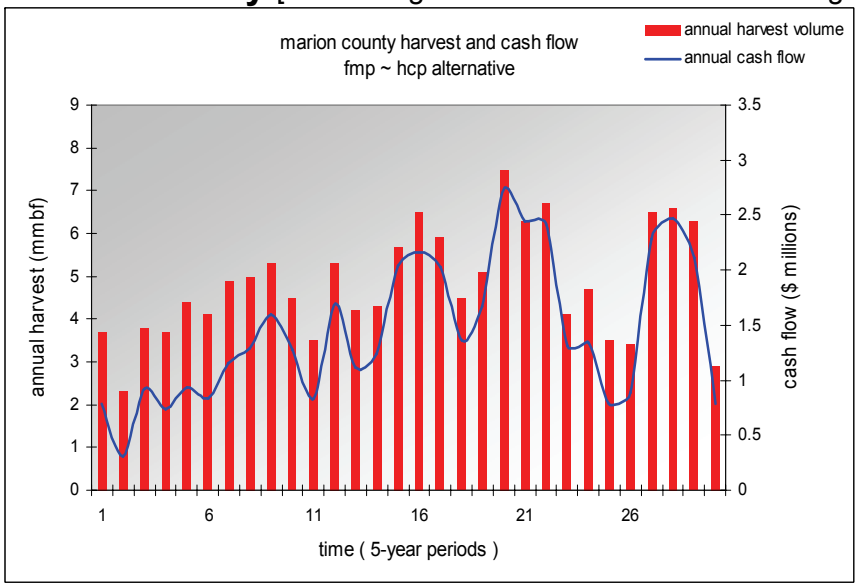



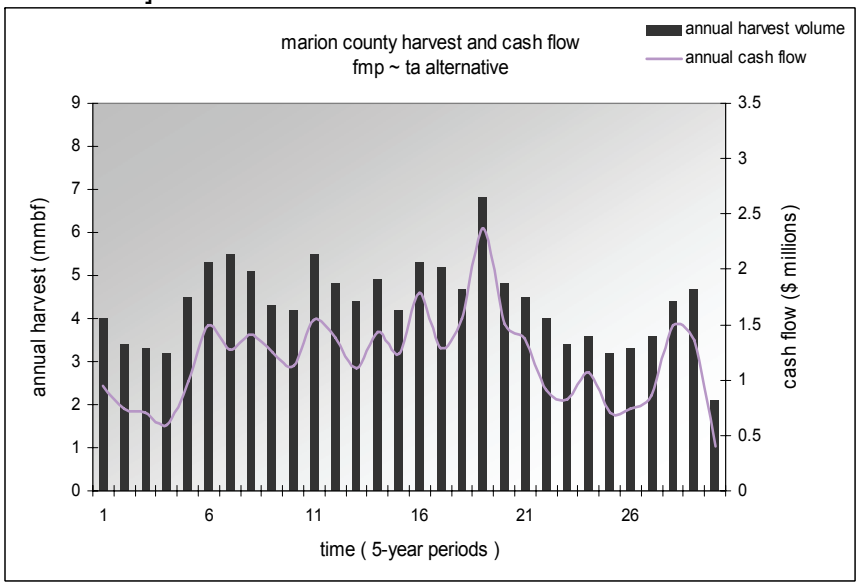
## **Linn County** [FMP using HCP alternative and FMP using TA alternative]



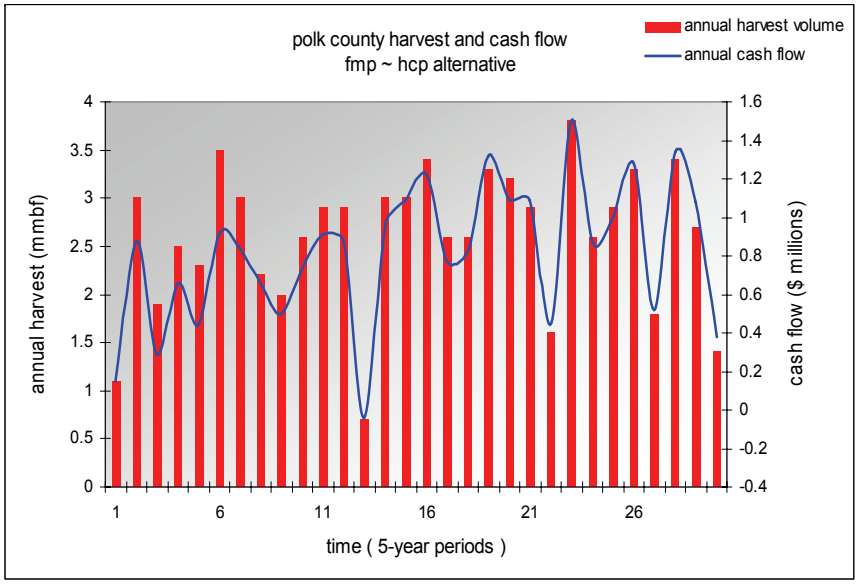



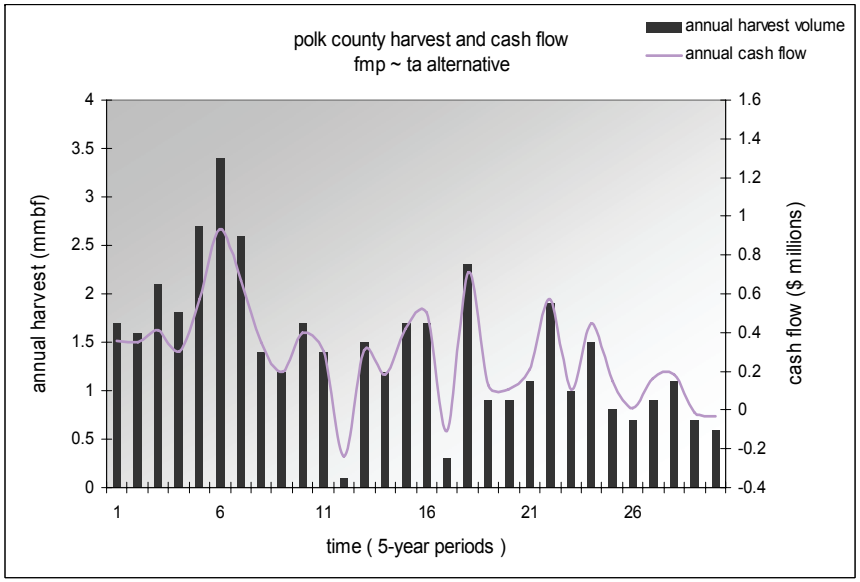

## **Marion County** [FMP using HCP alternative and FMP using TA alternative]



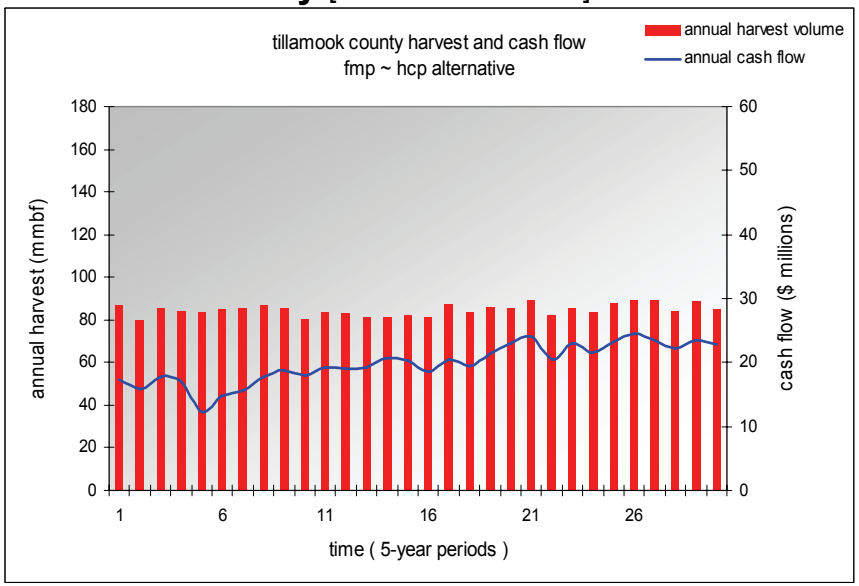



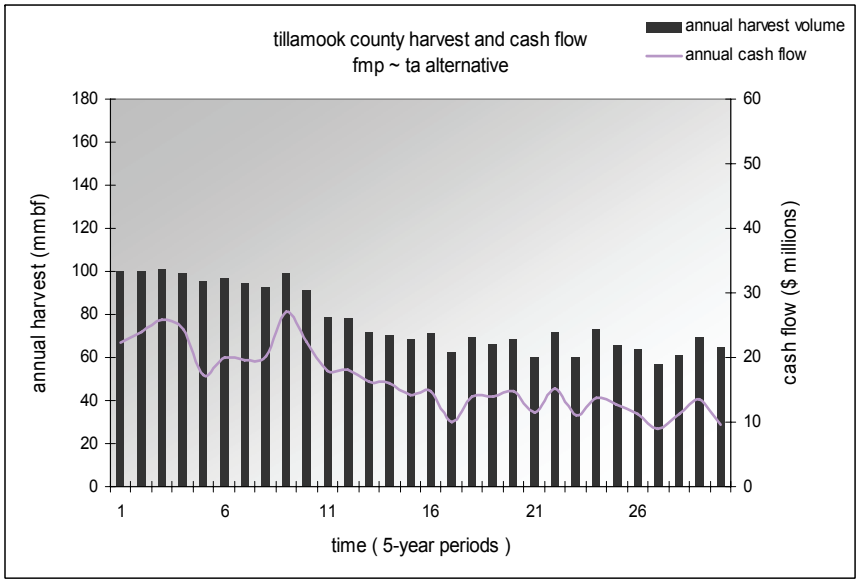
## **Polk County** [FMP using HCP alternative and FMP using TA alternative]

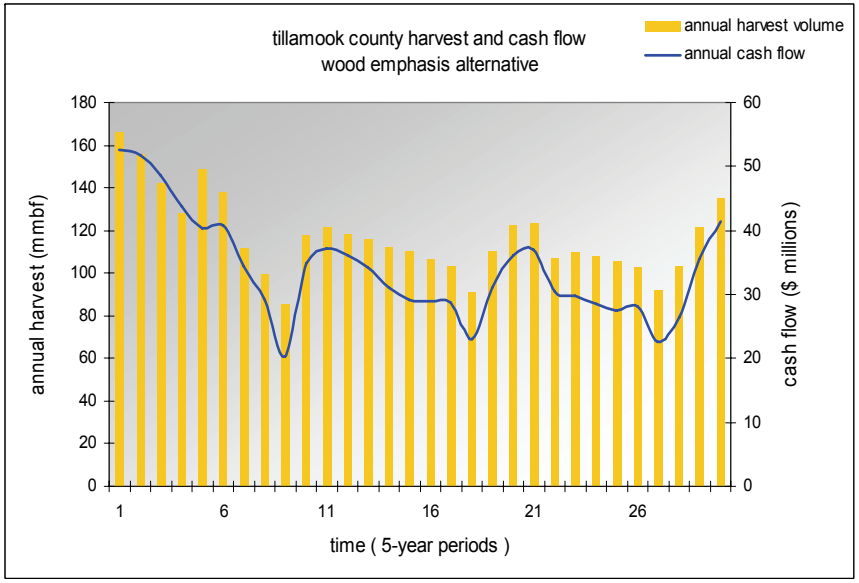


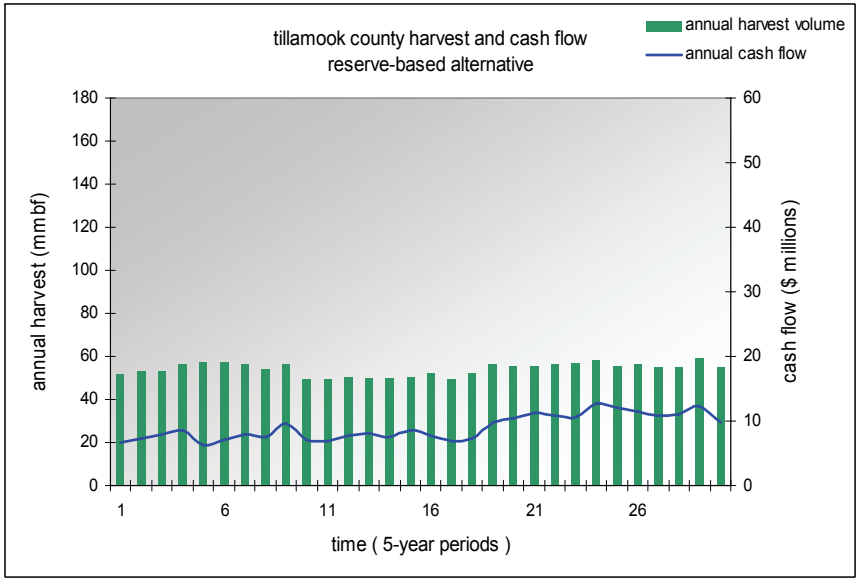



## **Tillamook County** [all four alternatives]

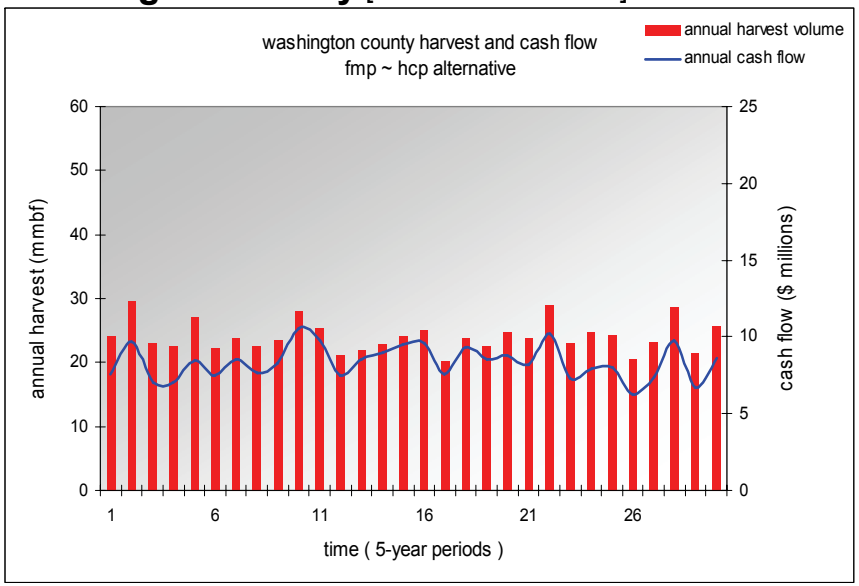


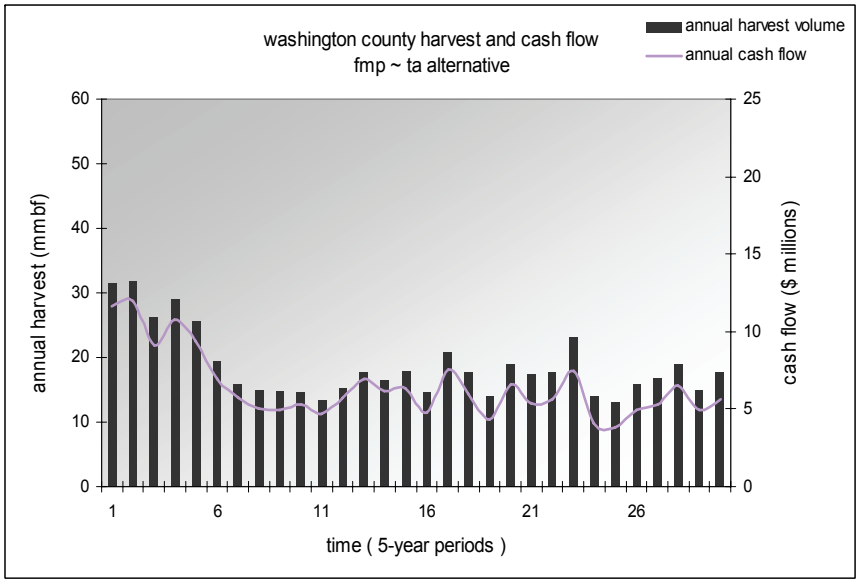



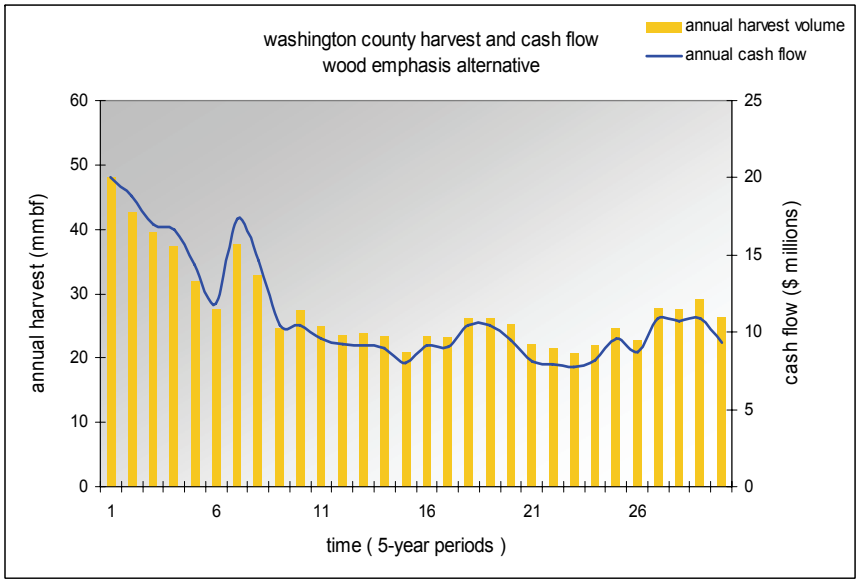



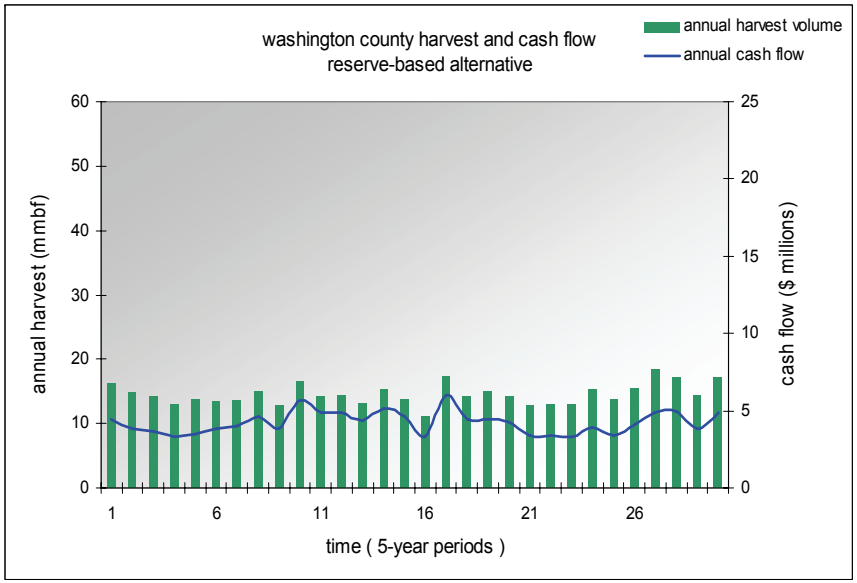



## **Washington County** [all four alternatives]



# Appendix J
# Salmon Anchor Habitat

*How the Harvest & Habitat Model addresses…*

## Salmon Anchor Habitat

August 16, 2005
(For specific model rules, refer to Linkage Document, Policy Section, Item #38)

As described in the March, 2003 Implementation Plans (IPs), Chapter 13:

> The *Northwest Oregon State Forest Management Plan* identifies the anchor habitat approach as a strategy for managing species of concern. The "Salmon Anchor Habitats Strategy for Northwest Oregon State Forests" establishes salmon focus areas in the Tillamook and Clatsop State Forests. Seventeen watersheds were identified as the core of salmon recovery efforts on the State Forests. These watersheds are managed in accordance with a strategy that prioritizes salmonid recovery while balancing multiple purposes of State Forests. This strategy is accomplished by lowering short term risk to salmonids in salmon anchor habitats while landscape strategies foster the development of properly functioning aquatic systems and suitable habitat forest-wide.

In addition to Chapter 13 of the IPs, refer to the FMP, "Strategies for Specific Species of Concern" (pg. 4-81) for more extensive background and discussion of Salmon Anchor Habitat (SAH) strategies.

The three north coast districts: Astoria, Tillamook, and Forest Grove, are currently implementing SAH strategies within their District Annual Operation Plans.

The following is a summary of how SAH strategies are being implemented within the model:

**Riparian Buffers within SAH Basins**

Within "Riparian Special" buffers on all streams: no harvesting.

- "Riparian Special" is a Land Management Classification System (LMCS) term. Buffer widths for streams with this classification are shown below:
    - Small, perennial Type N (no fish): (5' aquatic zone); 25' inner zone.
    - Small, Type F (fish) = (5' aquatic zone); 100' inner zone.
    - Medium, all streams = (10' aquatic zone); 100' inner zone.
    - Large, all streams = (20' aquatic zone); 100' inner zone.

On small, perennial Type N streams: no harvesting for an additional 25' for a total of 50' from the stream bank.

# Salmon Anchor Habitat (continued)

**Basin Harvest Limitations**

The amount of commercial thinning, clearcutting (CC), thinning+clearcutting, and stands currently in regeneration stand structure (Regen = stands <15 years old) will be limited to the percentages shown in Table 1 for the first decade (i.e., 2 model periods).

Harvest limitation percentages are based on the total number of acres owned by the Board of Forestry and/or State Land Board (managed by ODF) within a basin. Private or other publicly-owned forest lands within a basin are not part of the base acres.

**Table 1. Basin Harvest Limitations: Salmon Anchor Habitat Areas**

| # | District | Management Basin | Maximum Percent Threshold (First Decade) | | | |
|---|---|---|---|---|---|---|
| | | | Thin | CC | Thin+CC | Regen |
| 1 | AT | Fishhawk Lake Creek | | 7 | | 15 |
| 2 | AT | Buster Creek | | 5 | 20 | 15 |
| 3 | AT | Upper North Fork Nehalem River | | 7 | | 15 |
| 4 | AT/FG | Upper Rock Creek | | 7 | | 15 |
| 5 | FG | Lousignont Creek / Upper Nehalem River | | 5 | 20 | 15 |
| 6 | FG/TL | S. Fork Salmonberry River | 5 | 10 | | |
| 7 | TL | Cook Creek / Lower Nehalem River | 5 | 25 | | |
| 8 | TL | Foley Creek | 5 | 10 | | |
| 9 | TL | Cedar Creek | 5 | 25 | | |
| 10 | FG | Devils Lake Fork Wilson River | | 5 | 20 | 15 |
| 11 | TL | Middle Kilchis River | 5 | 10 | | |
| 12 | TL | Little N. Fork Wilson River | 5 | 16 | | |
| 13 | FG/TL | Elkhorn River | 5 | 10 | | |
| 14 | TL | E. Fork of the S. Fork Trask River | 5 | 25 | | |
| 15 | TL/AT | Coal Creek | 5 | 25 | | |
| 16 | TL | Miami River | 5 | 12 | | |
| 17 | FG/TL | Ben Smith Creek | 5 | 10 | | |

# Salmon Anchor Habitat (continued)

**Timeframe**

SAH strategies are intended to apply for 10 years: July 1, 2003 – June 30, 2013; exception: Harvest Limitations in SAH basins (i.e., Table 1) apply from July 1, 2001 – June 30, 2011. Specific on-the-ground measures are to be implemented from July 1, 2003 – June 30, 2013, unless modified through the NW FMP Adaptive Management process. For modeling purposes, SAH strategies apply to the first 2 periods (10 years): January 1, 2004 – December 31, 2013.

**SAH Strategies Not Modeled**

Certain SAH strategies cannot be built into the model. These include:

- SAH basins are a priority for conducting watershed assessment and analysis.
- Within 50' of small, seasonal Type N streams: no ground-based equipment allowed.
- Avoid harvesting on debris torrent fans.
- Additional harvesting restriction in "high energy reaches" in some basins.
- Enhance large wood recruitment or other aquatic and riparian functions by retaining large trees or extending buffers in specific areas as opportunities present themselves.
- Minimize operational disturbances in riparian areas by stream type.
- Stream restoration activities, based on input from ODFW is a priority.
- Avoid High Landslide Hazard Locations; review all road construction, road improvement, and all commercial harvest units with Geotechnical Specialist.
- Transportation planning is a priority. Expedite road repairs (especially fish passage); allow hauling activities only during weather conditions and use levels commensurate with the road system. Minimize risks from sedimentation from road-related activities.
- Fish presence and other surveys and monitoring efforts are a priority.
- Basin planning in consultation with ODFW for certain basins is a priority.

Please see Implementation Plans, Chapter 13, for more specific details about SAH strategies.

*This page left intentially blank*

# Appendix K
# Swiss Needle Cast

*How the Harvest & Habitat Model addresses…*

## Swiss Needle Cast Disease

August 16, 2005
(For specific model rules, refer to Linkage Document, Operational, Item #19)

Swiss needle cast (SNC) is a forest disease native to Oregon that affects Douglas-fir, the only susceptible tree species. This fungus attacks the needles, resulting in the tree "casting" (dropping) their needles. Although this disease rarely results in death, the loss of needles can severely affect a tree's ability to grow. Severely infected stands can experience a 30-50% loss of growth potential. This disease is found along the west side of the Coast Range, primarily within the fog-belt zone. Intensive planting of predominately Douglas-fir in this zone over the past half-century appears to have aggravated the disease.

When the Board of Forestry approved the Northwest Forest Management Plan in January, 2001, they included an Intent Statement (#6) which addresses management of this disease. This Intent Statement says:

> "The District Implementation Plans will reflect the principles and assumptions contained in OSU model run 1C-2, and will aggressively treat Swiss Needle Cast (SNC), consistent with the SNC Strategic Plan."

Model run 1-c-2 assumed that regeneration harvest was the most appropriate treatment for stands severely affected by Swiss needle cast. In order to "aggressively treat" these areas, stands severely affected with SNC were scheduled for regeneration harvest within the first two decades.

The Harvest & Habitat Model has been constructed to follow the Board of Forestry's Intent Statement. The following is a summary of how SNC is being implemented within the model:

### SNC Zones

Three SNC zones are spatially defined in the model: severe, moderate, and no impact. The following districts contain combinations of these zones; other districts have "no impact."

Astoria (AT) – severe, moderate, no impact
Tillamook (TL) – severe, moderate
West Oregon (WO) – moderate, no impact

### SNC Douglas-fir Growth Reduction

There is a growth reduction in basal area and height applied to Douglas-fir that is used in the creation of the yield tables.

A. Existing stands: The Douglas-fir growth loss percentage is assigned based on the average growth loss of the range from each of the 2 zones.

| | | Height% | Basal area% |
|---|---|---|---|
| Severe | AT, TL | 30 | 31 |
| Moderate | AT, TL | 17 | 18 |
| Moderate | WO | 10 | 10 |

# Swiss Needle Cast (continued)

B. Yield tables for future plantations in the severe and moderate zones have approximately 33% more growth in Douglas-fir trees than the existing stands, due to improved, site-appropriate seedlings.

The process by which the zones were identified, and the information base used to develop the zones and growth reductions is described in a report developed by Alan Kanaskie, ODF Forest Pathologist.

**SNC Zone Silviculture**

All harvest units in the severe zone that are predominately Douglas-fir (basal area >80%; referred to as 1D stands) are clearcut within the first 20 years. Harvest units that contain >50% 1D stands (by acreage) are considered as 1D harvest units.

Douglas-fir (1D) stands are not commercially thinned in the severe zone (such stands receive a “grow only” prescription until they are clearcut). The thinning of Douglas-fir stands can occur in the moderate zone.

Stands that are not predominately Douglas-fir in the severe zone may receive commercial thinning prescriptions but Douglas-fir trees are discriminated against (i.e., removed more often than other species) when thinning occurs.

In the moderate zone, commercial thinning harvest prescriptions are available for all stands (exception: there is no commercial thinning planned in hardwood stands). Also, Douglas-fir trees will not be discriminated against (i.e., not removed more often than other species) when thinning occurs.

An OSU/ODF research study, "Interactive Effects of Swiss needle cast and commercial thinning on Douglas-fir growth and development on State Forests" is in progress. Recent results indicate that

- Thinning does not increase SNC severity;
- The average SNC stand showed a positive basal area growth response to thinning.

Based on these results, regeneration harvest is still appropriate in the most severely affected stands, and commercial thinning is a viable treatment in more moderately affected stands. These results are reflected in the SNC silviculture model rules described above.

# Glossary of Common Terms

| | |
|---|---|
| Annual operations plan (AOP) | Yearly forest management activity plans, developed by the districts and approved by the District Foresters, which identify the details of specific operations to occur on the forests (harvesting, recreation infrastructure development, young-growth stand management projects, etc.). AOPs are based on 10-year Implementation Plans, which are approved by the State Forester. |
| Board feet (MBF) (MMBF) | Timber (or log, or lumber) volume expressed in board foot measure – one board foot of wood is 1" thick x 12" wide x 12" long. MBF stands for "thousand board feet", MMBF stands for "million board feet". Two-hundred fifty logging trucks are needed to carry one million board feet of raw logs, using an average volume per truck of 4,000 board feet. There's about 16 MBF of framing lumber in a typical 2000 sq ft home. |
| Cash flow | The annual net revenue from timber harvesting reported in five-year intervals over the modeled time-span (150 years). Annual net revenue is calculated by subtracting total period costs (logging costs, road improvement, construction, and maintenance costs, young growth management costs, and administrative costs) from total period gross revenues for each five-year interval and dividing by five. |
| Coarse Filter Wildlife Matrix (CFM) | A method to predict the amount of suitable habitat, based on a review of current scientific literature, for identified wildlife species. H&H model results are evaluated in five-year intervals to characterize the number of acres of suitable habitat available to specific species over 150 years. |
| Complex structure | Forest structure classification system reference to the combination of Older Forest Structure (OFS) and Layered (LYR) forest stand types. See also "Stand structure type". |
| Constraint | A specified level of achievement that must not be exceeded. In contrast, a goal is a level of achievement that the model strives to achieve, in consideration of all other active goals. |
| Departure | An initial interval of high harvest volume followed by an even flow or non-declining flow for the rest of the schedule that is at a lower harvest volume. |
| Desired Future Condition (DFC) complex | Mapped areas of the forest where the Department of Forestry seeks to develop or maintain complex forest structure. These mapped designations are a part of district implementation plans. |

| | |
|---|---|
| Discount Rate | The interest rate used in discounting future cash flows. A 4.5% discount rate was used for the NPV goal and for NPV reporting in the FMP~HCP, FMP~TA, and Reserve-Based. A discount rate of 8% was used in guiding the NPV goal for Wood Emphasis, although NPV is also reported with cash flows discounted at 4.5%. |
| Discounted cash flow | Calculates the value of all future harvests in today's dollars, using a specified discount rate. It is described as "discounted" cash flow because cash in the future is worth less than cash today. |
| District | One of nine Oregon Department of Forestry management units. Seven districts are in this project: Astoria, Tillamook, Forest Grove, North Cascade, and Western Oregon Districts, managed under the Northwest Oregon FMP; Western Lane and Southwest Oregon Districts, managed under the Southwest Oregon FMP. |
| Even flow | Harvest volume does not change from one period to the next. Some deviation from even flow may be accepted and still be classified as even flow. |
| Forest Management Plan (FMP) | Describes the vision, goals, objectives, and strategies to be used on state forest lands to achieve the mandates of social, economic, and environmental values. Two Forest Management Plans cover the lands in the H&H Project: *The Northwest Oregon Forest Management Plan*, and *The Southwest Oregon Forest Management Plan*. |
| Forest Management Plan using Habitat Conservation Plan | One of four modeled alternatives. See "Description of Model Alternatives" section for more details. |
| Forest Management Plan using Take Avoidance | One of four modeled alternatives. See "Description of Model Alternatives" section for more details. |
| Forest Practices Act (FPA) | Is state law (ORS Chapter 527) which regulates commercial forest activities with the goal of encouraging economically efficient forest practices that ensure the continuous growing and harvesting of forest tree species and the maintenance of forestland for such purposes as the leading use on privately owned land, consistent with sound management of soil, air water, fish and wildlife resources, and scenic resources within visually sensitive corridors as provided in ORS 527.755 and to ensure the continuous benefits of those resources for future generations of Oregonians (ORS 527.630). The H&H model includes rules which comply with the FPA. Various riparian management strategies are applied depending upon the model alternative (each strategy meets or exceeds FPA requirements). |

| | |
|---|---|
| Funds (ownership) Codes | Fund 51: Board of Forestry lands (also known as County Forest Trust Lands)<br>Fund 52: Common School Lands (also known as State Land Board Lands)<br>Fund 54: Board of Forestry/County Land Use Resolution Lands<br>Fund 55: Chaney-deeded lands (Board of Forestry lands with deed restrictions)<br>Fund 56: Weyerhaeuser-deeded lands (Board of Forestry lands with encumbrances)<br>Fund 57: Continental-deeded lands (Board of Forestry lands with encumbrances)<br>Fund 58: Consolidated-deeded lands (Board of Forestry lands with encumbrances)<br>Fund 62: Administrative sites (Board of Forestry lands with use restrictions)<br>Fund 75: Longview Fibre-deeded lands (Board of Forestry lands with encumbrances) |
| Geographic information system<br>(GIS) | Computer-based methods of recording, analyzing, combining, and displaying geographic information such as roads, streams, stand or habitat types, sensitive areas, political boundaries, or any other feature that can be mapped on the ground. GIS are especially useful in management planning and land-use decisions on a landscape scale. GIS tools and data have been used extensively in development and analysis of this project. Model functions include spatial considerations and relationships. |
| Goal<br>(model goal) | The level of achievement toward which the model endeavors to reach; an objective. Goals may be set in the model to be ON (the model actively pursues the goal) or OFF (there is no level of achievement, but still reports any amount achieved). |
| Goal multiplier<br>(weighting factor) | The factor, that when multiplied times the goal, gives a weight or importance to a goal. It is used to place emphasis or importance on one goal in relation to another goal. |
| H&H model | A spatial forest harvest scheduling model that uses information (data) about forest stands, roads, harvest settings, geophysical features, silvicultural prescriptions, and economics, along with rules and goals for the management of the forest, in order to provide estimates of future conditions and outcomes for the forest over a 150 year time-span. There are a total of 20 models used in the H&H Project, each specific to a district and management alternative. |

| | |
|---|---|
| H&H Project | Project with specified goals, objective, expectations with an organizational framework conducted by the Oregon Department of Forestry's State Forests Management Program which began in April of 2003. See "A Complex Project" in the Introduction and Background portion of this report for details. |
| Habitat Conservation Plan (HCP) | A method of compliance with the Federal Threatened and Endangered Species Act (necessary for receiving a U.S. Fish and Wildlife Service issued incidental take permit). |
| Harvest unit | Delineated forest parcels that reflect potential logical harvest operation areas considering topography and access. A unit for clearcut and thinning choices. |
| Implementation plan (IP) | 10-year district-specific plans approved by the State Forester in March of 2003 that describe the tactical guidance for implementation of FMP strategies. IPs are carried out operationally through Annual Operations Plans. Harvest ranges are set in the IPs. |
| Inventory (standing inventory) | The total amount of merchantable net volume in timber on the forest at any point in time, typically expressed in terms of thousand board-feet (MBF), or million board-feet (MMBF). |
| Model alternative (management alternative) | An optional philosophical strategy or approach to managing the forest. The H&H Project modeled four different alternatives – two within the FMP, and two outside the FMP. Each of the twenty H&H models is specific to one combination of district and model alternative. The alternatives are: FMP using an HCP, FMP using TA, Wood Emphasis, and Reserve-Based. |
| Model run | The process of selecting active goals, setting goal values, goal multipliers, control options, executing the model's software program code to create model results and reports. |
| Model Solution Review (MSR) | A process created by ODF for the H&H Project that examines the model's harvest schedule to verify model data, validate application of rules and assumptions, and analyze the feasibility and operability of harvest choices. Each district produced an MSR Report documenting their evaluation of the specific model run chosen for reporting purposes. (See "Level of Confidence" section for further detail.) |
| Must pay | An H&H optional model setting that, when ON, allows the model to schedule a harvest unit only if the revenues from the harvest are greater than the logging, hauling, loading, in-unit spur, and road construction costs of a specified number of road links leading out of the unit. |

| | |
|---|---|
| Net Present Value (NPV) | Economic term used to describe the sum of the present-day value of all future period revenues minus the period costs, discounted to the present at a specified rate. In simple terms, NPV is the sum of the discounted cash flow. NPV is strongly influenced by short-term revenues due to this discounting effect. NPV is reported for every run. Also maximizing the NPV is an optional goal. A 4.5% discount rate is used for FMP~HCP, FMP~TA, and Reserve-Based. A discount rate of 8% is used in the NPV goal for Wood Emphasis, although NPV is also reported with a 4.5% discount rate. |
| Non-declining flow | Harvest volume that can increase, but not decrease, from one period to the next. |
| North coast districts | Astoria, Tillamook, and Forest Grove Districts that collectively manage the Clatsop and Tillamook State Forests. |
| Period (H&H model period) | A five-year increment of time the model uses to evaluate model inputs, rules, and report outputs. The H&H model has 30 five-year periods. Period 0 is the beginning point of the model (January 1, 2004). The model uses the mid-point of each period for calculation of harvest activities. |
| Reserve-Based | One of four modeled alternatives. See “Description of Model Alternatives” section for more details. |
| Salmon Anchor Habitat (SAH) | Mapped watershed basins or sub-basins that have been identified as important to salmonid species. The concept of additional protection for “anchor habitats” is an FMP strategy; SAHs are identified within district Implementation Plans and describe limitations to forest activities. |
| Simulated annealing | Simulated annealing is a generalization of a Monte Carlo method. The concept is based on the manner in which liquids freeze or metals recrystalize in the process of annealing. In an annealing process a melt, initially at high temperature and disordered, is slowly cooled so that the system at any time is approximately in thermodynamic equilibrium. As cooling proceeds, the system becomes more ordered and approaches a "frozen" ground state at T=0. If the initial temperature of the system is too low or cooling is done insufficiently slowly the system may become quenched forming defects or trapped in a local minimum energy state. The model uses a “similar” process: it begins with an “unorganized” harvest solution, makes new harvest choices using model rules, and repetitively accepts or rejects choices based on their ability to reduce the difference from the goal, gradually building and improving the solution while getting closer to the goals until reaching a point that represents the best solution possible, given the number of iterations and amount of time specified for the model to run. |

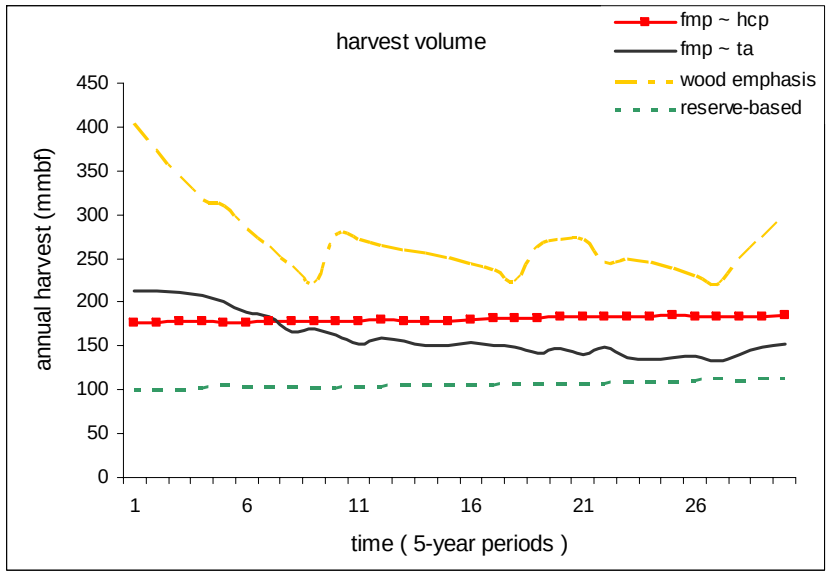
| | |
|---|---|
| Stand structure type | Classification of forest stands based on characteristics, such as: tree species, size, density, distribution, etc. A key element of the FMPs is the application of an approach referred to as structure based management – which calls for the creation and maintenance of various forest stand structure classifications (or types),over space and time. The FMPs identify five forest structure types: regeneration stands (REG), closed single-canopy stands (CSC), understory stands (UDS), layered stands (LYR) and older-forest structure stands (OFS). The H&H model provides estimates of current and future stand structure types. |
| Strata | A forest inventory term used to describe a grouping of forest stands with like characteristics. Each group (or strata) is characterized by a distinct combination of the stand's tree species, tree size class, and tree stocking level. Some stands within a strata are measured for their characteristics and some are not. These sampled stands provide a way to determine the average values for stands assigned to each strata. This is necessary because stand inventory data is not available for every stand (i.e., we have unmeasured stands, but we know what strata they belong to). The average values for each strata are the basis for the development of the H&H model's yield tables. |
| Swiss Needle Cast (SNC) | A forest tree pathogen (fungi) which interferes with the photosynthetic process and causes Douglas-fir to loose or "cast" their needles – reducing tree vigor and growth. The H&H model includes spatial data, management considerations and growth reductions for SNC. |
| Take avoidance (TA) | Take Avoidance is a method of compliance with the Federal Threatened and Endangered Species Act (avoiding the "take" of listed species). ODF has developed specific TA strategies for northern spotted owls and marbled murrelets. |
| Wood emphasis | One of four modeled alternatives. See "Description of Model Alternatives" section for more details. |
| Yield tables | Tabular data, provided in five-year intervals, that describes the characteristics (volume harvested, structure, standing inventory, tree size, diameter, stand age, etc.) of forest stands or strata as they grow (and suffer mortality) under a variety of different thinning prescriptions. The model references these yield table values in order to make necessary calculations during the run process. Yield tables were developed from district forest inventory information, using forest growth models with district calibration of results. |

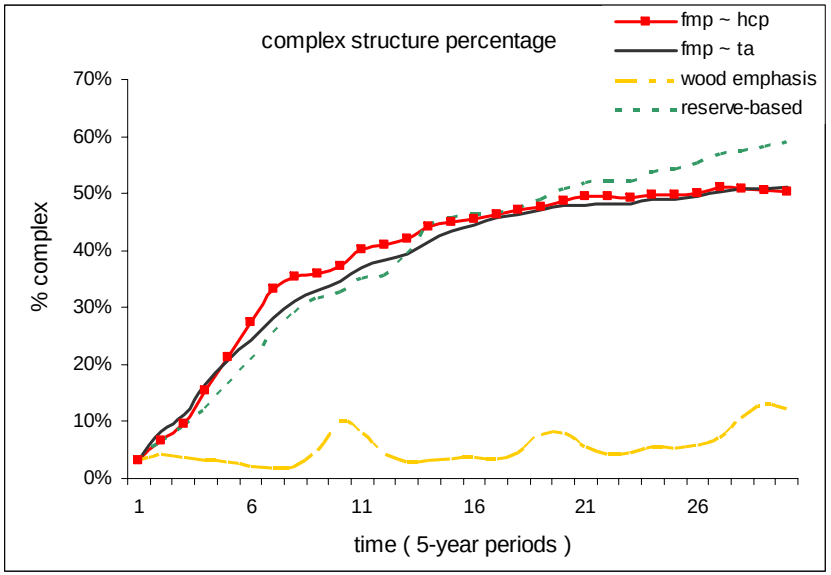
## Results: Comparison of Alternatives

# Three North Coast Districts Combined: All Alternatives

This section shows the results of all four alternatives: FMP~HCP, FMP~TA, Wood Emphasis, and Reserve-Based. The outputs compared appear in "Results: By Alternative."

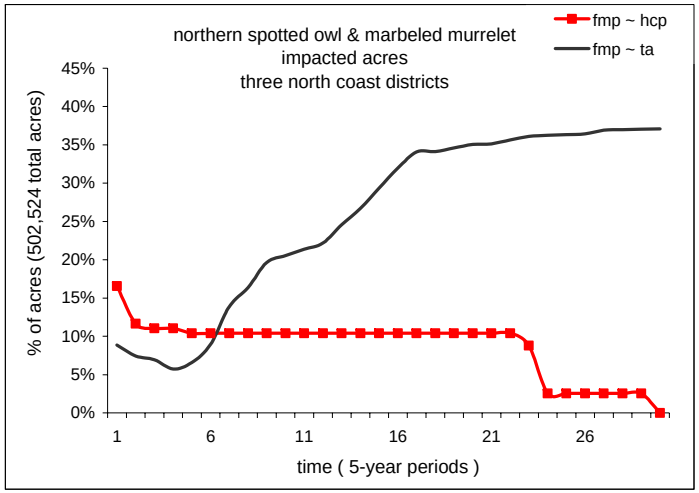
FMP~HCP has a 50% complex structure goal; FMP~TA uses the Base northern spotted owl population scenario with a 50% complex structure goal.



## Results: Comparison of Alternatives

## Three North Coast Districts Combined: All Alternatives (continued)




### Findings

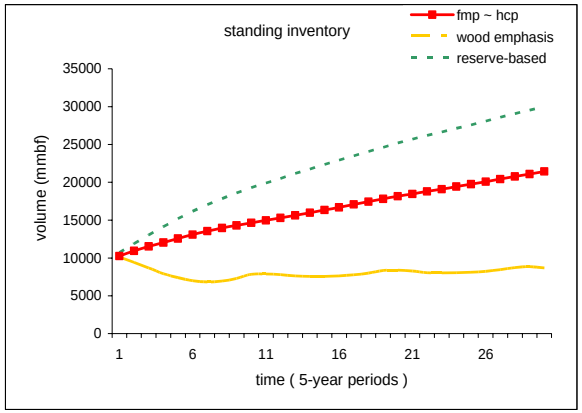
- Compared with FMP~HCP, FMP~TA produces 20% more harvest volume in the first decade, and continues to produce more volume for the first 30 years, because fewer acres are protected for northern spotted owls and marbled murrelets. But FMP~TA produces more than 10% less volume over 150 years because of the additional owl and murrelet habitat found with the take avoidance strategies.
- Wood Emphasis produces more than twice the amount of volume than FMP~HCP in the first decade and 50% more volume in 150 years because of the goal for 50-year harvest rotation, no goal for complex structure, and fewer acres in owl protection and riparian buffers. It develops about 10% complex structure compared with 50% for FMP~HCP because there is an emphasis on a 50-year rotation age.
- Reserve-Based produces about 40% less harvest volume than FMP~HCP because of the acres dedicated to reserves. In 150 years Reserve-Based develops 60% complex structure compared with 50% in FMP~HCP.
- FMP~HCP develops complex structure more quickly than FMP~TA or Reserve-Based because more acres are actively managed.
- The ratio of acres clearcut to acres thinned in all 150 years is similar in the FMP~HCP and Reserve-Based alternatives, each having about 37% of harvest acres being clearcut; FMP~TA alternative has 45%; and Wood Emphasis has 86% of the harvested acres being clearcut (see Appendix G, Table 3).

# Results: Comparison of Alternatives

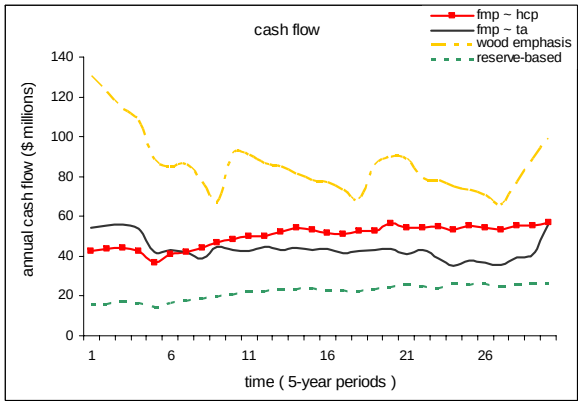
## Three North Coast Districts Combined: All Alternatives (continued)

### Standing Inventory

Standing inventory was not shown for FMP~TA because of the two-phased processing procedure of that alternative (see Results: By Alternative section: FMP~TA).




### Economics




| Alternative | NPV (millions $) |
|---|---|
| FMP ~ HCP | 971 |
| FMP ~ TA | 1124 |
| Wood Emphasis | 2387 |
| Reserve-Based | 376 |

### Findings

- Although standing inventory for FMP~TA is not shown, it would likely result in an inventory greater than FMP~HCP because of the reduced harvesting as new owls and murrelets are found.
- Wood Emphasis standing inventory declines by 20% over 150 years due to the goal of harvesting stands older than age 50. In 150 years the standing inventory is approximately 40% lower than FMP~HCP.
- Reserve-Based standing inventory triples in 150 years and is nearly 40% higher than FMP~HCP in 150 years because of the acres in reserves.
- Cash flow levels in all alternatives are closely correlated with harvest volume; however, cash flow is negatively impacted during the first 5 periods (25 years) due to road construction costs, especially in Tillamook.
- NPV is 245% higher for Wood Emphasis than FMP~HCP, Reserve-Based is 40% of FMP~HCP; and FMP~TA is 16% higher than FMP~HCP. FMP~TA is 16% higher than FMP~HCP due to the higher volume harvested in the first 30 years.

The Harvest and Habitat Model Project Final Report was presented to the Board of Forestry on March 8, 2006. In late March of 2006, an error was discovered in a yield table associated with the Wood Emphasis Alternative. The leave tree volume for the Forest Management Plan (FMP) with a Habitat Conservation Plan (HCP) alternative was mistakenly incorporated into the Wood Emphasis alternative. The FMP with a HCP leave tree volume included five larger green trees in addition to volume subtracted for downed wood and snags. The Wood Emphasis leave tree volume now represents the minimum requirement for the Forest Practices Act. The results on the next two pages are provided in an update to Appendices G (Pages G-2 and G-3) of the final report.

| Table 2: District Summary of All Alternatives: Harvest Volume, NPV, and Complex Structure | | Astoria | Tillamook | Forest Grove | 3 NC SUB-TOTAL | North Cascade | West Oregon | Western Lane | Southwest Oregon | 4 SOUTH SUB-TOTAL | GRAND TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **FMP using HCP** | Annual Volume 1st Dec[1] | 62 | 61 | 54 | **177** | 12 | 12 | 9 | 2 | **35** | **212** |
| | Annual Volume 150 yrs[1] | 63 | 62 | 55 | **180** | 13 | 14 | 10 | 2 | **39** | **219** |
| | NPV (millions $ @ 4.5%) | 374 | 206 | 391 | **971** | 71 | 78 | 43 | 2 | **194** | **1165** |
| | Total Structure Attained[2] | 52% | 50% | 51% | -- | 51% | 50% | 50% | 37% | -- | -- |
| | Years to Attain Structure[2] | 95 | 130 | 65 | -- | 90 | 70 | 75 | 85 | -- | -- |
| **FMP using TA** | Annual Volume 1st Dec[1] | 76 | 73 | 64 | **213** | 12 | 12 | 6 | 2 | **32** | **245** |
| | Annual Volume 150 yrs[1] | 58 | 57 | 46 | **161** | 11 | 12 | 7 | 2 | **32** | **193** |
| | NPV (millions $ @ 4.5%) | 432 | 277 | 415 | **1124** | 74 | 83 | 24 | 3 | **184** | **1308** |
| | Total Structure Attained[2] | 50% | 50% | 50% | -- | 50% | 51% | 50% | 38% | -- | -- |
| | Years to Attain Structure[2] | 80 | 130 | 70 | -- | 105 | 65 | 65 | 90 | -- | -- |
| **Wood Emphasis** | Annual Volume 1st Dec[1] | 145 | 131 | 112 | **388** | | | | | | |
| | Annual Volume 150 yrs[1] | 98 | 104 | 68 | **270** | | | | | | |
| | NPV (millions $ @ 4.5%) | 867 | 719 | 801 | **2387** | | | | | | |
| | Max~Avg Struct. Attained[3] | 20~7% | 12~5% | 13~5% | -- | | | | | | |
| **Reserve-Based** | Annual Volume 1st Dec[1] | 29 | 39 | 33 | **101** | | | | | | |
| | Annual Volume 150 yrs[1] | 32 | 41 | 33 | **106** | | | | | | |
| | NPV (millions $ @ 4.5%) | 105 | 76 | 195 | **376** | | | | | | |
| | Total Structure Attained[4] | 61% | 51% | 51% | -- | | | | | | |
| | Years to Attain Structure[4] | 60 | 150 | 70 | -- | | | | | | |

**Footnotes**

[1] Average annual harvest volume in 1st decade and over 150 years, in millions of board feet (mmbf).

[2] FMP w/HCP, FMP w/TA, and Reserve-Based Structure Goals (except SW) = **50%** LYR+OFS w/ a minimum of 25% OFS. SW = 35% LYR+OFS w/ a minimum of 20% OFS.

[3] Wood Emphasis has no Structure Goals; average % attained over 150 years is reported. See charts for reporting of structure attained by period.

[4] Reserve-Based Structure Goals apply to acres outside of "Reserves;" structure is reported across the total landscape.

| Table 3: District Summary of All Alternatives: Clearcut and Thinning Acres | | Astoria | Tillamook | Forest Grove | 3 NC SUB-TOTAL | North Cascade | West Oregon | Western Lane | Southwest Oregon | 4 SOUTH SUB-TOTAL | GRAND TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **FMP using HCP** | Clearcut Acres 1st Dec[1] | 1719 | 3241 | 1154 | **6114** | 375 | 228 | 234 | 117 | **954** | **7068** |
| | Thinning Acres 1st Dec[1] | 766 | 330 | 1225 | **2321** | 455 | 664 | 254 | 110 | **1483** | **3804** |
| | Clearcut Acres 150 yrs[1] | 1233 | 1420 | 829 | **3482** | 260 | 247 | 185 | 98 | **790** | **4272** |
| | Thinning Acres 150 yrs[1] | 1539 | 2351 | 1733 | **5623** | 411 | 420 | 268 | 57 | **1156** | **6779** |
| **FMP using TA** | Clearcut Acres 1st Dec[1] | 2107 | 3828 | 1462 | **7397** | 395 | 323 | 122 | 121 | **961** | **8358** |
| | Thinning Acres 1st Dec[1] | 890 | 267 | 1179 | **2336** | 406 | 578 | 262 | 85 | **1331** | **3667** |
| | Clearcut Acres 150 yrs[1] | 1249 | 1497 | 795 | **3541** | 233 | 231 | 132 | 100 | **696** | **4237** |
| | Thinning Acres 150 yrs[1] | 1322 | 1915 | 1126 | **4363** | 367 | 348 | 169 | 49 | **933** | **5296** |
| **Wood Emphasis** | Clearcut Acres 1st Dec[1] | 4589 | 6396 | 3270 | **14255** | | | | | | |
| | Thinning Acres 1st Dec[1] | 5 | 21 | 2 | **28** | | | | | | |
| | Clearcut Acres 150 yrs[1] | 2778 | 4118 | 2074 | **8970** | | | | | | |
| | Thinning Acres 150 yrs[1] | 605 | 584 | 215 | **1404** | | | | | | |
| **Reserve-Based** | Clearcut Acres 1st Dec[1] | 695 | 2056 | 569 | **3320** | | | | | | |
| | Thinning Acres 1st Dec[1] | 978 | 569 | 1125 | **2672** | | | | | | |
| | Clearcut Acres 150 yrs[1] | 602 | 889 | 533 | **2024** | | | | | | |
| | Thinning Acres 150 yrs[1] | 889 | 1710 | 941 | **3540** | | | | | | |

**Footnotes**

[1] Average annual harvest acres in 1st decade and over 150 years.