Appendix R
Vegetation Modeling

This appendix provides background on the vegetation modeling used to simulate the application of the land use allocations, management action, and forest development assumptions to characterize forest conditions into the future.

In this appendix:

Introduction

The alternatives considered in the plan revisions outline a range of approaches for managing the BLM forest lands by varying the land allocations and intensity with which these forests are managed. These different management approaches result in a range of outcomes in terms of the structural stages of the forest over time, types of habitat that are developed, and the sustainable harvest levels. Models allow simulation of the development of the forest over time under these various management strategies. Models were used in the plan revision to simulate the application of the land use allocations, management action, and forest development assumptions to characterize forest conditions 10, 20, 30, 40, 50, and 100+ years into the future. The models are also used to determine the level of harvest that can be produced and sustained over time. The outputs from modeling form a factual basis for comparing and evaluating these different land management strategies at the strategic level.

Two primary vegetation models were used for the plan revisions:

- ORGANON - Individual tree growth model that was utilized for the development of growth and yield projections for the major species groups on the BLM lands. ORGANON was developed by Oregon State University. http://www.cof.orst.edu/cof/fr/ research/ORGANON/. In this appendix, ORGANON refers to the generic model available in the public domain. DBORGANON refers to the version of the model specifically modified for BLM's Western Oregon Plan Revision.
- OPTIONS - Spatially explicit strategic planning model that was utilized to project the forest conditions over time by simulating the land allocations and management action of the alternatives. OPTIONS is proprietary software created by DR Systems Inc. http:// www.drsystemsinc.com/prod_options.html

Both of these models have been in use and under continued development for approximately 20 years, and provide a framework to bring the data and assumptions together to simulate these management scenarios. The extent of this modeling effort when looked at from an entire plan revision perspective can seem large and complex. It is easier to understand the modeling by looking at the major components used in the model formulation. These major components include; the GIS data that defines the land allocations and spatial representation of numerous resources, the forest inventory data, growth and yield projections, the definitions of habitats and structural stages, the assumptions on habitat and structural stage development, and management assumptions to simulate the alternatives.

This appendix provides an overview of the key components that were used in formulating the models used in the plan revision:

1. BLM Forest Inventory
2. Use of Inventory Data in Modeling
3. GIS – Defining the Land Base and Spatial Projections
4. Forest Growth and Yield Modeling
5. OPTIONS Modeling
6. OPTIONS Products

BLM Forest Inventory Data

Introduction

Three inventories of the BLM lands were used in the vegetation modeling for the plan revision:

- GIS Vegetation mapping with stand level attributes.
- Timber Productivity Capability Classification (TPCC)
- Current Vegetation Survey (CVS) – measured permanent plot data.

GIS Vegetation Mapping – Forest Operations Inventory & Micro*Storms

The Forest Operations Inventory (FOI) is a GIS layer that delineates vegetation polygons across BLM lands within the planning area. There are approximately 80,000 stands identified that average 32 acres in size. The minimum mapping feature is generally five acres but some finer scale non forest and harvest features are identified. Polygons are delineated based on vegetation attributes of cover condition, size class, density of trees, and age. (See *Figure R-1* below for an FOI mapping example)

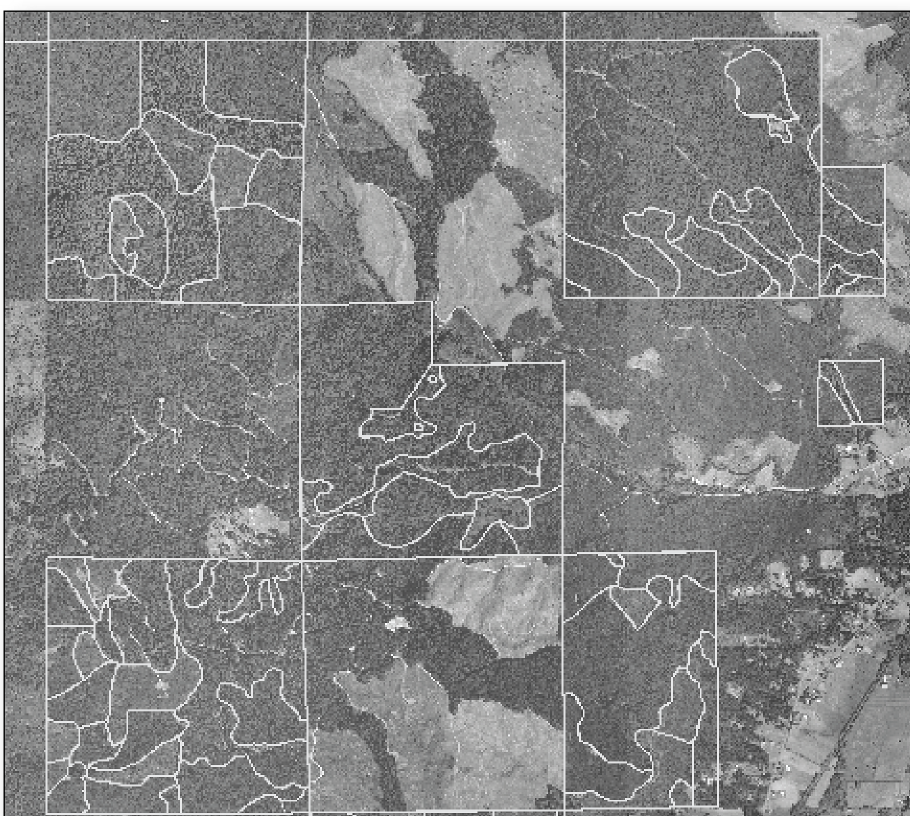


Figure R-1. Example Of FOI Mapping For Approximately A Three By Three Mile Area

The Micro*Storms database contains the attributes for the FOI polygons. The vegetation classification represents stand average characteristics that include:

- Cover Condition – Conifer, hardwood, mixed, or non forest.
- Single or Multi canopy stands.
- Species – Top five species with percent occupancy within a stand layer and listing of other species present.
- Stocking Class.
- Size Class – Diameter of the trees species by layer in 10" diameter classes.
- Birthdate of the layer.
- Ten-year age class.

Land management treatment history is recorded in Micro*Storms for the FOI polygons. These treatments include; timber harvest, site preparation, planting, stand maintenance / protection, pre-commercial thinning, fertilization, pruning and a variety of other treatments.

The data is updated by the districts on a regular basis as treatments are implemented and as conditions change. The data is updated by a variety of inventory methods. The FOI and its companion database, Micro*Storms, are operational datasets that are in daily-use by the districts for planning and tracking purposes.

The FOI and Micro*Storms data, as used in the plan revision, reflects the conditions of the BLM lands as of October, 2005 (vintage 2006). The FOI data is the spatial representation of the forest conditions for the OPTIONS vegetation modeling. The Micro*Storms data was used to develop modeling stratification for: species groups, site productivity, existing stand conditions, and 10-year age class.

Timber Productivity Capability Classification

The Timber Productivity Capability Classification (TPCC) is a classification of BLM lands based on the physical and biological capability of the site to support and produce commercial forest products on a sustained yield basis. Each TPCC unit is classified based on four assessments.

1) Forest / Non Forest

- ***Forest*** - capable of 10% tree stocking
- ***Non forest***

2) Commercial Forest Lands

- ***Commercial forest lands*** - capable of producing 20 cubic feet of wood per year of commercial species.
- ***Non commercial forest lands*** – not capable of producing 20 cubic feet of wood per year of commercial species.
- ***Suitable Woodland*** – Non Commercial Species or Low Site

3) Fragile Conditions

- ***Non Fragile*** – forest yield productivity is not expected to be reduced due to soil erosion, mass wasting, reduction in nutrient levels, reduction in moisture supplying capacity, and or the rise of ground water.
- ***Fragile*** - forest yield productivity may be expected to be reduced by soil erosion, mass wasting, reduction in nutrient levels, reduction in moisture supplying capacity, and/or the rise of ground water table.

Fragile sites are classified as:

— ***Restricted*** – Special harvest and or restricted measures are required.

— ***Non Suitable Woodland*** – Future production will be reduced even if special harvest and or restricted measures are applied due to the inherent site factors. These lands are not biologically and or environmentally capable of supporting a sustained yield of forest products.

4) Reforestation

Reforestation problem sites are those where environmental, physical, and biological factors have the potential to reduce the survival and or growth of commercial tree seedlings. These factors include light, temperature, moisture, frost, surface rock, animals and disease.

- ***Non Problem*** – Sites that can be stocked to meet or exceed target stocking levels, of commercial species, within 5 years of harvest, using standard practices.
- ***Restricted*** – Commercial forest land where operational reforestation practices in addition to standard practices are necessary to meet or exceed the minimum stocking levels of commercial species within 5 years of harvest.
- ***Suitable Woodland*** - Operational practices will not meet or exceed minimum stocking levels of commercial species within 5 years of harvest. These sites are biologically capable of producing a sustained yield of timber products.

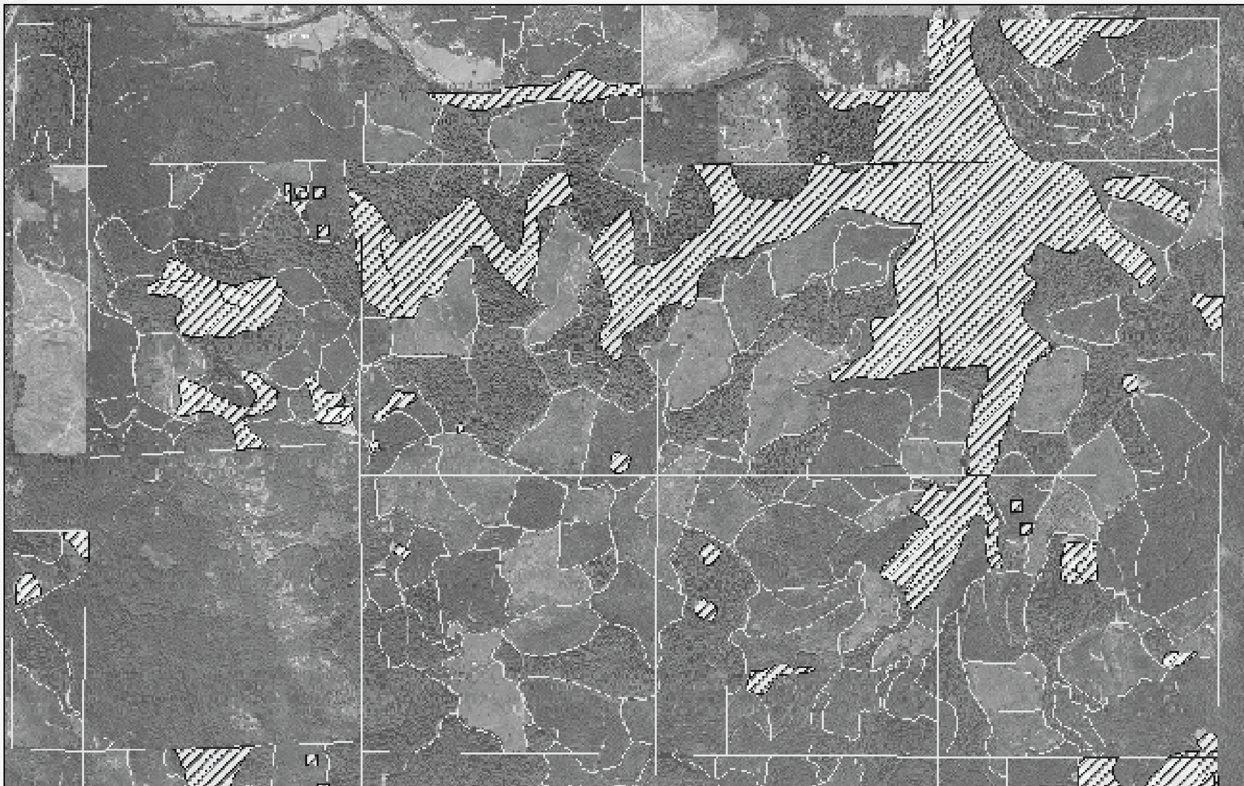
The BLM handbook 5251-1 (1986) provides the standards for the TPCC classification.

There are approximately 66,000 TPCC units mapped in GIS on the BLM lands within the planning area. The minimum mapping feature is generally five acres but some finer scale non forest features are identified in the data. The TPCC initial classification of all BLM lands in the planning area was performed in the late 1980s. The data is updated on an as needed basis as lands are acquired, and new information is obtained through field examination.

The data, as used in the plan revision, reflects the classification of the BLM lands as of October, 2005. For the Western Oregon Plan Revision the TPCC data is used to identify what portions of the BLM lands will contribute to the Allowable Sale Quantity. The non forest, suitable woodlands, and non suitable woodland categories are not included in the lands contributing to the Allowable Sale Quantity under the current plan.

In *Figure R-2,* the cross-hatched areas are examples of TPCC units withdrawn from the lands contributing to the Allowable Sale Quantity. The Forest Operations Inventory units are outlined for approximately a four by two mile area.

Figure R-2. Example Of TPCC Withdrawn Lands



Current Vegetation Survey – Measured Plot Inventory

The Current Vegetation Survey (Max, et al. 1996) provides comprehensive information on vegetative resources on BLM lands within western Oregon. The information was collected during the years 1997 to 2001. It consists of four 3.4-mile grids of field plots that are off-set from one another to produce one 1.7 mile grid across BLM lands for a total of 1,376 plots. The primary sampling unit is one hectare (approximately 2.5 acres) with five fixed-radius sets of subplots with trees 1.0 to 2.9 inches DBH measured on the 11.8 foot radius subplot, 3.0 to 12.9 on a 24.0 foot, 13.0 to 47.9 on a 51.1 foot and trees 48.0 and larger on the 1/5 hectare (approximately ½ acres) nested subplots. There is one subplot located at the plot center and four subplots each in a cardinal direction and 133.9 feet from the center of the plot (See *Figure R-3*). In addition, at each subplot, potential natural vegetation is determined using plant indicator keys, and coarse woody debris is measured along a transect. For specific information on the attributes that are collected refer to USDI BLM 2001).

The location of most of the plot centers have differentially corrected GPS coordinates. Since each subplot center was located at a precise distance from the plot center, the coordinates for the subplot centers were calculated and included in a GIS layer. The CVS layer was overlain on the Forest Operation Inventory GIS map. The CVS layer is independent of the FOI layer; consequently, the CVS data represents an unbiased sampling of the FOI layer. In *FigureR-3* below, the cross hair dot symbols are examples of CVS plot center locations on a 1.7 mile grid. The Forest Operations Inventory units are outlined for approximately a 4.5 by 3 mile area as shown in *Figure R-4.*

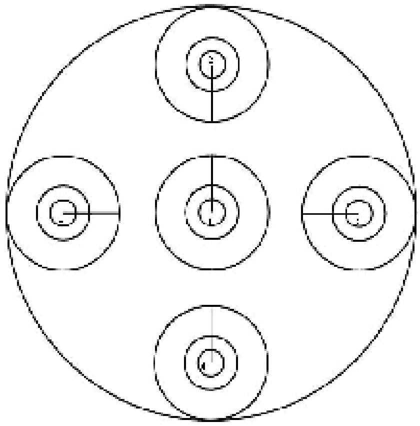
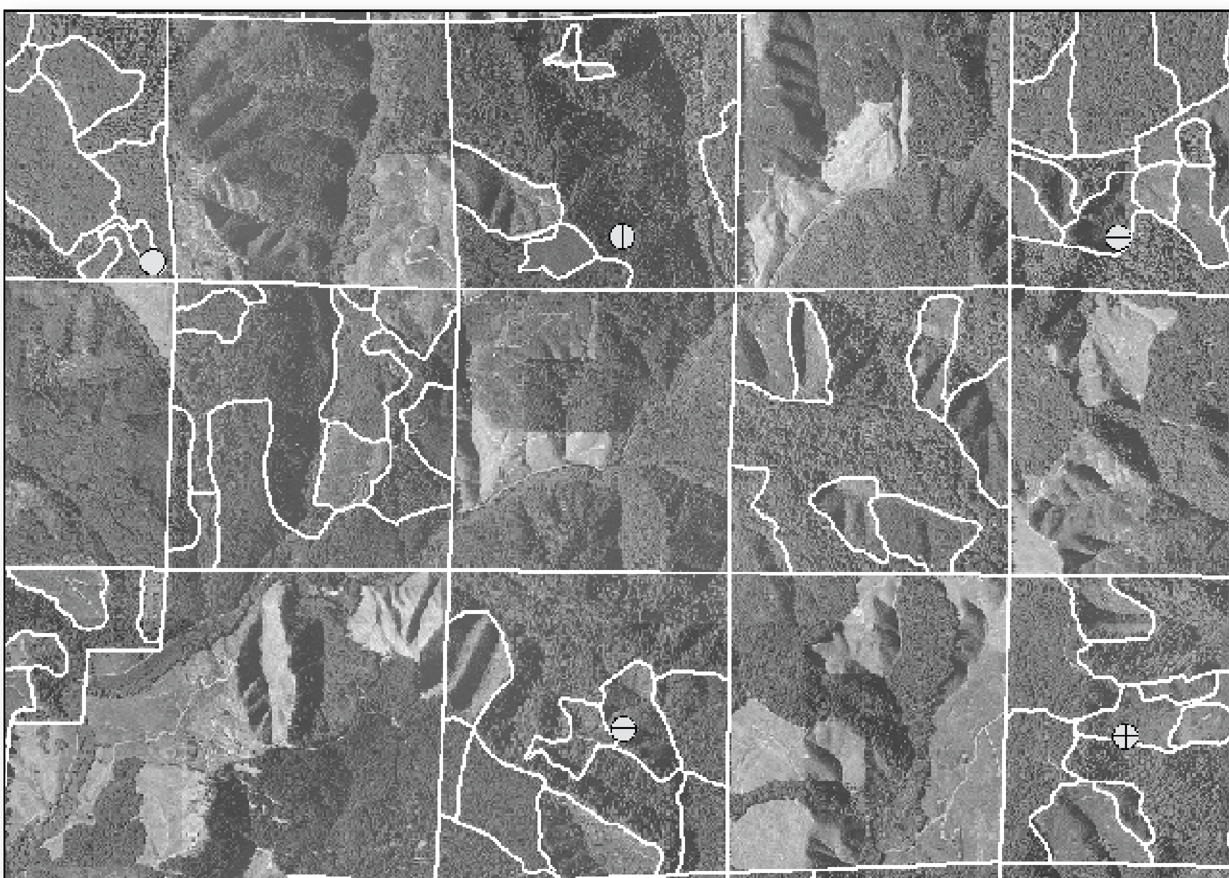


Figure R-3. CVS Plot Design

Figure R-4. CVS Plot Overlain With Forest Operations Inventory



Use of the Inventory Data in the Modeling

Introduction

The Forest Operations Inventory (GIS vegetation units) and the Current Vegetation Survey data (measured inventory plots) were divided into stratification units to identify groups of stands with like characteristics. The stratification was based upon Existing Stand Conditions (ESC), site class, stand age, and species groups. This stratification of the data carried forward into both the DBORGANON and OPTIONS modeling. DBORGANON is a version of the ORGANON growth and yield model customized for BLM by FORsight Resources. DBORGANON is discussed in more detail in the Growth and Yield section of this appendix.

Stratification of Forest Operation Inventory

Stand Age

For every Forest Operations Inventory unit there is a stand age recorded in the Micro*Storms database. (See *Figure R-5* and *Table R-1*) The stand ages reflect the conditions of the forest as of 2006. A Ten-Year age class was derived from these stand ages which served as the starting ages for the OPTIONS model. For multi-storied stands the Ten-Year age class was assigned to the predominant layer being managed. Stand ages over 200 years of age are in 50 year bands. All regeneration harvest timber sales sold by September 30, 2005 were considered depleted from the inventory and the stand ages were converted to year zero for OPTIONS modeling. Stand ages were not assigned to the Klamath Falls eastside management lands. Update instructions for the Forest Operations Inventory were issued to the districts through BLM Information Bulletin No. OR-2005–142 http://web.or.blm.gov/ records/ib/2005/ib-or-2005-142.pdf

Figure R-5. Western Oregon Age Class Distribution 2006 (Acres)

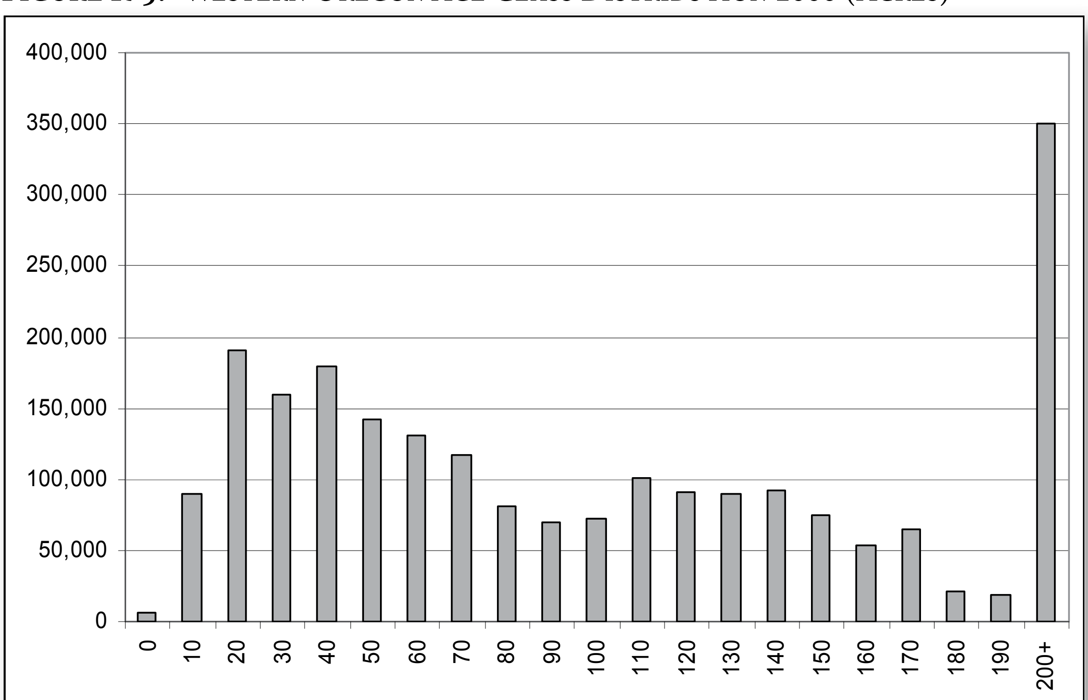


Table R-1. Western Oregon Age Class Distribution 2006 By Sustained Yield Unit (acres)

Age Class	Salem	Eugene	Roseburg	Coos Bay	Medford	Klamath	Total
0	273	110	1,374	1,311	3,654	0	6,722
10	13,172	12,108	23,079	16,176	24,742	969	90,247
20	32,098	30,163	37,483	31,292	56,403	3,483	190,922
30	34,395	31,666	39,203	32,757	20,328	1,595	159,944
40	35,946	32,071	32,483	37,476	38,329	2,578	178,883
50	23,067	27,581	29,673	28,794	30,865	1,731	141,710
60	41,409	41,547	13,198	12,676	20,213	1,913	130,956
70	30,922	29,659	8,997	15,946	28,680	2,699	116,902
80	22,908	12,567	5,387	9,272	26,627	3,905	80,667
90	13,738	6,701	5,584	3,519	35,325	5,365	70,232
100	12,047	4,423	5,607	4,161	42,860	3,421	72,519
110	12,393	6,021	12,661	3,576	62,101	4,216	100,968
120	20,751	7,949	6,573	9,223	44,948	1,908	91,353
130	20,598	6,204	7,679	10,557	43,225	1,048	89,311
140	9,165	1,623	11,233	5,528	62,066	2,797	92,412
150	7,502	1,223	25,360	8,570	30,226	2,046	74,927
160	1,876	2,073	2,310	7,321	39,218	455	53,253
170	2,756	400	8,285	3,810	49,008	396	64,655
180	429	424	1,552	635	17,796	70	20,906
190	201	3,952	2,497	1,739	9,969	92	18,450
200+	29,625	37,571	118,961	57,372	101,156	6,056	350,740
Total	**365,272**	**296,036**	**399,180**	**301,710**	**787,740**	**46,742**	**2,196,679**

Existing Stand Conditions (ESC)

The Existing Stand Condition coding aggregated Forest Operations inventory based on past management history and similar stand conditions. The Micro*Storms database was used to classify each of the Forest Operations Inventory units into one of the existing stand condition codes. This stratification was done prior to beginning the DBORGANON and OPTIONS modeling. Further collapsing of the ESC coding was done to formulate the DBORGANON and OPTIONS modeling groups. (See *Table R-2*)

Table R-2. Existing Stand Condition Codes

PROPOSED Existing Stand Condition (ESC) Codes - WOPR					REVISED as of 11/13/2005	
2005 ESC Code	1994 ESC Code	Description	Genetic Improved	Fertilized	Era Stand Created/ Treated	Remarks
1	1	GFMA target stocking (>= 80%) & 250 to 400 TPA density (unimproved TI)			1950 to 1995	previously regen harvested without retention trees including pre-RMP stands with 2 dispersed retention trees per acre
2	6	GFMA target stocking (>= 80%) & 250 to 400 TPA density (unimproved TI) FERTILIZED		X	1950 to 1995	
3	2	GFMA minimum stocking (60-79%) - 150 to 249 TPA density (unimproved TI)			1950 to 1995	
4	6	GFMA minimum stocking (60-79%) - 150 to 249 TPA density (unimproved TI) FERTILIZED		X	1950 to 1995	
5	3	GFMA below minimum stocking (< 60%) - 50 to 149 TPA density (unimproved TI)			1950 to 1995	
6	4	GFMA Overstocked/overdense - > 400 TPA density (unimproved TI)			1950 to 1995	
7	5	GFMA target stocking (>= 80%) & 250 to 400 TPA density (TI genetic stock)	X		1950 to 1995	
8	6	GFMA target stocking (>= 80%) & 250 to 400 TPA density (TI genetic stock) FERTILIZED	X	X	1950 to 1995	
9	5	GFMA minimum stocking (60-79%) - 150 to 250 TPA density (TI genetic stock)	X		1950 to 1995	
10	6	GFMA minimum stocking (60-79%) - 150 to 250 TPA density (TI genetic stock) FERTILIZED	X	X	1950 to 1995	
11	5	GFMA below minimum stocking (< 60%) - 50 to 149 TPA density (TI genetic stock)	X		1950 to 1995	
13	n/a	6-8 retention trees - at GFMA target stocking & density (TI genetic stock)	X		1996 to 2005	previously regen harvested with low (6-8 TPA) retention trees level
14	n/a	6-8 retention trees - at GFMA minimum stocking & density (TI genetic stock)	X		1996 to 2005	
15	n/a	6-8 retention trees - below GFMA minimum stocking & density (TI genetic stock)	X		1996 to 2005	
16	n/a	6-8 retention trees - Overstocked GFMA standard- need PCT (TI genetic stock)	X		1996 to 2005	
17	n/a	6-8 retention trees - at GFMA target stocking & density (unimproved stock TI)			1996 to 2005	
18	n/a	6-8 retention trees - at GFMA minimum stocking & density (unimproved stock TI)			1996 to 2005	
19	n/a	6-8 retention trees - below GFMA minimum stocking & density (unimproved stock TI)			1996 to 2005	
20	n/a	6-8 retention trees - overstocked GFMA standard- need PCT (unimproved stock)			1996 to 2005	

PROPOSED Existing Stand Condition (ESC) Codes - WOPR					REVISED as of 11/13/2005	
2005 ESC Code	1994 ESC Code	Description	Genetic Improved	Fertilized	Era Stand Created/ Treated	Remarks
21	n/a	12-18 retention trees - at GFMA target stocking & density (TI genetic stock)	X		1996 to 2005	previously regen harvested with moderate (12-18 TPA) retention trees level
22	n/a	12-18 retention trees - at GFMA minimum stocking & density (TI genetic stock)	X		1996 to 2005	
23	n/a	12-18 retention trees - below GFMA minimum stocking & density (TI genetic stock)	X		1996 to 2005	
25	n/a	12-18 retention trees - at GFMA target stocking & density (unimproved stock TI)			1996 to 2005	previously regen harvested with moderate (12-18 TPA) retention trees level
26	n/a	12-18 retention trees - at GFMA minimum stocking & density (unimproved stock TI)			1996 to 2005	
27	n/a	12-18 retention trees - below GFMA minimum stocking & density (unimproved stock TI)			1996 to 2005	
28	n/a	12-18 retention trees - overstocked GFMA standard- need PCT (unimproved stock TI)			1996 to 2005	
30	n/a	Density Mgt at age class 30			1996 to 2005	low/variable residual density commercial thinnings (immediate post- thin Curtis RD < 35)
31	n/a	Density Mgt at age class 40			1996 to 2005	
32	n/a	Density Mgt at age class 50			1996 to 2005	
33	n/a	Density Mgt at age class 60			1996 to 2005	
34	n/a	Density Mgt at age class 70			1996 to 2005	
35	n/a	Density Mgt at age class 80			1996 to 2005	
36	n/a	Density Mgt at age class 90 Plus			1996 to 2005	
37	10	CTed at age class 30			1950 to 2005	moderate/high residual density commercial thinnings (immediate post- thin Curtis RD > 35)
38	11	CTed & fertilized at age class 30		X	1950 to 2005	
39	12	CTed at age class 40			1950 to 2005	
40	13	CTed & fertilized at age class 40		X	1950 to 2005	
41	14	CTed at age class 50			1950 to 2005	
42	15	CTed & fertilized at age class 50		X	1950 to 2005	
43	16	CTed at age class 60			1950 to 2005	
44	17	CTed & fertilized at age class 60		X	1950 to 2005	
46	19	CTed & fertilized at age class 70		X	1950 to 2005	
47	20	CTed at age class 80			1950 to 2005	
48	22	CTed at age class 90			1950 to 2005	
49	n/a	CTed at age class 100			1950 to 2005	
50	n/a	CTed at age class 110			1950 to 2005	moderate/high residual density commercial thinnings (immediate post- thin Curtis RD > 35)
51	30	Mortality Salvaged or Sanitation Cut			Pre-RMP	

PROPOSED Existing Stand Condition (ESC) Codes - WOPR					REVISED as of 11/13/2005	
2005 ESC Code	1994 ESC Code	Description	Genetic Improved	Fertilized	Era Stand Created/ Treated	Remarks
52	40	56 to 500 years-old, no past silvicultural treatment			< 1950	unmanaged stands created prior to 1950
53	50	Brushfield, hardwood, noncommercial conifer or backlog conversion opportunity			Any	
54	60	Sold but not cut - regeneration harvest			Any	includes all unharvested litigated & unawarded sales
55	61	Cut, needs site preparation			Any	
56	62	Site prepped, needs regeneration			Any	
57	99	Nonforest			Any	
58	n/a	> 18/15 retention trees/acre - at GFMA target stocking & density (TI genetic stock)	X		1950 to 2005	Non SW Oregon - previously regen harvested with high (19-25 TPA) retention trees level SW Oregon - previously regen harvested with high (16-25 TPA) retention trees level
59	n/a	> 18 /15 retention trees/acre - at GFMA minimum stocking & density (TI genetic stock)	X		1950 to 2005	
60	n/a	> 18/ 15 retention trees/acre - below GFMA minimum stocking & density (TI genetic stock)	X		1950 to 2005	
61	n/a	> 18 /15 retention trees/acre - Overstocked GFMA standard- need PCT (TI genetic stock)	X		1950 to 2005	
62	n/a	> 18 /15 retention trees/acre - at GFMA target stocking & density (unimproved stock TI)			1950 to 2005	
63	n/a	> 18 /15 retention trees/acre - at GFMA minimum stocking & density (unimproved stock TI)			1950 to 2005	Non SW Oregon - previously regen harvested with high (19-25 TPA) retention trees level SW Oregon - previously regen harvested with high (16-25 TPA) retention trees level
64	n/a	> 18 /15retention trees/acre - below GFMA minimum stocking & density (unimproved stock TI)			1950 to 2005	
65	n/a	> 18 /15 retention trees/acre - overstocked GFMA standard- need PCT (unimproved stock TI)			1950 to 2005	
66	80	Hardwood-Suitable Woodland CFL			Any	Woodland
67	81	Conifer-Suitable Woodland CFL			Any	
68	85	Hardwood-NonSuitable Woodland CFL			Any	
69	86	Conifer-NonSuitable Woodland CFL			Any	
70	89	Hardwood-Suitable Woodland NonCFL			Any	

PROPOSED Existing Stand Condition (ESC) Codes - WOPR					REVISED as of 11/13/2005	
2005 ESC Code	1994 ESC Code	Description	Genetic Improved	Fertilized	Era Stand Created/ Treated	Remarks
71	90	Conifer-Suitable Woodland NonCFL			Any	
72	n/a	GFMA target stocking (>= 80%) & 250 to 400 TPA density (unimproved TI) PRUNED			1950 to 1995	previously regen harvested without retention trees including pre-RMP stands with 2 dispersed retention trees per acre PRUNED for wood quality only
73	n/a	GFMA target stocking (>= 80%) & 250 to 400 TPA density (unimproved TI) FERTILIZED PRUNED		X	1950 to 1995	
74	n/a	GFMA minimum stocking (60-79%) - 150 to 249 TPA density (unimproved TI) PRUNED			1950 to 1995	
75	n/a	GFMA minimum stocking (60-79%) - 150 to 249 TPA density (unimproved TI) FERTILIZED PRUNED		X	1950 to 1995	
77	n/a	GFMA target stocking (>= 80%) & 250 to 400 TPA density (TI genetic stock) FERTILIZED PRUNED	X	X	1950 to 1995	previously regen harvested without retention trees including pre-RMP stands with 2 dispersed retention trees per acre PRUNED for wood quality only
78	n/a	GFMA minimum stocking (60-79%) - 150 to 250 TPA density (TI genetic stock) PRUNED	X		1950 to 1995	
79	n/a	GFMA minimum stocking (60-79%) - 150 to 250 TPA density (TI genetic stock) FERTILIZED PRUNED	X	X	1950 to 1995	

Medford and Klamath Falls common codes from 1994 PRMP & Proposed ESC for Southern GFMA

Woodland codes may be applicable to all districts

Table R-3. No Action Alternative Existing Stand Condition Acres By Sustained Yield Unit

ESC	Salem	Eugene	Roseburg	Coos Bay	Medford	Klamath	E. Mgt. lands	Grand Total
1	83,348	60,695	57,832	31,920	92,475	6,635	398	333,303
2	14,241	11,706	32,549	29,367	9,614			97,476
3	30,299	31,441	28,320	29,331	18,634			138,026
4	1,662	6,464	6,502	16,663	5,269			36,559
5	2,004	222	644	8,383	6,012			17,266
6	14,057	1,269	23,182	6,899	1,811			47,218
7	4,034	13,481	2,158	6,615				26,288
8	338			487	2,037			2,862
9	1,132	231	870	4,576	539			7,348
10	18			380	15			413
11	43	314	1,023	910	211			2,501
12	2,789		1,346	3,443				7,578
13	512	1,983	342	153				2,989
14	13		154					167
16	672		557	778				2,007
17	200		1,135	157	12,178			13,670
18	37		152	20	5,717	19		5,946
19			19		2,254			2,273
20	275		218	424				917
21	62	430						491
22	250							250
24	86		37					123
25	18		19		617	189	2,750	3,592
26	3				225			228
27					77			77
28	46		212					258
30				908	7	683		1,598
31		72	201	1,853	206	2,214		4,547
32	39	676	507	1,139	229	1,437	112	4,138
33	1,123	990	845	809	149	1,362	782	6,059
34	297	754	102	316	839	2,384	629	5,321
35				330	822	3,485	1,183	5,820
36	49			148	9,473	18,482	9,811	37,962
37	458	52	159	313	105			1,087
38	35			131	98			264
39	3,277	851	2,218	992	145			7,483
40	16	283		956				1,255
41	8,935	4,163	3,154	1,919	238			18,408
42	1,766	856	9	2,633				5,265
43	8,201	5,683	2,023	843	204			16,955
44	824	1,049		831				2,704

ESC	Salem	Eugene	Roseburg	Coos Bay	Medford	Klamath	E. Mgt. lands	Grand Total
45	5,674	2,778	1,438		876			10,765
46	354	445	121					919
47	8,252	519	595	120	993			10,480
48	6,643	247	156	6	1,166			8,218
49	824	37	32		2,732			3,624
50	779		170	36	6,793			7,778
51		888	5,330	125	20,481	4,546		31,370
52	186,872	154,570	224,927	144,923	376,391	1,445	171	1,089,298
53		5,248	2,659	8,598	5,906	676	1,265	24,351
54	147		548	909	1,320			2,924
55	133	71		307				511
56		30	249	167				446
57	10,500	2,790	7,711	4,499	42,014	2,131	74,399	144,045
62					53			53
64					79			79
66					2,353			2,353
67					67,045	152	24	67,221
68			5,661		715	62		6,439
69		7	1,145	1,046	39,161	414	4,289	46,063
70					40,972	947	64	41,984
71					87,314	4,043	77,026	168,383
72	622	939	1,471	754	58			3,845
73	224	25	731	1,117	12			2,109
74			2,206	766	56			3,028
75			1,705	2,242				3,947
76			166	467				633
77				46				46
78				349				349
79			82	65				147
Total	**402,184**	**312,261**	**423,589**	**321,167**	**866,694**	**51,306**	**172,903**	**2,550,103**

Species Groups

The Micro*Storms database has a listing of the top 5 species within each stand layer with a ranking of relative abundance. This data was utilized to classify each Forest Operations Inventory Unit into one of the following species groups for modeling purposes. The Micro*Storms species group stratification was a starting point. For the OPTIONS and DBORGANON modeling some species groups were combined to attain adequate representation by the Current Vegetation Survey plots. (See *Figure R-6*)

Douglas-fir (DF)

This species group includes stands with single species DF listed, and those stands with minor quantities of other conifers or hardwoods. They would typically be "FCO" stands (forest conifer), and have either single or multiple sizes and ages indicated.

Northern True Fir (N_TF)

Stands of Noble or Silver fir, including other species mixed in such as Douglas- fir, western hemlock, or western red cedar, but where Silver or Noble are dominant.

Northern Mixed Conifer (N_MX_CON)

This species group includes stands with single species of western hemlock, western red cedar, Sitka spruce, or mixed conifer stands where Douglas-fir would not be the dominant species. They would typically be "FCO" stands (forest - conifer).

Northern Conifer / Hardwood Mix (N_CON_HWD)

These stands would have both conifer and hardwood species listed. Neither conifer nor hardwood would dominate these stands. Conifers or hardwoods could be indicated in the dominant or secondary position. Hardwoods would include big leaf maple and red alder mixed with conifer species. Many FMX stands (forest - conifer and hardwoods) would be located here.

Northern Hardwood (N_HWD)

Maple/alder mixes and pure alder are here. Pure or nearly pure alder stands, with limited maple fractions. FHD stand (forest - hardwoods) descriptions are here.

Southern Mixed Conifer (S_MX_CON)

Stands containing incense cedar, sugar pine, Ponderosa pine, Douglas-fir and white fir in varying fractions, but not including pure types without any secondary species indicated. This type may include some hardwood component but less than the southern conifer/hardwood mix. Hardwoods would not be listed as the dominant species.

Southern Conifer / Hardwood Mix. (S_CON_HWD)

This type consists of stands with the mixed conifer species, but with southern hardwoods such as oak, madrone, tanoak, myrtle, etc mixed in. The hardwoods may be in the majority or minority. FMX types (forest - conifer and hardwoods) are here.

Southern Hardwood (S_HWD)

This type consists primarily of southern hardwood species with limited mixed conifer component. Hardwoods would comprise the dominant species, possibly FHD types (forest - conifer and hardwoods).

Southern True fir (S_TF)

This type includes Shasta red fir and white fir types. White fir types could have other secondary species such as Douglas-fir.

Ponderosa Pine (PP)

These are stands with dominant Ponderosa pine. Stands with Douglas-fir or other species in the understory would be here, if not the dominant species. This would include dryer types with juniper as long as the Ponderosa pine was the dominant species.

Juniper (J)

This type is juniper dominant. This type would contain some limited pine on dryer lower site types.

Depending on the district and the DBORGANON variant used, lodge pole pine and knob cone pine types would go into Northern Mixed Conifer or Southern Mixed Conifer. Jeffery pine would go into a low site Ponderosa pine type. Mountain hemlock would go into northern true fir. Port-Orford-cedar would go into Southern Mixed Conifer.

Site Class

Site Class data in the Micro*Storms database / Forest Operation Inventory (FOI) come from a variety of sources, including estimations, measured on site, and/or soils mapping. The site class data in FOI is adequate for a general portrayal of productivity but due to the variety of sources it is of varying accuracy.

Site index data was measured on the CVS inventory at the plot level. Assignment of site index to the subplot level was made at the time of data collection. Using a site index conversion routine created by Mark Hanus (FORSight Resources), all measured site data for all species and base ages was converted to a Douglas-fir, 50-year base index, using King (1966) for Northwest Oregon, and Hann-Scrivani (1987) for SW Oregon.

Figure R-6. Species Group By District – Forested Acres

Frozen Micro*Storms 4/7/2006

Species Group	Salem	Eugene	Roseburg	Coos Bay	Medford	Kfalls	W. Oregon	
DF	284,856	247,212	300,796	250,087	396,459		1,479,411	64%
N_CON_HWD	54,316	40,127	8,883	27,751			131,076	6%
N_HWD	12,506	4,473	596	5,929			23,504	1%
N_MX_CON	17,163	8,127	327	1,818			27,434	1%
N_TF	9,935						9,935	0%
PP			1,437		57,445	33,544	92,426	4%
S_CON_HWD			28,341	11,206	159,802	2,125	201,474	9%
S_HWD			2,768	2,214	39,740		44,722	2%
S_MX_CON			57,653	734	118,473	29,262	206,122	9%
S_TF					21,170	8,277	29,446	1%
J						71,891	71,891	3%
Total	378,775	299,939	400,802	299,738	793,089	145,098	2,317,442	100%

It was assumed that the best representation for range of site productivity values and relative proportions of these values are the CVS data for areas as large as those occupied by combined species group within an SYU. The Measured CVS data was used to re-distribute the FOI site class data to reflect the profile of the measured data. Assignment from the CVS to the FOI was based on a set of rules. These data were apportioned to each sustained yield unit forest land base at the FOI unit level. Existing measured site index data from the Micro*Storms / FOI were retained for individual FOI units. For the remaining FOI units, site productivity values were assigned to all stands in the forest land base in such a manner to approximate the expanded CVS distribution for species groups at the SYU level. These FOI unit-level productivity assignments were held constant for the OPTIONS modeling of all alternatives.

Methodology for Site Class Re-Distribution - CVS to the FOI

The following methodology was applied at the district level to achieve a similar distribution of acres by species group and site productivity in the inventory as was present within the CVS information.

Source Information

A Microsoft Excel spreadsheet, with the following information, was prepared for each district:

- CVS Plot Number – unique plot number
- CVS District – the district for the plot
- CVS Species Group – the super species group for the plot
- CVS Site Productivity – the site productive class for the plot
- FOI Number – unique inventory number
- FOI Site Index Conversion Code – the conversion method used to calculate the Douglas-fir, 50-year base index
- FOI District – the district for the FOI
- FOI Species Group – the super species group for the FOI
- FOI Site Productivity – the site productivity class for the FOI
- FOI Acres – the acres for the FOI
- FO DBORGANON Variant - the DBORGANON Variant for the FOI

Assumptions

- FOI with measured site index information are not redistributed.
- FOI polygons are treated as whole units. An FOI polygon cannot be split in order to achieve desired acre redistribution.
- Redistribution of acres cannot result in an excess of acres over the desired target.
- Species Groups identified as 'NF' (non-forest) were not redistributed
- If either CVS or FOI information was not available, then no redistribution would occur, i.e. both CVS and FOI information must be available for redistribution to occur.

Methodology

1. Using the source CVS information, for each district (SYU) and species group (SSPG) combination, determine the percent distribution of plots within each site productivity class (SP). (See *Table R-4*)

2. Using the FOI information, for each district (SYU) and species group (SSPG) combination, determine percent distribution of acres within each site productivity class (SP). (See *Table R-5*)

3. Redistribute FOI acres between site productivity classes within the district species group to obtain the same percent distribution as indicated by the CVS information. Beginning redistribution starting with the highest site (1) and progress to the lowest site (5) as follows:

   a) Identify initial acres based on FOI information for the desired site productivity class
   b) Determine target acres based on percent distribution from CVS information for the desired site productivity class.
   c) If the initial acres are less then the target acres, then reassign acres from the next lowest site productivity class to the desired site productivity class until the target acres are met (but not exceeded). Acres from each subsequent site productivity class are reassigned until the target acres are achieved.

      In our example, for site productivity class 1, the initial 38,372 acres is less than the target acres of 50,869. Therefore, approximately 12,500 acres from productivity class 2 are reassigned to site productivity class 1. (See *Tables R-5* and *R-6* and *Figure R-7*)

   d) If the initial acres are greater then the target acres, then reassign acres from the current site productivity class to the next successively lower site productivity class until the target is met (but not exceeded).

      If our example was reversed and the initial acres for site productivity class were 50,869, then approximately 12,500 acres would be reassigned to site productivity class 2.

Table R-4. Example Of Distribution Of Plots By Site Productivity Class

SYU_SSPG	SYU_SSPG_SP	# of Plots in SYU_SSPG	# of Plots in SYU_SSPG_SP	% Distribution
Coos Bay_NDF	Coos Bay_NDF_1	673	132	20
Coos Bay_NDF	Coos Bay_NDF_2	673	273	41
Coos Bay_NDF	Coos Bay_NDF_3	673	182	27
Coos Bay_NDF	Coos Bay_NDF_4	673	61	9
Coos Bay_NDF	Coos Bay_NDF_5	673	25	3

Table R-5. Example Of Percent Distribution Of Acres Within Site Productivity Class

SYU_SSPG	SYU_SSPG_SP	Total Acres SYU_SSPG	Total Acres SYU_SSPG_SP	% Distribution
Coos Bay_NDF	Coos Bay_NDF_1	254347	38372	15
Coos Bay_NDF	Coos Bay_NDF_2	254347	133575	53
Coos Bay_NDF	Coos Bay_NDF_3	254347	68960	27
Coos Bay_NDF	Coos Bay_NDF_4	254347	13440	5
Coos Bay_NDF	Coos Bay_NDF_5	254347	0	0

Table R-6. Example Of Reassignment Of Productivity Class Acres To Match Percent Of CVS Plot Distribution

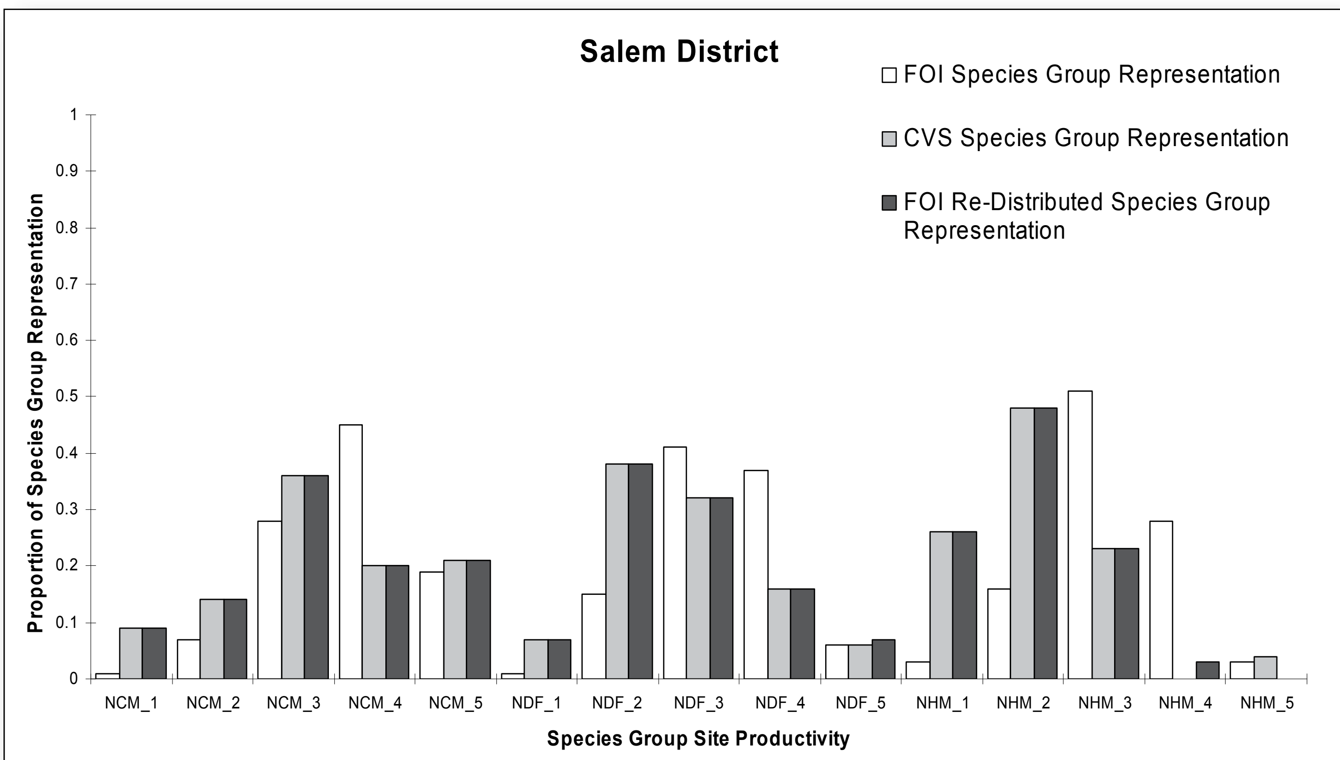
SYU_SSPG_SP	Total Acres in SYU_SSPG	Target %	Target Acres	Resulting Redistributed Acres	Resulting Redistributed % Distribution
Coos Bay_NDF_1	254347	20	50869	50884	20
Coos Bay_NDF_2	254347	41	104282	104224	41
Coos Bay_NDF_3	254347	27	68674	68324	27
Coos Bay_NDF_4	254347	9	22891	22538	9
Coos Bay_NDF_5	254347	3	7630	8376	3

4. For each FOI, reassign the corresponding mid-point site index value based on the new site productivity class and DBORGANON variant code. (See *Table R-7*)
   a) Southwest Oregon (SWO)
   b) Northwest Oregon (NWO)

Table R-7. Reassigning Mid-point Site Index Values

Site Productivity Class Midpoints by DBORGANON Variant Code	2	1
5	70	60
4	85	75
3	105	95
2	125	115
1	140	130

Figure R7. Salem District Site Class Re-Distribution Example (Species Groups NCM – Northern Conifer Mixed, NDF – Northern Douglas-Fir, NHM – Northern Hardwood Mixed)



Collapsing the Stratification into Modeling Groups

Both the Forest Operation Inventory (FOI) and Current Vegetation Survey (CVS) had an initial stratification based on stand age, existing stand condition (ESC), site productivity class, and species groups. Modeling Groups were developed to aggregate like types which represented significant quantities of the FOI acres and to assure there was sufficient measured data from CVS for each group.

The modeling groups were developed to:

- Classify the CVS data for the development of growth and yield curves with the DBORGANON model for each Modeling Group.
- Provide a consistent linkage between the growth and yield data from DBORGANON with the Forest Operation Inventory (FOI) for configuration, projection and the OPTIONS modeling.

The first step in the process involved grouping the CVS subplots, by DBORGANON variant, into strata of similar forest, past treatment, and productivity types. For each CVS subplot, the forest type and past treatment data was extracted from the FOI. The forest type was an assignment of a species group which had been derived by district personnel thru a series of queries on stand level information.

The past treatment groupings consisted of stands with similar management histories or trajectories. This designation was based on their existing stand condition data which had been reviewed and brought up to date (as of September 30, 2005) by district personnel. The third consideration used in this stratification process was the productivity level (50-year Douglas-fir Site Class) assigned to each CVS subplot.

The DBORGANON variants for Northwest (NWO) and Southwestern Oregon (SWO) were split primarily on District boundaries. (See *Figure R-8*) The Salem, Eugene and Coos Bay districts are being assigned to the NWO variant, with one exception. The southern portion of Coos Bay District which lies primarily in the Tanoak Zone was assigned to SWO for modeling. The Roseburg and Medford Districts and The Klamath Falls Resource Area were assigned to the SWO variant, again with one exception. Within the northwest portion of Roseburg district, some CVS subplots and a companion set of FOI units were within stands designated as species groups modeled only in the NWO variant.

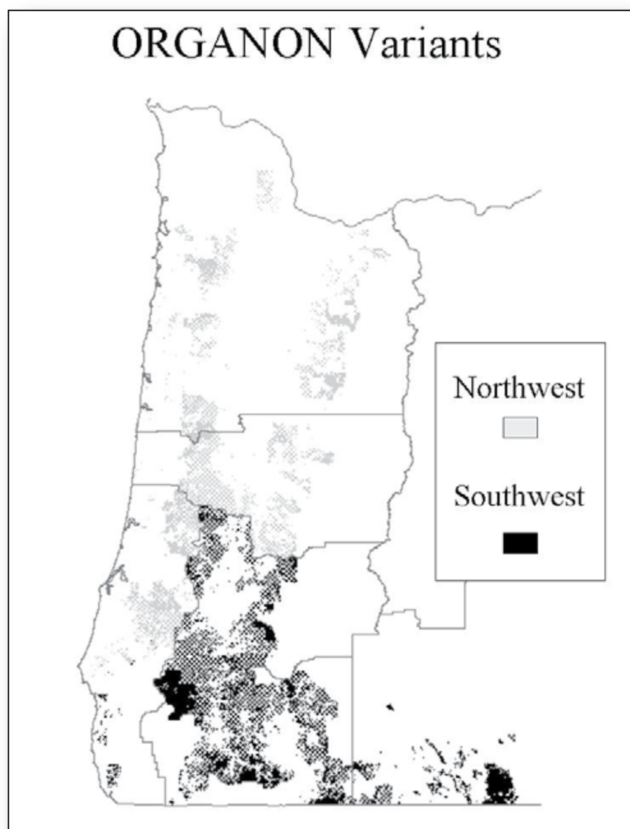


Figure R-8. Organon Variants

The stratification process involved partitioning the entire planning area; sampled by the over 5,300 forested CVS inventory plots, into logical modeling groups. This process involved a multi-day session with a workgroup of district personnel including but not limited to silviculture, timber and inventory specialists. A majority of these same district personnel were in a subsequent stage of the project, involved in development of the

Guide and Treatment Curves modeling the grouped CVS data with DBORGANON. Through an iterative process, the number of modeling groups with fewer than 30 subplots was minimized. Out of the final 53 existing-stand modeling groups, 22 for NWO and 31 for SWO, only 2 had fewer than 30 subplots.

Imputing Data from Current Vegetation Survey (CVS) to the Forest Operation Inventory (FOI)

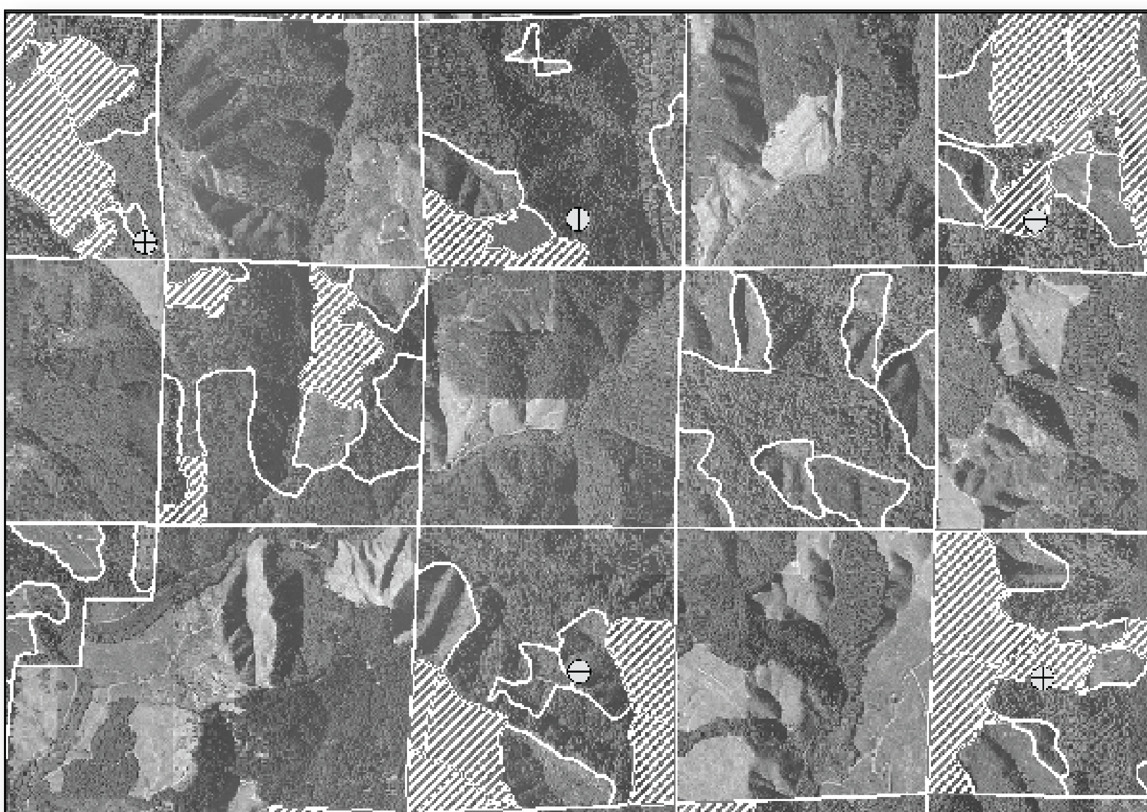
The objective was to create summary information for each Forest Operation Inventory (FOI) unit within the forested land base and to mimic the natural variation that exists among the FOI units. There is information to stratify each of the FOI units into Existing Stand Condition (ESC), Site Class, Age and Species Groups. There is CVS data for nearly every combination of characteristics found on BLM lands but there are FOI units without CVS data.

Information from the FOI: Existing Stand Condition (ESC), redistributed site productivity, stand age and species group, were used to stratify both the FOI and CVS. The combination of ESC, site class, age and species groups are non-overlapping strata. The resultant spatial relationship between the CVS plots and the FOI creates a stratified random sample of the plots with unequal number of subplots per plot. The CVS data within each of the characteristic combination represents an unbiased collection of data for that stratum.

In *Figure R-9*, the two plots on the right fall within the selected stratum (cross- hatched). These represent stands with common ESC, site productivity class and species groups.

The collection of CVS subplots that fell within the same stratum (defined by ESC, site productivity class and

Figure R-9. Example Of CVS Plots And FOI Units With A Common Existing Stand Condition



species groups but including different age categories) were projected with no future silvicultural treatments applied. This produced a smooth empirical curve that borrowed strength from adjacent age categories with more data to predict the current inventories for ages with less data.

To derive a set of stand attributes for each forested FOI unit, the subplots that fell within each stratum (ESC, site class, species group and age) were pooled and the subplots were drawn with replacement equal to the number of subplots within the category. If the number of subplots exceeded 30, then the summary information was calculated using the tree lists associated with each selected subplot and the summary information was assigned to an FOI unit. This process was repeated for each FOI unit within the stratum. This technique imputes values into each FOI unit.

Figure R-10 is an example of two FOI units that have been assigned 10 subplots with replacement from an original list of subplots numbered from 1 to 10.

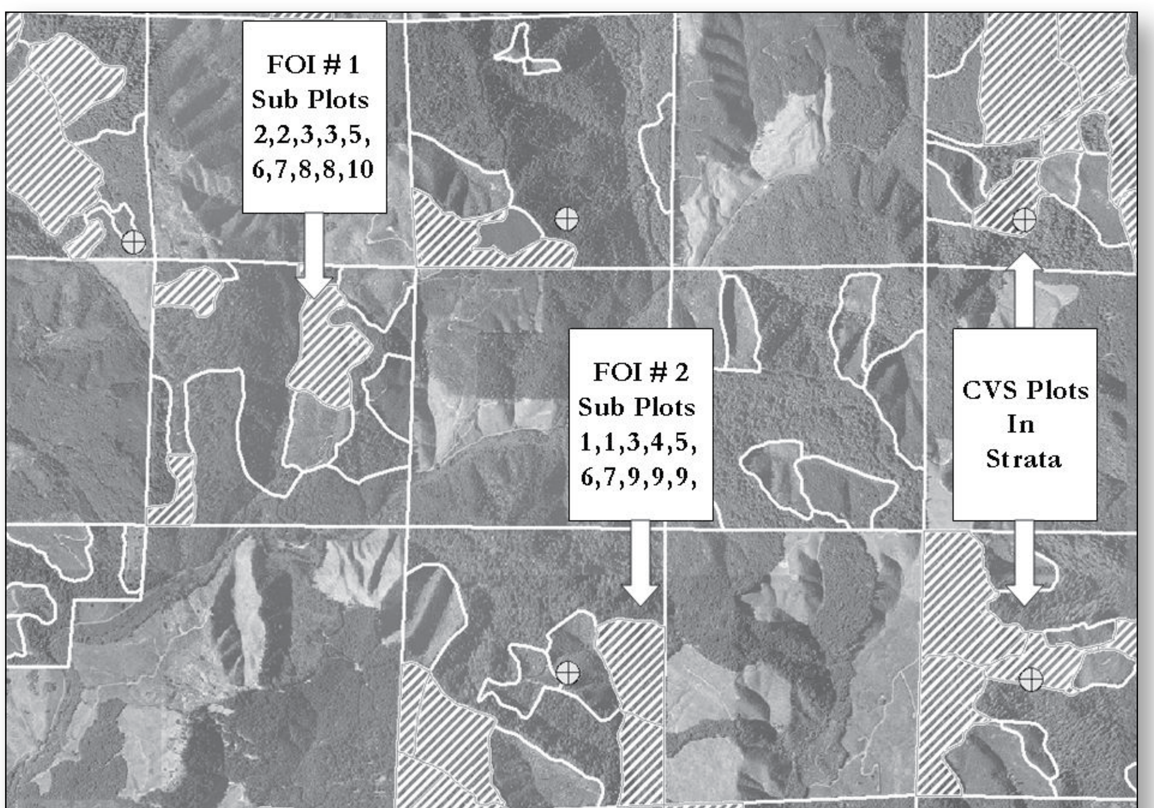
If the number of subplots within a stratum was less than 30, a shrinkage estimate was employed where the predicted attributed associated with the category was combined with the imputed summary statistic and combined estimate was assigned to the FOI unit. The shrinkage estimate can best be illustrated by an example. If there were 20 CVS subplots within a category, the shrinkage estimate is:

20/30 x CVS statistics + (30-20)/30 x modeled predicted values

As the number of subplots approach 30, most of the information comes from the CVS data. Conversely if there were relatively few CVS subplots, then the majority of the information came from the DBORGANON model. This method was repeated for each FOI unit with the category.

The stratification for the forested FOI units was the basis for applying the CVS derived values for basal

Figure R-10. Examples Of Subplot Data Imputed Into FOI Units



area, trees per acre, height, quadratic mean diameter, and board foot volume for the initial inventory in the OPTIONS modeling. The imputed initial inventory dataset provided a consistent basis for the OPTIONS modeling of all alternatives.

The use of the imputation provided attributes to the OPTIONS model that did not exist in the Forest Operations Inventory. Attributes assigned through imputation will not match the characteristics of each individual stand as measured on the ground but the statistics applied to the grouping of stands in the population, is statistically sound. The use of imputation is an attempt to mimic the natural variation that exists among the stands. Although, no process can accurately reflect the actual variation short of conducting a 100 percent cruise, this process is seen as more realistic than assigning the mean value for these statistics to all FOI units within a group.

Application of the Stratification in Growth and Yield Modeling

Each CVS subplot tree list within an existing stand modeling group was projected in the DBORGANON growth and yield model individually to simulate future development with and without future silvicultural treatments. Results from the simulations were averaged together to predict stand attributes at any point in time and to define an average yield function. This method is based on the fact that the CVS data represents a random sample of the modeling group hence the average of all projected curves for a modeling group represents the average projection for the FOI units within the modeling group. In OPTIONS terminology these average yield functions are the Guide Curves.

GIS – Defining the Land Base & Spatial Projections

Introduction

The Geographic Information System (GIS) data provides the OPTIONS model with a set of polygons with unique identifiers (WPR_ID), covering BLM lands in the planning area. Each of these polygons has attribute data which is used in defining the land base for application of modeling rules for simulation of the alternatives. GIS is also used for mapping the OPTIONS projections results of the forest conditions over time. This section provides an overview of the GIS process. The type of GIS data that was used for analyzing the alternatives and how it was applied is covered in the OPTIONS modeling section. Details on the GIS processing and datasets themselves are recorded with the GIS metadata.

Defining BLM Lands

The land lines theme (LLI) is the BLM's corporate GIS layer for land status - O&C, Public Domain, Coos Bay Wagon Road. The Forest Operations Inventory (FOI) is the spatial vegetation layer used for the OPTIONS modeling. The Forest Operations Inventory and Land Lines themes are not vertically integrated in GIS that results in slivering in the areas of misalignment. (See *Figure R-11* and *Table R-8*) For analytical purposes, BLM-administered lands are defined by the area in which the FOI and LLI overlap. This FOI & LLI mask was subsequently used to minimize the slivers from all GIS layers used in the analysis.

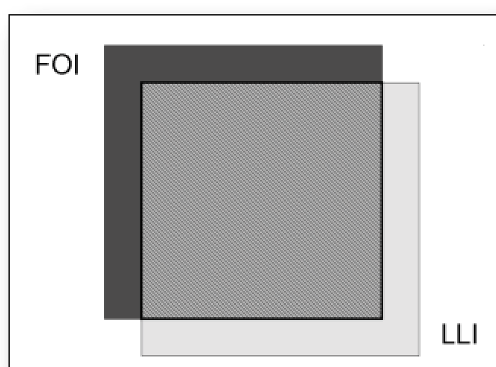


Figure R-11. Differences Between The FOI And LLI Themes

Table R-8. Acres Of Misalignment Between The FOI And LLI

FOI or LLI	Acres	Percent
FOI and LLI	2,550,000	100%
FOI only	9,200	0.36%
LLI only	8,200	0.32%

Intersection/Majority Rules

Where the subdivision of the FOI was important for simulating different modeling rules within each stand, within, the data layers were intersected in GIS to create unique areas. Riparian reserves and roads are good examples of this within stand subdivision that was important for simulating different modeling rules.

Some data layers came from external sources which were captured at coarser scales than the FOI mapping and do not align well with BLM checkerboard ownership. Northern Spotted Owl Critical Habitat Units is an example of this disparity between GIS data layers. In these situations, a majority rules analysis was performed where 50% or more of the FOI unit would need to coincide with the data theme, such as critical habitat, to receive the designation. This majority rules process was also applied to themes where spatial subdivision of FOI polygons was not needed and stand level designation was sufficient for the analysis.

Rasterizing and Unique ID Assignment

To facilitate GIS processing, all vector GIS data layers were converted to a 10 by 10 meter raster cell (1 cell = .025 acres – UTM zone 10, NAD83) and the data was partitioned into tiles which were based on 24K USGS Quads (~ 35,000 acres, 6 miles east/west by 8.5 miles north/south). Within each tile, every unique combination of GIS data layers was intersected with the Forest Operations Inventory and received a unique identifier (WPR_ID). The example in *Table R-9* illustrates one FOI unit (840369) being subdivided into 4 unique areas based on how riparian reserves and roads intersected the forest stand. This GIS subdivision of the forest stands allows the OPTIONS model to simulate how each portion of the stand would develop.

The unique ID (WPR_ID) carries through the OPTIONS modeling projections for the purpose of tracking each spatial entity. OPTIONS classification of allocations or projections of forest conditions were returned to GIS as attributes with the unique IDs which were linked back to the original grid to produce spatial products.

Table R-9. Example of Subdivision Of An FOI Unit And Assignment Of Unique Identifier

WPR_ID	FOI #	GIS ACRES	RIPARIAN RESERVE	ROAD BUFFER	DESCRIPTION
124000005	840369	28.84	N	N	Outside riparian reserve Outside of road buffer
124000008	840369	0.99	N	Y	Outside riparian reserve Within road buffer
124000004	840369	10.90	Y	N	Inside riparian reserve Outside of road buffer
124000013	840369	0.49	Y	Y	Inside riparian reserve. Within road buffer

Data Vintage

A snap shot of the Forest Operations Inventory (FOI), Land Use Allocation (LUA), Timber Production Capability Classification (TPCC), Occupied Marbled Murrelet Sites (OMMS), and the Landlines (LLI) data were captured for the Western Oregon Plan Revision (WOPR) analysis. The data represents the conditions as of 10/1/2005 (vintage 2006). The guidance on capture of this data was issued in the 2005 Information Bulletin IB-OR- 2005-142. The other GIS datasets reflect the best available information at the time of the analysis.

GIS Data Themes

See the modeling rules section for further description of the GIS data themes used in the modeling.

Forest Growth and Yield Modeling

Introduction

The purpose of simulating forest stand growth and development is to permit analysis of the effects of different silvicultural systems and silvicultural practices on timber yield and stand structure. Modeling estimates are not intended to describe the structures and volumes of current stands that may be quite different (higher or lower in volume) than projected future stands depending on the kind of management questions explored in the analysis.

The yield tables described in this section were used in the OPTIONS model to produce a series of different Allowable Sale Quantity (ASQ) estimates for different management alternatives.

Silvicultural Systems, Practices and General Modeling Approaches

Silvicultural Systems

A silvicultural system is a planned series of treatments for tending, harvesting, and re- establishing a stand**.** The system name is based on the number of age classes managed within a stand. Three recognized silvicultural systems are applicable to the land use allocations with a primary emphasis of timber management. These are the even-aged, two-aged and uneven-aged systems (Helms 1998)**.** Each of these systems is applied depending on the alternatives and the land use allocations objectives. (See *Figure R-12*)

These general silvicultural systems were modeled using CONIFERS young-stand model in concert with DBORGANON

The even-aged system uses the clearcutting or shelterwood cutting method to regenerate existing stands. Clearcutting essentially removes all trees from an area in a single harvest operation. Shelterwood harvest initially retains a number of shelter trees and has a similar visual appearance to a regeneration harvest using the two-aged silvicultural system (see *Figure R-13*). Unlike the two-aged system, the shelter trees are only temporarily retained and are harvested when they no longer are required for protection of the new regeneration.

The two-aged system uses a variable-retention harvest method to achieve the goal of establishing new regeneraton. At regeneration harvest, live trees are retained long-term (reserved from harvest) to facilitate the development of two-aged structure. The retained trees may be left in a dispersed, aggregated or combination of the two (see *Figure R-14*). For modeling purposes, dispersed retention was assumed for regeneration harvests in the No Action Alternative and Alternative 3. Aggregated retention was assumed for partial harvest in Alternative 3.

The uneven-aged system achieves regeneration through selection harvest. Trees are harvested singly or in groups (See *Figure R-15*).

Timber harvests on land managed for purposes other than timber employ an approach commonly referred to as variable-density thinning (USDA 2002). This approach combines elements of the two-aged and uneven-aged approaches for the purpose of promoting stand heterogeneity through the development of multi-layered canopies. Provision of conditions conducive to the initiation and growth of regeneration is often an objective of variable-density thinning to encourage understory development to contribute to stand heterogeneity. Variable-density thinning was modeled as a series of proportional commercial thinnings with simulated regeneration following the thinning harvests.

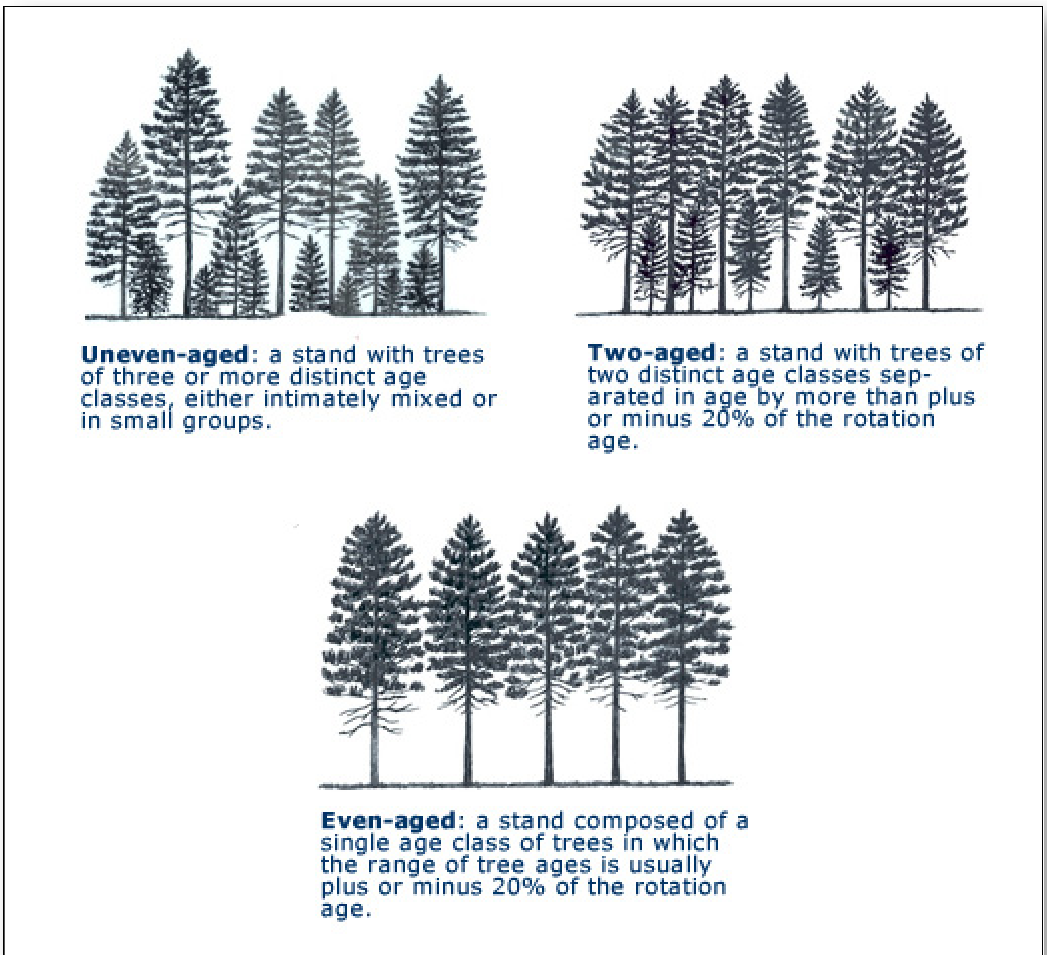
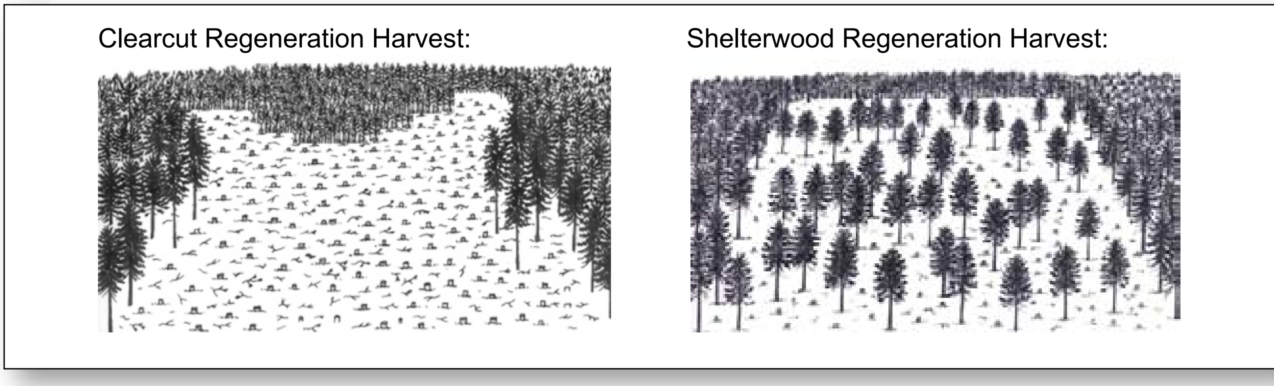


Figure R-12. Silvicultural Systems, Stand Structure Types

Figure R-13. Clearcut Regeneration Harvest Under Alternatives 1, 2, And The PRMP And Shelterwood Regeneration Harvest Under The No Action Alternative And PRMP



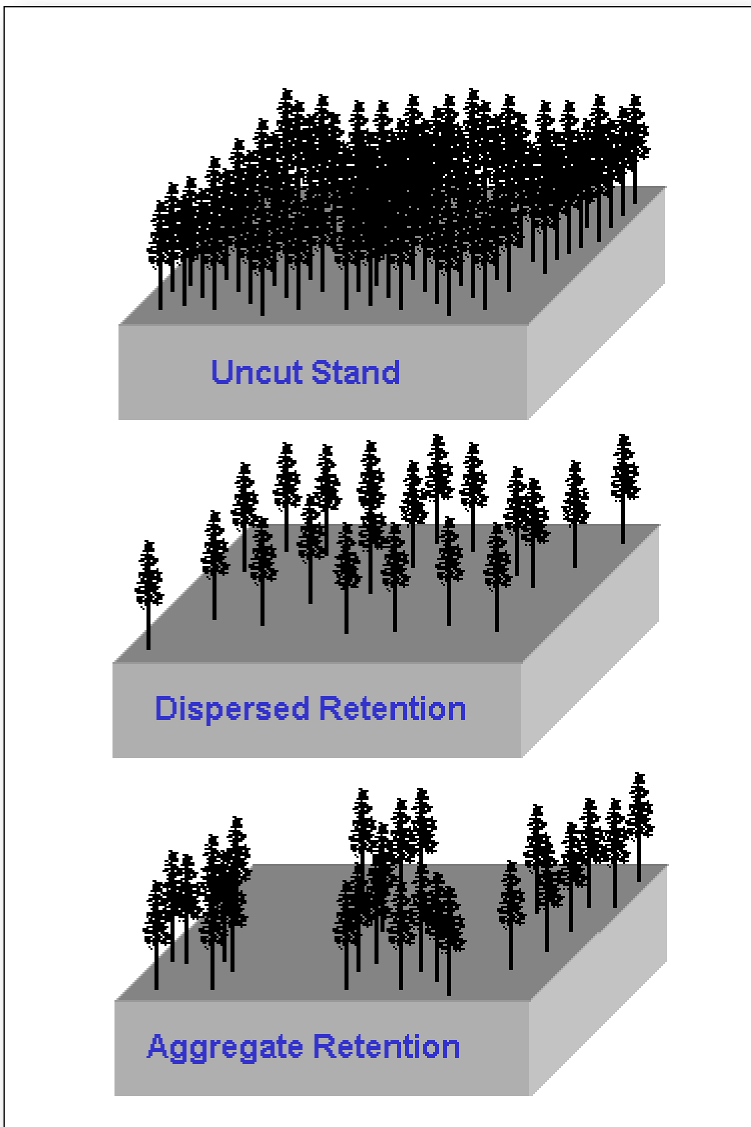


Figure R-14. Two-Aged Regeneration Harvest, Retention Tree Spatial Distribution Types Under Alternative 3 And The No Action Alternative

Figure R-15. Group Selection And Single-Tree Selection Regeneration Harvests Under Alternative 3

Silvicultural Practices

For each silvicultural system, a variety of practices other than harvesting, may be planned for specific periods in the life of the stand. These practices keep forest stands on desired developmental trajectories, speed the development of desired habitat components, and maintain or improve stand vigor. Silvicultural practices in this region have traditionally been applied to conifer stands, however, many of the same principles and treatments have application for the growth and development of other desired vegetation.

While both the types of practices used and timing vary between systems, most silvicultural systems require the full range of forest management tools and practices for their successful implementation. To predictably direct forest stands so that structural and other objectives are met may require some level of intensive stand tending practices whatever the system employed.

There are seven major silvicultural practices besides regeneration harvesting that affect forest stand growth, value, and structure. These are site preparation, regeneration, stand maintenance and protection, precommercial thinning and release, commercial thinning, fertilization, and pruning.

Site Preparation

If needed, site preparation procedures are used to prepare newly harvested or inadequately stocked areas for planting, seeding, or natural regeneration. Site preparation methods are selected to provide physical access to planting sites, control fire hazard, provide initial physical control of the site to channel limited resources on the site into desired vegetation, influence the plant community that redevelops on the site, influence or control animal populations, and ensure the retention of site productivity. Three types of site preparation techniques will be used. These are prescribed burning, mechanical, and manual methods.

Future site preparation treatment needs were based on historical experience.

Regeneration

Silvicultural systems would utilize existing regeneration, natural seeding, and prompt planting of desired conifer species to assure that regeneration targets and timeframes are met in timber emphasis land use allocations. Where available, the planting of genetically improved seedlings is emphasized. Planting may also be done in non-timber emphasis land use allocations to supplement, or in lieu of natural regeneration to enhance development of complex stand structure. Existing vegetation would be used to the extent possible in meeting management objectives dependent upon non-conifer vegetation. Where necessary to meet objectives, non-conifer vegetation would be established through seeding or planting.

The species composition, size, density and age of trees for development of tree lists representing future stands following a regeneration harvest were based on CVS subplots in the 20 years-old and younger age classes. Plots were stratified so as to have each species group and site class represented where possible. A basic modeling assumption was that future young stand species composition would be similar to current young stand composition.

Stand Maintenance & Protection

Stand maintenance and protection treatments occur after planting or seeding and are designed to promote the survival and establishment of trees and other vegetation by reducing competition from undesired plant species. Maintenance and protection techniques include actions such as mulching, cutting or pulling of unwanted species, placing plastic tubes/netting over seedlings to protect from animal damage, and animal trapping.

The effects of past maintenance and protection treatments are reflected in the current condition of existing young forest stands. It was assumed in the simulation of future regenerated stands that the same types and level of treatments would occur as in the current young existing stands that were used to derive the initial regeneration tree lists. Herbicides for stand maintenance were not available to BLM during the time period in which the current young stands developed. Therefore the initial conditions of the future tree lists derived from current stands attributes should exhibit the effects of non-herbicide treatment methods only.

Precommercial Thinning and Release

Precommercial thinning and release are treatments used to reduce the densities of tree and shrub densities, manipulate species composition, or promote dominance and/or growth of selected species. Species selection criteria can vary by vegetation zone and land use allocation management objectives. Treatments are usually implemented during the mid-range of the stand establishment structural stage. These treatments are used to influence stand developmental pathways so that desired stand and tree level characteristics result in the future.

Precommercial thinning and release treatments may be done by completely severing and/or girdling the stems of trees and shrubs with manual or mechanical tools.

Precommercial thinning enhances the growth and vigor of the residual trees by reducing inter-tree competition for growing space. The primary goal of precommercial thinning is to maintain high growth rates by effecting density control. This involves the removal of excess stocking which may consist of both desirable and undesirable species. The average number of trees remaining following treatment varies by alternative, land use allocation and species group as shown in *Table R-10.*

Release treatments are implemented to remove or reduce the competitive status of shrubs and undesirable tree species competing with desirable tree species. Thinning and release may occur simultaneously or as separate treatments.

Commercial Thinning

Commercial thinnings are implemented to recover anticipated mortality; control stand density for maintenance of stand vigor, place or maintain stands on developmental paths so that desired stand characteristics result in the future. Commercial thinnings are scheduled after developing stands reach a combination of relative density stem diameter and timber volume to permit a harvest entry that is economical. Generally, uniform tree spacing, more or less is implemented in stands on land use allocations with a timber emphasis. Generally, a variable-density approach is used in stands on land use allocations with a non-timber management emphasis as shown in *Table R-11* and as described further in the "Treatment Response Curves" section of this appendix.

Table R-10. Precommercial Thinning (PCT) Modeling Assumptions[a]

Species Group	Alternatives	Land Use Allocation	Post-PCT TPA Target
All except Pondersosa pine	No Action	Northern General Forest Mgt. Area	260
	No Action	Southern General Forest Mgt. Area	260
	No Action	Connectivity/Diversity Block	220
	No Action	Late-successional Reserve	Variable[b]
	No Action	Riparian Reserve	Variable[b]
	1, 2, PRMP	Timber Management Area	260
	1, 2, PRMP	Late-successional Mgt. Area	Variable[b]
	1, 2, 3, PRMP	Riparian Management Area	Variable[b]
	3	General Landscape Area	260
	3, PRMP	Uneven-aged Management Area	Variable[b]
Ponderosa Pine	No Action	Northern General Forest Mgt. Area	200
	No Action	Southern General Forest Mgt. Area	200
	No Action	Connectivity/Diversity Block	150
	No Action	Late-successional Reserve	Variable[b]
	No Action	Riparian Reserve	Variable[b]
	1, 2, PRMP	Timber Management Area	200
	1, 2, PRMP	Late-successional Mgt. Area	Variable[b]
	1, 2, 3, PRMP	Riparian Management Area	Variable[b]
	3	General Landscape Area	200
	3, PRMP	Uneven-aged Management Area	Variable[b]

[a] These are broad based modeling assumptions. Targets are residual densities reflecting current and anticipated future treatment targets averaged for all districts for particular species groups. Actual densities implemented may vary around the average by approximately 20±%.
[b] For modeling purposes, existing and/or post-harvest natural or planted regeneration density levels are assumed to average approximately 75-150 trees. Actual implementation target densities will vary depending on amount and spatial distribution of residual overstory trees, species mix and anticipated understory reduction due to future timber harvest entries.

Table R-11. Commercial Thinning (CT) Modeling Assumptions[a]

Species Group	Alternatives	Land Use Allocation	Pre-CT RD[b] Threshold	Post-CT RD[b] Target
All except Pondersosa pine	No Action	Northern General Forest Mgt. Area	55	35-40
	No Action	Southern General Forest Mgt. Area	55	35-40
	No Action	Connectivity/Diversity Block	55	35-40
	No Action	Late-successional Reserve	45-50	25-35
	No Action	Riparian Reserve	45-50	25-35
	1, 2, & PRMP	Timber Management Area	55	35-40
	1, 2, & PRMP	Late-successional Mgt. Area	45-50	25-35
	1, 2, 3, & PRMP	Riparian Management Area	45-50	30-40
	3	General Landscape Area	55	35-40
	3 & PRMP	Uneven-aged Management Area	55[c]	15-25[c]
Ponderosa Pine	No Action	Northern General Forest Mgt. Area	50-55	35-40
	No Action	Southern General Forest Mgt. Area	50-55	35-40
	No Action	Connectivity/Diversity Block	50-55	35-40
	No Action	Late-successional Reserve	50-55	35-40
	No Action	Riparian Reserve	50-55	35-40
	1, 2, & PRMP	Timber Management Area	50-55	35-40
	1, 2, & PRMP	Late-successional Mgt. Area	50-55	35-40
	1, 2, 3, & PRMP	Riparian Management Area	50-55	30-40
	3	General Landscape Area	50-55	35-40
	3 & PRMP	Uneven-aged Management Area	55[c]	15-25[c]

[a]These are broad-based modeling assumptions. Targets represent stand level averages. Thinnings for late-successional, riparian and uneven-aged management objectives may vary considerably on an acre-by-acre basis.
[b] Relative Density (RD) – The level of competition among trees or site occupancy in a stand relative to some theoretical maximum based on tree size and species composition. The values in this table are Curtis relative density basis. (Curtis 1982)
[c] Alternative 3 is based on basal area guidelines, not relative density. The PRMP is based on relative density.

Fertilization

Stand growth in western Oregon is often limited by the supply of available nutrients, particularly by available nitrogen. The supply of soil nutrients can be augmented through fertilization (Miller, Glendenen and Bruce 1988). Fertilization actions are usually designed to apply 200 pounds of available nitrogen with helicopters in the form of urea based prill (46 percent available nitrogen) group. See this appendix "Treatment Response Curves" section for additional information.
Occasionally, fertilizer may be applied in a liquid urea-ammonia form or with a mixture of other nutrient elements in addition to nitrogen.

Pruning

The primary objective of pruning is usually the improvement of wood quality, i.e., "clear knot free" wood for lumber and veneer production. Pruning for wood quality usually removes the live and dead limbs on selected trees up to height of about 18 feet. Treatments are generally implemented as a two-phase process or lifts between stand ages of approximately 15-40 years-old. Timing varies by site productivity, i.e. treatments occur earlier on stands of higher site productivity. Pruning is also used for disease and fuels management purposes.

Removal of up to one-third to one-half of the live tree crown at each lift is not expected to significantly affect diameter growth at breast height or height growth (Staebler 1963; Stein 1955; BCMOF 1995). Since pruning treatments are expected to be implemented within this range, no impact on growth and yield is assumed. Therefore no treatment response curves were developed that incorporated a growth effect for pruning treatments.

Modeling Assumptions by Alternative

Common to All Alternatives

An uneven-aged management system is assumed for the eastern portion of the Klamath Falls Resource Area.

Fertilization is modeled only on land use allocations with a timber management emphasis.

Variable-density thinning is the form of timber harvest used on land use allocations with non-timber management objectives.

No Action Alternative

The No Action Alternative employs a two-aged silvicultural system on the General Forest Management Areas, Southern General Forest Management Area and Connectivity/Diversity Block land use allocations. Regeneration harvests were modeled with the retention of a specific number of the largest overstory trees for non-timber objectives. The number of retention trees per acre totaled 7, 16 or 12 respective of the Northern General Forest Management Area, Southern General Forest Management Area, and Connectivity/Diversity Blocks land use allocations. In addition, 0, 3 and 4 hardwood trees were retained respectively. The spatial arrangement of retention trees was modeled as dispersed retention.

The OPTIONS model simulates retention trees by assuming that the retention trees continue to grow on the pre-harvest existing stand guide curve generated by DBORGANON while the regenerated portion of the stand follows a new DBORGANON generated future guide curve. The amount of green tree retention is determined on the basis of pre-harvest basal area being retained. For each land use allocation a single percent basal area was applied to all age groups, site classes, and modeling groups.

For The No Action Alternative the amount of retention tree basal area was determined by simulating the growth of a young stand modeling group of average density and site productivity to age 100 years-old, at which time a harvest treatment leaving the largest 7, 12 or 16 retention trees representing the Northern General Forest Management Area, Connectivity/Diversity Blocks, and Southern General Forest Management Area respectively is done. The percentage of the retention tree basal area divided by the pre-harvest total stand basal area at age 100 years-old determines the appropriate allocation for modeling green tree retention in OPTIONS.

Alternatives 1 and 2

Application of even-aged systems without green tree retention was modeled in the Timber Management Area land use allocation.

Alternative 3

Alternative 3 employs a two-aged silvicultural system in the General Landscape Area generally north of Grants Pass, Oregon. Depending on landscape structural stage criteria and vegetation zone, regeneration harvests were modeled with varying amounts of retained overstory trees as dispersed retention or aggregated retention. An uneven-aged management silvicultural system is applied in the zone south of Grants Pass, Oregon on the Medford and Lakeview Districts.

The dispersed retention approach used the DBORGANON yield functions derived for the No Action Alternative, Northern General Forest Management Area land use allocation which closely approximated (seven trees per acre) the Alternative 3 retention tree requirements for regeneration harvests of six trees per acre in the western hemlock zone or nine green trees per acre in the Douglas-fir and tanoak zones.

Aggregated retention is designated as partial harvest to further distinguish the difference in Alternative 3 with the dispersed retention harvest method. Partial harvests retained retention tree blocks constituting 18%, 33% or 37% of the existing stand in the Douglas-fir, tanoak, and western hemlock zones respectively. The proportion of the pre-harvest stand basal area retained was determined using similar methodology to that used for The No Action Alternative described above with the following exceptions. Simulated harvest ages were 80 years-old for the Douglas- fir and tanoak zones, and 120 years-old for the western hemlock zone. Also, the retention tree basal area was estimated using Alternative 3 retention tree minimum size classes definitions, which varied by vegetation zone. The basal area calculations also included some merchantable trees which did not meet the minimum retention tree size. Inclusion of these smaller trees was done based on the assumption that little or no harvest would generally occur within the aggregated retention blocks.

Future growth of the aggregated retention blocks was represented by their continued growth using the pre-harvest existing stand guide curve. Growth of the harvested portion was represented by Alternative 1 even-aged future stand guide curves with no retention. However, a reduction in timber yields is taken to account for the "edge effects" from the aggregated retention blocks.

The uneven-aged management zone harvests consist of periodic selection cuttings applied to stands from each representative modeling group. Harvest frequency ranged from 20 years to 60 years with harvests generally occurring more frequently on higher sites. Selection cutting was modeled as a proportional commercial thinning at regular intervals using residual basal area targets which varied by modeling group. Predominantly Ponderosa pine stands were managed at lower residual basal area levels than mixed-conifer groups. After each harvest a regeneration tree list was added to the simulation to reflect natural and artificial reforestation occurring. Regeneration tree lists generally included a proportional representation of species included in the stand's original species mixture.

Special adaptations to cutting practices were applied to the various modeling groups. For example, in the Ponderosa pine modeling groups, some stands were managed to reduce the proportion of Douglas-fir to favor pine growth.

PRMP

Application of even-aged systems using clearcutting and shelterwood regeneration harvest methods were modeled in Timber Management Area land use allocation.

Timber harvests on the Uneven-aged Timber Management Area land use allocation on the Medford District and the westside of the Klamath Falls Resource Area consisted of periodic selection cuttings applied to stands from each representative modeling group. Harvest and other silvicultural treatment frequency generally ranged from 20 years to 60 years with harvests generally occurring more frequently on higher sites. Selection cutting was modeled as proportional and low commercial thinnings at regular intervals using residual relative density targets to maintain stand average relative density between 25-55.

After each timber harvest, a regeneration tree list was added to the simulation to reflect natural and artificial reforestation occurring. Regeneration tree lists generally included a proportional representation of species included in the stand's original species mixture.

Special adaptations to cutting practices were applied to the various modeling groups. For example, in the Ponderosa pine modeling groups, some stands were managed to reduce the proportion of Douglas-fir to favor pine growth.

Stand Modeling Process

The prediction of forest stand development requires the growth projection of BLM's existing forest stand types into the future, with and without further silvicultural treatments, and the simulation of stands which represent future stands, i.e., new stands created following timber harvest. Depending on the management direction of the alternatives, both existing and future stands may be subject to different intensities of silvicultural treatments.

The results of DBORGANON growth projections are used to develop guide and treatment response curves for use in the OPTIONS modeled. See the "Types of Growth Curves" section in this appendix for more detail.

Two computer growth and yield simulation models, DBORGANON and CONIFERS were used to project the growth and development of forest stands under various silvicultural prescriptions.

Organon Model Description

ORGANON is an individual-tree, distance-independent model developed by Oregon State University from data collected in western Oregon forest stands (Hann 2005). The architecture of the model makes it applicable for simulations of traditional and non-traditional silviculture (Hann 1998).

Three variants of ORGANON are available for use in western Oregon. The northwest Oregon variant (NWO-ORGANON) and southwest Oregon variant (SWO-ORGANON) were deemed appropriate for modeling the stand types found on BLM-administered lands and the proposed management actions.

The standard ORGANON configuration is not conducive to the efficient processing of large numbers of individual tree lists representing forest stands within a stratum. It is not configured to merge multiple simulation results into average timber yield functions. Also, the standard model does not produce specific stand structural characteristics that have utility for effects analysis on resources other than timber production, or for the incorporation of factors to simulate growth improvement of trees due to genetic improvement programs. FORsight Resources developed a version of ORGANON for the BLM, referred to as DBORGANON, which incorporates all the basic ORGANON functions and equations and which meets the additional BLM requirements. DBORGANON was used to project the growth of forest stands greater than or equal to 15 years-old.

The BLM modified northwest Oregon variant (NWO-ORGANON) was used to project the growth of forest stands located on the Salem, Eugene, Coos Bay and Roseburg Districts. The basic data underpinning of this variant of the model is from predominantly conifer forest stands with ages ranging from about 10 to 120-years-old breast height age (Hann 2005).

The BLM modified southwest Oregon variant (SWO-ORGANON) was used to project forest stand growth on the Roseburg, Coos Bay and Medford Districts and the Klamath Falls Resource Area. The original basic data underpinning this variant of the model is from mixed-conifer forest stands with ages of the dominant trees ranging from about 13 to 138-years-old breast height age (Ritchie and Hann 1987). Subsequently, additional new data was collected and used to extend the applicability of the model to stands with older trees (250+ years-old), with higher proportions of hardwoods and with more complex spatial structure (Hann and Hanus 2001).

Simulations of stand growth of the WOPR silvicultural prescriptions extend beyond the ORGANON model's range of data for both variants. However, the timing of harvests and other silvicultural treatments generally occur within the range of the model's validated height growth projection and volume prediction capabilities. Height growth is the primary driving function in ORGANON (Ritchie 1999). Hann (1998) found that the SWO-ORGANON height growth equations can be extended to up to 245 years without loss of accuracy, or precision.

Conifers Model Description

The CONIFERS model is an individual-plant growth and yield simulator developed from young mixed-conifer stands in southern Oregon and northern California by the U.S. Forest Service. CONIFERS provides growth forecasts for young plantations of single or mixed-species growing with or without competition from shrubs (Ritchie 2006). The growth of forest stands less than 15 years-old were simulated using the CONIFERS young stand growth model. The tree lists were exported to DBORGANON at stand age 15 years-old for further simulation.

Existing Stands Modeling Groups Description

The land base consists of existing forest stands, the result of past harvests and natural disturbances, of various ages, structures, past management histories and potential for forest management. Tree lists from Current Vegetation Survey (CVS) inventory subplots were stratified into modeling groups as described elsewhere in this appendix. Using DBORGANON, these modeling groups were used for depicting current stand condition and simulating future development with and without future silvicultural treatments.

Each individual CVS subplot tree list within a modeling group was projected by DBORGANON subject to a common silvicultural prescription to stand ages 200 or 400 years-old, depending on the initial range of stand ages in the various modeling groups or the requirements of an alternative. Modeling groups consisting of younger managed stands, generally less than 60 years-old, were projected to stand age of 200 years. Older stand modeling groups were projected to a stand age of 400 years to insure that all CVS plots would be incorporated into the simulation.

Each individual tree list entered the simulation at its current age. This resulted in some stands having a greater weight on the overall group average characteristics, depending on the distribution of plot ages in a particular modeling group and the length of the growth projection. *Figure R-16* shows a simplified example of individual plot growth trends and the modeling group average.

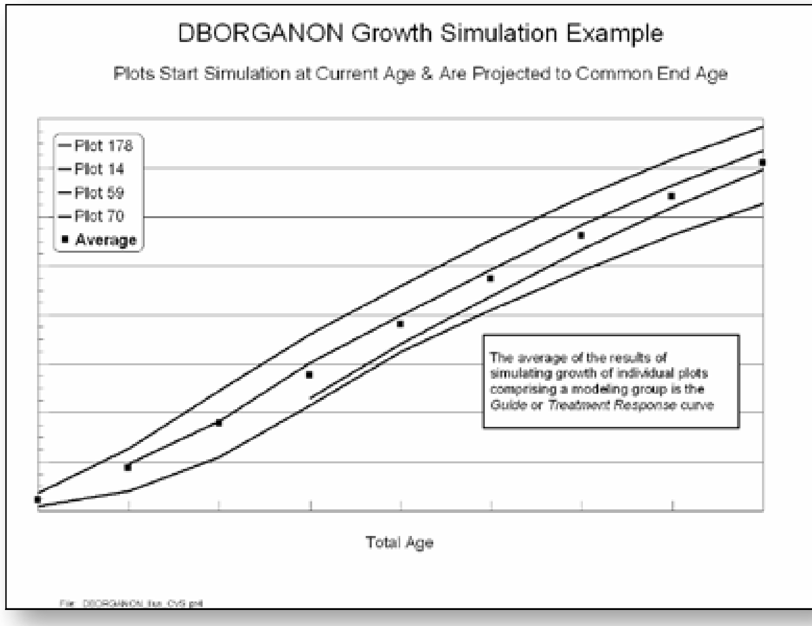


Figure R-16. Example of DBORGANON Simulation

Future Stands Modeling Groups Description

Modeling groups and tree lists for forest stand types or silvicultural prescriptions for which little or no specific CVS data existed, were developed from subsets of the CVS data and growth was modeled with CONIFERS.

Initial stand attributes for the future stands tree lists were derived from the 10 and 20 years-old age class CVS subplots, stratified by DBORGANON variant, species group and site class. It was assumed that the future young stand management intensity and tools available would be similar to the past two decades.

Review of the data indicated that the future stands could be represented by three basic modeling groups for the northwestern Oregon and six groups for the southwestern Oregon. A single future stand tree list based on the characteristics of existing CVS plots for each modeling group and site productivity was grown in CONIFERS to age 15 years-old, at which time the tree lists were exported to DBORGANON for further simulation. Projections were simulated to a stand age of 200 years-old, except for Alternative 3 where 400-year projections were required.

These future stand projections formed the basis for initiating new stands following regeneration harvests in all alternatives and the partial harvests in Alternative 3. The future stands category includes existing stand types created as a result of regeneration harvest prescriptions with green-tree retention under the current BLM Resource Management Plans. There were an insufficient number of CVS subplots with this type of management for Guide Curve modeling. Therefore, it was necessary to create tree lists for simulating those silvicultural prescriptions for existing and future stands under the No Action Alternative.

For all alternatives, a special subset of modeling groups was developed for modeling future stands within geographic areas currently identified with a high incidence of Swiss needle cast disease on the Salem District. Future tree lists species composition in the Swiss needle cast zone was based on an assumption of higher proportions of disease resistant species being used for the reforestation of future harvested areas.

Types of Growth Curves

Two types of curves are produced from DBORGANON simulations for further use by the OPTIONS model. The curves are referred to as guide and treatment response curves.

Guide Curves

Guide curves are used to provide guidance to the OPTIONS model with respect to the growth curve shape and projection values. Simply stated, guide curves represent the growth projection of forest stands without any additional silvicultural treatments. Individual guide curves are developed for each modeling group which incorporates geographical province, species groups, current stand condition, and site productivity class. Existing stand guide curves developed from CVS data were applicable to all alternatives. Future stand guide curves were developed specific to the management direction of the various alternatives Two-aged silvicultural prescriptions were developed for the No Action Alternative and Alternative 3. Even-aged curves were developed for Alternatives 1, 2, 3 and the PRMP. Uneven-aged curves were developed for Alternatives 3 and the PRMP.

Treatment Response Curves

Treatment Response curves were used to adjust the guide curves to reflect the effects of various silvicultural treatments (see discussion of Treatment Response). Growth projections were done to produce curves that simulated commercial thinning, fertilization, and uneven-aged management treatments. Precommercial thinning of future stands was incorporated into the initial ORGANON guide curve tree lists, so no growth response curves were necessary for that treatment type.

Within the constraints of other modeling assumptions, all possible combinations of treatments were simulated for each modeling group to allow a wide range of treatment timing, combination and flexibility within the OPTIONS model.

Commercial Thinning

Silvicultural prescriptions incorporating commercial thinning were developed using the modeling groups with stands less than 60 years-old. Guide curve simulations were examined for each modeling group to determine the earliest average age when an initial commercial thinning was feasible.

Evaluation criteria included four factors:

1) stand relative density (Curtis 1982),
2) attainment of minimum average stand diameter,
3) minimum harvestable volumes, and
4) residual canopy cover or shade requirements (late-successional and riparian areas only).

Relative density thresholds were based on published recommendations, such as Curtis and Marshall 1986; Hayes et al. 1997; and Chan et al. 2006 and professional judgment. Minimum diameter and volume thresholds were based on historical BLM timber sales.

For each modeling group, simulations were done to determine the appropriate timing of treatment based on relative density rules. Thinning was simulated when minimum criteria were met.

Relative density rules can vary by land used allocation within alternatives. Silviculture prescriptions for land use allocations with timber objectives including the Northern General Forest Management Area under the No Action Alternative, the Timber Management Areas under Alternatives 1, 2, and the PRMP, and the General Landscape Area under Alternative 3 were thinned to maintain relative densities between approximately 35 and 55. The timing of the final thinning is designed so that relative density recovers to a minimum of 55 at rotation age. Assumed rotation ages for treatment response simulations in land use allocations with timber objectives were based on culmination of mean annual increment (CMAI) and range from 100 to 125 years.

Commercial thinnings have been found to contribute to the establishment of conifer regeneration in the understory of thinned stands (Bailey and Tappeiner 1998). Simulation of the recruitment of this regeneration in the growth simulations was done to reflect expected stand dynamics following commercial thinning harvests. The ORGANON growth and yield model (Hann 2005) does not recognize trees with diameters less than 4.5 feet at breast height. Therefore, regeneration tree lists were developed using existing CVS data and growth relationships from current published and unpublished studies. The regeneration trees were added to DBORGANON simulations 20 to 25 years following any commercial thinning. The time lag represented the estimated time for all trees in the regeneration tree list to reach 4.5 feet tall.

Silviculture prescriptions for land use allocations with objectives other than timber were thinned to maintain relative densities between approximately 25 to 50 to a maximum age of 80 years-old in No Action Alternative, or until minimum desired stand structural class is attained in Alternatives 1, 2, 3, and the PRMP.

Fertilization

Fertilization with 200 pounds of active nitrogen per acre is simulated to occur after thinning in all alternatives**.** Fertilization was modeled for land use allocations with timber objectives where the stand was even-aged, two-aged with low green tree retention (≤ 8 dispersed retention trees per acre), two-aged with aggregated retention, i.e. partial harvested areas in Alternative 3, and when DBORGANON criteria were met. DBORGANON criteria for treatment were when the stand contains 80% or more Douglas-fir by basal area and total stand age is less than 70 years-old.

The fertilization equations in ORGANON were revised for the Final EIS growth simulations. A sensitivity analysis was done to compare differences in outputs. Differences between the estimated yield and other stand attributes varied by 1% or less from stand age 40 years-old and older. This level of change was not considered substantial enough to warrant new growth and yield simulations.

Growth and Yield Adjustments

The DBORGANON model projections of timber yields needed to be adjusted to account for increased growth due to genetic tree improvement and reduced to account for the effects of additional overstory mortality in older and partial cut stands. Adjustments for factors which could substantially affect stand dynamics including genetic tree improvement, Swiss needle cast disease, and other overstory mortality were accomplished by means of factors applied within the DBORGANON model. Other factors affecting recoverable commodity volumes were modeled as a percent reduction in volume. Timber defect and breakage, endemic insects and disease, soil compaction, future snag creation, future coarse woody debris creation, green tree retention were applied in the OPTIONS data preparation program to account for guidance requirements specific to each alternative.

Tree Improvement

Conifer species such as Douglas-fir and western hemlock have been selected for genetically controlled characteristics such as high growth rates and tree form. The BLM in cooperation with other landowners have established field test sites using progeny from the selected trees. These progeny test sites have been measured at regular intervals and the data collected has been used to select those parent trees which are ranked highest in growth rates. Seed orchards have been established to produce locally adapted seed from these selected trees for reforestation of harvested stands and natural deforestation.

The increased growth and yield effects from utilization of genetically improved seedlings was accomplished by the use of a one-time growth increase to tree lists exported from CONIFERS and the application of growth modifiers applied to future stand modeling groups in DBORGANON.

Height and diameter of genetically improved species exported from CONIFERS at age 15 years-old were increased before importation into DBORGANON by 7% and 8% respectively based on the observed height and diameter percentage increase of the top one-quarter trees in the progeny tests. After importation of the tree lists into DBORGANON, growth modifiers were applied to future stand modeling groups to account for incremental genetic gain expected to accrue beyond age 15 years-old. Growth modifiers have been found to be an effective way to incorporate genetic gain from tree improvement programs into growth models (Carson 2003).

Growth modifiers have not been publicly developed for Pacific Northwest tree improvement programs, although work is currently underway (USDA 2006b). Finalized growth modifiers for regional growth and yield models are expected within a year or perhaps more.

In the interim, growth modifiers were adapted from the preliminary feasibility work of Johnson and Marshall (2005) by BLM personnel. These factors are used to modify growth and mortality rates of genetically improved seedlings for simulations of the future stands modeling groups. The DBORGANON model was specifically configured to allow the use of growth modifiers for simulation of genetic gain and other purposes.

Growth modifiers are applied in DBORGANON as described below.

1) Growth modifiers apply to Douglas-fir within timber management land use allocations for all alternatives, when stands are managed under even-aged silvicultural systems, two-aged systems with aggregated overstory retention, or dispersed retention with low overstory density. No increased growth from genetic improvement is simulated for lands managed using uneven-aged silvicultural systems, or with high levels of dispersed retention overstory
2) Growth modifiers apply to western hemlock using the criteria as Douglas-fir except that it is confined to area designated as the Swiss needle cast zone on the Salem District only (see Disease section).
3) Growth modifiers were calculated for each BLM district, but since no significant difference was observed, average westside BLM growth modifiers were used.
4) Existing BLM seed orchards have the biological capability to produce improved seed in excess of probable BLM needs.
5) Growth modifiers were reduced to account for pollen contamination from non- genetically improved trees adjacent to and within the BLM seed orchards.
6) Growth modifiers are applied from stand age 15 to 100 years-old.

Analyses were updated for the Final EIS growth simulations to produce revised genetic improvement factors. A sensitivity analysis was done using five modeling groups representing both DBORGANON variants and a range of site productivity classes to simulate guide curves incorporating the new genetics factors. An additional simulation was done utilizing the new factors to test impacts on commercial thinning.

Within the range of assumed rotation ages (80-120 years), the yield differences varied from less than 1 to 4%. Changing the genetic factors did not change the timing of potential commercial thinning opportunities or result in a substantial change in yields or other stand attributes. In general, the magnitude of change in yields from the revised genetics factors alone was not considered substantial enough to warrant new growth and yield simulations. An exception to this was made for the Swiss needle cast disease zone on the Salem District; where new simulations were necessary due to changes in the Swiss needle cast disease growth adjustment factors (see the Swiss Needle Cast Disease section of this appendix).

Defect and breakage

A proportion of harvested trees can contain defects which reduce its utility from a commodity standpoint. Also, damage can occur during harvesting, that results in breakage which reduces recoverable timber volume. The proportion of volume which is not recoverable for commodity use generally increases with stand age. DBORGANON generated timber volume yields were reduced by BLM district-specific factors derived from historical timber sale cruise and scale data.

Soil Compaction

Districts with available data as to the extent and degree of soil compaction applied a yield reduction factor to DBORGANON yields. The deductions were applied to the Medford and Salem Districts and the Klamath Falls Resource Area.

Snag Retention

The yield impact of retaining varying amount of green trees for the creation of future snags was done by leaving extra retention trees or applying a percent volume reduction to meet the minimum snag requirements at the time of harvest. Retention requirements varied by alternative and by land use allocation.

Coarse Woody Debris Retention

The yield impact of retaining varying amounts for future down woody debris on timber yield was modeled as a percent volume reduction at the time of harvest. Retention requirements were varied by alternative and land use allocation.

Stocking Irregularity

For any level of stocking, a portion of a stand may consist of openings which do not contribute to stand volume at any point in time, i.e., a stand may contain non-stocked openings of a size sufficient to affect timber yield. These openings may be thought of in terms of less-than-perfect stocking or in terms of variation in tree location and fall into two categories; permanently incapable of growing commercial tree species, and those temporarily unoccupied by desirable trees.

Portions of stands may contain permanent areas of non-productive rock or other areas incapable of growing commercial tree species. This condition is partially accounted for by reductions in the timber base through the Timber Productivity Capability Classification.

Temporarily non-stocked areas occur due to variation in reforestation success from a variety of non-permanent factors, such as vegetative competition or logging slash.

The ORGANON model accounts for stocking variation by assuming that the degree of local competition experienced by a tree is reflected in its crown size. Trees growing next to openings have longer crowns and poor growth reflected as stem taper which reduces the volume of a tree next to the opening, compared to a similar size tree with shorter crown in an area with more uniform tree distribution. As long as the crown characteristics of sample trees are measured, then any long-term spatial variation within the stand will be modeled appropriately (Forsight 2006).

Since existing CVS data used for existing stands and the development of future stands modeling groups contain the necessary crown measurement, no external adjustment for stocking irregularity was applied to DBORGANON yields.

Green tree retention has two effects from a stand growth and yield standpoint. First, otherwise harvestable volume is foregone for commodity use at the time of harvest. Methodology for determining this allowance was described previously for each alternative. Second, retention trees compete for growing space with the newly regenerated trees.

The first effect of retained trees on foregone harvest volume is modeled with the OPTIONS model as a stand constraint. A proportion of the stand equating to the amount of basal area per acre of the uncut stand retained is set aside and is simulated to continue to grow on the existing guide curve until the next regeneration harvest. At that time a new set of retention trees would be set aside to grow for the subsequent harvest cycle. The proportions ranged from approximately 10% to 20% for the No Action Alternative and from 18% to 37% for Alternative 3 depending on land use allocation or vegetation zone.

The second effect was modeled using DBORGANON for the No Action Alternative and by using a fixed percentage yield reduction for Alternative 3.

The No Action Alternative future modeling group tree lists included the required number of retained trees as overstory. The retained trees slowed the growth of the new understory in roughly proportional to the amount of retained overstory trees. The volume of the retention trees was not included in DBORGANON estimates of potential timber yield, but included for evaluating overall stand characteristics and structural stages.

Alternative 3 partial harvest yields from future stands were reduced by 5% percent to account for edge effect, i.e., the effects of the aggregated retention blocks of overstory trees competing with the new tree regeneration. The factor used is an average reduction observed from modeling work in British Columbia (Di Lucca et al. 2004).

Disease

Two types of reductions were used to simulate the effects of endemic levels of insect and disease on timber yields. The first method was through the DBORGANON model using a growth modifiers approach for areas on the Salem District with moderate to severe levels of Swiss needle cast disease. The second method used a percentage reduction in yield approach applied in OPTIONS data-prep program to the guide curves for all districts to account for other insect and disease effects.

Swiss Needle Cast Disease

Portions of the Salem District are located in an area with a moderate to high occurrence of Swiss needle cast disease. This disease infects Douglas-fir trees only and reduces growth rates. It does not affect the growth of other tree species. A growth modifier approach similar to that used for modeling the growth of genetically improved trees was employed in DBORGANON to reflect the estimated growth reductions for Douglas-fir in the Swiss needle cast zone. Three Swiss needle cast (SNC) zones were developed for BLM land consistent with Oregon Department of Forestry (ODF) criteria, a severe, moderate, and a no impact zone.

The BLM calculated mean foliage retention values for the severe and moderate zone using plot data from ODF Swiss need cast surveys. The foliage retention values were used to calculate growth loss in height and basal area by severity zone using ODF methodology (Oregon Department of Forestry 2005). The growth loss modifiers were applied in DBORGANON to existing and future stand modeling groups in order to simulate more realistic stand dynamics. New Swiss needle cast factors were calculated based on information that became available after the growth simulations for the draft EIS were completed. The new factors are a product of ongoing work to develop a Swiss needle cast disease module for the ORGANON model. The difference in factors was considered substantial enough that new growth simulations for the PRMP were done. Revised genetic tree improvement factors were also incorporated in the simulations.

As stands are regeneration harvested in the Swiss needle cast zones, an average mix of tree species will be used for reforestation that is different than the current stand composition. Future tree lists reflecting tree lists with a minority of Douglas- fir were generated using the process described above for the future stands modeling groups. Tree lists with a single average species composition for both zones containing 28% Douglas-fir was used. Examination of the simulation results for the moderate and severe Swiss needle cast zones showed no substantial difference in predicted timber yields (<1%) so a single yield function was used.

Other Insects and Disease

Some of the effects of endemic levels of insects and disease other than Swiss needle cast on timber yields are assumed to be reflected in the defect and breakage allowance described previously and the additional overstory mortality factor described below. In addition to those factors, further allowance was deemed appropriate for insects and diseases by adjusting timber yields down by a percent volume reduction. These factors generally vary from about 1% to 3% increasing with stand age and are based on literature and professional judgment.

Additional Overstory Mortality Factor

The ORGANON model underestimates tree mortality from causes other than inter-tree competition, such as insects, disease, windthrow and stem breakage, (Tappeiner et al. 1997). This type of mortality is often irregular, or episodic in nature, and it is inherently difficult to predict the exact time period in which it will occur (Franklin et al 1987). The ORGANON mortality equations predict that the risk of dying is very low for trees over 20 inches in diameter or with crown ratios over 70% (Hann and Wang 1990). For mature stands, mortality from inter-tree competition becomes less significant as stands age and mortality from other factors becomes more substantial.

To account for mortality from these other factors, an irregular mortality adjustment of 1.4% per DBORGANON growth cycle (five years) was determined from a review of ecological literature and Continuous Forest Inventory data (Lewis and Pierle 1991).

The 1.4% factor was applied to existing and future stand modeling groups through a function in the DBORGANON model. The factor applied only to trees greater than 20" diameter breast height in stands aged 100 years-old and older, to simulate mortality of larger trees from causes other than inter-tree competition.

In addition, partial cutting has been reported to significantly increase wind damage, especially during the first few years after treatment. Amount and extent are dependent on individual site factors, landscape conditions, and severity of the storm event (Strathers et al 1994). Average mortality for retained trees in partial cut Douglas-fir stand during the first five years post harvest from non- suppression factors averages about 1-2% (Williamson and Price 1973; McDonald 1976; Jull 2001). To account for this type of mortality, the same 1.4% factor was applied to stands which represented regeneration harvests with dispersed green tree retention. Model limitations allowed the use of only one additional mortality factor in a simulation. Therefore, the additional mortality factor was applied at stand age of 20 years-old, corresponding to the end of the first growth cycle in DBORGANON to trees greater than 20" diameter breast height.

Application of the additional 1.4% mortality rate during growth simulations produced modeling results which more closely matched patterns of stand development supported by empirical data and ecological theory than simulations done without the factor (Lewis and Pierle 1991).

A review of the green-tree retention mortality rate assumptions used in the Draft EIS was completed due to the availability of new published information. Three previously unexamined publications were reviewed (Buermeyer et al. 2002; Busby et al. 2006; Maguire et al. 2006) for applicability. Based on the review, sensitivity analysis was done to determine if new growth simulations were warranted for the Final EIS. The results of the analysis indicated that new growth simulations using revised mortality assumptions were not necessary since the results were not expected to substantially affect predicted yields or structural class changes in those alternatives that reserved live overstory trees for stand structural values.

OPTIONS Modeling

OPTIONS Model

Background

The OPTIONS model version V (OPTIONS or the model) is a spatially explicit, rules-based, land management simulation model. OPTIONS, developed by D.R. systems inc. (DRSI), has been in use for more than 20 years and is regularly updated and refined to reflect current knowledge, issues in land management and modeling techniques. The model has been used to develop land management strategies and operationally feasible plans on more than 500 million acres throughout North America, South America, the South Pacific and Asia. Most of these projects involved complex, multi-resource objectives and environmental regulations.

In the western United States, OPTIONS has been used for a wide range of industrial and government analyses, including land trades, evaluation of lands for sale or purchase and the development of sustainable, multi-resource management plans. The model was used in Plum Creek Timber Company's 1997 Cascades Habitat Conservation Plan for central Washington State. The Habitat Conservation Plan was the first major, multi-species habitat conservation plan developed in the United States. The OPTIONS model was also used in the Washington State Department of Natural Resources 2004 Sustainable Forest Management Harvest Calculations. The Sustainable Forest Management Harvest Calculations applied an alternatives based approach toward developing a long-term, sustainable, multi-resource forest management plan on approximately 2.1 million acres of Washington State Trust Lands. The model was also recently used to complete Pacific Lumber Company's Long-term Sustainable Yield Calculations on approximately 217,000 acres of redwood forest land in northern California. The project set new standards for sustainable yield calculations and planning in California.

Currently the model is also being used by the University of Georgia to analyze the impacts of proposed regulations and policies on long-term timber supply, by the California Department of Forestry in a pilot project investigating new approaches to the sustainable yield calculations, as well as numerous operational analyses in Washington, Alaska and British Columbia, Canada. DR Systems' expertise in partnership with BLM staff was used in applying the OPTIONS model to analyze alternative management strategies for the Western Oregon Plan Revision.

This analysis provided the basis for comparing alternatives in terms of the forest conditions / wildlife habitats created over time as well as determining the sustainable harvest levels for the Western Oregon BLM districts.

OPTIONS Model Overview

The OPTIONS model simulates the growth and management of individual land management units within a BLM Sustained Yield Unit (SYU). Land management units are created in a GIS process that combines multiple layers of resource information and objectives into a single resultant layer. Examples of these resource layers would include Forest Operations Inventory units, administrative boundaries, riparian management areas, Late-Successional Management Areas, Visual Resource Management areas, (See *Figure R-17*).

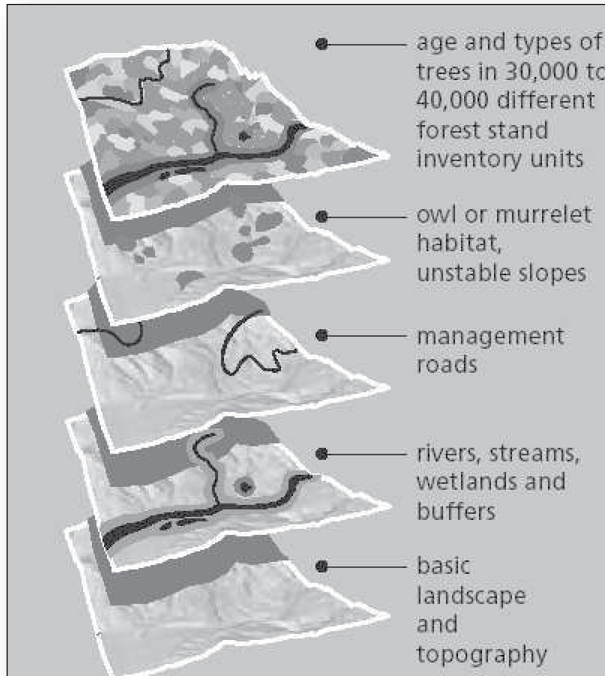
The model utilizes the resultant file to dynamically maintain all of the spatial identity across all contributing layers enabling the model to apply spatially explicit growth projections and management rules to individual resultant units (polygons), or groups of polygons throughout the Sustained Yield Unit.

The planning horizon of a simulation can extend as far as 400 years. Inventory information for each resultant unit is used to initialize the model and for each subsequent year in the planning horizon growth projections forecast future conditions for each polygon. However, these growth projections are sensitive to management activities and rules.

Management activities, such as silvicultural treatments (for example site preparation, fertilization or pre-commercial thinning) and harvesting activities (for example commercial thinnings, selection harvest or regeneration harvest) are distinguished from management objectives such as the exclusion of harvesting activities within riparian management areas. Activities are applied to polygons individually, while objectives may be applied to individual polygons, portions of a polygon, or collectively to a group of polygons.

Importantly, all objectives are implemented before any management activity can be applied, so harvest activities are simulated only after all environmental and habitat requirements have been satisfied.

Figure R-17. Graphic Example Of How A Resultant Layer Is Created From Multiple Resource Layers In GIS



Growth Projections

Throughout the planning horizon individual polygons are grown according to their individual forest inventory characteristics and growth trends established from a set of generalized growth projections. For this project, the growth projections were generated with the DBORGANON growth and yield model. These projections are imported into OPTIONS and used to forecast the nominal growth trend of each polygon. Within the model these growth projections are further refined to accommodate the unique characteristics of each polygon, including any unique management objectives, environmental conditions or inventory information. Growth projection attributes are tracked and reported including: stand height, diameter, basal area, density, and volume.

Incorporating Existing Inventory Information into the Simulation

Spatially explicit forest inventory information reflects current forest conditions. Depicting current conditions accurately is important in forecasting how alternative management strategies impact future forest conditions.

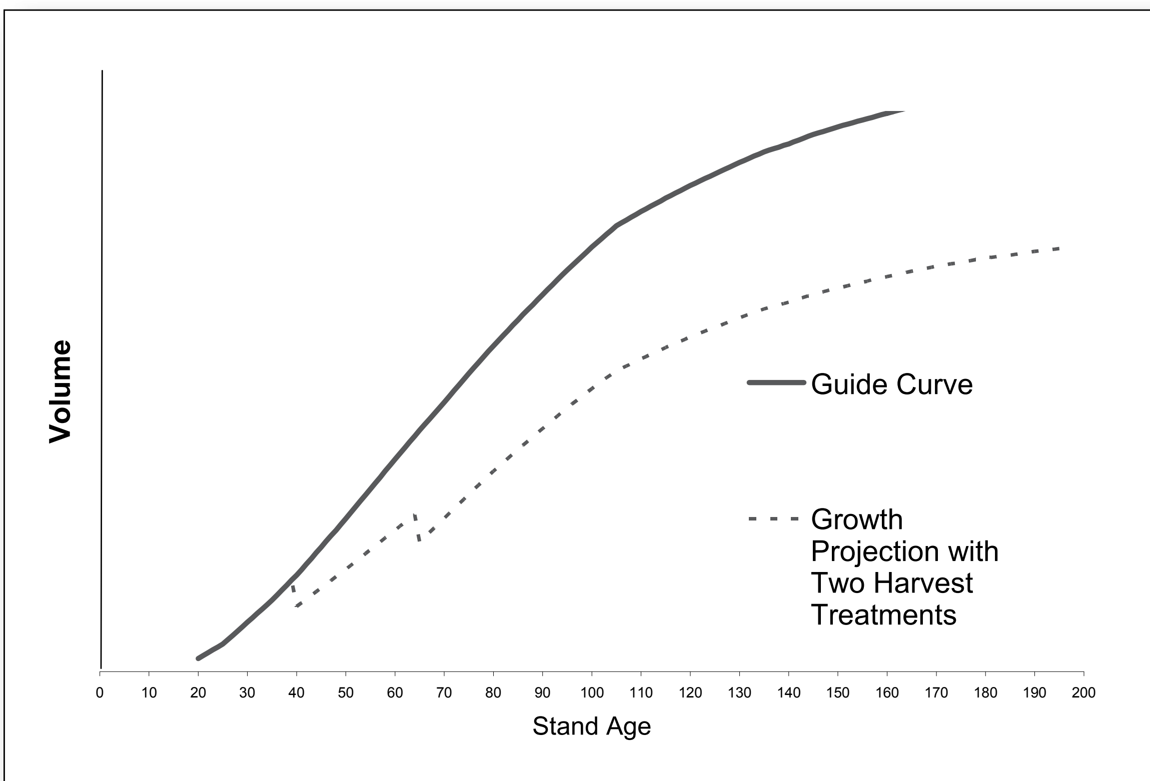
Where available, OPTIONS incorporates existing forest inventory information into the simulation analysis. Spatially explicit forest inventory information improves the analysis, but can create challenges because resource inventory classification systems often do not coincide directly with modeled growth projections. Although the generalized growth projections are accurate across a broad set of polygons, they do not capture variations of current inventory conditions at the individual polygon level. Thus, projecting the future growth of individual polygons requires an integration of existing inventory information with the generalized growth model projection. This integration is accomplished by utilizing algorithms to normalize future growth from the individual polygon's current inventory condition towards the long-term growth model projection. The rate of normalization is scaled according to the proximity of the inventory value to the model prediction. The process, referred to as the "trend to normality" captures, with spatial integrity, current conditions while accounting for the future growth within the polygon.

Treatment Adjustments and Responses

Growth projections are sensitive to management activities such as silvicultural treatments. Management activities are applied to individual polygons only when a set of eligibility criteria are met. Polygons that do not meet these criteria are not treated and their growth projection is uninterrupted. Stands that meet the eligibility criteria, as well as all other management objectives, are treated and their growth projection is adjusted. This adjustment is specific to stand age, species, site productivity level, as well as treatment type and intensity. All of these treatment and adjustment variables are defined in the model based on experience gained from the growth and yield modeling, professional judgment, research, and management objectives.

Figure R-18 provides an example of a volume growth projection and the adjustments applied for two stand thinning treatments. Growth projection for a polygon without treatment following the guide curve and the adjustments for two stand treatments at ages 40 and 60.

Figure R-18. Example Of A Volume Growth Projection Curve And Adjustments For Thinning Treatments



Management Activities and Rules

Management Activities

Forest management often requires intervention activities such as silvicultural treatments or harvesting activities. Silviculture treatments such as planting, pre-commercial thinning, pruning, fertilization, commercial thinning and selection harvest are explicitly defined, that is; their timing, intensity, duration and biological response are all defined in the model based on experience gained from the growth and yield modeling, professional judgment, and research.

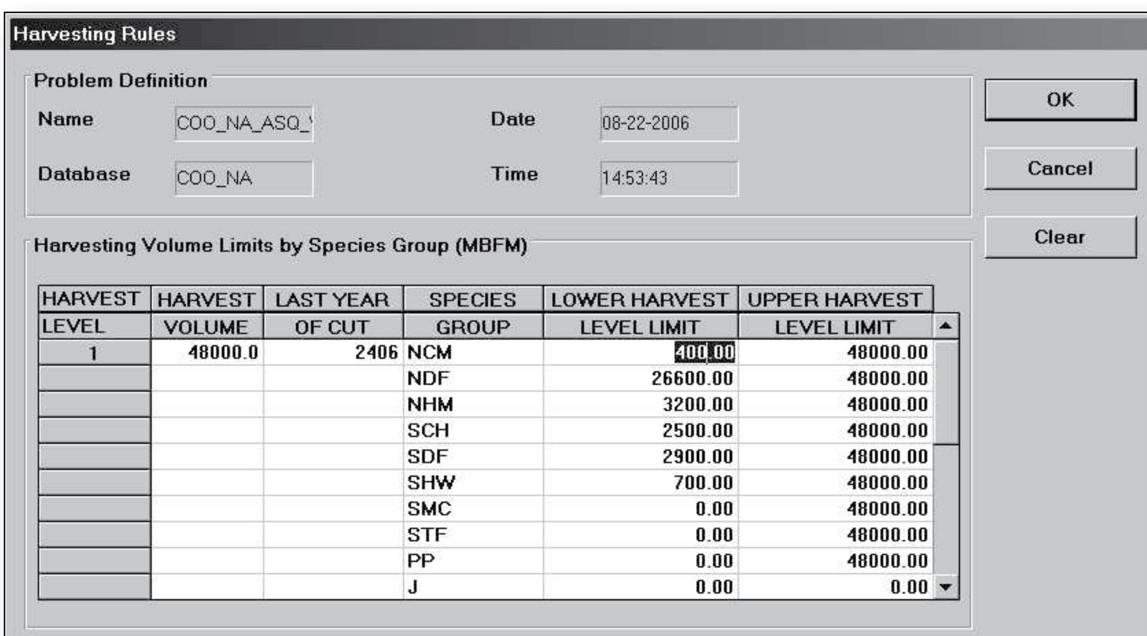
Additionally, treatments are subject to stand (polygon) level and landscape level eligibility criteria. An example of a stand level eligibility rule would be a minimum age or basal area threshold. A landscape level eligibility criteria would be an upper limit on the commercial thinning volume, within a Sustain Yield Unit. Silviculture treatments were not applied unless all eligibility criteria were met.

Harvesting activities are also subject to stand level and landscape level rules. An example of a polygon level harvest rule would be a minimum harvest age or a minimum residual volume per acre. There can be a number of landscape level harvest rules that control the maximum and minimum harvest levels by species type, species and wood-type priorities, polygon age and treatment type and landscape management objectives.

Figure R-19 provides an example set of landscape level harvest rules requesting minimum and maximum board foot volume level by species group.

Numerous management activities and silvicultural treatments can be developed and applied in various combinations, each combination defines a unique management regime. Polygons within a Sustained Yield Unit are assigned to a single, starting management regime. On completion of the management regime, or because of a specific harvest treatment, the polygon may return to the same management regime or continue under a new management regime.

Figure R-19. Landscape Level Harvest Rules Example



Harvesting Rules

Problem Definition

Name: COO_NA_ASQ_\ — Date: 08-22-2006

Database: COO_NA — Time: 14:53:43

OK | Cancel | Clear

Harvesting Volume Limits by Species Group (MBFM)

HARVEST LEVEL	HARVEST VOLUME	LAST YEAR OF CUT	SPECIES GROUP	LOWER HARVEST LEVEL LIMIT	UPPER HARVEST LEVEL LIMIT
1	48000.0	2406	NCM	400.00	48000.00
			NDF	26600.00	48000.00
			NHM	3200.00	48000.00
			SCH	2500.00	48000.00
			SDF	2900.00	48000.00
			SHW	700.00	48000.00
			SMC	0.00	48000.00
			STF	0.00	48000.00
			PP	0.00	48000.00
			J	0.00	0.00

Land and Resource Management Rules

In OPTIONS, resource management objectives can be applied as targets or constraints.

Targets and constraints can be applied to individual polygons or collectively to a group of polygons. Targets and constraints are applied for each year in the planning horizon, so all management objectives are maintained for every year within the planning horizon.

Targets are used to control conditions at the landscape level. For example, a target may be used to ensure that at any point in time 15% of the forested BLM-administered lands within a fifth field watershed will be in stands 80 years and older before regeneration harvest may occur. The model is flexible about which particular polygons are reserved to satisfy the target criteria. If current stand conditions do not achieve the target criterion the model will evaluate and recruit polygons that will contribute toward meeting the criterion soonest. Recruited polygons are deferred from harvest ensuring that the target criterion is met as soon as possible. Each year within the planning horizon, the model checks that sufficient polygons are available and deferred to meet the target criteria. The model only defers enough polygons to meet the modeling targets, thus allowing non-deferred polygons to contribute toward meeting other management objectives.

Constraints set explicit limitations on the amount, or kind, of activities permitted for an individual polygon, portion of a polygon or across a group of polygons, for a defined period. The defined period can extend through the entire planning horizon, or it can be defined for a shorter timeframe. For example, constraints can be used to exclude regeneration harvest activities from a riparian area throughout the entire planning horizon, while allowing commercial thinning activities until the stand reaches an age of 80, after which no further treatments are permitted.

GIS-Based Modeling Rules

The attributes associated with the GIS spatial data are used in OPTIONS to identify areas where modeling rules are applied to simulate the management action and land use allocations for the alternatives. This section will describe, by topic area, the modeling rules and GIS data as they were applied to simulate the alternatives with the OPTIONS model.

1) **Sustained Yield Units (SYU)**

   The BLM lands are subdivided into Sustained Yield Units for the purpose of defining the area in which the allowable sale quantity will be based. The Sustained Yield Units are based on the BLM-administered lands within the District boundaries for Salem, Eugene, Roseburg, Coos Bay, and Medford Districts. The western portion of the Klamath Falls Resource Area within the Lakeview District is also a SYU. The eastern portion of the Klamath Falls Resource Area does not contain any O&C lands and a sustained yield unit is not designated. The Forest Operations Inventory (FOI) District attribute data was used as the basis for the Sustained Yield Units in the OPTIONS modeling. The Land Use Allocation data segregated the Klamath Falls Resource into the Klamath SYU and the eastside management lands. An estimate of the sustainable harvest level was done for the eastside management lands under the No Action Alternative modeling assumptions. Allocations and management direction did not vary across alternatives for the eastside management lands and so they were not modeled in the action alternatives.

2) **Non Forest**

   Non-forest areas in the OPTIONS model remain static in the projections and do not carry vegetation attributes. Non forest information was derived from multiple sources of GIS data to form the non forest class in the OPTIONS modeling.

   Transportation data buffered by 22.5 feet to simulate the road network.

Timber Productivity Capability Classification non forest classes.

Forest Operations Inventory Existing Stand Condition non forest class.

In Alternatives 2 and 3 – open water class from the streams data.

3) Timber Productivity Capability Classification (TPCC)

The TPCC inventory is described in detail in the Inventory Data section of this appendix. Common to all alternatives, the non suitable woodlands and the suitable woodland categories of low site and non commercial species had no harvest modeled and were not included in the ASQ.

In the No Action Alternative, the reforestation suitable woodlands had no harvest modeled and were not included in the ASQ. In the Action Alternatives, these lands had harvest modeled and did contribute to the ASQ.

4) Recreation Sites

In all Alternatives, the existing recreation sites had no harvest modeled and were not included in the ASQ. In the Action Alternatives the proposed recreation sites had no harvest modeled and were not included in the ASQ. In the No Action Alternative the proposed recreation sites lands had harvest modeled and did contribute to the ASQ.

5) Wild and Scenic Rivers

In all alternatives, the existing Wild and Scenic Rivers had no harvest modeled and were not included in the ASQ. In the Action Alternatives, the eligible Wild and Scenic Rivers had no harvest modeled and were not included in the ASQ. In the No Action Alternative, the eligible Wild and Scenic Rivers had harvest modeled and did contribute to the ASQ. In the No Action Alternative, the existing recreation segments had harvest modeled and did contribute to the ASQ. (Note: not all recreation segments were able to be identified and put in the harvest land base).

6) Visual Resource Management (VRM)

In all alternatives, the VRM class one had no harvest modeled and was not included in the ASQ. Under Alternative 2 and the PRMP, on the PD or acquired lands, no regeneration harvest was applied on VRM class two (Note: The VRM class one GIS data was only used in the No Action Alternative and Alternative 2. In the other action alternatives, the combination of the Wild and Scenic River and Congressionally Reserved covered this allocation.)

7) Areas of Critical Environmental Concern (ACEC)

In the No Action Alternative, all of the existing ACECs had no harvest modeled and were not included in the ASQ. The proposed ACECs had harvest modeled and did contribute to the ASQ. In the action alternatives, all of the existing and proposed ACECs which passed through the O&C filter had no harvest modeled and were not included in the ASQ. Those ACECs that did not pass through the O&C filter had harvest modeled and did contribute to the ASQ.

O&C Filter - Used the following evaluation to determine how the each ACEC was modeled.

a) All ACECs that were Research Natural Areas (RNAs) had no harvest modeled and were not included in the ASQ.

b) For each of the action alternatives, the districts reviewed the existing and proposed ACECs and designated them as:
   - Whole ACEC does not conflict with the timber management objectives (On PD lands or on non commercial forest lands). These areas had no harvest modeled and were not included in the ASQ.

- A portion of the ACEC is in conflict with timber management but the portion of the ACEC outside of the O&C lands would remain as a valid ACEC. These portions of the ACECs that were not on O&C or CBWR lands had no harvest modeled and were not included in the ASQ.
- The entire ACEC conflicts with timber management objectives and is not carried forward under the alternative. These areas had harvest modeled and did contribute to the ASQ.

8) Marbled Murrelet Sites

Existing occupied marbled murrelet sites.

- No Action Alternative, Alternative 1, and PRMP, these areas had no harvest modeled and were not included in the ASQ.
- In Alternative 2, they became part of the Late-Successional Management Area which had thinning harvest modeled but this volume does not contribute to the ASQ.
- Alternative 3 had no harvest modeled until the landscape targets were met. In the modeling, one decade after the landscape target was met, these areas became available for harvest and they contributed to the ASQ. See the Assessment Area description for further information on the landscape targets and release dates.

The No Action Alternative Occupied Marbled Murrelet Site (OMMS) data was used to simulate the existing sites.

Projected future marbled murrelet sites.

The Draft EIS alternatives had a management action to limit harvest around marbled murrelet sites as they are identified. To simulate this in the modeling, the stands that are 120 years and older that are within four townships from the coast were used as a surrogate.

The No Action Alternative and Alternative 1, for Coos Bay only, had no harvest modeled and were not included in the ASQ. The LSR / LSMA in Salem and Eugene encompassed the majority of the area within 4 townships of the coast so no simulation was needed.

Alternative 2 had no projection for future sites.

Alternative 3 had no harvest modeled until the landscape targets were met. In the modeling, one decade after the landscape target was met, these areas became available for harvest and they contributed to the ASQ. See the Assessment Area description for further information on the landscape targets and release dates.

For the PRMP, marbled murrelet survey station data was used to determine the probability of finding a murrelet site when a survey occurred in stands that were likely habitat. A combination of District, Resource Area, and distance from the coast were used to subdivide the Marbled Murrelet Range into zones to develop these probabilities based on district Biologist professional judgment. Age breaks for each zone (generally 110 years) were used as a threshold for likely marbled murrelet habitat. The land outside of the large block Late Successional Management Areas within each zone and above the age threshold were identified as the population of potential sites. A random selection of stands from this population was done based on the probability for that zone. The center point of these stand was used to place a ½ mile buffer to select all stands meeting the likely habitat age criteria plus all stand within 30 years of that age threshold (for recruitment within 25 years). The selected stands within the half mile radius were used to simulate the future sites for the Marbled Murrelet in the OPTIONS modeling. These areas were modeled as no harvest.

9) Northern Spotted Owl

The No Action Alternative had 100 acres known owl activity centers identified which had no harvest modeled and were not included in the ASQ.

The No Action Alternative had Reserve Pair Areas identified in the Salem District.

- The suitable and next best reserved areas had no harvest modeled and were not included in the ASQ.
- The dispersal, next best, and non-habitat received thinning only with no regeneration harvest. These lands had thinning harvest modeled but this volume did not contribute to the ASQ.

Alternatives 1, 2, and the PRMP have no provisions for site management in the modeling.

Alternative 3 had 250-acre activity centers identified which had no harvest modeled until the landscape targets were met. In the modeling, one decade after the landscape target was met, these areas became available for harvest and they contributed to the ASQ. See the Assessment Area description for further information on the landscape targets and release dates.

10) Special Status Species

For the No Action Alternative, survey and manage species sites had no harvest modeled and were not included in the ASQ. Although the survey and manage mitigation was subsequently removed from the No Action Alternative, the modeling had already been completed.

In Alternative 1, 2, and 3 special status species which were on Public Domain or Acquired lands had no harvest modeled and were not included in the ASQ.

For the PRMP, all existing identified sites on all BLM lands were modeled as no harvest and were not included in the ASQ.

11) Species Management Areas

In all alternatives, species management areas were identified for bald eagle and golden eagles sites. These areas had no harvest modeled and were not included in the ASQ.

12) Riparian

GIS Modeling

The riparian reserves / riparian management areas vary across the alternatives based upon the management action outlined in *Chapter 2*. The GIS modeling was employed to estimate the extent of riparian areas so that management action could be simulated in the OPTIONS modeling. The GIS modeling, depending on the alternative, had many factors to consider in estimating the riparian area; presence/absence of fish, potential tree height adjusted specifically for each area, perennial versus intermittent streams, wetlands, lakes, ponds, and the potential to deliver large wood to streams. (See *Table R-12*) The description below is general in nature. The GIS metadata contains the technical details of the GIS riparian modeling.

<u>No Action Alternative, Alternative 1, and PRMP.</u> The GIS modeling varied the application of the site potential tree height based on district computed values usually by fifth-field watershed. To determine the GIS buffering widths, the potential tree heights were adjusted for the average stream side adjacent slope as determined by GIS analysis for each 5th field watershed. Attributes from the hydrography data were used to determine the presence and absence of fish, if a stream was intermittent or perennial, and the identification of ponds, wetlands and lakes. The GIS data for the OPTIONS modeling identified those areas in the riparian reserves as a Y/N classification.

<u>Alternative 2</u>. Three riparian management area zones were identified with GIS buffering of the hydrography data. All fish-bearing streams 0-25 feet (buf25). All non-fish-bearing intermittent 0-25 feet (shrub). Perennial and fish-bearing 25-100 feet (buf100). The GIS modeling was done to identify the areas likely to deliver large wood to streams which were identified in addition to the GIS buffering of the hydrography data (WDFLOW).

Alternative 3. Four riparian management areas zones were identified with GIS buffering of the hydrography data. 0-25 feet on all streams. Within the Coquille Tribal Management Area for all perennial streams and all intermittent streams with fish 25-50 feet. Within the Coquille Tribal Management Area for all fish bearing streams 50-100 feet. Outside the Coquille Tribal Management Area for all perennial streams and all intermittent streams with fish 25-100 feet.

Alternative 2 and 3 riparian GIS analysis identified open water that was not recognized in the No Action Alternative and Alternative 1 data. The open water was added to the other classes of non forest and not included in the modeled riparian area in Alternatives 2 and 3.

OPTIONS Modeling Rules

In the OPTIONS modeling, any harvest coming from the riparian areas does not contribute to the ASQ since the management action / modeling rules preclude continuous management. The shrub riparian area in Alternative 2 does contribute to the ASQ, because these harvest practices can continue over time. Harvest levels are determined for these lands along for the duration which harvest can occur given the modeling rules.

Operability limitations were modeled by limiting thinning activities within each riparian polygon to a maximum of 50% of the polygon area. Additionally, riparian stand that were commercially thinned were then deferred from subsequent thinning treatments for 60 years. This deferral was applied to the entire polygon.

Table R-12. Riparian Modeling Rules By Alternative

Alternative	GIS Data	Riparian Modeling Rules
No Action	Y – Yes inside riparian reserve	• No regeneration harvest • Commercial thinning modeled up to age 80. In Salem Adaptive Management Areas up to age 110 • 50% operability by polygon
Alternative 1 & PRMP	Y – Yes, inside riparian Management area	• No regeneration harvest • Commercial thinning modeled up to age 80. • 50% operability by polygon and 0-60’ no harvest (PRMP)
Alternative 2	0 to 25 feet	• No harvesting activities modeled
	25 to 100 feet	• No harvest in stands 80 years and older. • No regeneration harvest modeled • Commercial thinning modeled up to age 80 • 50% operability by polygon
	Shrub	• Regeneration harvest modeled with 10-15 conifer green tree retention. (Contributes to ASQ.)
	Wood Debris Flow Area	• No harvest activities modeled.
Alternative 3	0 to 25 feet	• No harvesting activities modeled
	25 to 100 feet	• No harvest in stands 80 years and older • No regeneration harvest modeled • Commercial thinning modeled to age 80 • 50% operability by polygon
	Coquille Management Area 25 to 50 feet	• No harvest in stands 80 years and older. • No regeneration harvest modeled. • Commercial thinning modeled to age 80 • 50% operability by polygon
	Coquille Management Area 50 to 100 feet	• No regeneration harvest modeled • 50% operability by polygon

13) Congressionally Reserved

Congressionally reserved areas had no harvest modeled and were not included in the ASQ for any alternative. The Land Use Allocation GIS layer and Wild and Scenic Rivers GIS layer were used to define these areas.

14) Late-Successional Reserves (LSR)

The Late-Successional Reserves had only thinning harvests modeled in those stands less than 80 years of age for the No Action Alternative. This volume estimate is not included in the ASQ since the harvest would diminish over time as the stands eligible for thinning matured. The OPTIONS modeling projected the duration and volume levels for this harvest as it stepped down over time. The Land Use Allocation GIS theme was used to define this allocation. The other Northwest Forest Plan LSR components, Occupied Marbled Murrelet Sites and Know Owl Activity Centers, were modeled independently of the large block reserves. Also see the Adaptive Management Area Reserve section.

15) Late-Successional Management Areas (LSMA)

Late-Successional Management Areas were defined for Alternatives 1, 2, and the PRMP.

Alternative 1 LSMAs were based on the No Action Alternative Late-Successional Reserves. Commercial thinning treatments within LSMA were consistent with the No Action LSR thinning treatments. Thinning was modeled in stands less than 80 years of age.

Alternative 2 LSMAs were developed by BLM utilizing rules for size and spacing of large blocks which was based on current science for the Northern Spotted Owl and discussions from the draft Northern Spotted Owl recovery team. The initial GIS mapping of these large blocks was revised in the OPTIONS data preparation program to designate whole BLM parcels/sections based on a majority rule. In addition the existing Occupied Marbled Murrelet Sites were added to the LSMA. Commercial thinning treatments within LSMA were consistent with the No Action LSR thinning treatments. Thinning was modeled in stands less than 80 years of age.

For the PRMP, the Late-Successional Management Areas were developed from three components.
Northern Spotted Owl Managed Owl Conservation Areas from the proposed recovery plan

- Currently Occupied Marbled Murrelet Sites (Occupied Marbled Murrelet Site – OMMS GIS Data)
- A subset of existing Marbled Murrelet Critical Habitat.
  - A MAMU zone that is 35 miles from the coast and extends inland 50 miles in Medford.
  - All stands 80 years and older (as currently mapped) within MAMU zone are part of the LSMA.

Note: All stands less than 80 years old (as currently mapped) in the MAMU zone are in the Timber Management Area and not include in the LSMA.

No harvest was simulated for the LSMAs associated with the occupied Marbled Murrelet Sites. Since the other components of the LSMA were related to critical habitat designations it was intended to have no thinning of stands 70 years and older. Although the model did not enforce this cap, this was inconsequential because it resulted in a minor increase in the overall thinning.

Harvest projections for the LSMAs are not included in the ASQ estimates. With the absence of regeneration harvest, timber production from commercial thinning would diminish over time as the stands mature and become ineligible for thinning.

16) Adaptive Management Area and Late Successional Reserves

Under the No Action Alternative, there are Adaptive Management Area designations that overlap the Late-Successional Reserves in the Salem and Medford Districts. The Medford area was modeled the same as the Late-Successional Reserves, with thinning harvests limited to those stands less than 80 years of age. For the Salem area, the thinning harvest was modeled up to age 110. Harvest projections for the areas are not included in the ASQ estimates. With the absence of regeneration harvest, timber production from commercial thinning would diminish over time as the stands mature and become ineligible for thinning. The OPTIONS modeling projected the duration and volume levels for this harvest as it stepped down over time. The Land Use Allocation GIS theme was used to define this allocation.

17) Adaptive Management Areas (AMAs)

Adaptive Management Areas applied to the No Action Alternative. These are the portions of the AMA that exist outside Late-Successional Reserves.

The AMAs in the Eugene and Roseburg Districts were modeled the same as General Forest Management Areas (GFMA).

The Medford AMA was modeled the same as Southern General Forest Management Areas (S_ GFMA).

The modeled harvest from these areas was included in the ASQ.

The Salem AMA was modeled under thinning only, up through age 110, with no regeneration harvest. Since this harvest level would diminish over time the modeled volume was not included in the Allowable Sale Quantity.

Modeling reductions to the harvest land base for administratively withdrawn and riparian reserves within the AMAs was the same as within the surrounding matrix lands. The Land Use Allocation GIS layer was used to define this allocation.

18) Connectivity Diversity Blocks

The connectivity diversity block allocations applied only to the No Action alternative. OPTIONS modeling rules were established so regeneration harvest would not occur until at least 25% of the forest area in the blocks was in stands 80 years or older. For each block a maximum of 1/150th of the forested area could be at age zero (regenerated) to simulate the area control requirement. The modeling blocks were based on all of the connectivity diversity lands within a township and Sustained Yield Unit. The Land Use Allocation GIS layer was used to define this allocation on a gross basis. The net acreage modeled for harvest is the area remains after all other reductions to the harvest land base have been made. The modeled harvest from these areas was included in the ASQ.

19) General Forest Management Areas (GFMA)

The GFMA allocation applied only to the No Action Alternative. The Southern GFMA in the Medford District and the Klamath Falls SYU has older minimum harvest ages and higher green tree retention than the GFMA allocations in the other SYUs. The Land Use Allocation GIS layer was used to define this allocation on a gross basis. The net acreage modeled for harvest is the area remains after all other reductions to the harvest land base. The modeled harvest from these areas was included in the ASQ.

20) Timber Management Area (TMA)

The TMA allocation applied to Alternatives 1, 2 and the PRMP. On a gross basis, these are the lands outside of the Late-Successional Management Area, Riparian Management Area, Congressionally Reserved, and the Cascade-Siskiyou National Monument. The net acreage modeled for harvest is the area which remains after all other reductions to the harvest land base. The modeled harvest from these areas was included in the ASQ.

21) General Landscape Area (GLA)

The GLA allocation applied to Alternative 3. On a gross basis these are the lands outside of the Riparian Management Area, Congressionally Reserved, and the Monument. The net acreage modeled for harvest is the area which remains after all other reductions to the harvest land. The modeled harvest from these areas was included in the ASQ.

22) District Defined Reserves

Under the No Action Alternative, there are district-defined reserves that were established in the 1995 RMP. These lands are defined in the Land Use Allocation GIS layer. No harvest was modeled for these areas and they were not included in the ASQ.

23) Miscellaneous District No Harvest Areas

Under all alternatives, individual OI units were earmarked by the districts to be excluded from the harvest land base for modeling. These included communications sites, seed orchards, and some omissions in the TPCC data for Klamath Falls. No harvest was modeled for these areas and they were not included in the ASQ.

24) Wilderness Characteristics

Under the action alternatives, wilderness characteristics areas were identified in GIS. Only those lands which fell on Public Domain were considered in the modeling. For those areas no harvest was modeled and they were not included in the ASQ.

25) Medford Granitic Soils

For the No Action Alternative, the areas identified in GIS for the Medford District as granitic soils in the Northern General Forest management Areas were modeled under the southern General Forest Management Areas prescriptions.

26) Medford Frost Areas

For the No Action Alternative, the areas identified in GIS for the Medford district as frost areas called for developing unique prescriptions to establish shelterwood prescriptions to retain trees for 30 years. The area was 8,000 acres in size. Due to the small size and complexity of modeling this no specific modeling was done for this area. For the PRMP, a shelterwood prescription was applied to the Medford frost areas.

27) Medford Deferred Watersheds

The Medford District 1995 RMP identified a set of monitoring watersheds which were deferred from harvest for one decade.

- In the No Action Alternative, these areas had no harvest modeled for 1 decade. After that, these areas would have harvest modeled according to the underlying land use allocation and contribute to the ASQ. One watershed was included that was not intended to be deferred and another was omitted. Overall, the modeling was 500 acres short on modeling this deferral.
- In Alternative 1, these watersheds were modeled as completely deferred with no harvest activities simulated. These lands did not contribute to the ASQ. The GIS data was corrected from the No Action dataset.

28) 15% Standard and Guideline (15% S&G)

The 15% S&G was modeled in the No Action Alternative. The OPTIONS model did not conduct any regeneration harvest until 15% of the forest area with in each fifth field (with in the SYU) was in stands 80 years or older. This constraint was enforced annually, prohibiting watersheds from going below the threshold. Thinning treatments were modeled irrespective of the 15% S&G status. Harvest in these areas does or does not contribute to the ASQ depending on the underlying land use allocation.

29) Swiss Needle Cast Area

The Salem District identified where the current extent of the Swiss needle cast infection exists. The OPTIONS model used a unique set of species groups to reflect the reduced yields of existing stands or the future growth and yields of disease resistant species mixes in the existing infection area.

30) Alt 3 Assessment Areas – Landscape Targets

A review of the age which the OPTIONS projection achieved Northern Spotted Owl habitat (category 4) was conducted for each province / SYU. From this review, 90 year or 140 year thresholds were established for each province / SYU for use as the landscape targets. (See *Table R-13*) Assessment areas were established based on the combination of province / SYU which were outside of the Uneven-aged Management Area in Medford and Klamath Falls and the Coquille Tribal management area. In OPTIONS, regeneration harvest was not modeled until 50% of the forest area in each assessment area was above the landscape target age. Partial harvest and commercial thinning were modeled for the entire projection period independent of the landscape targets and assessment areas. Marbled Murrelet Sites and Northern Spotted owl sites were modeled as no harvest until one decade after the landscape targets were met. At that time those lands were available for harvest.

Table R-13. Landscape Areas, Habitat Threshold Ages, and Assessment Area Names (Alternative 3)

	Cascades	Coast	Klamath	Total (acres)
Coos Bay		269,634	51,533	321,166
Threshold Age		90 Years	90 Years	
Assessment Area		CB Coast / Coquille	CB Klamath	
Eugene	151,974	160,286		312,261
Threshold Age	90 Years	90 Years		
Assessment Area	Eug Cascades	Eug Coast		
K-Falls	51,306			51,306
Threshold Age	n/a			
Assessment Area	Uneven Age			
Medford	229,873		636,819	866,692
Threshold Age	140 Years & n/a		140 Years & n/a	
Assessment Area	Med Cascades & Uneven Age		Med Klamath & Uneven Age	
Roseburg	152,313	129,039	142,236	423,588
Threshold Age	90 Years	90 Years	140 Years	
Assessment Area	Ros Cacades	Ros Coast	Ros Klamath	
Salem	170,027	232,157		402,184
Threshold Age	90 Years	90 Years		
Assessment Area	Sal Cascades	Sal Coast		

31) Coquille Tribal Management Area

The Coquille Tribal Management Area was modeled in Alternatives 2 and 3. No northern spotted owl site harvest constraints were applied in this area under both alternatives. Under Alternative 3, the landscape targets were not applied which limited regeneration harvest. See Riparian section for Alternative 3 modeling for the riparian area. The TMA/ GLA lands were modeled under the No Action GFMA prescription.

32) PRMP Deferred Timber Management Area

The Northern Spotted Owl Recovery Plan Recovery Action 32 - "*Maintain substantially all of the older and more structurally complex multi-layered conifer forests on Federal lands outside of MOCAs.*" BLM staff met with the Interagency Support Team supporting the recovery team to gain an understanding of how this could be defined. The BLM staff and the Interagency Support Team agreed that the structurally complex forest classification approximates the types of conditions they were describing. The BLM does not have an in place stand level classification of structurally complex forest. A comparison was done with the BLM stand age data with the modeled structurally complex classification. Stands with ages of 160 years and older reasonably approximates the stands mapped currently as structurally complex (80% of structurally complex stands are 160 years and older; 85% of the stands 160 years and older are structurally complex) Stands currently mapped as 160 years and older were mapped as the Deferred Timber Management Area land use allocation. These lands were deferred from harvest for 15 years in the modeling.

Recovery action 32 states – "*Land managers have made significant investments of time and resources in planning projects that may have been developed prior to the approval of this Recovery Plan, thus some forests meeting the described conditions might be harvested*". The planned timber sale areas for the 2009 and 2010 were not included in the Deferred Timber Management Area allocation. The modeling occurred before this adjustment was made so these lands were simulated as a 15 year deferral in determining the harvest levels.

GIS Data – Modeling Harvest and Contribution to ASQ

Table R-14 provides a summary of how each category of GIS data was modeled and which categories contribute to the Allowable Sale Quantity.

Table R-14. GIS Modeling Data Layers

GIS Modeling Data Layers	No Action	Alternative 1	Alternative 2	Alternative 3	PRMP
Roads	X	X	X	X	X
TPCC Non Forest	X	X	X	X	X
TPCC Non Suitable Woodlands	N	N	N	N	N
TPCC Suitable Woodlands - Low Site and Non Commercial Species	N	N	N	N	N
TPCC Suitable Woodlands - Reforestation	N	Y	Y	Y	Y
Recreation Sites Existing	N	N	N	N	N
Recreation Sites Proposed	Y	N	N	N	N
Wild and Scenic Rivers - Existing	N	N	N	N	N
Wild and Scenic Rivers - Eligible	Y	N	N	N	N
Visual Resource Management Class 1	N	N/A	N On PD Only	N/A	N On PD Only
Visual Resource Management Class 2	N/A	N/A	P On PD Only	N/A	P On PD Only
Areas Of Critical Environmental Concern - Existing	N	N – If Passes O&C Filter	N –If Passes O&C Filter	N – If Passes O&C Filter	N – If Passes O&C Filter
Areas Of Critical Environmental Concern - Proposed	Y	N – If Passes O&C Filter	N – If Passes O&C Filter	N – If Passes O&C Filter	N – If Passes O&C Filter
Occupied Marbled Murrelet Sites	N	N	N	D	N
Simulation Future Marbled Murrelet Sites	N	N	N	D	N
Known Owl Activity Centers	N - 100 Acres	Y	Y	D - 250 Acres	N/A
Reserve Pair Areas (Salem)	N	N/A	N/A	N/A	N/A
Survey and Manage Species	N	N/A	N/A	N/A	N/A N
Special Status Species	N/A	N - For Those On PD Lands	N - For Those On PD Lands	N - For Those On PD Lands	N
Species Management Areas	N	N	N	N	N
Riparian Reserves	P	N/A	N/A	N/A	N/A
Riparian Management Areas	N/A	P	P	P	P
LUA - Congressionally Reserved	N	N	N	N	N
LUA - Late-Successional Reserves	P	N/A	N/A	N/A	N/A
LUA - Late-Successional Management Areas	N/A	P	P	N/A	P
LUA - Adaptive Management Areas	Y/P	N/A	N/A	N/A	N/A
LUA - Adaptive Management Areas/Reserves	P	N/A	N/A	N/A	N/A
LUA - Connectivity Diversity Blocks	Y	N/A	N/A	N/A	N/A
LUA - General Forest Management Areas	Y	N/A	N/A	N/A	N/A
LUA - Southern General Forest Management Areas	Y	N/A	N/A	N/A	N/A
LUA - Timber Management Area	N/A	Y	Y	N/A	Y
LUA - Gen Landscape Area	N/A	N/A	N/A	Y	N/A
LUA - District Defined Reserves	N	N/A	N/A	N/A	N/A
Misc. District No Harvest Areas	N	N	N	N	N
Wilderness Characteristics on PD Lands	Y	N	N	N	N
Medford Deferred Watersheds	D	N	N/A	N/A	N/A
15% Standard & Guide	D	N/A	N/A	N/A	N/A
Deferred Timber Management Area (15 Years)	N/A	N/A	N/A	N/A	D

Y = Harvest is modeled and contributes to ASQ
P = Harvest is modeled but does not contribute to ASQ since the harvest can not be sustained continuously over time.
N = No harvest is modeled.
D = Harvest is deferred for 1 or more decades and contributes to ASQ.
X = Non Forest
N/A = Does not apply to the alternative

Reference Analysis Modeling Rules

1) **Maximum Harvest**

The Alternative 2 data was used for this analysis. All lands were made available for harvest with the exception of TPCC Non Suitable Woodlands, TPCC Suitable Woodland (low site and non commercial species), Wild and Scenic Rivers, existing recreation sites. 25' buffer on streams (buf_25), Congressionally Reserved lands, and the National Monument. CMAI was used in setting the minimum harvest ages similar to Alternative 2.

2) **No Harvest**

No harvest was simulated.

Green Tree Retention

No Action Alternative

Green Tree Retention (GTR) was modeled as a stand level constraint in the No Action Alternative. Within each polygon, a retention level was applied at the time of harvest. Retention levels varied by land use allocation as presented in Table R-15.

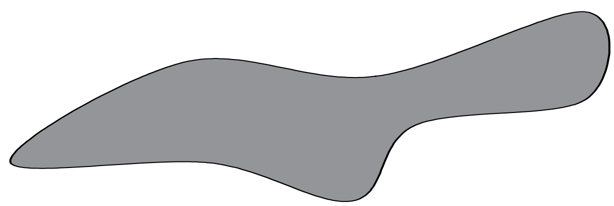
Table R-15. Green Tree Retention Percent By Land Use Allocation For The No Action Analysis

Land Use Allocation	Green Tree Retention Percent
General Forest Management Area (GFMA), North GFMA, Adaptive Management Areas, No Designation	11%
South General Forest Management Area (including Granitic Soils Areas)	24%
Connectivity Diversity Blocks, District Defined Reserves, Congressionally Reserved, National Monument	18%
Late-Successional Reserves, Adaptive Management Area Reserves	Not Applicable
Eastside Management Lands	Not Applicable

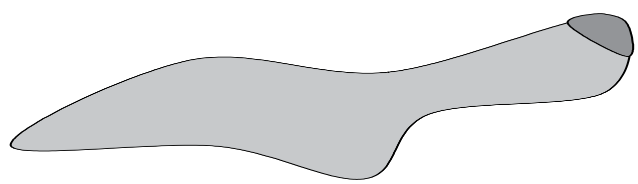
The retained portions of the polygons were modeled as contiguous areas and reserved until a subsequent rotation when the areas were made available for harvest and GTR retention was applied. Thus, in each subsequent harvest a smaller portion of the original retention area was reserved while younger GTR areas were also retained.

Figure R-20 provides a graphic example of modeling 11% green tree retention. In the model the retention areas is not spatially defined with in the polygon but is tracked as a proportion of the area.

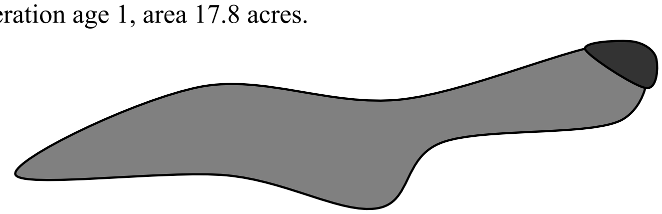
Figure R-20. Green Tree Retention Accounting Within The OPTIONS Model



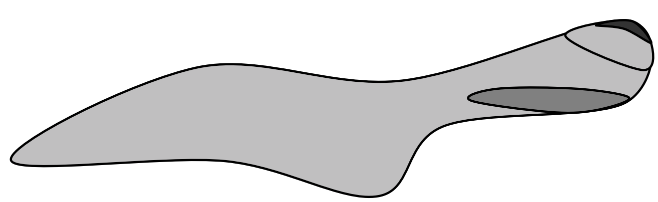
Polygon prior to first harvest. Stand age 100 years. Area 20 acres.



Polygon after first harvest. Retention stand age 101, area 2.2 acres; regeneration age 1, area 17.8 acres.



Polygon prior to second harvest. Retention stand age 181, area 2.2 acres; regeneration age 81, area 17.8 acres.



Polygon after second harvest. Oldest retention stand age 181, area 0.24 acres; younger retention stand age 81, area 1.96 acres; regeneration age 1, area 17.8 acres.

Alternative 1 and PRMP

No green tree retention was applied.

Alternative 2

Management action for two trees per acre green tree retention was not simulated in the modeling since the volume reduction would be minor. Green tree retention for the Coquille Management Area was modeled the same as the No Action alternative General Forest Management Area.

Modeling of the tree retention levels for future snags and coarse woody debris in the Late-Successional Management Areas varied individual SYUs and physiographic provinces. This retention was modeled as a stand level constraint by reserving a percentage of each stand being thinned. (See *Table R-16* below)

Table R-16. Late-Successional Management Areas Tree Retention Percent By Sustained Yield Unit / Retention Zone

Retention Zone	Lakeview	Salem	Eugene	Roseburg	Medford	Coos Bay
Western Hemlock	0%	7%	8%	14%	0%	8%
Douglas-fir	9%	0%	0%	8%	12%	0%
Tan Oak	9%	0%	0%	0%	13%	5%

Alternative 3

Assessment areas were established based on the combination of province / SYU which were outside of the Uneven-aged management area in Medford and Klamath Falls and the Coquille Tribal management area. Age thresholds (90 yr or 140 yr) were established as landscape target for each assessment area. (See GIS Based Modeling Rules – Assessment Areas) Regeneration harvests were not modeled until 50% of the Assessment Area was in ages at or above the landscape target threshold.

After regeneration harvests, green tree retention was modeled in a similar manner as in the No Action and Alternative 2. However, retention levels for Alternative 3 were based on species group. (See *Table R-17* below)

Table R-17. Regeneration Harvest Prcent Volume Tree Retention For Green Tree, Snag, And Coarse Woody Debris Creation By Species Group

Species Group	Green Tree Retention Percent	Green Tree + Future Snag and CWD
Northern Hardwood Mixed	7%	15%
Northern Mixed Conifer	6%	14%
Northern Douglas-fir	6%	14%
Southern Douglas-fir	7%	10%
Southern Mixed Conifer	8%	12%
Sothern Conifer Hardwood	10%	13%
Southern Hardwood	9%	13%
Southern True Fir	8%	11%
Ponderosa Pine	15%	24%

In Alternative 3, intermediate harvests, termed partial harvests, were permitted prior meeting the older forest targets. For intermediate harvests, green tree retention was modeled as a partial harvest, and stand attributes of the retained stems were incorporated into the blended yield curves. The blended yield curves reduced the retained and regenerated components of the harvest unit proportionally, similar to the stand level constraint method described above, however, the retained portions of the polygons are not reported independently. (See *Tables R-18* and *R-19* below)

The Coquille Management Area was modeled the same as the No Action General Forest Management Area.

Table R-18. Stand Treatment Age And Retention Used To Blend Yield Curves For Intermediate Harvests

Zone	1st Intermediate Harvest		2nd Intermediate Harvest		3rd Intermediate Harvest		4th Regeneration Harvest	
	Age	%	Age	%	Age	%	Age	%
Hemlock	120	35	240	35	0	0	360	n/a
Douglas fir	80	19	160	19	0	0	240	n/a
Tanoak	60	35	120	35	180	35	240	n/a

Table R-19. Partial Harvest Retention Plus Supplemental Retention For Snag And Coarse Woody Debris Creation

Zone	1st Intermediate Harvest		2nd Intermediate Harvest		3rd Intermediate Harvest		4th Regeneration Harvest	
	Age	%	Age	%	Age	%	Age	%
Hemlock	120	42	240	42	0	0	360	*
Douglas fir	80	22	160	22	0	0	240	*
Tanoak	60	39	120	39	180	39	240	*

* GTR levels by Species Group

Scribner Volume

For OPTIONS modeling, Scribner volumes were generated as a part of the guide curve modeling with the ORGANON Shell. The equations for these volumes are based 16-foot BLM volume rules.

Volume Adjustments

Guide Curve Adjustments to volume were made for Defect and Breakage (D&B), Green Tree Retention (GTR), Snags, Coarse Woody Debris (CWD), Insect and Disease, and Soil Compaction.

With the exception of GTR, all adjustments to the Guide Curves were compiled outside the OPTIONS model as percent basal area reductions. Estimates for D&B, Insect and Disease, and Soil Compaction were supplied by the districts or based on values derived for the most recent RMP. The guidelines for Snags and Coarse Woody Debris (CWD) varied by alternative. These adjustments were made to the Guide Curves with the OPTIONS data preparation program and applied within the OPTIONS modeling as volume reductions. Adjustments were compiled and applied by ORGANON variant, Species Group, stand type (managed, unmanaged, or future) and harvest type where appropriate. For Alternative 3, these adjustments were further stratified by Vegetation Zone; Western Hemlock, Douglas-fir and Tanoak to account for differences in Snag and Coarse Woody Debris requirements. (See *Figure R-21*)

Figure R-21. An Example Of Adjustments Utilized For A Single Alternative And District

Alternative 3 Yield Adjustments - Factors Varying by Management Status and Retention Zone																
District:	Roseburg							GTR Green Tree Retention %BA Adj for Regen Harvest Only			Snag Creation/Retention %BA Adj for Partial & Regen Harvest			CWD %BA Adj for Partial & Regen Harvest		
Alternativ	Alt 3															
ESC/Modeling Grou	MG11&15=Unmanaged															
Land Use Allocation:	GLA															
Regen Harvest Age	Soil Compac-tion	Insect & Disease	Cruise Gross to Net [D&B]	GTR Edge Effect	Sum of Adjust-ments	Final Adjustment Factor Managed & Future	Final Adjustment Factor Unmanaged (w/o Soil I&D)	WH Retention Zone GTR %BA	DF Retention Zone GTR %BA	TO Retention Zone GTR %BA	WH Retention Zone Snag %BA	DF Retention Zone Snag %BA	TO Retention Zone Snag %BA	WH Retention Zone CWD %BA	DF Retention Zone CWD %BA	TO Retention Zone CWD %BA
30	0.00	0.005	0.050	0.050	0.105	0.895	0.900	0	0	0	0	0	0	0	0	0
40	0.00	0.007	0.050	0.050	0.107	0.893	0.900	0	0	0	0	0	0	0	0	0
50	0.00	0.008	0.050	0.050	0.108	0.892	0.900	0	0	0	0	0	0	0	0	0
60	0.00	0.010	0.050	0.050	0.110	0.890	0.900	0	0	0	0	0	0	0	0	0
70	0.00	0.011	0.050	0.050	0.111	0.889	0.900	0	0	0	0	0	0	0	0	0
80	0.00	0.012	0.050	0.050	0.112	0.888	0.900	0	0	0	0	0	0	0	0	0
90	0.00	0.014	0.050	0.050	0.114	0.886	0.900	0	0	0	0	0	0	0	0	0
100	0.00	0.015	0.060	0.050	0.125	0.875	0.890	0	0	0	0	0	0	0	0	0
110	0.00	0.016	0.070	0.050	0.136	0.864	0.880	0	0	0	0	0	0	0	0	0
120	0.00	0.018	0.080	0.050	0.148	0.852	0.870	0	0	0	0	0	0	0	0	0
130	0.00	0.019	0.090	0.050	0.159	0.841	0.860	0	0	0	0	0	0	0	0	0
140	0.00	0.020	0.090	0.050	0.160	0.840	0.860	0	0	0	0	0	0	0	0	0
150	0.00	0.022	0.090	0.050	0.162	0.838	0.860	0	0	0	0	0	0	0	0	0
160	0.00	0.023	0.100	0.050	0.173	0.827	0.850	0	0	0	0	0	0	0	0	0
170	0.00	0.024	0.110	0.050	0.184	0.816	0.840	0	0	0	0	0	0	0	0	0
180	0.00	0.026	0.120	0.050	0.196	0.804	0.830	0	0	0	0	0	0	0	0	0
190	0.00	0.027	0.130	0.050	0.207	0.793	0.820	0	0	0	0	0	0	0	0	0
200	0.00	0.028	0.200	0.050	0.278	0.722	0.750	0	0	0	0	0	0	0	0	0
210	0.00	0.028	0.200	0.050	0.278	0.722	0.750	0	0	0	0	0	0	0	0	0
220	0.00	0.028	0.200	0.050	0.278	0.722	0.750	0	0	0	0	0	0	0	0	0
230	0.00	0.028	0.200	0.050	0.278	0.722	0.750	0	0	0	0	0	0	0	0	0
240+	0.00	0.028	0.200	0.050	0.278	0.722	0.750	0	0.083	0.074	0	0.012	0.018	0	0.028	0.035
360+	0.00	0.028	0.200	0.050	0.278	0.722	0.750	0.065	0.083	0.074	0.030	0.012	0.018	0.043	0.028	0.035

Exceptions to these were limited to the modeling of GTR for Regeneration harvests in the No Action Alternative and Alternative 3 and the Partial harvests in Alternative 3. These reductions were taken at time of harvest within the OPTIONS model in the form of reduced harvest unit acreage.

Minimum Harvest Age

The OPTIONS model uses a minimum harvest age to control the lower limit where regeneration harvest could occur.

In the No Action Alternative, the minimum harvest ages were set by direction in the existing plans. For all districts, except Medford, the minimum regeneration harvest age was set to 60 years. For the Medford District, the minimums were 100 years in the North General Forest Management Areas and 120 years in the South General Forest Management Areas.

For Alternatives 1, 2, and the PRMP, minimum harvest ages were based on Culmination of Mean Annual Increment (CMAI) for regeneration harvests.

Culmination of Mean Annual Increment (CMAI) results can vary widely depending on the unit of measurement used, the utilization standards and whether net or gross growth is considered. It has been a commonly accepted forestry theorem that even- aged stands should be harvested at CMAI in order to maximize biological yields.

Current Annual Increment (CAI) is defined as the annual increment of wood grown for a particular stand, or in this case a group of inventory plots representing similar growing conditions. Mean Annual Increment (MAI) for a particular stand or set of plots is the total increment of wood at a given stand age divided by that stand age. CMAI is the point when the CAI, sometimes termed Periodic Annual Increment (PAI) and the MAI are equal. Culmination occurs when the maximum MAI is reached. From the ORGANON Guide

Curve runs, Total Stem Cubic Volume (TSCV) was used for CMAI determination. This approximates a biological decision rule for the point of harvest. For this evaluation, the CMAI threshold was assumed to be the first age (5-year ORGANON modeling cycle) at which the difference between PAI and MAI was zero or negative. The gross volume CMAI statistics generated from ORGANON were adjusted to approximate net volume CMAI and allow the OPTIONS modeling greater flexibility in harvest scheduling.

In Alternatives 1 and 2, the OPTIONS minimum harvest age was set at the 90% level of CMAI to give the model a reasonable level to vary from the estimated values. (See *Table R-20*)

For Alternative 3, minimum both partial harvest and regeneration harvest minimum harvest ages were established in the management action. (See *Table R-21*)

Table R-20. Forest Maturity Criteria: Proposed Minimum Harvest Ages At 90% CMAI By Species Group And Site (Productivity) Class

Species Group	Productivity Classes				
	SP5 (yrs)	SP4 (yrs)	SP3 (yrs)	SP2 (yrs)	SP1 (yrs)
NCM	110	105	95	95	85
NDF	110	95	85	85	75
NHM	95	95	85	80	80
SCH	155	120	110	110	110
SDF	140	120	110	105	100
SHW	155	120	110	110	110
SMC	155	120	110	110	110
STF	145	140	120	120	120
PP	140	115	115	115	115
SSCH	155	120	110	110	110
SSDF	140	120	110	105	100
SSHW	155	120	110	110	110
SSMC	155	120	110	110	110
SSTF	145	140	120	120	120
SPP	140	115	115	115	115
CNCM	130	110	95	90	85
CNDF	130	110	95	90	85
CNHM	130	110	95	90	85

Table R-21. Minimum Stand Treatment Ages For Partial And Regeneration Harvests (Alternative 3)

Zone	1st Partial Harvest	2nd Partial Harvest	3rd Partial Harvest	Regeneration Harvest
	Stand Age (yrs)	Stand Age (yrs)	Stand Age (yrs)	Stand Age (yrs)
Hemlock	120	240	0	360
Douglas fir	80	160	0	240
Tanoak	60	120	180	240

Modeling Thinnings

Commercial thinning modeling criteria were derived from two sources.

1. Simulation rules for management action for an alternative.

Example - Modeling "caps' were used to limit commercial thinning in Late- Successional Reserves to stands less than 80 years to simulate the plan requirement to only apply treatments that would promote the development of late-successional forest.

2. Growth and yield team's results for the ORGANON modeling of existing and future stands.

ORGANON modeling determined the timing, extent and number of treatments which were specific to modeling groups. The lower and upper treatment ages, treatment intensity and the number of treatments along with modeling criteria, targets and guidelines are documented under the Forest Growth and Yield Modeling section.

The Treatment Response approach allowed the OPTIONS model to adjust for the total growth in the thinned stand by modifying the growth rate (slope) of the Guide Curve for the untreated stand. The growth rate was adjusted such that the ORGANON modeled growth response of the treated stand, i.e. the increase in volume growth at the end of the treatment response period, was approximated within the OPTIONS modeling for that particular stand type and a specific thinning treatment. For use in the OPTIONS model, the commercial thinning treatment results, for each modeled combination of Species Group(s), Productivity Class(es) and thinning entry number (1st, 2nd, 3rd…) were subsequently analyzed to determine a "Treatment Response". Treatment Response Period was defined as 30 years or the number of years between modeled thinning entries, whichever was less.

Within the OPTIONS model, the thinning availability window was set in all alternatives to 5 years prior and 15 years after the ORGANON modeled treatment age for a specific stand type. If, within the OPTIONS model, a particular vegetation polygon was not thinned during a treatment window, the opportunity for the model to apply that specific commercial thinning treatment was foregone. If that particular stand was modeled for subsequent thinning treatments at older ages, it became available for treatment evaluation like any other stand regardless of whether the previous treatment was applied.

Before the OPTIONS model could apply a commercial thinning treatment to a particular stand, the current stand attributes were reviewed to ensure that the prescribed removal would meet the minimum per acre harvest targets. The minimum targets were – Salem Roseburg, Coos Bay – 8,000 board feet per acre, Eugene – 6,000 board feet per acre, Medford 4,000 board feet per acre, and Klamath Falls 2,000 board feet per acre. If the residual stand criteria could not be met, the stand would be left to grow and be re-evaluated in subsequent years as long as it remained within the treatment window or until the treatment was applied. Since all the existing stands were assigned an imputed stand attributes, not the average guide curve values, some lower-stocked stands which could not meet the minimum post-harvest criteria could be left to grow. Depending on the stand, the priority for commercial thinning in a particular alternative and the harvest related criteria described above, stands might or might not receive treatment.

Shelterwood Modeling

Shelterwood treatment areas were identified and mapped for the Medford District in areas with frost problems or granitic soils. Within these areas, all stands classified as Ponderosa pine Species Group were excluded from modeling under the Shelterwood Management Regime and modeled along with like stands according to the rules of the underlying general LUA.

Shelterwood regeneration harvest levels used in OPTIONS modeling were computed using the basal area difference between the existing stand pre- and the post-shelterwood treatment basal area levels. It was assumed that the ORGANON cycle 3 (15-year) residual stand basal area statistics approximated that of the post-shelterwood treatment stand.

Shelterwood treatments were modeled to occur approximately 30 years prior to 90% CMAI for Productivity Class 5 Species Groups and approximately 20 years for Productivity Classes 1- 4.

Shelterwood stands, for modeling purposes were stratified into separate age-based grouping: Young, Mature, Old and Very Old stands. (See *Table R-22*) These are identified with Species Group prefixes of S, M, O and V respectively (e.g. SSDF represents Young Southern Douglas-fir, MSDF for Mature, OSDF for Old and VSDF for Very Old). The partition of stands into these various modeling groups was based on initial ten-year age class and varies by Species Group – Site Productivity combinations.

Table R-22. Initial Age Criteria For Shelterwood

Shelterwood Species Group Age Criteria									
Species Group	Site Productivity Class	Maximum Group Age by Shelterwood Modeling Species Groups							
		Young		Mature		Old		Very Old	
PP	SP1	115	SSPP	200	MPP	285	OPP	370	VPP
PP	SP2	115	SSPP	200	MPP	285	OPP	370	VPP
PP	SP3	115	SSPP	200	MPP	285	OPP	370	VPP
PP	SP4	115	SSPP	200	MPP	285	OPP	370	VPP
PP	SP5	140	SSPP	220	MPP	300	OPP	380	VPP
SCH	SP1	110	SSCH	195	MSCH	285	OSCH	370	VSCH
SCH	SP2	110	SSCH	195	MSCH	285	OSCH	370	VSCH
SCH	SP3	110	SSCH	195	MSCH	285	OSCH	370	VSCH
SCH	SP4	120	SSCH	205	MSCH	285	OSCH	370	VSCH
SCH	SP5	155	SSCH	230	MSCH	305	OSCH	380	VSCH
SDF	SP1	100	SSDF	190	MSDF	280	OSDF	370	VSDF
SDF	SP2	105	SSDF	195	MSDF	280	OSDF	370	VSDF
SDF	SP3	110	SSDF	195	MSDF	285	OSDF	370	VSDF
SDF	SP4	120	SSDF	205	MSDF	285	OSDF	370	VSDF
SDF	SP5	140	SSDF	220	MSDF	300	OSDF	380	VSDF
SHW	SP1	110	SSHW	195	MSHW	285	OSHW	370	VSHW
SHW	SP2	110	SSHW	195	MSHW	285	OSHW	370	VSHW
SHW	SP3	110	SSHW	195	MSHW	285	OSHW	370	VSHW
SHW	SP4	120	SSHW	205	MSHW	285	OSHW	370	VSHW
SHW	SP5	155	SSHW	230	MSHW	305	OSHW	380	VSHW
SMC	SP1	110	SSMC	195	MSMC	285	OSMC	370	VSMC
SMC	SP2	110	SSMC	195	MSMC	285	OSMC	370	VSMC
SMC	SP3	110	SSMC	195	MSMC	285	OSMC	370	VSMC
SMC	SP4	120	SSMC	205	MSMC	285	OSMC	370	VSMC
SMC	SP5	155	SSMC	230	MSMC	305	OSMC	380	VSMC
STF	SP1	120	SSTF	205	MSTF	285	OSTF	370	VSTF
STF	SP2	120	SSTF	205	MSTF	285	OSTF	370	VSTF
STF	SP3	120	SSTF	205	MSTF	285	OSTF	370	VSTF
STF	SP4	140	SSTF	215	MSTF	295	OSTF	370	VSTF
STF	SP5	145	SSTF	225	MSTF	300	OSTF	380	VSTF

Uneven-Age Management Modeling

To facilitate OPTIONS modeling, stands in the Uneven Age Management Area were stratified into three separate Management Regimes; Young, Old and Future. (See *Table R-23*)

Uneven-age modeling was applied to the Uneven-Age Management Area land use allocation in the Medford District and to most of Klamath Falls Resource Area of the Lakeview District.

The sequence of 5 treatments was similar in all three OPTIONS Management Regimes and across all combinations of Species Group and Site Productivity classes. Harvest entries were modeled at 20, 30 or 50-year intervals, depending on Species Group, productivity level and stand type. The initial entry, at whatever age, might be best termed a Preparatory or Fuels Hazard Reduction treatment. The ORGANON modeling for this harvest entry focuses on thinning from below, concentrating on removal of smaller diameter trees. The second and third treatments are more traditional proportional commercial thinnings, removing trees across the range of diameters. The fourth treatment entry was, with a few exceptions, a non-commercial thinning entry for reducing the number of smaller, younger trees and potential fuel ladders. The fifth and final entry in this modeling sequence is another thinning entry which the OPTIONS model identifies as a Selection Harvest. After the Selection Harvest entry, both the Young and Old modeling groups shift to the Future stand Management Regime and follow another similar treatment sequence for the remainder of the modeling cycle.

Table R-23. Old Versus Young Age Class Thresholds By Site Productivity Level

Species Group	Old Versus Young Age Class Threshold by Site Productivity Level				
	SP5	SP4	SP3	SP2	SP1
	Age	Age	Age	Age	Age
SCH	200	130	130	130	n/a
SDF	200	200	200	130	130
SHW	200	130	130	n/a	n/a
SMC	200	130	130	130	130
STF	130	130	130	130	130
SPP	70	70	70	70	70

Harvest Priorities

Within the OPTIONS model the source of harvest volume could be prioritized by three categories of "Wood Type" defined and held constant across all alternatives.

- Older Forest – Regeneration harvest stands 200 years and older.
- Second Growth – Regeneration harvest of stands less than 200 years.
- Thinning – All thinning, intermediate, or partial harvests.

Within the model, Wood Types are assigned priorities 1 through 3, with 1 being the highest and 3 the lowest priority for harvest.

Within each Wood Type a lower and an upper harvest request limit can be designated.

An overall harvest volume is established in the Model as a maximum harvest level for any one year. The model will then attempt to satisfy the first priority Wood Type lower harvest request. Then do the same with the other two Wood Type priorities. After the lower harvest limits have been, to the extent possible, implemented across all three Wood Types, the model goes through the Wood Types by priority to satisfy any upper limit of harvest requests. If the upper harvest limit can not be satisfied in the first wood type priority then it proceeds to the next wood type priority until it attains the over all harvest level requested.

These lower and upper limits for each wood type can be modified for specific time periods of the projection.

These harvest priority controls can be used to control the rate of harvest in a particular Wood Type as well as balancing the levels of harvest across wood types.

Establishing Harvest Levels

The OPTIONS modeling projections occurred in increments of one year. Thus, all management objectives were maintained, and requested harvest levels met, in each year of the planning horizon. The planning horizon for all analyses was 100 years, although the final ASQ harvest level for each alternative was tested at 400 years to ensure its long-term sustainability. The sustainability analyses were subject to the same criteria as the 100 year analyses.

Harvest volume projections were based on the lands available for harvest, under the assumptions of the alternative within each sustained yield unit. Those lands which contribute to the ASQ can be managed over an extended period of time to provide a sustainable non declining level of harvest. Harvest from reserves (Late-Successional Reserves / Late Successional Management Areas and or Riparian Reserves / Riparian Management Areas) would diminish as stands grow past the conditions suitable for thinning and would not produce a sustainable harvest over time.

The sustainable harvest level from the land base supporting the ASQ was modeled separately from that harvest which can be derived from the reserves. Segregating the landbase and modeling of harvest volume in this manner isolated the interaction of these two types of allocations.

For ASQ lands, a non-declining even flow (NDEF) strategy was applied. Based on this approach a single maximum harvest level was modeled for the entire planning horizon and tested within a defined level of precision (increments of 1 million board feet, 0.1 for Klamath Falls). The exception to this approach was in the modeling of Alternative 3 where a future increase in the ASQ harvest levels were determined after landscape targets were achieved for an entire Sustained Yield Unit.

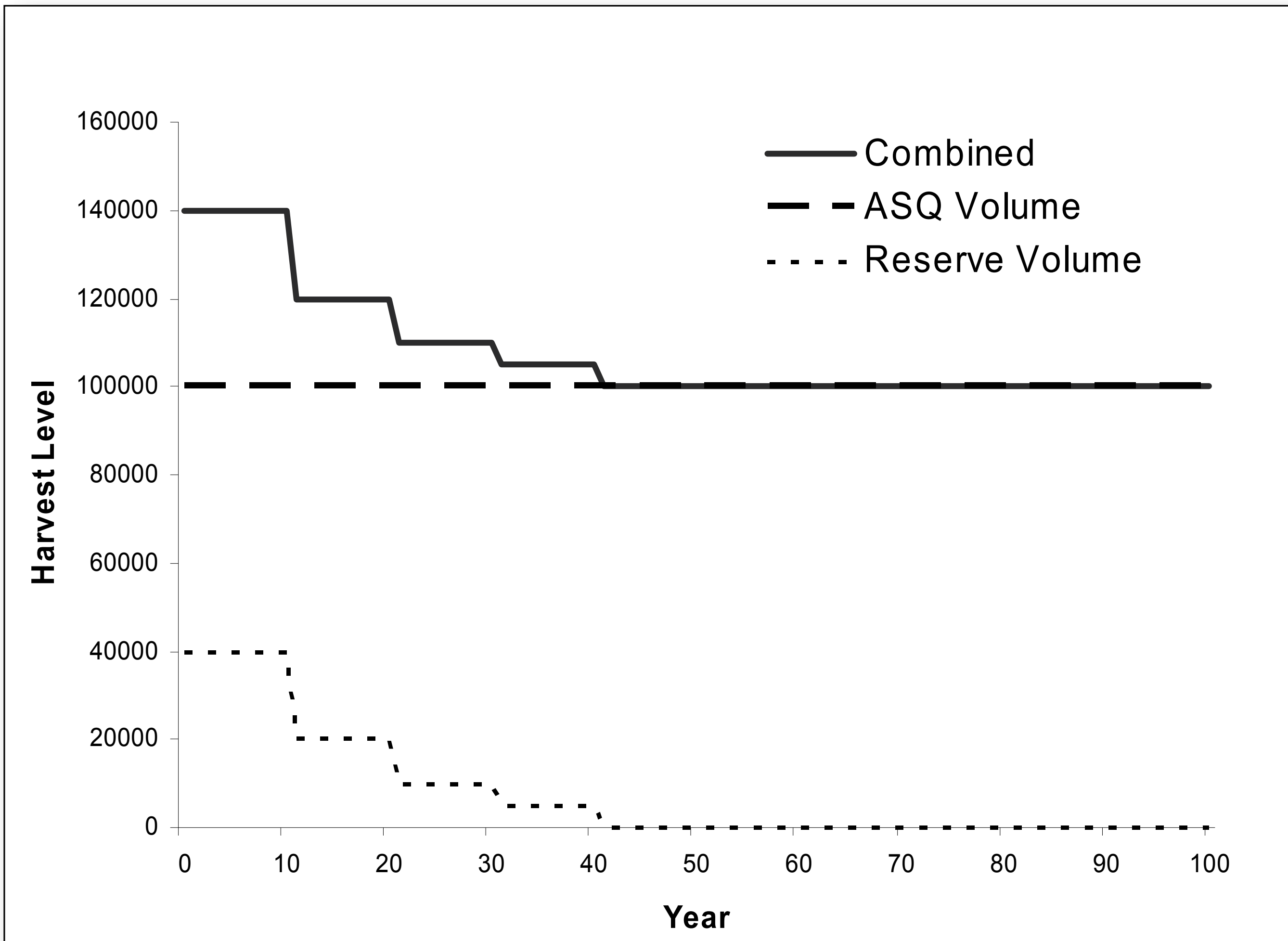
Generally, reserve lands permit limited management activities and thus have a limited period of availability. The NDEF strategy was not an appropriate method of modeling these areas so an uneven flow strategy was applied. Reserve lands only provided timber within the short-term (within the first 80 to 100 years, depending on the alternative), so a stair- stepped method was used to characterize and report partial harvest volume. With this approach a maximum harvest volume for each 10-year period was determined.

A combined ASQ and reserve land OPTIONS run was performed for the production of the Ten-Year Scenario, Northern Spotted Owl Habitat Projections, Structural Stage Projections and other post processing reporting. A maximum harvest level of the larger combined harvest landbase was not modeled. The total harvest volume modeled was the simple sum of the ASQ and reserve harvest volumes, although the reserve harvest volume amount was first reduced by 20% to approximate operational fall down. A maximum harvest volume level of the larger combined harvest levels landbase was not modeled. The overall thinning harvest level in terms of acres and volume matched the combined request but the proportions coming from inside and outside reserves was not controlled in the combined run. This appeared in Alternative 3 where a very small amount of riparian thinning (2 MMBF out of 473 MMBF total) was requested in the combined run but none if occurred in the riparian areas.

The sustainable harvest level for the PRMP was initially determined to be 523 MMBF. When the stands in the deferred timber management area became available for harvest, there was a high proportion of the volume coming from regeneration harvest of these stands and the thinning levels elsewhere were lower. The sustainable harvest level of 502 MMBF was established to maintain a balanced level of regeneration harvest and thinning over time.

Figure 22 is an example of non-declining ASQ harvest volume, stair-stepped reserve harvest volume and combined harvest volumes.

Figure R-22. Reserve, ASQ, And Total Volume



Creating Blended Yield Curves for Alternative 3

Alternative 3 included rules that excluded regeneration harvests until older forest retention target thresholds were achieved. Additionally, within each landscape unit intermediate harvests with high levels of green tree retention were permitted prior to achieve the landscape target levels of older forests. (See *Table R-24)*

In the other alternatives, yield curves were developed by the growth and yield team with the Organon model. However, the high retention levels of the intermediate harvests in Alternative 3 presented a modeling challenge for Organon. Investigation by the growth and yield specialists revealed that in the ORGANON model, it would be difficult to develop an appropriate set of tree data to represent the multi-storied character of the intermediate harvests. As an alternative, a simple mathematical approach was considered a suitable technique for developing the blended guide curves for the multi-storied stand conditions resulting from intermediate harvests. It was recognized that this approach did not account for the treatment, competition, or edge effects of the intermediate harvest. The blending process was applied to the Organon stand summary table for the OPTIONS analysis, and for the Organon detailed stand tables for use with the Northern Spotted Owl habitat index and structural stage classification.

This mathematical approach involved combining (or blending) the yield curve of the untreated portion of the stand with the yield curve of the treated portion of the stand. The blending technique apportioned basal area, volume and density based on the retention level of the intermediate harvest. Stand height and diameter were not blended. These attributes were based wholly on the yield curves for the treated portion of the stand.

Table R-25 provides an example of the pairing between the untreated overstory yield curve and the treated understory yield curve that resulted in a blended yield curve. The values represent the Current Vegetation Survey name prefix. A curve naming convention was established to identify the resulting blended yield curve based on the zone and treatment age. For example, the generation of the 1st intermediate harvest at age 120 for the Hemlock Zone would result in the blended curves shown in *Table R-25.*

For example, if the intermediate harvest retained 40% of the original stand, the blended curve would include

Table R-24. Stand Treatment Age And Percent Retention Used To Blend Yield Curves For Intermediate Harvests

Zone	1st Intermediate Harvest		2nd Intermediate Harvest		3rd Intermediate Harvest		4th Intermediate Harvest	
	Age	%	Age	%	Age	%	Age	%
Hemlock	120	35	240	35	0	0	0	0
Douglas-fir	80	19	160	19	240	19	0	0
Tanoak	60	35	120	35	180	35	240	35

Table R-25. Initial, Regeneration, And Resulting Blended Yield Curves

Overstory Curve	Understory Curve	Blended Curve
MG1_1_NCM_NONE	NDF_NO_OS_1_PCT260	ALT3_H120_MG1_1_NDF
MG1_2_NCM_NONE	NDF_NO_OS_2_PCT260	ALT3_H120_MG1_2_NDF
MG1_3_NCM_NONE	NDF_NO_OS_3_PCT260	ALT3_H120_MG1_3_NDF
MG1_4_NCM_NONE	NDF_NO_OS_4_PCT260	ALT3_H120_MG1_4_NDF
MG1_5_NCM_NONE	NDF_NO_OS_5_PCT260	ALT3_H120_MG1_5_NDF

40% of the stems from the original and 60% of the regenerated stand curve. The curves assigned to existing stands differed from curves assigned to recently regenerated areas to reflect current and/or future regenerations standards. In the model, the treated stand retains the age of the overstory which represents the initial age of the blended curve. Figure R-23 compares a stand's initial yield curve, the regeneration yield curve, the blended curve, and how a stand progresses from its initial curve to the blended curve. In the example shown in *Figure 23*, a stand receives an intermediate harvest at age 80. At the time of treatment, the stand supports a volume of approximately 70,000 board feet/ acre. Immediately after treatment, the stand retains its age of 80, and has a residual volume of approximately 15,000 board feet/acre, or approximately 22% of the original stand volume. After treatment, the stand is assigned to the blended yield curve and grows at the blended rate.

Within the various landscape units, multiple intermediate harvests were permitted, and for each possible intermediate harvest an additional blended yield curve was required. Blended curves were applied after intermediate harvest treatments. Where the blended curve of the first intermediate harvest was created from the initial curve combined with a regeneration curve, each successive treatment combined the previously blended curve with a regeneration curve. Once the landscape targets were achieved, stands were regeneration harvested and then assigned to an unblended regeneration curve. The blended curves extended to a stand age of 400 years. In OPTIONS, stands older than this were assigned the attributes of the 400 year old stand.

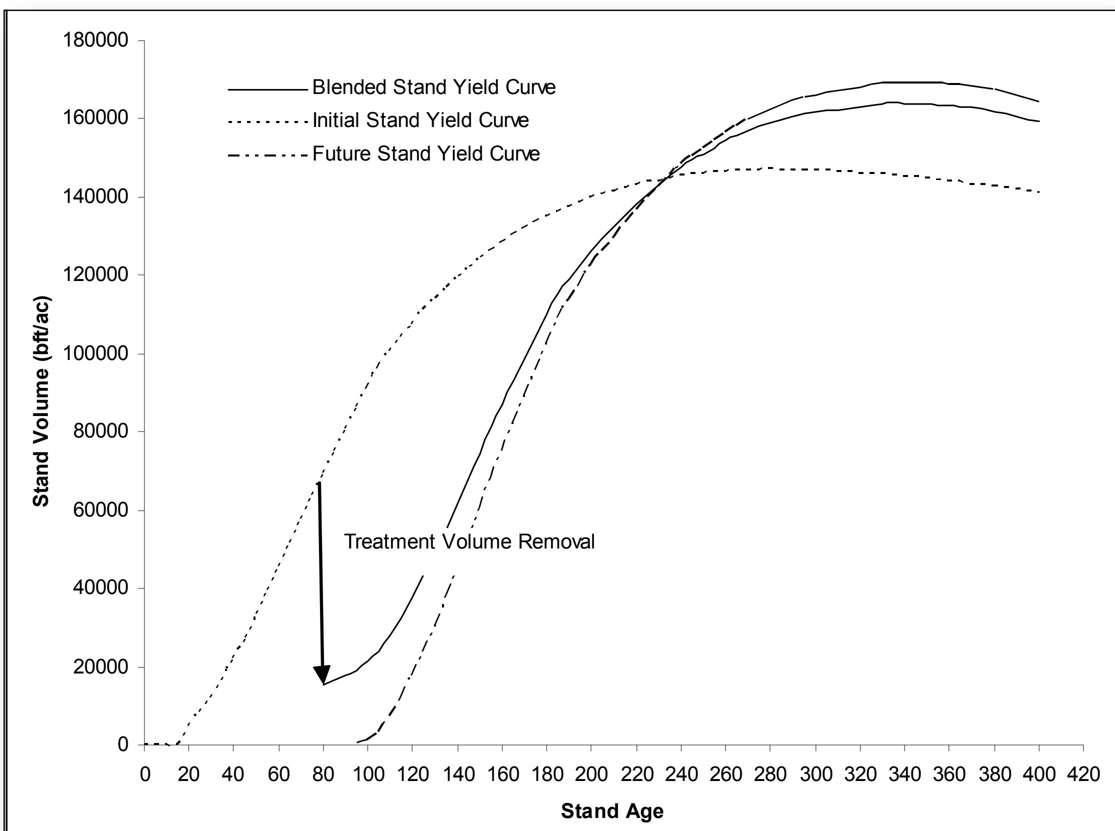


Figure R-23. A Comparison Of An Initial Yield Curve, The Regenerated (Future) Yield Curve And The Blended Curve

Alternative 3 Blended Curve Procedures

Create a blended curve for a stand within the Douglas-fir Zone (DF) with an intermediate harvest at age 80 years. This is the first intermediate harvest age and the green tree retention level is 19%.

Stand Summary Blending

1. Initialize the new blended yield curve with the stand characteristic from the overstory yield curve beginning at the blending age and continuing to the end of the projection horizon.

2. Incorporate the stand characteristics from the understory yield curve, matching the blended stand age with the initial understory age. In this example, the overstory stand characteristics at age 80 are matched with the stand characteristics of the understory at age 0.

3. Calculate the blended stand characteristics through the simple mathematical approach of summing the retention percent of the overstory stand and the remaining percent of the understory stand. In this example, 19% of the overstory stand is combined with 81% of the understory stand. This approach is applied to basal area, trees per acre and volume. Quadratic Mean Diameter (QMD) and height are re-set to the understory levels. Relative density (RD) is recalculated based on blended values for QMD and basal area.

Stand Table Blending

1. Initialize the new blended stand table with the overstory stand table values for each species and diameter beginning at the blended stand age and continuing to the end of the projection horizon.
2. Incorporate the stand table values from the understory stand table by species and diameter, matching the blended stand age with the initial understory age. In the case where there is no matching understory species and diameter, incorporate these additional stand table values into to the blended stand table.
3. Calculate the blended stand table values through the simple mathematical approach of summing the retention percent of the overstory stand with the remaining percent of the understory stand. This approach is applied to basal area, live trees per acre, dead trees per acre and board foot volume and cubic foot volume. Height is re-set to the understory value.

   In the case where there are only overstory stand values, the retention percent of the overstory stand values are used. In our example, 19% of the overstory stand values would be used.

OPTIONS Products

Introduction

The projection of forest conditions with OPTIONS is based on the model tracking the change over time for five basic attributes:

- Density – trees per acre
- Volume – board feet per acre
- Diameter
- Basal Area
- Height

The growth and yield curves coming from the ORGANON modeling can also be used as a source for forest attribute information since each OPTIONS polygon has a relationship with a growth curve.

Additional modeling was performed to create look up tables for the presence and absence of dead wood which could be related back to the OPTIONS projections.

Considering each alternative has between 400,000-600,000 polygons, each with 5 attributes, projected in annual increments for 200-400 years the potential data array from OPTIONS alone is considerable. Drawing data relationships from ORGANON or other models to derive forest attributes related to the OPTIONS projections increase that potential data to draw upon. Many of the outputs for the modeling required custom programming to extract and formulate the products for the ID team analysis.

Although OPTIONS performs projections in annual increments, only key projection reporting periods (0, 10, 20, 30, 40, 50, and 100 years) were established for the ID team analysis.

The following products from the OPTIONS modeling are described in this section.

- ASQ / NON ASQ Volume
- Ten-Year Scenario
- Projections
  - — Structural Stages Projection
  - — Northern Spotted Owl Habitat Projection.
  - — Age Projection
  - — Carbon Projection
  - — Large Wood Projections
  - — OPTIONS Projections – Technical Papers
- Economic Analysis Data
- Time Slice Report
- State of the Forest
- Net Down Report
- Attribute Data for GIS

ASQ / NON ASQ Volume

Harvest volumes are a direct output from the OPTIONS model. Volumes from OPTIONS for the plan revisions are based upon scribner16 foot short log volumes. Harvest volumes are based on the capabilities of the forest lands in each individual Sustained Yield Unit given the management action and allocations of the alternative. All volumes are rounded down to the nearest whole million board feet.

- **ASQ Volume** - ASQ is synonymous with the O&C Act term Annual Productive Capacity. For each alternative, the non declining even flow volume that can be sustained from the harvest land base is the basis for, determining the Allowable Sale Quantity. Under Alternative 3 a two tiered volume was reported to account for the increased harvest level that can be attained after the landscape targets are met (regeneration harvest begins) and the owl and murrelet sites are released, resulting in an increase in the size of the harvest land base
- **Non ASQ** – Thinning harvest is simulated for the Riparian Reserves / Riparian Management Areas and for the Late-Successional Reserves / Late Successional Management Areas as they apply to the alternatives. The management actions for these allocations do not permit regeneration harvest and there are modeling age caps on the thinning treatments, thus a sustainable source of harvest cannot be expected from these lands. The OPTIONS modeling determined the amount of harvest volume that could be produced from these lands and stepped down harvest levels as the stands aged and their thinning treatment windows closed.

The ASQ and Non ASQ volumes were recorded by SYU for each alternative and reference analyses. The duration of the Non ASQ volume and the long term increase in ASQ for Alternative 3 was summarized as well.

No ASQ was calculated with the OPTIONS model or declared for the East-side Forest Management Areas in Klamath Falls since there are no O&C lands in that area.

Ten-Year Scenario

The Ten-Year Scenario selects polygon records that were harvested in the first ten years of the OPTIONS projections. For each polygon, the acreage and volume harvested is reported by harvest type; regeneration, commercial thinning or selection. The OPTIONS Ten-Year Scenario report also identified a random 1/3 sample of BLM sections that were harvested in the first decade and identified all harvest units within those sections.

The OPTIONS output of the polygons harvested by harvest type with acreages and volume were brought back to GIS to make map products with these attributes. The Districts evaluated the harvest units in the sample sections to identify the logging system, and road construction needs.

The Ten-Year Scenario reports were produced for the No Action and all action alternatives. A database was created with the first decade polygons harvested, with acreage and volume by harvest type at the SYU and District level. This data was linked to the vegetation polygons to make GIS coverages and map products.

See the Timber Appendix for further description of the methodology of the Ten-Year scenario.

Projections

Post processing of the OPTIONS data created a classification of every OPTIONS vegetation polygon record at year 0, 10, 20, 30, 40, 50, and 100 years for the structural stage classification, Northern Spotted Owl habitat classification and age class distributions. Databases were created for the No Action, action alternatives, and reference analysis. This data was linked to the vegetation polygons in GIS for further spatial analysis.

1) Structural Stage Projections

The following structural stage classifications were used in the modeling:

1) Stand Establishment

1a.) Without Structural Legacies

1b.) With Structural Legacies

2) Young

2a.) Young High Density

2a1.) Without Structural Legacies

2a2.) With Structural Legacies

2b.) Young Low Density

2b1.) Without Structural Legacies

2b2.) With Structural Legacies

3) Mature

3a.) Single Canopy

3b.) Multiple Canopy

4) Structurally Complex

4a.) Existing Structurally Complex

4a1.) Existing Old Forest

4a2.) Existing Very Old Forest

4b.) Developed Structurally Complex

2) Northern Spotted Owl Habitat Projections

Three classes of habitat were determined based on diameter class, canopy cover, presence/ absence of snags (10 snags per hectare greater than 25 centimeters), presence / absence of down woody debris (greater than 2% ground cover).

The classification used in the Draft EIS was revised for the Final EIS as follows:

- Exception for size 11-20, canopy cover 60-100 for the Salem District only.
- Dispersal habitat that was in mature multi canopy or structurally complex structural stages were re-classified as suitable (tracked as code 2-ss).

Table R-26. Northern Spotted Owl Habitat Projections

Diameter Class (Inches)	Canopy Cover (%)	Snag Presence (p) / Absence (a)	Down Woody Debris Presence (p) / Absence (a)	Habitat Code Value[a]
[a]Habitat Code values: 1 - non-habitat, 2 - dispersal, 4 - suitable and dispersal (Finalized 10/18/2006)				
11-20	0-40	a	a	1
11-20	0-40	p	a	1
11-20	0-40	a	p	1
11-20	0-40	p	p	1
0-11	0-100	n/a	n/a	1
20-30	0-40	a	a	1
20-30	0-40	p	a	1
20-30	0-40	a	a	1
20-30	0-40	p	a	1
20-30	0-40	a	p	1
20-30	0-40	p	p	1
20-30	0-40	a	p	1
20-30	0-40	p	p	1
30-100	0-40	a	a	1
30-100	0-40	p	a	1
30-100	0-40	a	a	1

Diameter Class (Inches)	Canopy Cover (%)	Snag Presence (p) / Absence (a)	Down Woody Debris Presence (p) / Absence (a)	Habitat Code Value[a]
[a]Habitat Code values: 1 - non-habitat, 2 - dispersal, 4 - suitable and dispersal (Finalized 10/18/2006)				
30-100	0-40	p	a	1
30-100	0-40	a	p	1
30-100	0-40	p	p	1
30-100	0-40	a	p	1
30-100	0-40	p	p	1
11-20	40-60	a	a	2
11-20	40-60	p	a	2
11-20	40-60	a	p	2
11-20	60-100	a	a	2
11-20	60-100	p	a	2
20-30	40-60	a	a	2
20-30	40-60	p	a	2
20-30	40-60	a	a	2
20-30	40-60	a	p	2
20-30	60-100	a	a	2
20-30	60-100	a	a	2
30-100	40-60	a	a	2
30-100	40-60	p	a	2
30-100	40-60	a	a	2
30-100	40-60	p	a	2
30-100	60-100	a	a	2
30-100	60-100	a	a	2
11-20	40-60	p	p	2
11-20	60-100	a	p	4/2 Salem
11-20	60-100	p	p	4/2 Salem
20-30	40-60	p	a	2
20-30	40-60	p	p	2
20-30	40-60	a	p	2
20-30	60-100	p	a	4
20-30	60-100	p	a	4
20-30	60-100	a	p	4
20-30	60-100	p	p	4
30-100	40-60	a	p	2
30-100	40-60	p	p	2
30-100	60-100	p	a	4
30-100	60-100	a	p	4
20-30	40-60	p	p	4
20-30	60-100	a	p	4
20-30	60-100	p	p	4
30-100	40-60	a	p	4
30-100	40-60	p	p	4
30-100	60-100	p	a	4
30-100	60-100	p	p	4
30-100	60-100	a	p	4
30-100	60-100	p	p	4

3) Age Class Projections

Starting age classes derived from the Forest Operations Inventory (see inventory data section of this appendix) increment forward on an annual basis with the OPTIONS projections until regeneration harvest treatments reset the age. The stand ages under Alternative 3 should be treated as broad age groups since the yield curves and the progression of stands over time reflect multi storied stand conditions in which a single age does not well represent a multi storied stand.

4) Carbon Projections

The carbon sequestration projection forecasts the total-unit standing inventory volume of carbon within each forest stand at the reporting point (report date years 0, 10, 20, 30, 40, 50, 100)). This carbon volume (metric tonnes) is based on individual forest stand volume which reflects the management activities (treatments) scheduled in the OPTIONS model and the volume projections (ASQ and non-ASQ) derived from the ORGANON model. A series of factors are then applied to convert the stand volumes (per acre) to total carbon volume for each forest stand

See Appendix C, (Carbon Storage Modeling) for further details on the carbon projection.

5) Large Wood Projections

The Large Wood projection provides statistics for each forest stand on the number of stems, density, height and diameter of the live and standing dead trees by 10 inch diameter class for conifer and hardwood at each reporting point (0, 10, 20, 30, 40, 50, 100 years). The reports account for management activities and stand growth and mortality.

See Appendix J, (Fish) for further details on the large wood projections.

6) OPTIONS Projections (Technical Papers Spotted Owl Habitat / Structural Stage, Carbon, Large Wood)

Northern Spotted Owl (NSO) Habitat and Structural Stage Classification

ORGANON Stand Tables for NSO Habitat and Structural Stage Classification Data

The NSO dispersal habitat and structural stage classifications are based on a number of stand averages and stand table statistics. Stand height is an example of stand average information, the number of stems greater than a threshold diameter, or the number of snags of a particular decay class, are examples of stand table information. The OPTIONS model utilized and reports stand average data but did not provide the detailed stand table information required in the dispersal habitat and structural stage classifications. To project habitat and structural stage conditions throughout the planning horizon, ORGANON stand tables were required.

In the modeling environment, each WOPR unit may receive a number of possible treatment combinations throughout the planning horizon. The number of possible treatments varies by management regime (a series of treatments), species group, site productivity and alternative. The actual sequence of treatments a WOPR unit receives is a dynamic modeling process, dependent upon stand and landscape level targets and rules; it cannot be forecast outside of the OPTIONS model. However, it is possible to describe all possible combinations of treatments, and from this all inclusive set, select the actual scenario of treatments as reported by OPTIONS. Thus, an ORGANON stand table was created for each possible unique combination of treatment, species group and site productivity, for each management regime and for each alternative. A crosswalk table was defined to provide a reference between the treatment combinations and the corresponding stand table.

Modeling Process

There are a number of stand attributes to be considered in the habitat and structural stage classification for an individual WOPR unit, at a particular point in time. The ORGANON treatment stand tables were pre-processed, and then further analyzed to calculate specific habitat and structural stage statistics. These statistics, referred to as 'index values', are reference values in a look-up table; the Index Table. The index values for every modeling group, stand group, site index and treatment are stored in the Index Table.

One of the key steps in the pre-processing of the stand tables for northern spotted owl habitat classification was to generate index values for snags and down woody debris. The CWDM model was used to generate this information based on input from the stand table dead trees. Together, the stand tables and snag and downed woody debris information provided the detailed information necessary to complete the habitat. Information from the CWDM is also reported within the Index Table.

The OPTIONS model records for each WOPR unit and for all years in the planning horizon, all silvicultural and harvest treatments performed. Also recorded are details of the treatments such as: the area treated, the type of treatment, the volume removed, as well as stand attribute information after treatment. Based on this information it is possible to compile a complete history of activities for each WOPR unit for the entire planning horizon.

Based on the information from the WOPR unit activity history provided by OPTIONS, the appropriate stand table reference is identified in the crosswalk table. This stand table reference is used to locate the index values in the Index table that will be evaluated to define the NSO dispersal habitat and structural stage classification.

Methodology

The following methodology was applied to generate the NSO Habitat and Structural Stage Index Report.

Source Information

<u>NSO Dispersal Habitat Classification</u>

An NSO Dispersal Habitat definition table was used to define the stand conditions required to meet dispersal habitat. These included:

- Diameter Range– average stand diameter from summary table
- Canopy Closure – based on relative density as follows:
  Canopy Closure = -12.298 + 2.375(RD) – 0.014(RD)^2
- Snag presence: 10 snags/acre greater than 10”
- Down woody debris presence: 2% ground cover. The percent ground cover was approximated using a conversion factor and volume by retention plant zones
  (Volume (cu ft/ac)/X var = % cover) (see *Table R-27*)

Table R-27. Plant Zone and Down Woody Debris Volume

Retention Plant Zone	DWD Volume (ft3/ac)
Ponderosa Pine/Douglas Fir	362.648
Southwest Oregon conifer	465.179
Westside conifer	62.771

Note: TanOak and DF = SW Oregon, and W. hemlock = West side conifer
Note: Species Group of P. Pine for the p.pine/d.fir in SW Oregon

- Canopy (single/multi-story): A diameter diversity index (DDI) of 60 was used to determine the distinction between single and multi-story canopy, with single-story canopy having a DDI greater than 60 and multi-story canopy having a DDI less than or equal to 60.

Structural Stage Classification

Structural Stage Classification definitions were provided based on the following stand characteristics:

- Age: stand age from summary table
- Height: average stand height from summary table
- TPA: number of trees per acre by diameter from the stand table
- Relative Density: average stand relative density from the summary table
- Legacy Presence: the presence of legacy as an initial condition (based on MicroStorms structure stage classification) as well as the future creation of legacy based on alternative harvest prescriptions.
- CVgt(10): from summary table coefficient of variation of tree diameters greater than 10" dbh.

All Possible Treatment Yield Curve Crosswalk Table

This table (ACT2CVS_XWALK) identifies which treatment yield curve to use for the required stand characteristics and index values to determine the NSO Dispersal Habitat and Structural Stage Classifications. The treatment yield curve is identified based on the current alternative, management regime, species, site productivity class, and treatment age. Below is an example of the crosswalk table.

Index Value Lookup Table

This table, (INDX_LKUP) is an alternative-based lookup table containing projected stand characteristics and index values for each treatment yield curve. Some of the index values available include:

- Stand characteristics: age, basal area, TPA, QMD, height, volume, crown ratio, canopy closure, relative density, SDI, CV, DDI,
- TPA by 10" diameter classes: # of trees in 0" to 9", 10" to 19", 20" to 29", 30" to 39", greater than or equal to 40"
- Snags by 10" diameter classes: # of snag in 0" to 10", 11" to 20", 21" to 30", 31" to 40", greater than 40"
- Snag TPA: # of snags greater than 10" dbh
- CWD by 10" diameter classes: sum of volume in 0" to 10", 11" to 20", 21" to 30", 31" to 40", greater than 40"
- CWD vpa: sum of volume greater than 10"
- Calculated canopy closure: canopy closure calculated based on relative density
- Overstory stand characteristics: available for Alternative 3 blended curves, based on the untreated yield curve (basal area, tpa, qmd, height, volume relative density, tpa by 10" diameter class, CV, DDI)
- Understory stand characteristics: available for Alliterative 3 blended curves, based on the treated yield curve (basal area, tpa, qmd, height, volume relative density, tpa by 10" diameter class, CV, DDI)

OPTIONS Run Files

To post-process an OPTIONS run, the following OPTIONS run files are required:

- OPTIONS data files (.DBF, .DBS, .SPG, .SIC)
- OPTIONS run files (.DEF, .DEV, .RUN, .I, .II., .V)

Procedure

For each Alternative:

1. Using ORGANON, generate the possible treatment stand tables based on the Alternative's management regime definitions. Create the Crosswalk Table to identify which stand table to reference for a particular treatment combination.

2. Based on the Crosswalk Table, pre-process each treatment stand table to generate the index values that will be used to define the habitat and structural stage classifications. This includes projecting snag and CWD using stand table attributes. Create the Index Table to identify which index values to use for a particular treatment stand table.

3. Initialize a Habitat Report Table by listing for each WOPR unit the OPTIONS inventory values for forest type (forest, non-forest, road), initial management regime, species group, site productivity class and area.

For each forested WOPR unit in the Habitat Report Table:

4. Set initial conditions:
   - Initial Structural Stage and legacy (based on OPTIONS inventory structural stage)
   - Plant Series/Retention Zone (based on OPTIONS inventory)
   - NSO Variance: based on plant series, species group and habitat definition
   - Alternative 2 GTR (green tree retention) flag for MOCA and SHRUB areas

5. Based on the OPTIONS run results, build the WOPR unit Activity History Table including harvest activities and state of the forest years in chronological order. Also record the stand management regime, species group, site productivity and age at which these actives occur. This history table represents the changes in stand characteristics over time.

For each Activity in the Activity History:

6. Determine the current thinning treatment combination, partial harvest condition and legacy based on the type of activity completed.

   For Regeneration Harvest: reset thinning treatment combination, reset partial harvest conditions, re-evaluate legacy:
   - No Action Alternative (modeled tree retention), legacy is present (WL)
   - Alternative 1 (no modeled tree retention), then legacy is not present (WOL)
   - Alternative 2 (no modeled tree retention), then legacy is not present (WOL).
   - Alternative 2, MOCA and SHRUB area (modeled tree retention), then legacy is present (WL)
   - Alternative 3 (modeled tree retention), legacy is present (WL)
   - PRMP, area with GTR the legacy is present (Snag retention in LSMA –WL) otherwise legacy is not present (WOL)

   For Selection Harvest: reset thinning treatment combination, set partial harvest condition, re-evaluate legacy:
   - No Action Alternative, Alternative 1 and Alternative 2 there is no modeled selection harvest
   - Alternative 3 and PRMP has modeled selection harvest, so legacy is present (WL)

For Commercial Thinning: set thinning treatment combination based on thinning age and thinning sequence, no change to partial harvest condition or legacy.

7. Set activity stand table reference from Crosswalk Table based on the treatment combination.

8. Retrieve stand characteristics and index values from Index Table based on stand table reference.

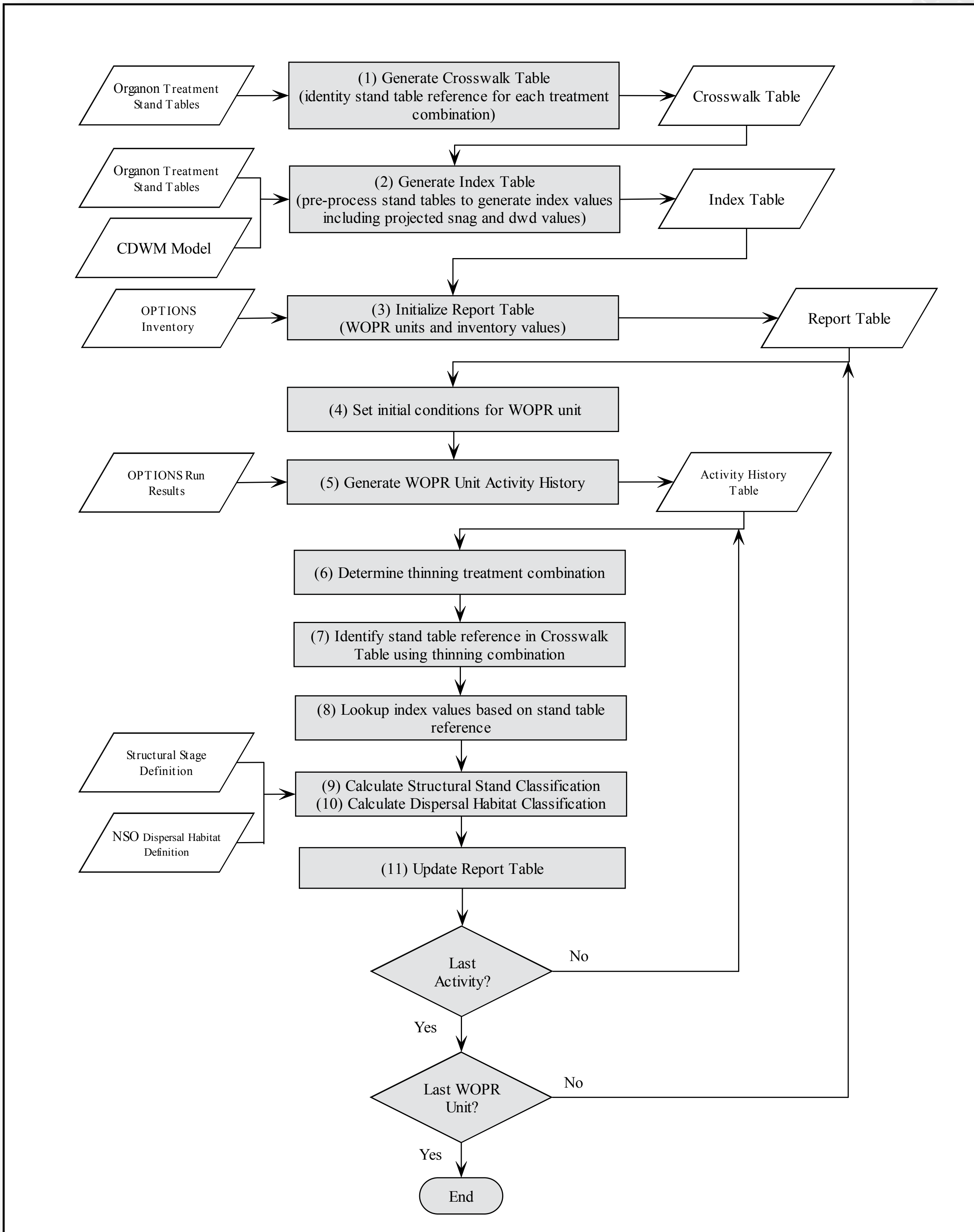
9. Calculate Structure Stage Classification based on index values and structural stage definition.
    - For Alternative 3 with partial harvest conditions, if height is <50' Structural Stage is based on understory values. Otherwise Structural Stage is based on stand values.
    - For Alternative 3 with partial harvest conditions, if Structural Stage is calculated as Mature-Single-Story, then canopy is reset to multi-story.

10. Calculate NSO Dispersal Habitat Classification based on index values and dispersal habitat definition.
    - For Alternative 3 with partial harvest conditions, canopy is set to multi- story. Otherwise, canopy is set based on DDI values.
    - The NSO Classification is then re-evaluated for Dispersal Classifications (class 2) that are within Mature Multiple Canopy or are Structurally Complex. These are re-classified as Dispersal with Structural Stage (class 2-SS)

11. Update Report Table with Structural Stage and NSO Dispersal Habitat Classification values for reporting years

See *Figure R-24* for a data flow diagram of this procedure.

Figure R-24. Data Flow Diagram For Owl Habitat And Structural Stage Classification



Carbon Sequestration Projection

The carbon sequestration projection forecasts the total-unit standing inventory volume of carbon within each WOPR unit at the reporting point (report date). This carbon volume (metric tonnes) is based on individual WOPR unit stand volume which reflects the management activities (treatments) scheduled in the OPTIONS model and the volume projections (ASQ and non-ASQ) derived from the ORGANON model. A series of factors are then applied to convert the stand volumes (per acre) to total carbon volume for each WOPR unit.

Modeling Process Overview

The calculation of total carbon volume requires information about the stand volume per acre, including both ASQ and non-ASQ species. However, because OPTIONS utilizes and reports stand information for ASQ species only, it was necessary to adopt a method to determine the total (ASQ and non-ASQ) stand volume for each WOPR unit at each reporting point.

In the OPTIONS model, each WOPR unit is uniquely managed based on the hierarchy of management assumptions and objectives. The application of these assumptions and objectives create a dynamic modeling process that affects the sequence and timing of stand level treatments, this sequence cannot be forecast outside of the OPTIONS model. However, based on the OPTIONS modeling framework it was possible to define the entire range of possible treatment combination based on modeling group, site index and treatment timing and intensity, which were then modeled in ORGANON to create stand tables with total stand volume (ASQ and non-ASQ species).

For modeling convenience this large set of ORGANON volume data was consolidated into a single Index Table that contained the volume information to represent every combination of modeling group, species group, site index and treatment timing and intensity. This volume information was expressed as the total board foot volume per acre unit. The per acre stand inventory volume was determined for each WOPR unit by reviewing the sequence of OPTIONS treatment details and then referring to the corresponding ORGANON volume data from the Index Table.

Board foot volumes were then converted to cubic foot volumes and then to dry wood weight by applying species sensitive conversion factors. An expansion factor was then applied to the dry wood weight to account for non-merchantable biomass including roots and branches. The dry wood weight was further converted to carbon volume and then multiplied by the WOPR unit area to derive a total carbon volume within the WOPR unit.

Methodology

The following methodology was applied to generate the Carbon Credit Report.

<u>Source Information</u>

Carbon Factor Lookup Table:

> A Carbon Factor Lookup table was provided that defines the board foot to cubic foot conversion factor by species. Also included in this table are various prices for carbon by cubic ton.

All Possible Treatment Yield Curve Crosswalk Table (ACT2CVS_XWALK):

> This table identifies which treatment yield curve to use for the required stand characteristics to calculate available carbon. The treatment yield curve is identified based on the current alternative, management regime, species, site productivity class, and treatment age.

Index Value Lookup Table (INDX_LKUP):

This table is an alternative-based lookup table containing projected stand characteristics and index values for each treatment yield curve. Some of the index values available include:

- Stand characteristics: age, basal area, TPA, QMD, height, total volume, crown ratio, canopy closure, relative density, SDI, CV, DDI,
- TPA by 10" diameter classes: # of trees in 0" to 9", 10" to 19", 20" to 29", 30" to 39", greater than or equal to 40"
- Snags by 10" diameter classes: # of snag in 0" to 10", 11" to 20", 21" to 30", 31" to 40", greater than 40"
- Snag TPA: # of snags greater than 10" dbh
- CWD by 10" diameter classes: sum of volume in 0" to 10", 11" to 20", 21" to 30", 31" to 40", greater than 40"
- CWD vpa: sum of volume greater than 10"
- Calculated canopy closure: canopy closure calculated based on relative density
- Overstory stand characteristics: available for Alternative 3 blended curves, based on the untreated yield curve (basal area, tpa, qmd, height, volume relative density, tpa by 10" diameter class, CV, DDI)
- Understory stand characteristics: available for Alliterative 3 blended curves, based on the treated yield curve (basal area, tpa, qmd, height, volume relative density, tpa by 10" diameter class, CV, DDI)

<u>OPTIONS Run Files</u>

To post-process an OPTIONS run, the following OPTIONS run files are required:
— OPTIONS data files (.DBF, .DBS, .SPG, .SIC)
— OPTIONS run files (.DEF, .DEV, .RUN, .I, .II., .V)

Procedure

<u>For each Alternative:</u>

1. Using Organon, generate the possible treatment stand tables based on the management direction for each Alternative. Create the Crosswalk Table to identify which stand table to reference for a particular treatment combination.
2. Based on the Crosswalk Table, pre-process each treatment stand table to generate the index values that will be used to define the habitat and structural stage classifications. This includes projecting snag and CWD using stand table attributes. Create the Index Table to identify which index values to use for a particular treatment stand table.
3. Initialize a Carbon Report Table by listing for each WOPR unit the OPTIONS inventory values for forest type (forest, non-forest, road), initial management regime, species group, site productivity class and area.

<u>For each forested WOPR unit in the Carbon Report Table:</u>

4. Set initial conditions:
   — Initial Structural Stage and legacy (based on OPTIONS inventory structural stage)
   — Plant Series/Retention Zone (based on OPTIONS inventory)
   — NSO Variance: based on plant series, species group and habitat definition
   — Alternative 2 GTR (green tree retention) flag for MOCA and SHRUB areas
5. Based on the OPTIONS run results, build the WOPR unit Activity History Table including harvest activities and state of the forest years in chronological order. Also record the stand management regime, species group, site productivity and age at which these actives occur. This history table represents the changes in stand characteristics over time.

<u>For each Activity in the Activity History:</u>

6. Determine the current thinning treatment combination, partial harvest condition and legacy based on the type of activity completed.

For Regeneration Harvest: reset thinning treatment combination, reset partial harvest conditions, re-evaluate legacy:

- No Action Alternative (modeled tree retention), legacy is present (WL)
- Alternative 1 (no modeled tree retention), then legacy is not present (WOL)
- Alternative 2 (no modeled tree retention), then legacy is not present (WOL).
- Alternative 2 – MOCA and SHRUB area (modeled tree retention), then legacy is present (WL)
- Alternative 3 (modeled tree retention), legacy is present (WL)
- PRMP area with GTR the legacy is present (Snag retention in LSMA –WL) otherwise legacy is not present (WOL)

For Selection Harvest: reset thinning treatment combination, set partial harvest condition, re-evaluate legacy:

- No Action Alternative, Alternative 1 and Alternative 2 there is no modeled selection harvest
- Alternative 3 and PRMP has modeled selection harvest, so legacy is present (WL)

For Commercial Thinning: set thinning treatment combination based on thinning age and thinning sequence, no change to partial harvest condition or legacy.

7. Set activity stand table reference from Crosswalk Table based on the treatment combination.
8. Retrieve stand characteristics and index values from Index Table based on stand table reference.
9. Calculate the total number of metric tons of carbon dioxide OPTIONS reports volume in board foot per acre. Convert this volume to merchantable cubic feet per acre. For this report, we used a factor of 6.00.

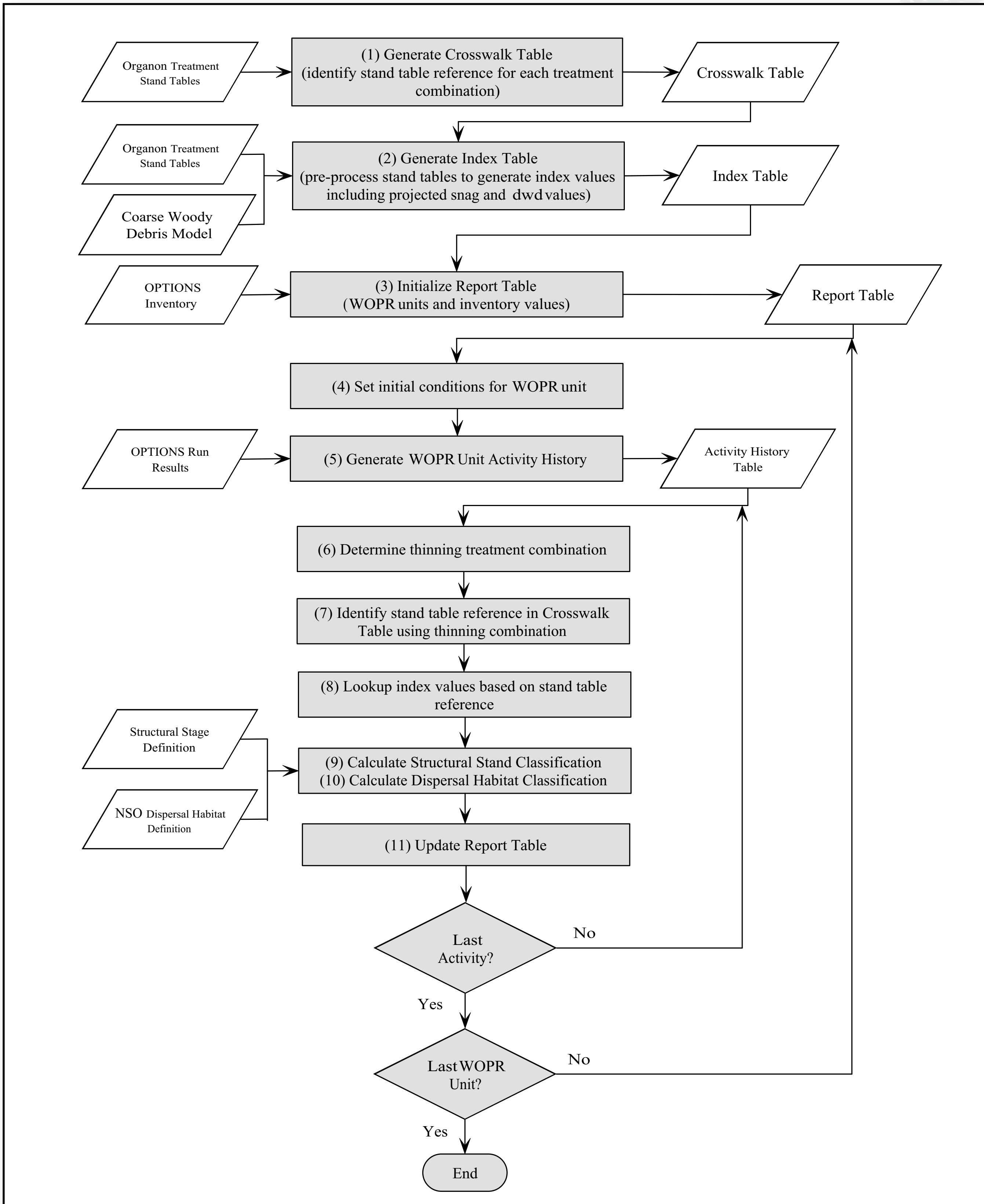
MERCH_CUFT = BDFT volume /6.00

A. Initialize the conversion factor (LBS_CUFT) for calculating the number of pounds of dry weight of a cubic foot of wood based on the species group. This conversion factor is located in the CARBON FACTOR Lookup table.
B. Calculate the number of pounds of dry weight (MERCH_LBS) per acre using the corresponding species conversion factor.
MERCH_LBS = MERCH_CUFT * LBS_CUFT
C. Calculate the total dry biomass in trees (TOT_LBS) per acre. The expansion factor is set to 1.85 for all units, meaning that total tree biomass (including tops and roots) is 1.85 times merchantable dry weight.
TOT_LBS = MERCH_LBS * 1.85
D. Calculate the number of pounds of carbon (LBS_C) per acre.
LBS_C = TOT_LBS * 0.50
E. Calculate the number of metric tons of carbon (TONS_C) per acre.
TONS_C = LBS_C / 2200.0
F. Calculate the number of metric tons of carbon dioxide (TONS_C02E) per acre.
TONS_CO2E = TONS_C * 3.667
G. Calculate the total number of metric tons of carbon dioxide
TOT_CO2E = TONS_C02E * unit area.

10. Update Report Table with carbon values for reporting years.

See *Figure R-25* for a data flow diagram of this procedure.

Figure R-25. Data Flow Diagram For Carbon Projection



Large Wood Projection

The Large Wood projection provides statistics for each forest stand (WPR_ID) on the number of stems, density, height and diameter of the live and standing dead trees by 10 inch diameter class for conifer and hardwood at each reporting point (report date). The reports account for management activities and stand growth and mortality.

Modeling Process

The Large Wood Report requires stand table information on live and dead trees by species type. The abundance of live and dead trees is sensitive to management activities. Detailed information about these activities is provided by WOPR unit from the OPTIONS model. However, since OPTIONS utilizes and reports stand average information, it was necessary to adopt a method to determine the stand table information for each WOPR unit at each reporting period.

In the OPTIONS model, each WOPR unit is uniquely managed based on the hierarchy of management assumptions and objectives. The application of these assumptions and objectives create a dynamic modeling process that affects the sequence and timing of stand level treatments, this sequence cannot be forecast outside of the OPTIONS model. However, based on the OPTIONS modeling framework it was possible to define the entire range of possible treatment combination based on modeling group, site index and treatment timing and intensity, which were modeled in ORGANON to create to create individual stand tables

For modeling convenience, this large set of ORGANON stand tables was consolidated into a single Index Table for every combination of modeling group, species group, site index and treatment timing and intensity. In creating the Large Wood Report this detailed stand table information for each WOPR unit was determined by reviewing the sequence of OPTIONS treatment details and then referring to the corresponding ORGANON data in the Index Table.

Methodology

The following methodology was applied to generate the Large Wood Analysis Report.

<u>Source Information:</u>

All Possible Treatment Yield Curve Crosswalk Table (ACT2CVS_XWALK)

> This table identifies which treatment yield curve to use to obtain the required stand characteristics and index values for the large wood analysis report. The treatment yield curve is identified based on the current alternative, management regime, species, site productivity class, and treatment age.

Index Value Lookup Table (INDX_LKUP)

> This table is an Alternative based lookup table containing projected stand characteristics and index values for each treatment yield curve. Some of the index values available include:
>
> — Stand characteristics: age, basal area, TPA, QMD, height, volume, crown ratio, canopy closure, relative density, SDI, CV, DDI,
>
> — TPA by 10” diameter classes for live and dead trees by Conifer and hardwood: # of trees in 0” to 9”, 10” to 19”, 20” to 29”, 30” to 39”, greater than or equal to 40”
>
> — Average height by 10” diameter classes for live and dead trees by Conifer and hardwood: weighed height by TPA in 0” to 10”, 11” to 20”, 21” to 30”, 31” to 40”, greater than 40”
>
> — Average diameter by 10” diameter classes for live and dead tree by conifer and hardwood: weighted diameter by TPA in 0” to 10”, 11” to 20”, 21” to 30”, 31” to 40”, greater than 40”

OPTIONS Run Files

To post-process an OPTIONS run, the following OPTIONS run files are required:
— OPTIONS data files (.DBF, .DBS, .SPG, .SIC)
— OPTIONS run files (.DEF, .DEV, .RUN, .I, .II., .V)

Procedure

For each Alternative:

1. Using Organon, generate the possible treatment stand tables based on the management direction for each alternative. Create the Crosswalk Table to identify which stand table to reference for a particular treatment combination.
2. Based on the Crosswalk Table, pre-process each treatment stand table to generate the index values that will be used to in the large wood analysis. Create the Index Table to identify which index values to use for a particular treatment stand table.
3. Initialize a Large Wood Report Table by listing for each WOPR unit the OPTIONS inventory values for forest type (forest, non-forest, road), initial management regime, species group, site productivity class and area.

For each forested WOPR unit in the Large Wood Report Table:

4. Set initial conditions:
   — Initial Structural Stage and legacy (based on OPTIONS inventory structural stage)
   — Plant Series/Retention Zone (based on OPTIONS inventory)
   — NSO Variance: based on plant series, species group and habitat definition
   — Alternative 2 GTR (green tree retention) flag for MOCA and SHRUB areas
5. Based on the OPTIONS run results, build the WOPR unit Activity History Table including harvest activities and state of the forest years in chronological order. Also record the stand management regime, species group, site productivity and age at which these actives occur. This history table represents the changes in stand characteristics over time.

For each Activity in the Activity History:

6. Determine the current thinning treatment combination, partial harvest condition and legacy based on the type of activity completed.

   For Regen Harvest: reset thinning treatment combination, reset partial harvest conditions, re-evaluate legacy:
   - No Action Alternative (modeled tree retention), legacy is present (WL)
   - Alternative 1 (no modeled tree retention), then legacy is not present (WOL)
   - Alternative 2 (no modeled tree retention), then legacy is not present (WOL).
   - Alternative 2 – MOCA and SHRUB area (modeled tree retention), then legacy is present (WL)
   - Alternative 3 (modeled tree retention), legacy is present (WL)
   - PRMP area with GTR the legacy is present (Snag retention in LSMA –WL) otherwise legacy is not present (WOL)

   For Selection Harvest: reset thinning treatment combination, set partial harvest condition, re-evaluate legacy:

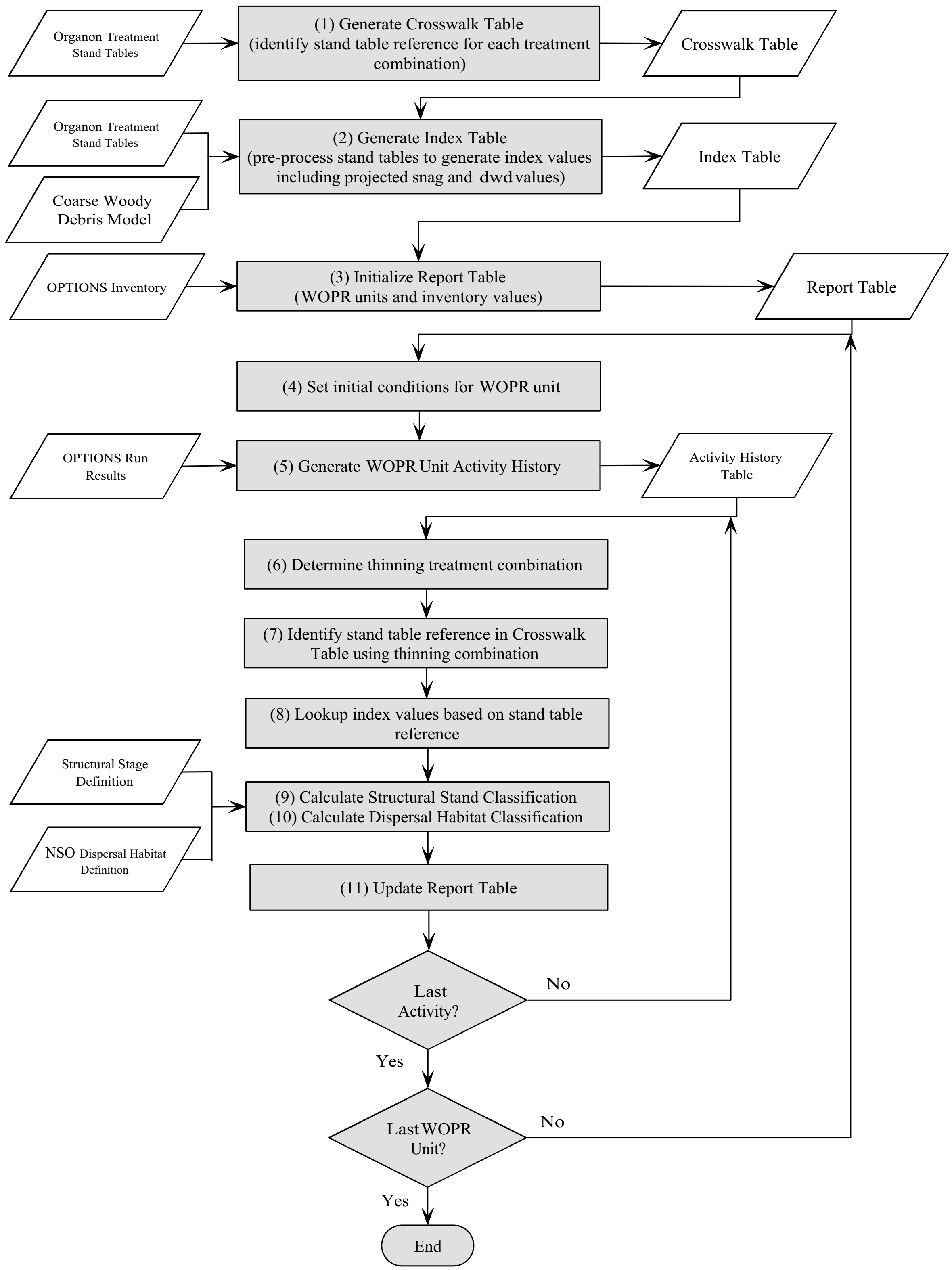
   - No Action Alternative, Alternative 1 and Alternative 2 there is no modeled selection harvest
   - Alternative 3 and PRMP has modeled selection harvest, so legacy is present (WL)

For Commercial Thinning: set thinning treatment combination based on thinning age and thinning sequence, no change to partial harvest condition or legacy.

7. Set activity stand table reference from Crosswalk Table based on the treatment combination.
8. Retrieve stand characteristics and index values from Index Table based on stand table reference.
9. Calculate Structure Stage Classification based on index values and structural stage definition.
   - For Alternative 3 with partial harvest conditions, if height is <50' Structural Stage is based on understory values. Otherwise Structural Stage is based on stand values.
   - For Alternative 3 with partial harvest conditions, if Structural Stage is calculated as Mature-Single-Story, then canopy is reset to multi-story.
10. Update Report Table with Structural Stage and stand table values such as TPA, average HT and DBH for live and dead trees by conifer and hardwood in 10" diameter classes for each reporting year

See *Figure R-26* for a data flow diagram of this procedure.

Figure R-26. Data Flow Diagram For Large Wood Projection



Economic Analysis Data

Two inputs were provided for post processing of the OPTIONS data for the calculation of timber harvest value.

- Costs necessary for harvesting were computed using an historical basis of timber sales from FY 1996 thru FY 2006 (part). Costs were brought to 2005 dollars and expressed in $/MBF. Thinning and partial harvest for Alternative 3 were separated from regeneration harvests and costs averaged by harvest method for each district. See Appendix E, Timber, for additional information.
- The weighted pond value was calculated for each district for each structural stage and harvest method. This weighted pond value included both a weighting for the level of expected species from each district and additionally weighted for grades expected from each structural stage. See Appendix E, Timber, for additional information

OPTIONS post processing produced a report by each SYU with the attributes listed below. This data is in excel spreadsheet by sustained yield unit for the No Action alternative, Action alternatives, and reference analyses.

- Projection year – Annual for first ten years.
- Harvest Land Base – distinguish ASQ from non ASQ volume sources.
- County, Name, Resource Area
- Harvest Type
- Volume in MBF 16' scribner for the action
- Weighted pond value of timber for action X (totvol)
- Average stump to truck cost - falling, yarding and loading, $/MBF X totvol Average road construction, improvement and renovation cost/MBF X totvol Average hauling cost to mill, $/MBF X totvol
- Average road maintenance and road use fees X totvol
- Average misc. cost, includes slash disposal, special requirements, etc X tot vol
- Sum (stump, roads, transport, maintain, misc.)
- Revenue-(tot cost), estimate of value of action, (Stumpage in MBF X tot vol)

Time Slice Report

For 10-year increments, spanning 200 years, this report summarizes the acres and volume harvested for the combination of data elements listed below.

- Sustained Yield Unit
- County
- Resource Area
- Harvest Land Base – Distinguish ASQ from Non ASQ volume
- Harvest type
- Ten-Year age class at time of treatment
- Treatment area
- Harvest volume

This report was generated for the No Action and Action Alternatives. The data is compiled in Access databases.

State of the Forest

The state of the forest contains the attributes tracked in OPTIONS for each vegetation polygon record at the time of the projections periods – year 0, 10, 20, 30, 40, 50, and 100. These attributes include

- Management regime
- Species group
- Volume
- Trees per acre
- Height Basal Area
- Harvest Land Base
- Age Class
- Sustained Yield Unit.

This report was generated for the No Action and action alternatives. The data is compiled in Access databases.

Attribute Data for GIS

A GIS input file was created for each alternative. This spatial analysis dissected the vegetation polygons by all of the GIS layers which formed an allocation, modeling rule, or reporting unit needed for the OPTIONS modeling. The OPTIONS data prep program utilized this GIS file to further classify and format the data for OPTIONS modeling. Harvest Land Base coding is an example for this reclassification of the data. The data from the OPTIONS data preparation program is returned to GIS so selected attributes can then be linked and used for subsequent spatial analysis. This provides a common data set used in both the OPTIONS analysis and the resulting GIS spatial analysis. Access databases with the data going to the OPTIONS model and data returned to GIS were generated for the No Action and action alternatives.

Vegetation Modeling Team Members

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