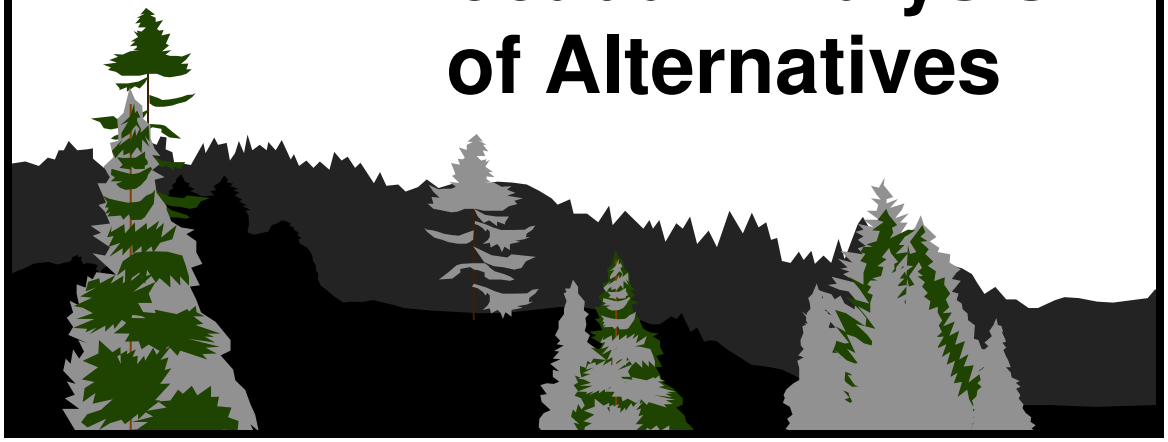
Appendix I

Decadal Analysis of Alternatives



Improved Harvest Scheduling Model

The Harvest Scheduling Model used by the ODF to evaluate policy alternatives for State Forests has been significantly improved through two major projects since the adoption of the Northwest Oregon State Forest Management Plan in 2001: the Harvest and Habitat Model Project (2004 through 2006); and the Clatsop and Tillamook State Forests Strategies for the Achievement of the Board of Forestry Performance Measures (2008 and 2009). These model projects evaluated a range of alternatives similar to those examined when the FMP was initially developed. These updated models informed the Board of Forestry's deliberations on the balance of economic, social, and environmental values provided through implementation of the Northwest Forest Management Plan on the Tillamook and Clatsop State Forests. The Board of Forestry's discussions led to the adoption of a revised plan in XX[b1].

The Harvest and Habitat Model Project (H&H) was undertaken to address seven key elements of the Harvest Scheduling Model. These key elements were described in the *Work Plan to Address Harvest Schedule Modeling and Sustainable Harvest Levels in the District Implementation Plans*[1] and included developing and incorporating into the model transportation systems, harvest units, landscape design maps, improved inventory, more comprehensive silvicultural prescriptions, and more accurate growth modeling. The last key element included the development of a field review process for the model outputs.

[1] See the Implementation Plans for Northwest and Southwest Oregon Forest Management Plans notebook (2003)

The H&H Project also made numerous other improvements to the Harvest Scheduling Model. The H&H Project developed four scenarios for modeling different strategies, including: Forest Management Plan using the Draft Western Oregon Habitat Conservation Plan Strategies; Forest Management Plan using the State Forests Take-Avoidance Strategies; Wood Emphasis; and Reserve Based. More information on this project and the model outputs can be found in the *Harvest & Habitat Model Project Final Report* (March 8, 2006).

The primary purpose of the *Clatsop and Tillamook State Forests Strategies for the Achievement of the Board of Forestry Performance Measures* (CTS) project was to develop several model scenarios to achieve the Performance Measure targets for the Clatsop and Tillamook State Forests set by the Board of Forestry.[2] The CTS project also made improvements to the yield tables used in the model by incorporating a larger number of inventoried stands and using a better method of estimating stand conditions where inventory information is not available. The CTS project developed two model scenarios and reported the outputs to the Board of Forestry at its November 6, 2008 meeting.[3] These two scenarios included: a 'Base Case' that represented the Forest Management with Habitat Conservation Plan, as applied through the district implementation plans; and a scenario that strived for the achievement of Performance Measure 1 (Revenue) or Performance Measure 6 (Wildlife Habitat).

Additional model scenarios were developed between November 2008 and April 2009 under the CTS project. These scenarios included three different Wood Emphasis scenarios, two scenarios that focused on either Performance Measure 1 (Revenue) or Performance Measure 6 (Wildlife Habitat), two scenarios based on a modified Forest Management Plan with Species of Concern Strategies, and two scenarios based on the Forest Management Plan with the Draft Western Oregon Habitat Conservation Plan Strategies. The results of these model scenarios were reported to the Board at its April 24, 2009 meeting.[4]

Harvest Scheduling Model

The Harvest Scheduling Model used to inform adoption of the plan in 2001 was developed by Professor John Sessions of Oregon State University. The model ~~to~~ assisted the Oregon Department of Forestry (ODF) in evaluating policy alternatives for the *Northwest Oregon State Forests Management Plan* and *Western Oregon State Forests Habitat Conservation Plan* by providing decadal information on harvest levels, revenue, and vegetation conditions for a planning horizon of 200 years.

[2] Reference to the Board of Forestry minutes from the November 2007 meeting, including the performance measure report.
[3] Reference to the Board of Forestry minutes from the November 2008 meeting, including the performance measure report.
[4] Reference to the Board of Forestry minutes from the April 2009 meeting.

The model combines a spatial timber (inventory) layer, ODF inventory data, tree growth and yield projections, and management goals with a search technique to allocate timber management activities over the planning area and planning horizon.

The spatial timber inventory database maintained by ODF was stratified into groups of stands of like species, size, and stocking. For each timber strata a number of treatment alternatives were developed as potential management regimes that could be assigned to timber stands to meet management goals. The ORGANON model was used to project growth and yield for the strata under the potential management regimes for twenty 10-year periods.

ODF has five primary management goals: 1) provide a sustainable supply of timber, 2) improve riparian habitat, 3) reach and maintain a specified percentage of mature forest structure, 4) reach and maintain a spatial distribution of forest structures (patches) across the landscape, and 5) provide a reasonable present net value.

A search technique was developed to assign the potential management regimes to timber stands to meet management goals. Feasible assignment of management regimes to timber stands required tracking contiguous areas of mature forest habitat, contiguous areas of young stands and coordination of riparian and upslope management regimes. To maintain spatial feasibility, a heuristic search procedure was chosen. The search procedure is guided by an objective function that seeks to maximize present net value while minimizing deviations between goals for timber supply and forest structure.

The search procedure begins with an initial assignment of timber regimes that result in a feasible initial spatial solution. Following the initial assignment of timber regimes, the search procedure tests a trial move by randomly selecting a timber stand, randomly selecting a timber regime eligible for the stand and evaluating the change in the objective function. If the objective function value improves, the trial move is accepted. If the objective function value does not improve, it may be accepted anyway if the loss in value does not exceed certain criteria. The theory behind accepting a non-improving trial move is to prevent the search from becoming stalled in a local maximum rather than continuing to search for higher values.

Different solutions can be explored by weighting the coefficients of the objective function to increase or decrease the relative importance of the different goals. Goals could be either one-way or two-way. One-way goals penalize either overachievement or underachievement, thus using the goal as a maximum or minimum respectively. Two-way goals penalize both overachievement and underachievement, thereby seeking the specified goal as a target. Goals can also be weighted such that larger deviations from a goal are penalized proportionately more than small deviations.

ODF chose the heuristic search procedure because it is better able to solve spatial problems than optimization methods such as linear programming. Although linear programming has been widely used in forest management planning, it cannot solve a spatial problem at the scale of this planning area due to the large number of variables and constraints required to formulate the problem. The Astoria-Tillamook-Forest Grove planning area contains approximately 25,000 stands divided into 130,000 upland and riparian parcels with a planning horizon of twenty 10-year periods. Depending on the degree of spatial representation, up to 2.6 million variables could be required.

Other alternative approaches could solve the nonspatial problem first and then either try to fit the nonspatial solution to a map or ignore the spatial requirements. These alternative approaches might be adequate for comparative analysis, but may over-represent the attainment of goals by not considering the spatial constraints. ODF chose to maintain spatial representation, recognizing that a heuristic search procedure cannot find the "optimal" solution but instead finds the best of many feasible solutions. Heuristic search procedures have been shown to produce good solutions in a number of industries including forestry.

Alternatives for Harvest Scheduling Model

Seven alternatives were constructed in order to compare different management approaches. All of the alternatives were modeled except Alternative 5 that was not fully developed. Additional optional runs were made on 4 of the 6 remaining alternatives to demonstrate the effect of certain constraints or strategies.

All alternatives were initially run with the constraints of non-declining even flow of harvest volume using a guiding discount rate of 4.5 percent. However, additional runs were made in response to issues that arose during the presentation of preliminary model outputs: using a higher guiding discount rate, removal of the flow constraints and operability reductions, lower complex structure targets, and an aggressive Swiss needle cast strategy.

Guiding discount rate — To test the sensitivity of a higher discount rate on the net present value of the solution, several runs were made earlier in the modeling process using a 7 percent guiding discount rate. Although they are not included in the summary options below, it was concluded that under non-declining even flow with a minimum final harvest age between 45 and 50 there was no significant difference in the net present value between 4.5 percent and 7 percent.

Constraints removed — To see the maximum net present value that could be achieved while modeling the proposed aquatic and riparian strategies, an option was run with most constraints to high net present value removed. Alternative 3, option E, has constraints removed for even-flow, minimum final harvest age, and operability reductions.

Reduced complex structure target — Alternative 4 option B was constructed to compare the harvest volume outputs from an option with a 30 percent complex stand structure target to that of the proposed structure-based management complex structure targets of 40 percent to 60 percent.

Swiss needle cast strategy — Alternative 1, option C, and Alternative 4, option B, have the same assumptions as option A of the same alternative, except that they aggressively treat severely affected SNC stands within the first 2 decades. A departure from even flow was allowed in decade 1 and 2 to accommodate the higher level of harvest.

The alternative approaches are:

Alternative 1: Structure-based management (SBM) with Habitat Conservation Plan (HCP)

- SBM (target in OFS and LYR of 20% - 30% each, with average of 25%)
- Proposed northern spotted owl (NSO) and marbled murrelet (MM) strategies
- Proposed aquatic and riparian strategies
- 4.5% discount rate

Objectives: Achieve Stand Structure targets as soon as possible, secondarily emphasize net present value (NPV).

Option A: Non-declining even flow (of volume)

Option C: Same as Option A, but with Swiss needle cast strategy and a departure from even flow allowed in the first 2 periods

Alternative 2: SBM with no HCP

- SBM (target in OFS and LYR of 20% - 30% each, with average of 25%),
- Take avoidance for NSO and MM
- Proposed aquatic and riparian strategies
- 4.5% discount rate

Objectives: Achieve Stand Structure targets as soon as possible, secondarily emphasize NPV.

Option: Non-declining even flow

Alternative 3: Emphasize net present value (NPV)

- No targets for stand structure types
- Take avoidance for NSO and MM
- Proposed aquatic and riparian strategies

Objectives: Emphasize NPV.

Option A: Non-declining even flow @ 4.5% discount rate

Option E: Unconstrained flow @ 7.0% discount rate, no operability reductions, and no minimum final harvest age

Alternative 4: SBM with reduced complex stand structure targets:

- SBM with reduced complex structure targets
- Take avoidance for NSO and MM
- Proposed aquatic and riparian strategies
- 4.5% discount rate

Objectives: Achieve Stand Structure targets as soon as possible, secondarily emphasize NPV.

Option A: Complex structure target in OFS and LYR of 5% each, non-declining even flow

Option B: Complex structure target of 30% in combined OFS and LYR, Swiss needle cast strategy, non-declining even flow with a departure in first 2 periods for SNC strategy

Alternative 5: Balance mean annual increment and NPV

- This alternative was not modeled

Alternative 6: 50% reserves

- 50% reserved management basins have limited thinnings allowed in first few decades only
- Remaining 50% managed as in Alternative 1, Option A
- Assumes HCP based on reserve areas. All NSO and MM habitat is located within 50% reserve acres; no proposed NSO or MM strategies or take avoidance in managed 50%
- All riparian buffer zones are "no harvest"

Objective: Achieve Stand Structure targets as soon as possible, secondarily emphasize net present value (NPV).

Option B: No flow constraint

Alternative 7: Exclusive reserve approach

- 100% reserves.

Objective: Grow only.

Summary of Model Run Outputs

The tables on the next few pages summarize the outputs of the model runs for nine alternative options. Table I-1 is a summary of the 20-decade outputs for the combined North Coast districts, Astoria, Tillamook, and Forest Grove. Table I-2 summarizes the 20-decade outputs for four alternative options for the Clackamas-Marion, Western Lane, and West Oregon districts.

Table I-3 summarizes the time projected for each alternative option to reach the desired future condition for complex stand structure (layered and older forest structure stand percentages). Note that different alternatives have different desired future conditions. Alternatives 3-A, 3-E and 7 have no desired future condition for complex stand structure percentages. Not all options were run for the three Willamette Region districts (Clackamas-Marion, Western Lane, and West Oregon). This table also shows the long-term average percent of layered and older forest structure stands on the landscape for each alternative option.

Table I-1. Summary of North Coast Outputs: Astoria, Tillamook and Forest Grove Districts

Alternative	20 Decade Total MMBF Harvest	20 Decade Total Thinned Acres	20 Decade Total Clearcut Acres	20 Decade Total Net Cash Flow in Millions	20 Decade Net Present Value in Millions	20 Decade Average Clearcut Harvest Age	20 Decade Average OFS %	20 Decade Average LYR %
1-A SBM/HCP	59,910	1,428,540	646,970	$25,680	$2,168	114	20.3%	22.7%
1-C SBM/HCP (SNC)	58,630	1,333,710	651,280	$25,254	$2,256	114	20.5%	21.6%
2 SBM/no HCP	52,360	1,245,080	563,440	$22,210	$1,934	109	25.4%	20.9%
3-A emphasize NPV	59,760	868,900	861,350	$26,800	$2,594	87	15.0%	2.3%
3-E no op. reductions	47,110	1,163,090	1,100,440	$19,068	$4,028	64	14.2%	4.1%
4-A 5%OFS, 5% LYR	59,270	1,100,520	856,120	$25,240	$2,451	88	16.4%	6.0%
4-B SBM/No HCP 30% OFS/LYR	56,210	1,212,400	785,670	$23,678	$2,641	89	21.0	9.7
6-B 50% reserves/SBM	22,710	636,460	273,970	$8,888	$1,367	91	43.2%	10.3%
7 grow only	0	0	0	$0	$0	0	58.3%	1.7%

Key Drivers for the Alternatives

This summary analyzes alternatives as applied to the three North Coast Districts, Astoria, Tillamook and Forest Grove.

Most of the following assumptions do not apply to Alternative 7, which allows no harvest.

All alternatives assume proposed aquatic and riparian strategies.

All alternatives emphasize net present value (NPV) at 4.5% discount rate.

For all alternatives except Alternatives 3-E, operability reductions are applied to the first 3 periods (period 1 – 25%, period 2 – 15%, period 3 – 5%).

Two alternatives, 1-C and 4-B harvest all merchantable stands that are severely affected by Swiss needle cast (SNC) in the first two decades.

For all except Alternatives 3-A and 3-E, there is no clearcut harvest below age 50. Alternative 3-A has a minimum harvest age of 45, and 3-E has no minimum final harvest age. In addition, during the first 2 decades of Alternatives 1-C and 4-B, severely affected Swiss needle cast stands may be harvested with a 25 year minimum harvest age.

All alternatives except 3-A, 3-E and 7 assume structure-based management (SBM). The goals for complex stand structures (LYR and OFS) in Alternatives 1-A, 1-C, and 2 are 20-30% each, average 25%. Alternatives 4-A and 4-B have reduced goals for complex stand structures of 10% and 30% respectively (combined OFS and LYR stands).

Alternatives 1-A, 1-C, and 6-B assume an HCP; Alternatives 2, 3-A, 3-E, 4-A, and 4-B use take avoidance strategies (no HCP). Alternative 7 needs no HCP.

Table I-2. Summary of Willamette Area Outputs: Clackamas-Marion, Western Lane and West Oregon Districts

Alternative	20 Decade Total MMBF Harvest	20 Decade Total Thinned Acres	20 Decade Total Clearcut Acres	20 Decade Total Net Cash Flow in Millions	20 Decade Net Present Value in Millions	20 Decade Average Clearcut Harvest Age	20 Decade Average OFS %	20 Decade Average LYR %
Outputs for Clackamas-Marion District								
1-A SBM/HCP	6,460	162,770	70,930	$2,831	$292	114	18.1	23.0
2 SBM/no HCP	5,410	134,620	61,530	$2,391	$232	111	21.9	21.4
3-A emphasize NPV	5,640	88,340	84,370	$2,585	$275	91	15.1	2.7
4-B SBM/No HCP 30% OFS/LYR	5,280	104,840	72,190	$2,358	$249	97	21.3	8.8
Outputs for Western Lane District								
1-A SBM/HCP	4,470	79,540	39,430	$2,018	$185	122	21. 3	19.7
2 SBM/no HCP	2,560	47,950	22,930	$1,157	$82	130	37.3	14.5
3-A emphasize NPV	2,690	33,740	29,470	$1,236	$95	110	32.1	1.7
4-B SBM/No HCP 30% OFS/LYR	2,770	43,670	29,630	$1,226	$91	111	35.4	4.7

Table I-2. Summary of Willamette Area Outputs (cont.)

Outputs for West Oregon District								
1-A SBM/HCP	6,480	140,850	52,820	$2,827	$296	114	20.7	20.5
2 SBM/no HCP	4,340	99,380	38,280	$1,924	$184	108	28.8	19.2
3-A emphasize NPV	6,400	89,720	68,770	$3,012	$290	87	14.2	1.6
4-B SBM/No HCP 30% OFS/LYR	5,930	103,020	56,230	$2,678	$263	96	21.6	8.6

Key Drivers for the Alternatives

All alternatives assume proposed aquatic and riparian strategies and emphasize net present value (NPV) at 4.5% discount rate.

All alternatives have non-declining even flow, except as affected by the Swiss needle cast (SNC) strategy in Alternative 4-B. In that alternative, all merchantable stands that are severely affected by Swiss needle cast are harvested in the first 2 decades, with non-declining even flow in decades 3-20.

Alternatives 1-A and 2 assume Structure-Based Management (SBM) with goals for OFS and LYR of 20%-30% each, with average of 25%. Alternative 4-B has reduced goals for complex stand structures of 30% OFS/LYR stands (combined).

Alternative 1-A assumes an HCP. Other alternatives use take avoidance strategies.

The minimum age for clearcuts is 50 years, except in Alternative 3-A where the minimum age is 45 years, and the first 2 decades (SNC strategy) of Alternative 4-B, where there is a 25 year minimum harvest age.

All alternatives have operability reductions applied to first 3 periods. From draft implementation plans:

Clackamas-Marion (5% all periods)
West Oregon (period 1 – 10%, period 2 – 7%, period 3 – 3%)
Western Lane (period 1 – 21%, period 2 – 15%, period 3 – 5%)

Table I-3. Summary of Model Results on Desired Future Condition

Alternative	NW Districts (Astoria, Tillamook, Forest Grove Districts)		Willamette Districts (Clackamas-Marion, Western Lane, West Oregon Districts)	
	Decade When Complex Stand DFC Met	Long-Term Average LYR/OFS %	Decade When Complex Stand DFC Met	Long-Term Average LYR/OFS %
1-A SBM/HCP	7 (40% LYR/OFS)	49.3%	8 (40% LYR/OFS)	47.5%
1-C SBM/HCP (SNC)	7 (40% LYR/OFS)	49.7%	—	—
2 SBM/no HCP	7 (40% LYR/OFS)	56.0%	7 (40% LYR/OFS)	57.4%
3-A emphasize NPV	N/A	21.7%	N/A	27.6%
3-E no op. reductions	N/A	24.1%	—	—
4-A 5%OFS, 5% LYR	2 (10% LYR/OFS)	27.3%	—	—
4-B SBM/No HCP 30% OFS/LYR	7 (30% LYR/OFS)	36.3%	7 (30% LYR/OFS)	38.4%
6-B 50% reserves/SBM	8 (40% LYR/OFS)	74.6%	—	—
7 grow only	N/A (40% LYR/OFS at decade 8)	88.4%	—	—