Appendix H
Report: Marbled Murrelet Habitat Mapping and Validation

H.1. BACKGROUND

H.1.1. Introduction

The Oregon Department of Forestry (ODF) Habitat Conservation Plan (HCP) for the northern spotted owl and marbled murrelet on the Elliott State Forest was approved by the U.S. Fish and Wildlife Service (USFWS) in 1995. The Incidental Take Permit (ITP) issued to the ODF for the marbled murrelet was for six years; that permit expired in 2001. The ODF is interested in re-establishing the marbled murrelet as a covered species in the HCP.

In the 1995 HCP, suitable marbled murrelet habitat was defined as stands 100 years old and older. Before any timber harvest operations were planned, all stands at least 100 years old were ranked as “low quality,” “medium quality,” or “high quality” habitat; these designations were based on a field survey on the characteristics of marbled murrelet habitat.

Hamer Environmental was contracted to test and validate the habitat rating procedure described in the HCP. Hamer Environmental found that, while the rating procedure correctly predicted occupied stands, it was not accurate in predicting unoccupied stands. Thus, Hamer Environmental developed a simpler, more accurate habitat rating strategy using a standardized, repeatable, reliable field method of measuring habitat conditions on the Elliott State Forest (Hamer and Meekins 1996). This alternative strategy used transects covering 10 percent of the stand area to collect data on only two variables: number of platforms and percent slope. A logistic regression model was then developed using these data to rate stands as having either a low, medium, or high probability of occupancy. One limitation of this model is that it was based on only a portion of stands in the Elliott State Forest, and these stands were not randomly selected. Nevertheless, this alternative procedure was adopted for rating the probability of occupancy by marbled murrelets in stands 100 years old and older on the Elliott State Forest.

The ODF would like to develop a method of identifying marbled murrelet habitat that focuses on structure rather than age, and that does not require application on an operational basis. Marbled murrelet surveys and research on the characteristics of marbled murrelet habitat on state forest lands in the Oregon Coast range (Nelson and Wilson 2002) have shown that marbled murrelets may use stands younger than 100 years old if they contain the appropriate nesting structure, and that stands greater than 100 years old may not contain nesting structures. By using age to define suitable habitat, some important habitats may be overlooked, and stands without nesting structure may be considered suitable habitat based on age alone.

The method chosen involved the use of aerial photos to identify areas of the forest containing potentially suitable marbled murrelet nesting structures. This method focused on stand structural characteristics that are visible from aerial photos; because it did not require field surveys, all habitat could be identified at once rather than on an operational basis.

H.1.2. Marbled Murrelet Habitat Delineation

Two persons from Hamer Environmental and Bob Fields and Norma Kline with ODF, identified potential marbled murrelet habitat by analyzing orthophotos and aerial photos for areas that appeared to contain suitable structures for marbled murrelets. This exercise was performed in 2002, using orthophotos constructed from a orthophoto flight in 1996 as the base layer and stereo pairs of aerial photos (2001) for verifying questionable areas. This mapping project utilized Bob's and Norma's knowledge of the Elliott State Forest and skills in interpreting textural differences on aerial photos. Marbled murrelets nest on large branches, which are typically associated with large trees, and which in turn can be identified on aerial photos by their height and crown spread.

Bob has worked as a forester on the Elliott State Forest since 1976. Since 1992, he has been the district contact for marbled murrelet survey projects and habitat research. In this role, Bob assessed habitat on the forest for the need to conduct marbled murrelet surveys, conducted such surveys, located nesting areas for marbled murrelets, and assisted researchers Tom Hamer and Kim Nelson with their Elliott State Forest marbled murrelet research projects. Norma has worked as a forester on the Elliott State Forest since 1996. Because her knowledge of marbled murrelets on the forest is less extensive than Bob's, she utilized a different perspective in observing the forest. Both foresters examined orthophotos for the entire forest, and drew polygons designating the suitable habitat directly on the photos. They digitized the results into the ArcView geographic information system.

After the initial mapping exercise, the resulting habitat layer was refined. Mapped habitat that was within the boundaries of sold timber sales was deleted. Habitat polygons were cross-checked with stand age, polygons in stands less than 65 years old were rechecked on aerial photos, and stand data were examined for any noted residual trees. Stands without evidence of residual trees were deleted from the habitat layer.[1] The orthophotos tended to have reduced resolution, particularly around the edges. The orthophotos were examined for any polygons located in these "fuzzy" areas. The polygons were then rechecked on the aerial photos, and any polygons that did not appear to have marbled murrelet structures in the aerial photos were deleted from the habitat layer. Polygons less than five acres also were reexamined on the aerial photos. If appropriate, these slivers were connected with adjacent polygons of habitat. Otherwise, most of the polygons were redrawn to include at least five acres around the habitat patch. Finally, all of the corrections were double checked for accuracy. Figure H-1 shows the resulting mapped marbled murrelet habitat on the Elliott State Forest. There are a total of 662 polygons of mapped habitat (17,381acres).[2] The average polygon size is 29 acres, with a minimum of 2 acres, and a maximum of 665 acres.

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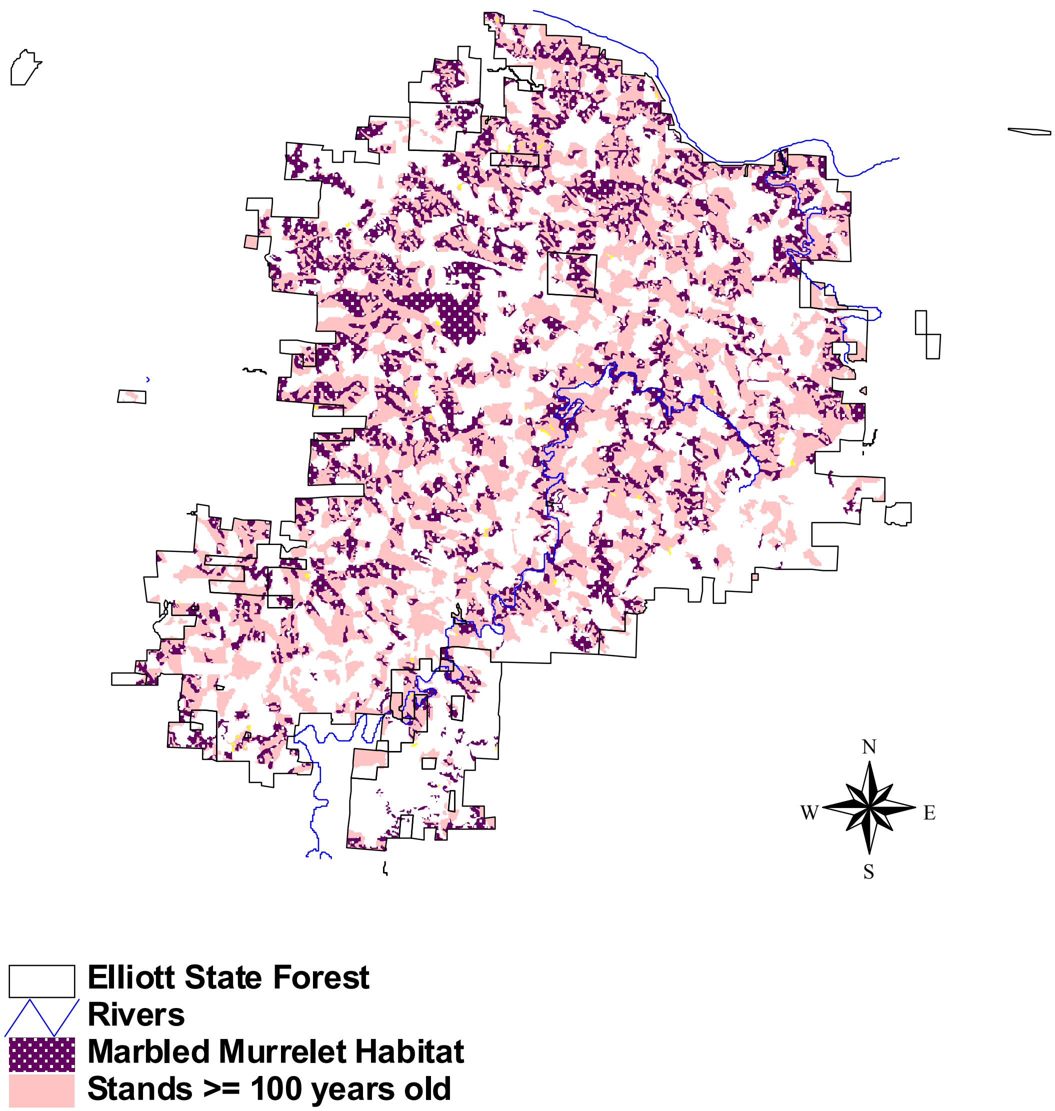
[1] Although the majority of occupied stands on the Elliott State Forest are over 100 years old, subcanopy behaviors have been observed in stands as young as 70 years, and in younger stands elsewhere. Because of the age structure of the Elliott, 65 years was considered a reasonable minimum age for finding occupied stands on the Elliott State Forest.

[2] This acreage has since been updated to be consistent with the current condition of the forest, and to account for habitat that has been harvested since the 1996 orthophotos.

Figure 1. Mapped marbled murrelet habitat on the Elliott State Forest and stands at least 100 years old.



H.2. METHODS

H.2.1. Study Design Overview

A study was designed and implemented to determine whether the marbled murrelet habitat layer resulting from the mapping exercise is an adequate representation of suitable marbled murrelet nesting habitat on the Elliott State Forest. The study compared vegetation characteristics associated with marbled murrelet occupancy or nesting (such as platform density and moss cover) in the mapped polygons ("mapped") to those same characteristics in known occupied stands ("occupied") and in mature stands (more than 65 years old) that were not mapped as habitat ("unmapped"). This was designed to demonstrate that characteristics in the mapped habitat were similar to the same characteristics in the occupied stands, and that the characteristics differed between mapped habitat and unmapped stands.

The study involved several steps:

1. Determining an adequate number of stands to sample such that differences could be detected. The assumptions and calculation are described in Section H.2.2, "Sample Size."

2. Ensuring that enough stands were available in each habitat type for an adequate sample. Although a sufficient number of mapped polygons and unmapped stands were available from which to draw a sample, the number of known occupied stands was not adequate for the required sample size. For this reason, additional marbled murrelet surveys were conducted in an effort to locate more occupied sites. These surveys are described in more detail in Section H.2.3, "Additional Marbled Murrelet Surveys."

3. Devising a sampling scheme for the collection of habitat data in the three habitat types. The design of this sampling is described in Section H.2.5, "Plot Selection."

Results from the data collection and analysis are described in Section H.3, "Results." Lisa Ganio, a consulting statistician, was consulted in the study design and analysis of results.

H.2.2. Sample Size

A sample size estimate was calculated using the following formula:

$$\eta = (Z_{\alpha/2} + Z_{\beta})^2 s^2 / (\mu_A - \mu_0)^2$$

where Z is the Z-statistic, α is the Type I error rate, β is the Type II error rate, s^2 is an estimate of the population variance, and μ_A-μ_0 is the effect size.

The calculation for sample size used the population variance for the mean number of platforms from Kim Nelson's research on state forest lands, including the Elliott State Forest (Nelson and Wilson 2002). Nelson collected data on variables, including platform density in 25-meter-radius (0.49-acre) plots centered on nest trees, and randomly selected trees without nests. One of the findings from this study was the significant difference between the mean number of platforms in nest and non-nest plots, at p less than 0.0001. The mean number of platforms in nest plots was 112.8 [Standard Error (SE) equals 13.8, number of samples (n) equals 32], and the mean number of platforms in non-nest plots was 61.8 (SE equals 6.0; n equals 131). The population variance for the mean number of platforms in nest plots was 78.

We made the following assumptions for the other variables for the calculation of sample size: a Type I error rate of 0.05, a Type II error rate of 0.2, and an effect size of 30. The sample size estimate using these numbers was 53. That is, detecting a difference of 30 or more platforms among habitat types, with only a 5 percent chance of finding a difference that does not exist (Type I error) and a 20 percent chance of missing an effect that does exist (Type II error), given a population variance of 78, would require that 53 plots be sampled per habitat type (mapped, occupied, and unmapped), for a total of 159 plots sampled.

Of the three habitat types, there are 610 polygons of mapped habitat, 1,138 polygons of stands aged at least 65 years that were not mapped, and 50 polygons representing occupied stands (see Figure H-1).

H.2.3. Additional Marbled Murrelet Surveys

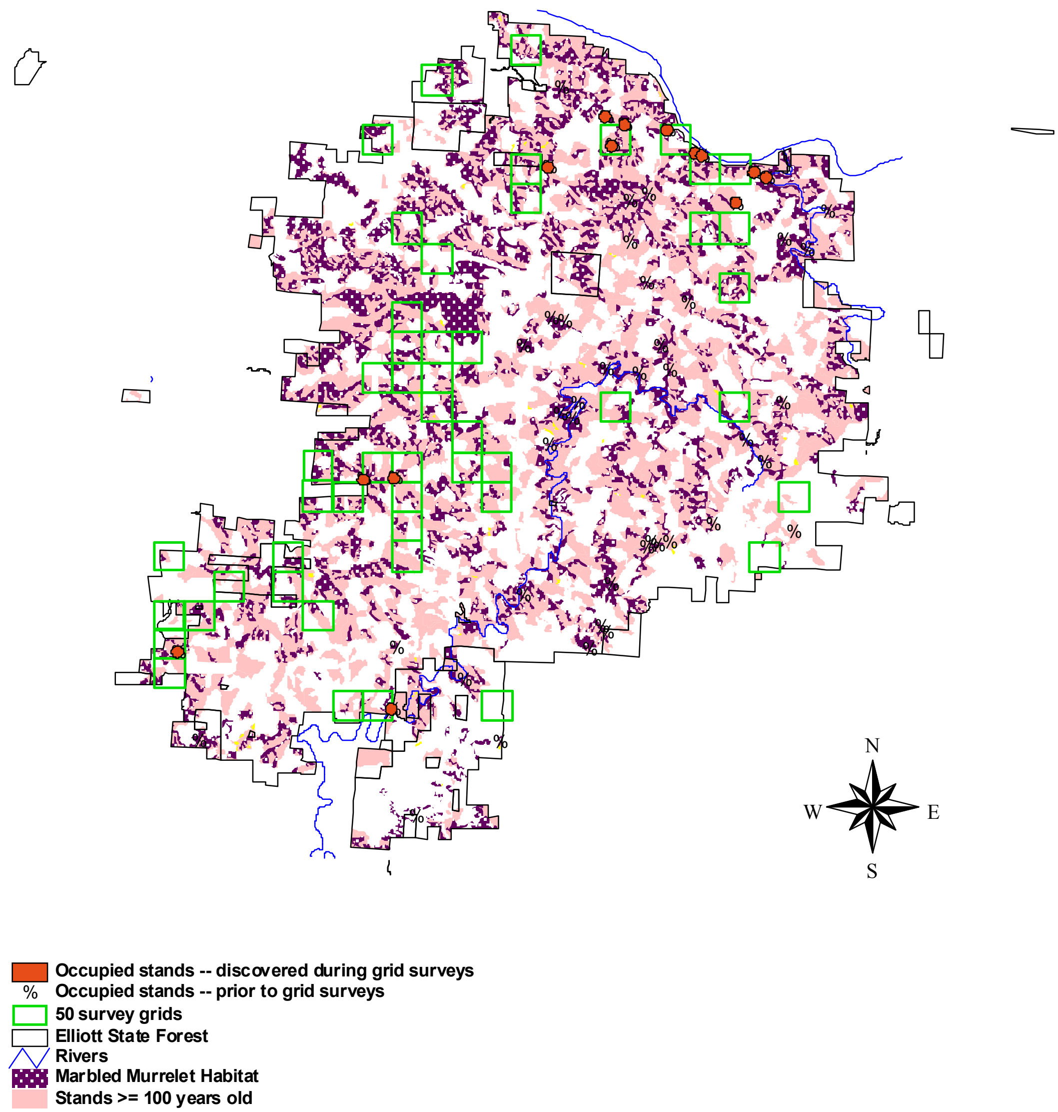
At the beginning of this study, the locations of 50 occupied stands for marbled murrelets were known. These stands were discovered as a result of surveys conducted between 1992 and 1995, and beginning again in 1999 to 2001. Most of these surveys were performed in timber sale areas, although some were conducted for research purposes. During that period, few timber sales were planned in the western management basins on the forest, where northern spotted owls were resident. As a result, timber sale activity, and thus survey effort, was concentrated in the eastern management basins, and most of the known occupied marbled murrelet stands are located in this part of the forest.

Based on the sample size calculation, this number of known occupied sites was not sufficient for the study. In addition, the locations of these sites were biased to certain parts of the forest. Marbled murrelet surveys were planned to locate additional occupied sites that were more representative of the forest as a whole. This was accomplished by a random selection of survey sites. First, a grid of the forest was created, using a 240-acre cell size. This size was selected because it could be covered efficiently in a general habitat survey. Grid cells meeting the following criteria were eliminated from the sample pool:

- Cells containing sold sales or within one-quarter mile of sold sales. This was a necessary practical consideration to avoid potential disturbance from sale operations, conflicts with marbled murrelet surveys for timber sales, and potential contractual conflicts with the sales.
- Cells already containing an occupied stand.

A total of 50 grid cells were randomly selected for survey from the resulting pool of grid cells. This was the highest number of cells that could be surveyed within the financial constraints. Figure H-2 shows the location of the randomly selected grid cells.

Figure 2. Location of 50 survey grids and occupied stands before and after grid surveys.



Professionally trained and certified surveyors conducted the marbled murrelet surveys (Turnstone Environmental 2002) using the 2000 version the Inland Survey Protocol (Evans et al. 2000) as a guideline. Survey stations were established and mapped in sufficient number to adequately cover potentially suitable habitat within each grid.

Because the objective of the surveys was to locate as many occupied sites as possible, rather than to establish probable absence of marbled murrelets in an area, the survey methodology employed for this study differed from the inland survey protocol. Both general and intensive surveys were used in an effort to observe the marbled murrelet interacting with its nesting habitat. General surveys were used at the start of the field season to survey larger tracts of suitable habitat. All grid cells received at least one general survey, conducted between June 16 and July 5. (Previous surveys have indicated that over 80 percent of detections on the Elliott State Forest have occurred after June 16.) In some cases, general surveys were repeated to obtain additional information for a future intensive survey.

Once marbled murrelet presence was established using the general surveys, intensive surveys were used to gather more site-specific information. Not all grid cells received intensive surveys. Intensive surveys were conducted between July 1 and July 31 at or near the location of the detections recorded during the general survey. Multiple intensive surveys were conducted in grids with high activity levels. In addition, five new survey areas were added when surveyors observed occupied behaviors adjacent to the selected grid cells. Surveyors re-evaluated their locations on a daily basis, and modified subsequent survey locations based on the area of the last detections. Surveyors continued to monitor high activity grids until occupied behavior was observed in site-specific stands.

Surveyors recorded significant detections in ten of the 50 grid cells. Presence was only detected at an additional 14 grids. Detections from established grids and areas adjacent to the established grids were analyzed, identified ten new occupied stands were identified.

Survey methods and results are described in more detail in *Marbled Murrelet Surveys for the Elliott State Forest Habitat Conservation Plan, Final Report* by Turnstone Environmental Consultants, Inc. (2002).

H.2.4. Delineating Occupied Stands

Once all of the occupied stands were identified, these areas were required to be mapped and then excluded from the selection pool for the mapped and unmapped plots. The following process was used to map the occupied stands to exclude from the selection pool.

All Marbled Murrelet Management Areas (MMMAs) were excluded from the selection pool for mapped and unmapped habitat. MMMAs are areas designated by the ODF and the Oregon Department of Fish and Wildlife for the protection of marbled murrelets, and include occupied stands discovered prior to 2001.

For occupied sites discovered during the additional surveys described above, 645-foot-radius circles (30 acres) were delineated around the point identified as the center of marbled murrelet activity. Thirty acres is the maximum field survey coverage that can be accomplished from one point (station) according to the inland survey protocol. These 30-acre circles also were excluded from the selection pool for mapped and unmapped habitat.

H.2.5. Plot Selection

H.2.5.1. Plot Selection for Mapped and Unmapped Habitat

A one-half-acre grid was created on the forest and associated with a sequentially numbered table. Grid cells were selected randomly and assigned as locations for mapped or unmapped plots according to which type made up the majority of the cell (before all categories filled), or according to which category had not been filled. If the selected random cell was located entirely in a MMMA or occupied habitat circle, or entirely in a polygon not falling in any of these categories (i.e., "non-habitat" [age less than 65]), it was thrown out and replaced by the next number on the list. These steps were repeated until 53 cells were selected in each of the mapped and unmapped populations.

After random cells were selected, the plot point was placed within the habitat type assigned for the cell. The plot points were located in the center of the cell if that represented the habitat type assigned to the cell, or in the center of the habitat type. Points were moved to avoid known obstacles, such as a road intersection or the face of a cliff. Data in each plot were collected from entirely within the designated habitat type. Figure H-3 shows the location of all 159 plots sampled in the forest.

H.2.5.2. Plot Selection for Occupied Habitat

For occupied stands, an effort was made to locate the plot center as near as possible to probable nest locations. There were seven known nest tree locations on the Elliott State Forest. However, for the most part, actual nest locations were not known. When nest locations were not known, data from surveys were used to estimate probable nest locations from evidence of marbled murrelet interaction with a stand. The plot location was determined using one of the three methods listed below. Bracketed figures indicate the number of plot centers identified using that specific method. Table H-1 lists all occupied plots selected, the method used for plot selection, the basis for the plot location, and the date of the observations.

- Method 1 involved locating plots at or in near proximity of known nest trees (NEST) discovered during tree climbing projects conducted by the Oregon Cooperative Fish and Wildlife Research Unit (Nelson and Wilson 2002).
- Method 2 involved selecting the plot center based on the best estimate of the center of the marbled murrelet activity from the results of the 2001 additional surveys. A group consisting of ODF biologists, contract administrators, and surveyors (GROUP) evaluated the results from the general and intensive surveys (described in Section F.2.3 above), and selected the plot center.
- Method 3 involved locating plots based on marbled murrelet detection data recorded during marbled murrelet surveys conducted between 1992 and 2001 in timber sale units.

Figure 3. Location of 159 vegetation sampling plots by type.

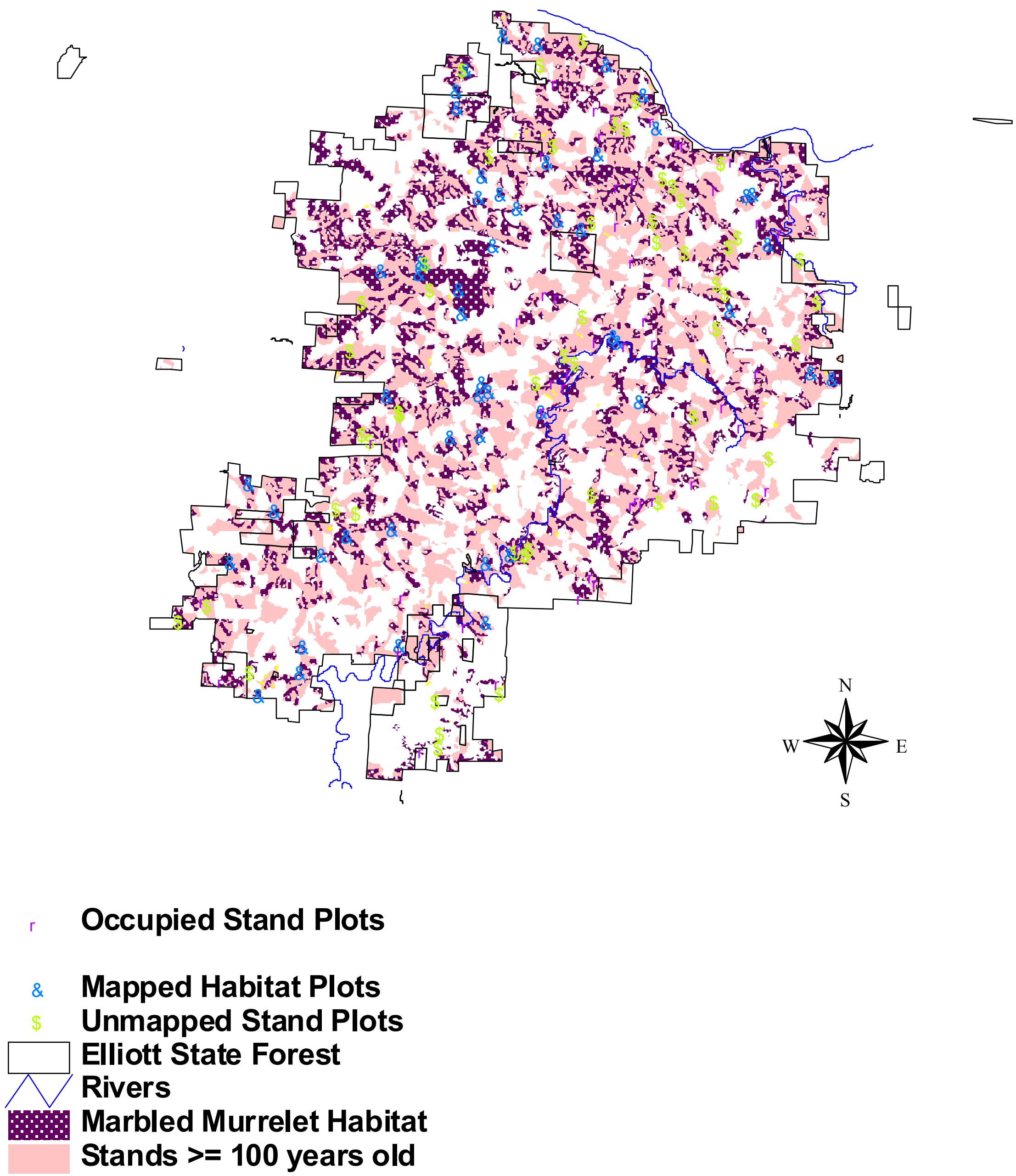


Table H-1
Occupied Plots, Method Used for Plot Selection, and Information Used to Establish Plot Location

Plot #	Method	Plot Location	Location Name	Site	Station	Date
Plot 107	3	Personal Comm.	Fish Ridge No. 2	1	5	19930623
Plot 108	3	Station	Charlotte Luder	1	4	19930712
Plot 109	3	Personal Observ.	Elk Pass No. 3	1	5	19930713
Plot 110	3	Personal Observ.	Slingshot Ridge	1	3	19930716
Plot 111	3	Personal Comm.	Beaver Creek No. 2	1	4A	19930720
Plot 112	3	Personal Observ.	West Fork Glenn Creek No. 3	1	5	19930725
Plot 113	3	Station	Johanneson Creek No. 1	1	3	19940731
Plot 114	3	Station	Charlotte Luder	2	7	19920729
Plot 115	3	Station	Buck Ridge	3	4A	19930722
Plot 116	3	Personal Observ.	Camp Creek No. 3	1	2	20010723
Plot 117	3	Station	Marlow Lockhart Trio	1	6	20010719
Plot 118	3	Station	Salander Headwaters	2	4	19930723
Plot 119	3	Station	Schumacher Ridge No. 2	1	4	19930719
Plot 120	3	Station	Knife Forks	1	1F	19940724
Plot 121	3	Station	Deer Creek No. 5	3	3	19940730
Plot 122	3	Personal Observ.	Elk Creek Divide	2	2	19930715
Plot 123	3	Personal Comm.	Elk Creek Divide	2	5A	19930721
Plot 124	3	Station	Fish Ridge No. 3	2	3	19940520
Plot 125	3	Station	Upper Deer Creek	1	4	19940801
Plot 126	3	Personal Comm.	Bickford Creek Thinning	1	1	19940511
Plot 127	3	Station	Deer Knife Thinning	2	2	19940722
Plot 128	3	Personal Comm.	Henry's Bend	1	1	19940726
Plot 129	3	Personal Comm.	West Fork Headwaters	2	1	19930713
Plot 130	3	Personal Comm.	Sullivan Creek Headwaters	1	6	19930724
Plot 131	3	Station	Upper Joes Creek Thinning	1	3	19940720
Plot 132	3	Station	Fish Ridge Thinning	1	3	19940718
Plot 133	3	Station	South Marlow Ridge No. 9	2	2	20000802

Table H-1 – continued

Plot #	Method	Plot Location	Location Name	Site	Station	Date
Plot 134	3	Station	Panther Creek		3	19940622
Plot 135	3	Station	Puckett Creek	1	4	19940722
Plot 136	1	Nest	Beaver Creek Nest Tree			
Plot 137	3	Station	Knife Otter Nest Search		D	19940713
Plot 138	1	Nest	Elk Forks	1	1	19950802
Plot 139	3	Station	Beartooth Point	1	3	20010620
Plot 140	1	Nest	Silver Creek Nest Trees			
Plot 141	1	Nest	Howell Creek Nest Tree			
Plot 142	1	Nest	Fish Creek Nest Tree			
Plot 143	1	Nest	Knife Creek Nest Trees			
Plot 144	1	Nest	Buck Creek Nest Tree			
Plot 145	2	Group	Grid 24			
Plot 146	2	Group	Grid 25 North			
Plot 147	2	Group	Grid 25			
Plot 148	2	Group	Grid 26 East			
Plot 149	2	Group	Grid 26 Mill			
Plot 150	2	Group	Grid 26 South			
Plot 151	2	Group	Grid 37			
Plot 152	2	Group	Grid 38			
Plot 153	2	Group	Grid 7			
Plot 154	2	Group	Grid 15			
Plot 155	2	Group	Grid 16 East			
Plot 156	2	Group	Grid 5			
Plot 157	2	Group	W. Charlotte Creek - West			
Plot 158	2	Group	W. Charlotte Creek - East			
Plot 159	3	Personal Comm.	Camp Creek No. 3			20010605 PM

The survey stations with the best information on marbled murrelet use were chosen, rather than using random selection. To determine which stations had the best information, individual visits to survey stations were ranked based on the quantity and type of marbled murrelet detections observed. Each visit point for each detection recorded was assigned one of three significant behavior categories, indicating marbled murrelet activity within a stand (circle below, fly through, landing). The selected stations and their rankings are shown in Table H-2. Plots were located at or in proximity to survey stations (STATION) where significant behaviors were observed, unless the ODF District Contract Administrator and Coordinator had personally observed marbled murrelets at that location (personal observation) or received personal communication from the on-site surveyor (personal communication) to indicate a specific location that the marbled murrelets were using.

Table H-2
Ranking of Timber Sale Survey Areas According to Quality of Information on Marbled Murrelet Behavior in the Area, Used to Select Occupied Stands in Method 3

Rank	Survey Area Name	Site	Station	Date	Circle Below	Fly Thru	Landing	Total Rank[a]
1	Camp Creek No. 3	1	2	20010723	22	21	0	108
2	Deer Creek No. 5	3	3	19940730	9	21	0	69
3	Henry's Bend	1	1	19940726	13	8	0	55
4	Fish Ridge Thinning	1	3	19940718	9	0	0	27
5	Knife Otter Nest Search		D	19940713	2	10	0	26
6	South Marlow Ridge No. 9	2	2	20000802	2	5	0	16
7	Panther Creek		3	19940622	4	2	0	16
8	Knife Forks	1	1F	19940724	4	0	0	12
9	Upper Deer Creek	1	4	19940801	1	4	0	11
10	Elk Pass No. 3	1	5	19930713	3	1	0	11
11	Beaver Creek No. 2	1	4A	19930720	1	4	0	11
12	Deer Knife Thinning	2	2	19940722	0	3	1	9
13	Bickford Creek Thinning	1	1	19940511	2	1	0	8
14	Upper Joes Creek Thinning	1	3	19940720	2	1	0	8
15	Elk Creek Divide	2	2	19930715	2	1	0	8
16	Slingshot Ridge	1	3	19930716	0	4	0	8
17	Fish Ridge No. 2	1	5	19930623	1	1	1	8
18	Johanneson Creek No. 1	1	3	19940731	2	1	0	8
19	Puckett Creek	1	4	19940722	1	2	0	7
20	Schumacher Ridge No. 2	1	4	19930719	1	2	0	7

Table H-2 – continued

Rank	Survey Area Name	Site	Station	Date	Circle Below	Fly Thru	Landing	Total Rank[a]
21	Charlotte Luder	1	4	19930712	0	3	0	6
22	West Fork Glenn Creek No. 3	1	5	19930725	0	3	0	6
23	Beartooth Point	1	3	20010620	1	1	0	5
24	Salander Headwaters	2	4	19930723	1	1	0	5
25	West Fork Headwaters	2	1	19930713	1	1	0	5
26	Fish Ridge No. 3	2	3	19940520	0	2	0	4
27	Charlotte Luder	2	7	19920729	0	2	0	4
28	Buck Ridge	3	4A	19930722	0	2	0	4
29	Sullivan Creek Headwaters	1	6	19930724	0	2	0	4
30	Elk Creek Divide	2	5A	19930721	1	0	0	3
31	Marlow Lockhart Trio	1	6	20010719	0	1	0	2
32	Camp Creek No. 3	2	3	20010606	0	1	0	2

[a] Significant behaviors were weighted as follows: Circle below = 3 points; Landing = 3 points; Fly through = 2 points. Numbers of behaviors were multiplied by weighting factor and added together for total rank.

H.2.6. Vegetation Sampling Design

H.2.6.1. Shape and Size of Plots

A one-half-acre rectangular plot was used for collection of vegetation data in the habitat types. The one-half-acre plot size was used to correspond with the plot size used in (Nelson and Wilson 2002) for comparing nest and non-nest plots. However, rather than using a circular plot, a rectangular plot 132 feet wide by 165 feet long was used; this plot could be fully covered by the samplers walking parallel transects along the steepest portion of the slope. Because of the steepness and ruggedness of terrain on the Elliott State Forest, this design was chosen as a more efficient sampling method to cover an equivalent area. The rectangular plots were centered on selected points.

H.2.6.2. Variables

Hamer Environmental was contracted to collect data in vegetation plots. Variables measured in each plot are shown in Table H-3. These variables were chosen after the examination of variables that differed in nesting stands collected in other studies of marbled murrelet habitat (Hamer and Meekins 1996; Nelson and Wilson 2002), as well as personal communication with biologists (Tom Hamer, Hamer Environmental; Lee Folliard, USFWS). See *Marbled Murrelet Habitat Measurements for the Elliott State Forest* (Hamer Environmental 2002) for more details on variables and methods of collection.

Table H-3
Variables Measured in ½-Acre Plots

On All Plots	For All Trees ≥ 8” DBH	For Conifer Trees ≥ 24” DBH	Calculated for Each Plot
Percent slope	DBH	Live crown ratio	Number of trees per acre
Aspect	Height[a]	Number of platforms	Trees per acre ≥24” DBH
	Species	Size of platforms[a]	Trees per acre with platforms
		Moss cover on limbs[a]	Average DBH of trees with platforms
		Moss depth on limbs[a]	Standard deviation of tree height

[a] Categorical variables

DBH = diameter breast height

H.2.7. Data Analysis

The data were compiled in Excel (Microsoft Excel 97, Microsoft Corporation) and variables analyzed using the STATISTIX7 (Analytical Software 1985, 2000) statistical package for conducting univariate analyses and SAS (SAS Institute, Inc. 1999–2000) for conducting multivariate analyses. Variables were assessed for normality and constant variance using residual plots and box plots of residuals, and were transformed as necessary to meet the assumptions for analysis of variance (ANOVA) and multivariate analyses. A Spearman Rank Correlation table was constructed for the variables to examine correlations between variables.

ANOVA was used to compare variables that conformed to assumptions of constant variance and normal distribution (in either an original or transformed state) among the plot types. The non-parametric Wilcoxon Rank Sum test was used to examine variables that did not conform to either the constant variance or normalcy assumptions.

For multivariate analyses, multivariate analysis of variance (MANOVA) and Discriminant Function Analysis were used to examine how multiple variables might be working together to produce the differences in habitat types that were observed. Only variables that met the assumptions for these analyses were used. A P-value of 0.05 was considered to be significant, consistent with the calculations for sample size.

H.3. RESULTS

Results from Spearman's Rank Correlation are shown in Table H-4. Variables that were highly correlated with each other included MOSS DEPTH and MOSS PERCENT (0.89) and NUM. LARGE PLATFORMS and PLATFORMS PER PLOT (0.99). MOSS DEPTH and MOSS PERCENT also were correlated with diameter breast height (DBH), NUM. LARGE PLATFORMS, and PLATFORMS PER PLOT. TREES W/PLATFORMS was correlated with NUM. LARGE PLATFORMS, and PLATFORMS PER PLOT. Finally, correlations with values between 0.5 and 0.8 were observed between TREES W/PLATFORMS and SD_HEIGHT, and between DBH and HEIGHT.

H.3.1. Univariate Analyses

Plots that were included in polygons mapped as suitable marbled murrelet habitat were characterized by more trees with platforms, taller trees, larger trees, trees with a higher percent cover of moss, deeper moss, and a higher variation in tree heights than plots in stands greater than 65-years-old but that were not mapped as suitable marbled murrelet habitat (Table H-5). Plots in mapped polygons were similar to plots in occupied stands with respect to these characteristics. Plots in occupied stands had more platforms per plot and more large platforms than plots in either mapped or unmapped polygons. Plots in all three habitat types were similar with respect to the number of large conifer and hardwood trees, live crown ratio, slope, and aspect (Table H-5).

H.3.2. Multivariate Analyses

MANOVA was used to compare the three plot types using different combinations of variables. The MANOVA that included all variables meeting the assumptions of constant variance and normal distribution, DBH, (LOG)LCR, MOSS PERCENT, HEIGHT, SD_HT, (LOG) MOSS DEPTH AND NUM. CONIFER gave a result indicating that plots in the three habitat types differed with respect to the combination of these variables [F equal 7.46 (Wilk's Lambda); p less than 0.0001].

A discriminant function analysis was conducted to find the combination of variables that best discriminated the habitat types. The combination of DBH, MOSS PERCENT, LOG_LCR, HT, MOSS DEPTH, and NUM. CONIFERS was most effective in properly classifying plots. Using this combination, mapped plots were misclassified as unmapped 19 percent of the time; occupied plots were misclassified as unmapped 12 percent of the time; and unmapped plots were classified correctly 73 percent of the time.

Table H-4
Spearman Rank Correlations

Variable	Aspect	Average Live Crown Ratio	Average Height of Conifer Greater than 24 inches DBH	Average Number of Large Platforms	Average Moss Depth	Average Moss Percent	Average DBH of Conifer Greater than 24 inches DBH	Number of Conifers Greater than 24 inches DBH	Number of Hardwoods Greater than 24 inches DBH	Number of Large Platforms per Plot	Standard Deviation of Heights	Slope
Average Live Crown Ratio	.07											
Average Height of Conifers Greater than 24 inches DBH (Height)	.07	.08										
Average Number of Large Platforms (No. Large Platforms)	.01	.21	.31									
Average Moss Depth (Moss Depth)	.12	.36	.32	**.55**								
Average Moss Percent (Moss Percent)	.14	.18	.27	.48	**.89**							
Average DBH of Conifer Greater than 24 inches DBH	.15	.43	**.57**	.48	**.61**	**.51**						
Number of Conifers Greater than 24 inches DBH (Num. Conifers)	.14	.23	.05	.00	.26	.26	.16					
Number of Hardwoods Greater than 24 Inches DBH (Num. Hardwoods)	.18	.22	.19	.17	.39	.36	.40	.33				

Table H-4 – continued

Variable	Aspect	Average Live Crown Ratio	Average Height of Conifer Greater than 24 inches DBH	Average Number of Large Platforms	Average Moss Depth	Average Moss Percent	Average DBH of Conifer Greater than 24 inches DBH	Number of Conifers Greater than 24 inches DBH	Number of Hardwoods Greater than 24 inches DBH	Number of Large Platforms per Plot	Standard Deviation of Heights	Slope
Number of Large Platforms Per Plot (Platforms Per Plot)	.01	.21	.29	**.99**	**.55**	.46	.46	.05	.17			
Standard Deviation of Heights (Standard Height)	.04	.04	.50	.42	.17	.15	.46	.31	.08	.39		
Slope	.19	.34	.08	.07	.17	.09	.32	.09	.11	.09	.10	
Number of Trees with Platforms (Trees with Platforms)	.06	.02	.31	**.63**	.33	.30	.30	.49	.04	**.66**	**.53**	.04

Notes:

DBH = diameter breast height

Correlations greater than 0.5 are highlighted in bold.

Table H-5
Characteristics of Variables Measured in Mapped, Unmapped, and Occupied Plots [Mean, (Standard Error), Range]

Variable	Habitat Type: Mapped	Habitat Type: Unmapped	Habitat Type: Occupied	F-Statistic (ANOVA) P-value	Wilcoxon Rank Sum
Height (Feet)	172.43 (3.17) 115-210 **A**	153.53 (6.08) 0-203.33 **B**	171.69 (4.28) 0-210.00 **A**	.0155	
LOG_LCR	33.60 (1.48) 15.29-70 **A**	28.92 (2.14) 0-75 **A**	30.69 (1.57) 0-65 **A**	.1582	
SD_Height	51.63 (1.85) 27.42-78.22 **A**	40.86 (2.03) 9.27-75.49 **B**	51.12 (1.81) 9.26-74.64 **A**	.0001	
DBH (Inches)	38.35 (1.02) 24.71-60.00 **A**	31.45 (1.36) 0-61 **B**	37.75 (1.26) 0-62 **A**	.0001	
Number of Conifers	12.19 (1.04) 1-31 **A**	11.49 (1.12) 0-32 **A**	12.68 (.92) 0-28 **A**	.7159	
Number of Hardwoods	1.02 (.25) 0-9 **A**	.57 (.18) 0-7 **A**	.94 (.21) 0-7 **A**		1) .1267 2) .9108
Log_Moss Depth	.58 (.06) .05-1.8 **A**	.28 (.05) 0-1.8 **B**	.64 (.05) .05-1.8 **A**	.0000	
Moss Percent	55.24 (3.19) 8.33-95.00 **A**	36.9 (3.13) 0-95 **B**	57.65 (2.63) 8.24-90.00 **A**	.0000	
Trees With Platforms	6.20 (.66) 0-20 **A**	2.52 (.41) 0-14 **B**	7.50 (.77) 0-23 **A**		1) .2462 2) .0000
Number of Large Platforms	.20 (.05) 0-1.4 **A**	.04 (.01) 0-.6 **B**	.55 (.11) 0-3.25 **C**		1) .0051 2) .0006
Platforms Per Plot	6.4 (1.66) 0-63 **A**	1.19 (.41) 0-15 **B**	14.55 (2.47) 0-78 **C**		1) .0060 2) .0011
Slope (Percent)	70.09 (3.28) 15-125 **A**	68.45 (3.09) 10-105 **A**	59.15 (4.20) 0-125 **A**	.0670	
Aspect (Azimuth)	N 26% S 28 % W 21% E 25% **A**	N 6% S 13 % W 43% E 21% **A**	N 23% S 26 % W 23% E 23% **A**	.3483	

Notes: Categories with different letters are significantly different. P-Values ≤ 0.05 were considered significant.

H.4. DISCUSSION

Mapped plots were similar to occupied plots for many characteristics, and differed only in that occupied plots had more platforms per plot and more large platforms than either mapped or unmapped plots. Also, the mapped plots were significantly different from plots in stands that were not mapped in several key characteristics (DBH, HEIGHT, SD_HT, MOSS PERCENT, MOSS DEPTH, TREES W/PLATFORMS). These results suggest that the mapping process was successful in selecting areas of the forest that are similar to occupied stands in characteristics that may be biologically meaningful to marbled murrelets and in screening out areas having less habitat suitability for marbled murrelets.

Obviously, characteristics such as moss percent, moss depth, and presence and number of platforms are not visible from aerial photos. However, these characteristics are fairly highly correlated with tree size, which can be identified on aerial photos by a combination of height and crown spread. The characteristics of stands most likely to be discernable from aerial photos include tree height, tree density, live crown ratio, and variation in tree heights.

All plot types had a similar number of large (greater than 24 inches DBH) conifers, although both mapped and occupied plots had significantly more trees with platforms than did unmapped plots. However, tree density was a factor in distinguishing among stand types with the multivariate models. This result may indicate that large tree density in and of itself does not indicate suitable habitat. Other conditions must also be present for platform development to occur.

Because tree crowns are visible from aerial photos and contribute to the perceived "texture" of a stand, live crown ratio is expected to differ between mapped and unmapped plots. In addition, large tree crowns would be expected to provide better platform cover than small tree crowns, and thus indicate more suitable habitat. Although mapped plots had a higher live crown ratio on average than unmapped plots, the difference was not significant. As expected, occupied plots and mapped plots were similar in this characteristic. Live crown ratio was a factor in distinguishing among stand types with the multivariate models.

The standard deviation of tree height was analyzed as an indicator of tree height diversity, and the resulting crown complexity and potential vertical cover, within a plot. This measurement was higher in mapped and occupied plots than in unmapped plots. However, it was not included in the combination of variables that best discriminated the plot types.

Another variable expected to differ among stand types was percent slope. In its logistic regression modeling using Elliott State Forest data, Hamer Environmental (Hamer and Meekins 1996) found that occupied stands were on significantly flatter slopes than unoccupied stands. Similarly, Nelson and Wilson (2002) found slopes to be significantly different between nest and non-nest plots on the Elliott State Forest. Occupied plots were found to have less slope than either mapped or unmapped plots, although the difference was not significant at p equals 0.05. This study is the only one of the three in which plots were selected completely at random, and this may account for the slightly different finding.

Mapped plots and occupied plots were not similar in all characteristics. Occupied plots had more platforms per plot and more large platforms than mapped plots. This suggests that the mapped polygons have a larger variation in platform density than the occupied polygons.

Nelson and Wilson (2002) also found that trees with platforms were more numerous in nest plots than in non-nest plots. However, their nest and non-nest plots did not differ with respect to tree height or diameter. Nelson and Wilson did not compare variation of tree heights, moss percent, moss cover, or number of large platforms in their nest and non-nest plots, although they did examine some of these variables in nest trees compared to other platform trees without nests. Nelson and Wilson (2002) found that platform trees in nest plots were larger than platform trees in other site plots, and that the percent moss on the tree was greater for nest trees than other platform trees. They also found that substrate (moss) depth was greater on nest trees than other platform trees, but this difference was not significant for other platform trees in nest plots. Their multivariate analyses confirmed that number of platforms and percent substrate were important variables distinguishing nest trees from platform trees without nests. Hamer Environmental (Hamer and Meekins 1996) found that platform density and percent slope were stand characteristics most predictive of stand occupancy on the Elliott State Forest.

The results of the current study may differ from previous studies on the Elliott State Forest due to differing study designs. This study chose plots randomly from the mapped, unmapped, and occupied stands throughout the Elliott State Forest. In addition, surveys for marbled murrelets were conducted at randomly selected grids across the forest to increase the sample size of occupied stands and to search for marbled murrelets in unbiased locations. Previous studies on the Elliott State Forest were limited to known occupied sites that were located primarily by timber sale surveys, and thus were biased to certain areas of the forest where timber sales were being planned. Because of this random design, these results are applicable to the area of the Elliott State Forest. Finally, the sample size in the current study was robust enough to have reasonably high power (0.80) to detect differences in characteristics among stands. Therefore, it is likely that any differences in characteristics among stand types that exist were detected with this study.

There are limitations to using aerial photo analysis to identify suitable habitat for marbled murrelets, and it is possible to miss suitable habitat in typing using aerial photos. However, some suitable habitat would likely also be missed using other methods of identifying suitable habitat, such as plots or transects.

There are several advantages to using aerial photo analysis as a method of identifying suitable habitat for marbled murrelets. Aerial photo analysis allows for identification of microsites of suitable habitat, at a scale that timber stand inventory is not generally collected. In addition, aerial photo analysis uses available resources (aerial photos) to delineate suitable habitat all at once, rather than the method employed in the previous HCP in which data on habitat characteristics were collected on an operational basis.

Appendix I
Elliott State Forest Harvest Modeling

I.1. DESCRIPTION OF THE HARVEST SCHEDULING MODELS

The Harvest Scheduling Models were developed by Oregon Department of Forestry (ODF) staff, in cooperation with Professor John Sessions of Oregon State University to assist the ODF in evaluating policy alternatives for the *Elliott State Forest Management Plan* (FMP) and Habitat Conservation Plan (HCP). The models provided information on harvest levels, revenue, and vegetation conditions for a planning horizon of 150 years.

The models combine a spatial representation of land classifications, ODF inventory data with growth and yield projections, and management goals; they utilize a search technique to allocate timber management activities over the planning area throughout the planning horizon.

In the model versions before 2004, the ODF's stand inventory database was stratified into strata of like species, size classes, and density. For each timber strata, a number of treatment alternatives were developed as potential management regimes that could be assigned to timber stands to meet management goals.

The ORGANON model was used to project the growth and yield for the strata's management regimes for 30 five-year periods. In 2004, the inventory data were updated, and the growth and yield model was changed to the U.S. Forest Service's (USFS') Forest Vegetation Simulator (FVS), Pacific Northwest Coast Variant, to project growth and yield for the stands under up to 125 potential management regimes for 30 five-year periods. In 2006, the stand inventory no longer used strata. Sampled stands were selected to represent non-sampled stands making the inventory stand-based.

To maintain spatial feasibility, a heuristic search procedure was chosen to assign the eligible management regimes to timber stands to meet management goals. Assignment of management regimes to timber stands required tracking contiguous areas of mature forest habitat, areas of young stands, land classification restrictions, and the coordination of riparian and upslope management regimes. The search procedure is guided by an objective function that minimizes deviations between goals for timber supply and forest structure while secondarily seeking to maximize present net value.

The ODF considered four primary management goals for modeling: 1) maximize long-term revenue to the Common School Fund; 2) produce a sustainable, even-flow harvest of timber; 3) maintain properly functioning aquatic habitat conditions; and 4) provide habitats that contribute to maintaining or enhancing wildlife populations at self-sustaining levels.

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

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

The ODF chose the heuristic search procedure because it is better able to solve spatial problems than optimization methods such as linear programming. Although linear programming has been widely used in forest management planning, it cannot solve a spatial problem at the scale of this planning area due to the large number of variables and constraints required to formulate the problem. The Elliott State Forest planning area contains approximately 2,100 stands divided into 62,456 upland and riparian parcels with a planning horizon of 30 five-year periods. Depending on the degree of spatial representation, up to 500,000 variables could be required.

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

I.2. USE OF MODELS FOR DECISION SUPPORT

The goals of modeling for the Elliott State Forest planning process are to:

- Establish a baseline of the 1995 FMP and HCP outputs.
- Explore various management scenarios early in the revision process.
- Display a relative comparison of resource conservation and fiscal tradeoffs for decision-makers and the public.
- Compare modeling outputs to narrow the focus of the revision process.
- Possibly provide a basis for alternatives in the National Environmental Policy Act process.

In 2001, the Elliott State Forest core planning team developed eight different management scenarios for the forest, including the 1995 FMP. The ODF staff worked with Dr. Sessions to translate these parameters into spatial computer models. The eight models represented a wide range of possible management scenarios, ranging from an emphasis on conservation to an emphasis on timber production. The model displays the impacts and outputs of those management strategies throughout 30 five-year periods. Outputs are displayed through various quantitative tables and geographic map displays.

In 2002, the core team and steering committee analyzed the outputs from the eight scenarios to help narrow the focus of the planning effort and identify strategies that would best accomplish the resource goals for the forest. From this analysis, the steering committee identified three concepts for the core team to include in the planning effort: 1) conservation areas for protection of important habitat; 2) revised aquatic/riparian strategies; and 3) use of stand structure concepts in defining habitat.

Using the three concepts, the core team developed a draft Integrated Landscape Strategy. This draft strategy was modeled to help determine how well the strategies achieved the goals for the forest. Initial model runs of the draft landscape strategy were conducted in early 2004. The inventory data used in the models were updated to include recent stand data collected since 2000.

In addition to the eight original management scenarios and the draft Integrated Landscape Strategy (ninth scenario), three other scenarios were identified for analysis; however, one was a variation of the draft Integrated Landscape Strategy and was not modeled. Each of the management scenarios that were chosen were then used for comparative purposes in developing the draft landscape strategy.

During 2004, new yield tables incorporating the latest Stand Level Inventory (SLI) data for the Elliott State Forest were developed in collaboration with a contractor, and were incorporated into the models in early 2005. To help inform decision-makers and represent a broad range of possible management alternatives, the draft Integrated Landscape Strategy and several of the original 12 management scenarios were selected for analysis in the revised HCP and updated with the new yield tables and spatial data.

In addition to the 12 original management scenarios, one additional scenario was developed in 2006 in response to public scoping comments for the Environmental Impact Statement (EIS). In the EIS, three alternatives were analyzed in detail: 1)the 1995 HCP (no change); 2) ODF's proposed revised HCP (preferred); and 3) a modified version of the Forest Ecosystem Management Assessment Team's stream buffers and reserve areas for northern spotted owls and marbled murrelets. The third alternative allocated 50 percent of the forest to reserve areas for listed species and stream buffers, and applied intensive forest management on the remaining 50 percent of the forest. All three alternatives were modeled once more in 2006 with updated spatial layers and inventory information. Outputs from these models were used by the EIS contractor, Jones & Stokes Associates, Inc., to analyze effects of the alternatives in the EIS.

In addition to the modeling for the EIS analysis, in 2006, the ODF also modeled two versions of take avoidance. One management scenario assumed no HCP and applied ODF take avoidance policies for both the northern spotted owl and the marbled murrelet. The second take avoidance scenario assumed no HCP and delisting of the marbled murrelet. This scenario then applied ODF take avoidance policies for the northern spotted owl. This information was used to help inform decision-makers in the HCP development process.

I.3. SUMMARY OF THE ELLIOTT STATE FOREST HARVEST SCHEDULE MODELING ASSUMPTIONS

The following information provides an informational brief on the policy/rules that were applied to the various models, and indicates the associated assumptions that were input into the models to reflect the resource conservation, operational constraints, and fiscal objectives. Certain modeling assumptions were common to all of the modeling scenarios and are provided first on the following pages; other modeling assumptions are scenario-specific and are categorized by scenario.

I.4. DOCUMENTATION FOR ELLIOTT STATE FOREST MODELING SCENARIOS, MODELS 9U2, 6U2, 5B2, 2B2, 2C2, AND 12U2

I.4.1. Reports for All Models

To facilitate comparisons and analyses, modeling solutions will include acreages in specified stand structure and age classes. These are identified in column (structure types) heading definitions in the Adobe Acrobat and/or Excel tables, and are as follows:

- NF = non-forested
- EARLY = Early Structure
- INT = Intermediate Structure
- ADV1 = Advanced Structure
- ADV2 = Advanced Structure, with eight trees per acre (TPA) or more that are 32 inches diameter breast height (DBH) or greater
- ADV3 = Advanced Structure, with eight TPA or more that are 32 inches DBH, including four TPA or more that are 38 inches DBH or greater
- GT 95 = Forest is 100 years old or older
- GT75 = Forest is 80 years old or older
- GT65 = Forest is 70 years old or older

These acreages will be reported using the 13 management basins identified in Model 9 as the geographic base for all models.

I.5. Draft Summary for Elliott State Forest Harvest Schedule Modeling Assumptions Common to Model 9U2, Model 6U2, and Model 5B2, Model 2C2, Model 2B2, Model 12U2

No.	Assumption Type/Issue	Policy/Rule	Modeling Assumption
Model Assumptions			
1.	Model *Starting Inventory and Modeled Periods*	The length and number of modeled periods were directed by the Harvest and Habitat Executive Team. The initial inventory was current as of December 31, 2003. The model outputs reflect data at the approximate mid-point of each five-year period.	The initial inventory is current and updated to December 31, 2005. It included 2,139 stands, 1,090 of which are sampled. The model will reflect outputs for 30 five-year periods for a total of 150 years. The model outputs reflect data at the mid-point of each five-year period. Because five is not evenly divisible by two, the output data are reported after two years of growth. Period 0 is 2005, period 1 is 2007. See Table I-1 for the percent of each district's acres and stands that were inventoried at the time the yield tables were created.

No.	Assumption Type/Issue	Policy/Rule	Modeling Assumption
2.	Model *Model Goals/ Constraints*		Each goals can be "on" or "off" for a model run. Goal description: <u>Primary Goals</u> • Harvest volume goal of millions of board feet of volume harvested per five-year period • Goal for acres of Advanced 1 structure that is outside core, SUV, and "no harvest" stream buffer per basin. • Districtwide goal that at least 50 percent of the Advanced 1 is Advanced 2. • Goal for acres of thinning in period 1 • Goal to maximize net present value <u>Constraint</u> • Amount of marbled murrelet habitat that can be clearcut per period with incentive for new development
3.	Model *Growth Model for Projection*	The growth models used for creating the yield tables were recommended by Mason, Bruce and Girard, Inc. as part of the deliverables for the Yield Table Creation Contract. By contract specification, each district approved the growth model selection. The stand characteristics, volume estimates, and structure development of the current inventory were projected for 150 years, by five-year intervals, using a currently available growth and yield model.	The USFS' FVS was recommended for use in creating the models' yield tables on all harvest and habitat planning districts by Mason, Bruce and Girard. The FVS is an individual-tree, distance-dependent growth and yield model. The Pacific Northwest Coast Variant, was recommended to create model yield tables for the Elliott State Forest. The model was calibrated to a maximum SDI of 600 for Douglas-fir and 720 for western hemlock. Flewelling's taper equations were used to calculate tree volume.

No.	Assumption Type/Issue	Policy/Rule	Modeling Assumption
4.	Model *Inventory Stratification*	The ODF SLI provides a stratification of stands into 70 Forest Projection System groups based on species groups, diameter classes, and tree density. Because the ODF district stands do not have current inventory for all stands, the SLI stand stratification methodology was employed for the model to represent the inventory. Not all strata were represented on every district. For modeling purposes, the inventory was further stratified into 105 groups. The additional strata were derived from dividing the high density group into medium and high and the 8-inch- to 20-inch-diameter group into 8-inch to 14-inch and 14-inch and 20-inch. The stratification for the Elliott model was based on: • Species Groups: 1D, 1W, 1H, DX, WX, HX, OT • DBH Classes: 0- to 8-inch, 8- to 14-inch, 14- to 20-inch, 20- to 30-inch, 30-inch+ Density Classes: low = 0 to 30 SDI; medium = 30 to 50 SDI, and high = 50+ SDI.	Each of the 1,090 sampled stands has a yield table based on the inventory tree list that becomes a strata based on the stand's tree list. The unsampled stands were assigned to a sampled stand based on their similarity to species, tree size, stand density, and site. Strata were grown in three site groups. The group ranges were derived by ordering the district stands by site index and grouping them into thirds. The representative site for each group was the average of the sites. The following are the group ranges and midpoint. The strata number that represents each spatial polygon was derived from concatenating district number, sampled stand number, and site group. Non-tree strata are assigned a strata number = 888; non-ODF is assigned strata number = 999. Existing stands with strata XC1N are clearcut stands in the inventory with no plantation inventory specified. They were assigned the plantation strata appropriate for the spatial location. Site groups are: • Site 1: greater than 125 SI, average 128 • Site 2: 113 to 124, average 117 • Site 3: less than 113, average 109
Policy/Rule Modeling Assumptions			
5.	Policy/Rule *No Harvest Areas*	Forest Land Management Classification is the administrative rule that contains the basic requirement for the State Forester to classify all forestlands within the planning area. Oregon Administrative Rule 629-035-0050	SUVs classified as "special" stewardship with a subclass of Administrative sites, Cultural Resource, Operationally Limited, Visual, or Wildlife have been included in a SUV layer and are "off-base" to harvesting. No harvest outside fund 51 or 52 and in non-forested areas.

No.	Assumption Type/Issue	Policy/Rule	Modeling Assumption
6.	Policy/Rule *Non-declining, Even Flow*	The Department of State Lands Asset Management Plan states that "Forest lands are to be managed primarily to produce a sustainable, even-flow harvest of timber, subject to economic, environmental and regulatory considerations, according to specific plans developed by forest managers."	The Steering Committee determined that the desirable pattern of harvest volume is even flow with volume trending upward during the 150-year modeling period.
7.	Policy/Rule *Maximum Clearcut Size and Green-up Requirements of Harvest Areas*	The FPA requires a maximum clearcut size of 120 acres and planted trees to be four feet tall or four years old and "free to grow" before an adjacent stand can be final harvested (FPA 527.740).	A maximum of 120 acres of contiguous stands can be harvested in each five-year period. This restriction is assumed to meet FPA reforestation and "green-up" rules.
Operational/Economic Modeling Assumptions			
8.	Operational *Harvest Units*	The Coos District created a digital representation of logical operational clearcut harvest units for use by the model to schedule harvests.	HUs delineate clearcut units with the appropriate logging system.
9.	Operational *Thinning Prescriptions*	Timber harvest modeling requires a description of the silvicultural management regimes that will likely be implemented. The Coos management team designed 63 regimes that would likely be used during a stand's rotation.	Each strata was projected for up to 123 silvicultural prescription pathways for 30 five-year periods. Prescription pathways simulating current forest management practices were developed having zero to four thinnings starting at age 35, removing a specified percent of trees in stand diameter classes down to a specified SDI between 10 and 40. 30 five-year interval thinning pathways were described for single or multiple thinnings using the criteria of age at thinning and residual stand density index after thinning. The general density target to trigger a thinning was the achievement of 50 to 55 SDI. Prescriptions were written to produce complex structure,

No.	Assumption Type/Issue	Policy/Rule	Modeling Assumption
			maximize volume, or accommodate prescription limitations in land classifications such as riparian, northern spotted owl, and marbled murrelet areas. Prescription series were numbered in the yield tables as follows: • 100 – existing strata - regular • 200 – existing strata - fertilization • 300 – existing strata - thin before age 80 • 400 – plantation strata - regular • 500 – plantation strata - fertilization • 600 – plantation strata - thin before age 80 Every polygon was assigned the "grow only" prescription at the start of the annealing process. Minimum harvest volume for clearcut and thinning is 3 MBF per acre. Prescriptions assume natural seed-in (ingrowth) of trees after each thinning (see Table I - 4). The TPA and species are dependent on the residual SDI of the thinning and the species group of the original stand. Defect and breakage assumed is four percent of the harvest volume for stands less than less than 80 years old and eight percent for stands greater than age 80.
10.	Operational *Natural Disturbance*	The Coos District has a low rate of natural disturbance of fire, pest infestation, and disease. Landslides occur under extreme rain conditions. SNC disease is light to moderate.	SNC is a minor issue on the Elliott Forest and is not being modeled. Effect of natural disturbances from fire, insects, and landslides are not modeled.

No.	Assumption Type/Issue	Policy/Rule	Modeling Assumption
11.	Operational *Harvest Units*	The district has delineated 1,904 harvest settings to be used as harvest units. They are based on topography and road access.	HU is eligible for harvest if less than 10 percent of HU is under age 40. Eligible acres are ODF acres that are not in Core, SUV, Riparian=1 and adjusted Vegetation Identifier=888. The polygon age is found in the GIS spatial data (age 2006) and in the yield tables. Age was assigned by the district. Each HU is assigned a logging system: cable, tractor, or helicopter. Logging costs are specified for each logging system.
12.	Operational *Planted Stands (Plantations)*	At regeneration, the district plants different TPA and species composition depending on the slope and location within the SNC affected zone. Yield tables for 30 periods were developed for the plantations that have grown with all of the silvicultural prescriptions.	Each district identified plantations described as species, TPA, DBH, and height to be planted on specific locations based on spatial criteria after clearcut. See Table I-3. Yield tables for simulated plantations assumed natural regeneration and live tree retention. Some plantations assumed that a precommercial thinning occurred at age 15. Plantation strata are numbered 8710, 8720, 8730, and 8740. Plantations were assigned based on their spatial location, and were grown for each average site. The yield table assigned was based on the site group that the stand's site fell within. Three plantations are used on the east side of the district (eastwest=0), and are assigned based on probability of 70 percent, 15 percent, and 15 percent. One plantation is assigned to the west side (eastwest=1). Each plantation is developed for three different site indices, 128, 117, and 109.
13.	Operational *Precommercial Thinning*	These are standard practices in precommercial thinnings.	Plantations planted with 500 or more TPA are assumed to have a precommercial thinning at age 15.

No.	Assumption Type/Issue	Policy/Rule	Modeling Assumption
14.	Operational *Live Tree Retention*	Residual live trees were retained to meet the short-term habitat needs of wildlife species, to serve as a source of future snags and downed wood, and to provide legacy trees in future stands.	Live tree retention was accounted for in two ways in the model. There was a volume and value reduction at clearcut harvest to account for the live trees that were left for the purpose of live tree retention, snags, and downed wood. There were yield tables created for these values: summaries_leave_tree_vol.txt summaries_leave_tree_value_rem.txt Live trees were added to plantations that replaced a clearcut stand to account for the competition from the overstory residual live trees.
15.	Operational *Natural Reproduction*	Natural reproduction occurs in stands after thinning. The rate and species of reproduction is determined by the species on the site and the amount of growing space available for survival (residual density of thinning prescription). Foresters on each district provided data for the reproduction simulated in the yield tables. Natural reproduction species, diameter, TPA, and height were provided for trees greater than two inches DBH.	The projected stands added natural reproduction after a thinning to simulate the ingrowth of trees after thinnings. TPA and species added were described by the district and differed based on the residual SDI, SLI species groups, and number of thinnings. The trees were added to the yield tables the number of years after thinning that corresponds to the age of the reproduction. The number of TPA of reproduction added to a thinned stand decreased after the second thinning because of competition from previous reproduction.

No.	Assumption Type/Issue	Policy/Rule	Modeling Assumption
16.	Operational *Fertilization*	ODF Policies and Guidelines ODF Swiss Needle Cast Strategic Plan Fertilizer Response Information written by Doug Robin on May 18, 2004	The yield tables have prescriptions that used fertilization (from Doug Robin's recommendation on May 18, 2004) in these circumstances: • Species group "1D" both in existing stands and in plantations. • All site groups (recommendation was to apply fertilization for Site class II (site 140) and below). There was a priority for fertilization of III, IV, and II, in that order. • Fertilization was to occur after the first and second thinning. • Stands that will be regeneration harvested or thinned within 10 years. • Fertilization was not allowed in root rot or SNC severe stands or riparian special classifications. • The cost for fertilization was $75 per acre. • Fertilization will be added to pathways 101, 102, 104, 105, 106, 108, 109, and 110 after the first and second thinnings only (200 series in prescriptions). • Fertilization increases the site index by 10 points for 10 years.
17.	Operational *Roads*	Acres out of production and average hauling costs are estimated.	Road locations are taken from the ODF Coos GIS road layer. Road right-of-way is estimated to be 30 feet total road width. The right–of-way acres are subtracted from the polygon acres when calculating volume and value. It is not subtracted from the acres when calculating acres of structure.

No.	Assumption Type/Issue	Policy/Rule	Modeling Assumption
18.	Economics *Costs*		Volume is based on 32-foot logs, 5-inch top diameter inside bark, 12-foot minimum log, and 1-foot stump height. Administrative costs are $25 per acre per year. Road maintenance cost is $12 per MBF. Project cost of $19/MBF is subtracted from the pond values. Precommercial thinning cost is $85 per acre applied to 25 percent of the clearcut acres at age 15. Regeneration costs are $500 per acre and include planting and all activities to get free-to-grow. Fertilization cost is $75 per acre. A bid-up factor of 1.12 is applied to the pond value net of logging costs and project costs. For stands less than age 76, a bid-up factor of 1.38 is applied. Logging costs (including hauling costs) per MBF are: Clearcut / Thin Tractor/Cable 137 280 Difficult Cable 165 380 Helicopter 300 430

Notes:

FPA = Forest Practices Act

GIS = geographic information system

HU = harvest unit

MBF = thousand board feet

SDI = stand density index

SNC = swiss needle cast disease

SUV = steep, unique, or visual land

<table>
<tr><th colspan="4">Model 9u2 Preferred Alternative (Integrated Landscape Strategies)
Assumptions</th></tr>
<tr><td colspan="4">Row heading definitions in the Adobe Acrobat and/or Excel tables are:
• "TE" includes all acres within T&E Cores.
• "SUV" includes only SUV acres that are not also within a T&E Core.
• "Stream Buffer" includes only stream buffer acres that are not also T&E or SUV.
• “Production” includes all acres not in conservation areas (T&E, SUV, or Stream Buffer).
Acreages identified in the Adobe Acrobat and/or Excel tables meet the Stand Structure (biological) definitions specified in the 2007 Elliott State Forest HCP. The Advanced* Target Outside Conservation Areas (acres) identified in Table I-1 are administratively determined based on the crediting of all conservation acres as Advanced Structure</td></tr>
<tr><td>1.</td><td>Model 9
Live Tree Retention and Downed Wood</td><td>Three TPA will be retained outside riparian special zone to account for live tree retention.</td><td>Live tree retention and downed wood rules are from the Northwest Oregon State Forests FMP. Clearcut harvest volume and value are reduced by three TPA, depending on the age of the stand. This retention accounts for the trees left in both the riparian focused and the upland portion of the stand.</td></tr>
</table>

Model 9u2 Preferred Alternative (Integrated Landscape Strategies) Assumptions			
2.	Model 9 *Riparian Management Zone Buffer Width*	The riparian strategies are similar to those developed for the Northwest Oregon State Forests Management Plan. Two riparian buffer designations, special and focused, are derived from management objectives based on stream size and type for all perennial and intermittent streams. The stream layer that was used to create the buffered riparian data was created by the Coos District GIS specialist from a merging of the "stream" layer and "draw" layer. The "draw" layer was included to account for additional small intermittent streams, all of which were not represented in the "stream" layer.	Timing of thinnings in the riparian zone will be associated with either clearcut or thinning in the upland portion of the stand. Buffer widths for each side (horizontal distance) are as follows: • Special: 100 feet - all Type F streams and large and medium Type N streams • 50 feet - small Type N perennial streams (25 feet for FMP requirements and an additional 25 feet for operational considerations); 25 feet - small Type N intermittent streams Focused: The buffer extends outward from the edge of the Special buffer to 160 feet on all perenniel and seasonal streams. In the model, Focused buffers do not have any specific riparian harvest restrictions. They are eligible to receive the same prescriptions as the upland portion of the stand. The rationale is that, when clearcutting, the live tree retention in the upland portion accounts for the trees retained in the Focused buffer.

Model 9u2 Preferred Alternative (Integrated Landscape Strategies) Assumptions			
		The "draw" layer was developed by a contractor in the 1990s that created a line feature to designate a stream in all drainage depressions using the digital elevation model. Because the streams were not ground-truthed, the "draw" layer was thought to over-estimate the stream miles. The "stream" layer was a further refinement of the "draw" layer by another contractor that eliminated streams where streams were thought not to exist. A polygon layer representing the streams buffered with the "special" and "focused" Forest Land Classification buffer widths were sent to the modeling coordinator for use in the harvest scheduling models. These data provide the best available information to represent riparian acres with prescription limitations ("Special" and "Focused") due to the riparian strategies for projected estimates of forest structure and harvest volume.	Prescriptions: Riparian Special. May have one or two thinnings before age 80. After the stand reaches age 80, no harvesting of any type is allowed. Riparian Focused. There are no harvest restrictions.
3.	Model 9 *T&E Core Areas*	Thirty-three core areas with a total of approximately 13,500 acres were developed from northern spotted owl activity centers, northern spotted owl core use areas, marbled murrelet use areas, and other unique habitats. Core areas are conservation areas that are permanent and fixed in their location. Harvest activities may be conducted to enhance advanced habitat characteristics.	No regeneration harvesting in core=1. Thinning is permitted if stand age is less than 80. Use the riparian thinnings in column 4 of the valid_rx.txt file.

Model 9u2 Preferred Alternative (Integrated Landscape Strategies) Assumptions			
4.	Model 9 *Advanced Habitats*	Approximately 23,236 acres of advanced habitat, in addition to Cores, SUVs, and Riparian Special, will be managed. Each basin has a specified target of complex acres that must be attained and maintained. The function of advanced habitat is to provide additional habitat for species of concern, connectivity among conservation areas, and dispersal habitat on the landscape. Structure classes are defined as: **Early:** Less than 15 years old **Intermediate:** Not advanced or early **Advanced1**: Greater than 20 TPA greater than 18 inches DBH that includes: • greater than ten TPA greater than 24-inches DBH, • Quadratic mean diameter of trees greater than 8-inches DBH at least 15 inches DBH, and • 150 to 325 square feet of basal area **Advanced2**: greater than 20 TPA greater than 18 inches DBH that includes: • greater than ten trees per acre greater than 24 inches DBH, • greater than eight trees per acre greater than 32 inches DBH. and • 150 to 325 square feet of basal area	Basin goal: Each basin has a goal for the amount of Advanced 1 structure that should be developed. (See Table I-1 for Basin Target for Advanced Acres.) Acres that count toward the basin advanced (Advanced 1) target are those ODF advanced acres outside the Core, SUV, and Riparian Special (right-of-way is not subtracted from the acres). There are no basin targets for Advanced 2 and Advanced 3; however, their acres are listed in the reports. District-wide structure goal: The district acres of Advanced 2 should be at least 50 percent of the district acres of Advanced 1. An entire HU is advanced if greater than 50 percent of the clearcut harvestable acres are advanced. If less than 50 percent, the HU is not advanced.

Model 9u2 Preferred Alternative (Integrated Landscape Strategies) Assumptions			
		Advanced3: • greater than 20 TPA greater than 18 inches DBH that includes: • greater than ten TPA greater than 24 inches DBH, • greater than eight TPA greater than 32 inches DBH, • greater than four TPA greater than 38 inches DBH, and • Quadratic mean diameter of trees greater than 24 inches DBH at least 35.2 inches DBH, and • 150 to 325 square feet of basal area	

Notes:

MBF = thousand board feet

SUV = steep, unique, or visual land

T&E core = threatened and endangered core

<table>
<tr><th colspan="4">Model 6u2 No Action Alternative (1995 ESF - HCP)
Assumptions</th></tr>
<tr><td colspan="4">Row heading definitions in the Adobe Acrobat and/or Excel tables are:
• "TE" includes all acres within conservation areas and marbled murrelet management areas.
• "SUV" includes only SUV acres that are not also within T&E designations.
• "Stream Buffer" includes only stream buffer acres that are not also TE or SUV.
“Production” includes all acres not in conservation areas (T&E, SUV, or Stream Buffer).</td></tr>
<tr><td>1.</td><td>Model 6
Live Tree Retention and Downed Wood</td><td>Three TPA will be retained outside riparian special zone to account for live tree retention.</td><td>Live tree retention and downed wood rules are from the NW FMP (Oregon Department of Forestry. 2001a) Clearcut harvest volume and value are reduced by three TPA depending on the age of the stand. This retention accounts for the trees left in both the riparian focused and the upland portion of the stand.</td></tr>
<tr><td>2.</td><td>Model 6
Riparian Management Zone Buffer Width</td><td>The riparian strategies are as stated in the 1995 Elliott State Forest HCP (pg. V-35). Riparian buffer width for perennial streams is 100 feet on fish-bearing streams and 50 feet on non-fish-bearing streams. Buffer widths for intermittent are 75 feet on fish-bearing streams and no buffer on non-fish-bearing streams. However, for this analysis, all fish streams, both perennial and intermittent, were buffered with a 100-foot slope distance buffer converted to a 95-foot horizontal distance.</td><td>Timing of thinnings in the riparian zone will be associated with either clearcut or thinning in the upland portion of the stand.
Buffer widths for each side (slope distance converted to horizontal distance) are as follows:
• All Type F streams: 95 feet (perennial and intermittent)
• All Type N streams: 45 feet (perennial only)
Prescriptions:
<u>Riparian Buffers</u>. May have one or two thinnings before age 80. After the stand reaches age 80, no harvesting of any type is anticipated.
<u>Riparian Buffers</u>. At clearcut harvest, buffers may be wider than required and include an upland portion of the stand. These areas would be credited as leave trees.</td></tr>
</table>

Model 6u2 No Action Alternative (1995 ESF - HCP) Assumptions			
3.	Model 6 *Conservation Areas*	Twenty-one areas with a total of approximately 6,370 acres. These were considered northern spotted owl and marbled murrelet use areas, plus other unique habitats. Conservation areas are permanent and fixed in their location. Harvest activities may be conducted to enhance habitat characteristics in stands less than 80 years old.	No regeneration harvesting in conservation areas. Thinning is permitted if stand age is less than 80 years. Use the riparian thinnings in column 4 of the valid_rx.txt file.
4.	Model 6 *Marbled Murrelet Management Areas*	ODF survey protocol is simulated for take avoidance. As of December 2005, there were 36 areas with a total of approximately 10,000 acres. These areas were designated using the ODF Marbled Murrelet Management Policy. Up to an additional 5,000 acres of MMMAs could be identified during the modeling process to simulate "Take Avoidance" and occupied stand protection.	No regeneration harvesting in MMMAs. New MMMAs will be approximately 100 acres. The maximum number that may be created in a period is 25 percent of the HUs in that period. When the current MMMA and newly found MMMA reach 15,000 acres, the model will stop looking for new MMMAs. Thinning is permitted in MMMAs if stand age is less than 80. Use the riparian thinnings in column 4 of the valid_rx.txt file.

Model 6u2 No Action Alternative (1995 ESF - HCP) Assumptions			
5.	Model 6 *Habitats*	Three habitat types and related constraints were identified in the 1995 Elliott State Forest HCP. **Northern Spotted Owl:** Dispersal. Forest vegetation with at least 40 percent canopy closure and an average stand diameter of 11 inches or more. Each of the 17 management basins is required to maintain 50 percent of its geographical area in acreage that has an average tree diameter of 11 inches. Nesting, Roosting, Foraging. Habitat with the forest structure, sufficient area, and adequate food source to meet the need of a nesting pair of northern spotted owls. Each management basin has an acreage stipulation related to the amount of this structure type required in the basin. **Marbled Murrelet:** Nesting Stands. Mature or old-growth forest with large trees that have broad crowns and large, flat limbs, or platforms suitable for nests.	Structure classes are defined in the model. Northern Spotted Owl: Dispersal. Stands with at least 40 percent canopy closure and an average stand diameter of 11 inches or more. Any thinning or clearcut is allowed as long as 50 percent dispersal is maintained. If a basin does not have at least 50 percent dispersal, thinnings must maintain a minimum of 35 SDI, and no clearcutting is allowed. Nesting, Roosting, Foraging. Stands in the 80+ age classes (age greater than 75) were designated as containing the structural characteristics to qualify as Nesting, Roosting, and Foraging habitat types. Thinning is allowed in Nesting, Roosting, Foraging habitat to a residual SDI of at least 40 (light thinning). Clearcutting is allowed only when the basin Nesting, Roosting, Foraging habitat acres meet or exceed the basin Nesting, Roosting Foraging targets. The acres that count toward the Nesting, Roosting, Foraging targets are acres outside of conservation areas, riparian buffer, and SUVs (not MMMAs). Marbled Murrelet: Nesting Stands. Stands in the 100+ age classes (age greater than 95) were designated as containing the structural characteristics to qualify as Nesting stands. If less than target Nesting, Roosting, Foraging habitat, no clearcut in basin. If greater than target Nesting, Roosting, Foraging habitat, maintain minimum of target amount.

Notes:

MMMA = Marbled Murrelet Management Area

SUV = steep, unique, or visual land

T&E core = threatened and endangered core

Model 5b2 Combined Reserve and Intensive Forestry Assumptions			
Row heading definitions in the Adobe Acrobat and/or Excel tables are: • "TE" includes all acres within conservation areas and MMMAs. • "SUV" includes only SUV acres that are not also within TE designations. • "Stream Buffer" includes only stream buffer acres that are not also TE or SUV. • “Production” includes all acres not in conservation areas (T&E, SUV, or Stream Buffer).			
1.	Model 5 *Live Tree Retention and Downed Wood*	Three TPA will be retained outside riparian special zone to account for live tree retention.	Live tree retention and downed wood rules are from the NW FMP (Oregon Department of Forestry. 2001a). Clearcut harvest volume and value are reduced by three TPA depending on the age of the stand. This retention accounts for the trees left in both the riparian focused and the upland portion of the stand.
2.	Model 5 *Riparian Management Zone Buffer Width*	The riparian strategies simulate the Forest Ecosystem Management Assessment Team buffers. Riparian buffer widths include the Elliott FMP riparian buffers, and also include additional areas between the buffers that are operationally not feasible to harvest. They apply to all perennial and intermittent streams	Riparian buffers are “no harvest.” Buffer widths for each side (horizontal distance) are as follows: • All Type F streams: 160 feet • All Type N streams: 100 feet
3.	Model 5 *Reserves*	Reserves include acres in conservation areas and MMMAs.	Reserve attribute is a combination of conservation areas and MMMAs, and has a value of “1.” Reserve is “no harvest” designation.
4.	Model 5 *New 50 Reserves*	Approximately 50 percent of the district has been designated as a “no harvest” reserve. The 50 percent is composed of conservation areas, MMMAs, riparian buffer, and SUVs.	New_50_reserve attribute has a value of “1” when SUV=1, Stream=1 or Reserve=1.

Notes:

MMMA = Marbled Murrelet Management Area

SUV = steep, unique, or visual land

T&E core = threatened and endangered core

Model 2c2 ODF Wood Emphasis (Take Avoidance for Northern Spotted Owl and Marbled Murrelet) Alternative Assumptions			
Row heading definitions in the Adobe Acrobat and/or Excel tables are: • "TE" includes all acres within northern spotted owl cores and MMMAs. • "SUV" includes only SUV acres that are not also within T&E designations. • "Stream Buffer" includes only stream buffer acres that are not also TE or SUV. • "Production" includes all acres not in conservation areas (T&E, SUV, or Stream Buffer).			
1.	Model 2 *Live Tree Retention and Downed Wood*	Two 14-inch DBH TPAs will be retained outside riparian special zone to account for live tree retention.	Live tree retention and downed wood rules are from FPA. Clearcut harvest volume and value are reduced by two 14-inch DBH TPAs. No merchantable volume is used to meet the down wood requirement.
2.	Model 2 *Riparian Management Zone Buffer Width*	The riparian strategies simulate the FPA buffers. Buffers for fish-bearing streams are on both perennial and intermittent streams. Non-fish-bearing streams have only perennial stream buffers.	Riparian buffers are "no harvest." Buffer widths for each side (horizontal distance) are as follows: • Large Type F streams: 100 feet • Medium Type F streams: 70 feet • Small Type F streams: 50 feet • Large Type N streams: 70 feet • Medium Type N streams: 50 feet

Model 2c2 ODF Wood Emphasis (Take Avoidance for Northern Spotted Owl and Marbled Murrelet) Alternative Assumptions			
3.	Model 2 *Northern Spotted Owl*	ODF circle strategy is used for take avoidance.	Northern Spotted Owl core has no harvest. Northern spotted owl inner 0.7-mile radius circle has a goal of at least 50 percent of the circle's acres with at least age 75. Northern spotted owl 1.5-mile radius circle has a goal of at least 40 percent outside the inner circle with at least age 75. Specific acres within the northern spotted owl circles have no harvest for 25 years. They are eligible for harvest in period 6. Nesting, Roosting, and Foraging habitat and dispersal are not in this model.
4.	Model 2 *Marbled Murrelet*	ODF survey protocol is simulated for take avoidance. As of December 2005, there were 36 areas with a total of approximately 10,000 acres. These areas were designated using the ODF Marbled Murrelet Management Policy. Up to an additional 5,000 acres of MMMAs could be identified during the modeling process to simulate "Take Avoidance" and occupied stand protection.	No final harvesting in MMMAs. New MMMAs will be approximately 100 acres. The maximum number that may be created in a period is 25 percent of the HUs in that period. Thinning is permitted if stand age is less than 80. Use the riparian thinnings in column 4 of the valid_rx.txt file.

Notes:

FPA = Forest Practices Act

MMMA = Marbled Murrelet Management Area

SUV = steep, unique, or visual land

T&E core = threatened and endangered core

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Assumptions</th></tr>
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• "TE" includes all acres within northern spotted owl cores.
• "SUV" includes only SUV acres that are not also within TE designations.
• "Stream Buffer" includes only stream buffer acres that are not also TE or SUV.
• “Production” includes all acres not in conservation areas (T&E, SUV, or Stream Buffer).</td></tr>
<tr><td>1.</td><td>Model 2
Live Tree Retention and Downed Wood</td><td>Two 14-inch DBH TPAs will be retained outside riparian special zone to account for live tree retention.</td><td>Live tree retention and downed wood rules are from FPA. Clearcut harvest volume and value are reduced by two 14-inch DBH TPAs. No merchantable volume is used to meet the down wood requirement.</td></tr>
<tr><td>2.</td><td>Model 2
Riparian Management Zone Buffer Width</td><td>The riparian strategies simulate the FPA buffers. Buffers for fish-bearing streams are on both perennial and intermittent streams. Non-fish-bearing streams have only perennial stream buffers.</td><td>Riparian buffers are “no harvest.”
Buffer widths for each side (horizontal distance) are as follows:
• Large Type F streams: 100 feet
• Medium Type F streams: 70 feet
• Small Type F streams: 50 feet
• Large Type N streams: 70 feet
• Medium Type N streams: 50 feet</td></tr>
</table>

Model 2b2 ODF Wood Emphasis (Take Avoidance for Northern Spotted Owl) Alternative Assumptions			
3.	Model 2 *Northern Spotted Owl*	ODF circle strategy is used for take avoidance.	Northern spotted owl core has no harvest. Northern spotted owl inner 0.7-mile radius circle has a goal of at least 50 percent of the circle's acres with at least age 75. Northern spotted owl 1.5-mile radius circle has a goal of at least 40 percent outside the inner circle with at least age 75. Specific acres within the northern spotted owl circles have no harvest for 25 years. They are eligible for harvest in period 6. Nesting Roosting, and Foraging habitat and dispersal are not in this model.
4.	Model 2 *Marbled Murrelet*	This alternative assumes that marbled murrelets are not listed.	

Notes:

FPA = Forest Practices Act

SUV = steep, unique, or visual land

T&E core = threatened and endangered core

Model 12u2 FPA Wood Emphasis (Take Avoidance for Northern Spotted Owl) Alternative Assumptions			
Row heading definitions in the PDF and/or Excel tables are: • "TE" includes all acres within northern spotted owl cores. • "Steep" includes only steep acres that are not also within TE designations. • "Stream Buffer" includes only stream buffer acres that are not also TE or Steep. • "Production" includes all acres not in conservation areas (T&E, Steep, or Stream Buffer).			
1.	Model 12 *Model Goals and Constraints*		No minimum clearcut age. Ending inventory goal outside "Steep, Cores, and Riparian Buffer" that is at least equal to the 50-year old regulated forest. Runs that maximize the first 30-year harvest and also: • has no other flow constraints • permits maximum 5-year harvest deviation of 25 percent around the 30-year period harvest average. • non-declining flow • stabilizes volume at an output equal to that of a regulated forest under 50-year rotation within 50 to 70 years • permits a maximum of 20 percent deviation from the previous decade
	Model 12 *Thinning Prescriptions*	The model has the option to choose prescriptions both with and without fertilization. Only commercial thinnings with at least eight MBF per acre will be conducted.	Minimum volume to permit a thinning is eight MBF per acre.

Model 12u2 FPA Wood Emphasis (Take Avoidance for Northern Spotted Owl) Alternative Assumptions			
2.	Model 12 *Live Tree Retention and Downed Wood*	Two 14-inch DBH TPAs will be retained outside riparian special zone to account for live tree retention.	Live tree retention and downed wood rules are from FPA. Clearcut harvest volume and value are reduced by two 14-inch DBH TPAs. No merchantable volume is used to meet the downed wood requirement.
3.	Model 12 *Riparian Management Zone Buffer Width*	The riparian strategies simulate the FPA buffers. Buffers for fish-bearing streams are on both perennial and intermittent streams. Non-fish-bearing streams have only perennial stream buffers.	Riparian buffers are "no harvest." Buffer widths for each side (horizontal distance) are as follows: • Large Type F streams: 100 feet • Medium Type F streams: 70 feet • Small Type F streams 50 feet • Large Type N streams: 70 feet • Medium Type N streams: 50 feet
4.	Model 12 *Northern Spotted Owl*	Northern spotted owl protection is the 70-acre core habitat.	Northern spotted owl core has no harvest. Core stay on the landscape for the entire planning horizon.
5.	Model 12 *Marbled Murrelet*	This alternative assumes that marbled murrelets are not listed.	

Notes:

FPA = Forest Practices Act

MBF = thousand board feet

SUV = steep, unique, or visual land

T&E core = threatened and endangered core

Table I-1
Model 9 Basin Targets for Advanced 1 Structure Acres

Basin	Advanced [a] Target Outside Conservation Areas (acres)	Advanced Target Outside Conservation Areas (%)	Non-Conservation Areas (acres)	Conservation Areas [b] (acres)	Basin Acres
1	0	0%	2,661	2,695	5,356
2	66	1%	3,919	2,503	6,422
3	2,327	32%	5,975	1,321	7,296
4	2,024	41%	4,020	970	4,990
5	2,505	32%	6,417	1,406	7,823
6	2,653	36%	5,620	1,797	7,417
7	2,859	45%	5,388	934	6,322
8	1,599	25%	4,870	1,671	6,541
9	0	0%	5,701	2,583	8,284
10	206	3%	4,764	1,748	6,512
11	2,785	27%	8,222	2,651	10,873
12	1,466	13%	8,254	3,060	11,314
13	825	20%	2,891	1,241	4,132
Total	**19,315**	**21%**	**68,702**	**24,580**	**93,282**

[a] Advanced areas are not spatially designated

[b] Conservation Area acres include core, SUVs (steep, unique, or visual lands), and riparian reserves

Table I-2
April 2006 Yield Table Pond Values (dollars/MBF)

Species	Price 1	Price 2	Price 3	Price 4	Price 5	Price 6
CX	423	423	423	400	380	0
DF	668	668	668	638	605	0
IC	724	724	724	708	708	0
PC	611	611	611	611	611	0
RA	610	610	610	610	610	0
RC	900	900	900	850	743	0
SS	423	423	423	400	380	0
WH	452	452	452	441	416	0
WP	432	432	432	406	406	0

Note: MBF = thousand board feet

Species

RA = Red alder

CX = unknown conifer

DF = Douglas fir

IC = Incense cedar

WP = White Pine

WH = Western hemlock

RC = Western Red cedar

SS = Sitka spruce

PC = Port Orford cedar

Table I-3
Species Composition for Yield Table Plantations - Fall 2004

Strata Codes	ID #		Total TPA	Species 1	%	DBH	Ht	Species 2	%	DBH	Ht	Species 3	%	DBH	Ht	Species 4	%	DBH	Ht	Location
78710x	1a	Plant	436	DF	100	0	1.5													Non SNC east side
1DR1	1a	Age 15	300	DF	95	6	28	RA	5	7	45									Non SNC east side - use 70% of time
78720x	1b	Plant	538	DF	50	0	1.5	WRC	50	0	1.5									Non SNC east side
DXR2	1b	Age 15	400	DF	50	6	28	WRC	50	4	22									Non SNC east side - use 15% of time
78730x	1c	Plant	538	DF	50	0	1.5	WH	50	0	1.5									Non SNC east side
DXR3	1c	Age 15	400	DF	50	6	28	WH	50	4	22									Non SNC east side - use 15% of time
78740x	2	Plant	538	DF	50	0	1.5	WRC	25	0	1.5	WH	25	0	1.5					SNC west side
DXR4	2	Age 15	400	DF	45	6.5	35	WRC	23	4.5	25	WH	22	5	30	RA	10	7.5	45	SNC west side

Notes:

DF = Douglas fir

HT = Height

RA = Red alder

SNC = swiss needle cast

WH = Western Hemlock

WRC = Western Red cedar

Table I-4
Natural Regeneration Assumed 15 years after First Thinning by SDI or Age

Species Group	SDI 10 - 19			SDI 20 - 29			SDI 30 - 39			SDI 40 +		
	TPA/ Species	DBH	Ht	TPA/ Species	DBH	Ht	TPA/ Species	DBH	Ht	TPA/ Species	DBH	Ht
1D	50 DF	5	30	30 DF	3	20	10 DF	2.5	15			
	200 WH	5	25	150 WH	3	20	100 WH	2.5	15			
	20 WRC	5	25	20 WRC	3	20	20 WRC	2.5	15			
	20 WRC	5	25	20 WRC	3	20	20 WRC	2.5	15			
1W	1000 WH	2.5	10	750 WH	2.5	20	300 WH	2.5	15	100 WH	1	10
DX	300 WH	5	25	100 WH	3	15	50 WH	3	15			
WX	1000 WH	2.5	10	750 WH	2.5	10	300 WH	2.5	10	100 WH	1	10
	75 DF	2.5	15	75 DF	2.5	15	50 DF	2.5	15			
HX	300 WRC	3	15	200 WH	2.5	10						

Notes:

DF = Douglas fir

Ht = height

RA =Red Alder

SNC = swiss needle cast

WH =Western hemlock

WRC =Western red cedar

Species Groups:

1D = Douglas-fir;

1W = Western hemlock

DX = DF majority mix

WX = Hemlock majority mix

HX = Hardwood majority mix

OT = Other species, singular or mixes

The trees per acre are reduced by one third for each successive thin.

Table I-4 continued

Species Group	Age 55			Age 65			Age 80 (Alder Stand Dies)		
1H	10 WH	3	15	10 WH	7	30	10 WH	15	80
				10 WH	3	15	10 WH	7	30
							10 RC	3	15

Notes:

RC = Western Red cedar

WH = Western hemlock

Species Groups:

1H = Hardwood

Table I-5
Volume and Value Deleted from Regeneration Harvest Stand for Live Tree Retention

Stand Age	Live Tree Retention	Volume per Tree	Volume per Acre	Value per Acre	DWD per Volume per Acre
40 - 60	3	250	750	$267	250
60 - 90	3	500	1,500	$675	500
90 - 120	3	1,000	3,000	$1,440	1300
120 - 160	3	1,800	5,400	$2,808	1300
160 +	3	2,400	7,200	$4,320	1300

Note:

DWD = downed woody debris

Table I-6
Trees Added to Plantations to Represent Live Trees Retained from the Previous Stand

Plantation No.	Species	TPA	DBH	Height	Crown Ratio
Plantation_1a	DF	1	24	140	30%
	WH	1	20	120	35%
	WRC	1	20	120	35%
Plantation_1b	DF	1	24	140	30%
	WH	1	20	120	35%
	WRC	1	16	80	40%
Plantation_1c	DF	1	24	140	30%
	WH	1	20	120	35%
	WRC	1	20	120	35%
Plantation_2	DF	1	24	140	30%
	WH	1	20	120	35%
	WRC	1	16	80	40%

Notes:

DF = Douglas fir

WH = Western hemlock

WRC = Western Red cedar

Appendix J
Annual HCP Stand Structure Reporting Process Using Oregon Department of Forestry's Stand Level Inventory

J.1. OVERVIEW

The Oregon Department of Forestry's (ODF's) State Forests Stand Level Inventory (SLI) provides current or recent information about forest vegetation characteristics and where they occur on the landscape. The SLI system is used for information-based decision making, focusing on facilitation and assessment of operational forest management activities. Information on vegetation elements, including live and dead trees, non-tree vegetation (herbs-shrubs-grasses), and downed woody material, is gathered via field sampling techniques within stratified forest stands. The current field sampling protocol is described in the SLI Field Guide (Version ODFSLI 2.00, October 2004).

The ODF's State Forests Program's long-term goal in using SLI is to achieve and maintain the following current inventory information:

- 100 percent of stands, from seedling stage to when they first become merchantable
- 50 percent of merchantable stands

Once 50 percent of the merchantable stands have been measured, the inventory amount will be reduced to a maintenance mode of four to five percent per year, assuming that this amount of inventory will provide an adequate degree of confidence in the data assigned to non-measured stands. Data for non-measured stands will be derived by extrapolating data from measured stands to similar stands that have not been measured.

Data from the Young Stand Inventory completed in 1998 and the Mature Stand Inventory completed in 2000 were collected using a sampling protocol other than SLI, but approximately the same level of information on the vegetation characteristics was gathered. These data have been reformatted to SLI descriptions.

Data for certain stand structure attributes, such as the snag and downed wood components, are collected during the SLI process, but not at a sampling level that would allow an acceptable statistical representation of these attributes on a stand level basis. Sample data from individual stands can be combined to reduce statistical limitations for indicating the level of intensity for these types of structure components over a larger geographic area (i.e., management basin level) or overall in a stand structure class (intermediate structure, advanced structure).

J.1.1. Current Status

As of December 2005, approximately 50 percent of the stand polygons on the Coos district State Forest Ownership have been sampled, which is approximately 61 percent of the acreage on the ownership. The district's processing format (updating of re-digitized stand polygons and insertion of new inventory data) is an ongoing process as the information becomes available. By December of each year, all changes in the data files and geographic information system (GIS) files are compiled and archived, and the new updated version is distributed for use in planning and tracking efforts.

J.2. SLI DATA COLLECTION

By December of the seventh year after approval and issuance of an Incidental Take Permit by the regulatory agencies, using SLI sampling protocol, the Coos district State Forest Program will collect and compile data on 100 percent of age class 70, and older, stands located outside designated conservation areas on the Elliott State Forest.

J.2.1. Stand Structure Summaries

The Coos district State Forest Program's annual updating process is described in the following pages. Table J-1 (at the end of this appendix) displays the reporting format. The structure class assigned to any one stand polygon has the potential to change annually based on harvesting prescriptions, stand management activities, projected stand growth, or newly collected SLI data. An annual stand structure summary would be generated and distributed each January. This report would provide acreages and related percentages of the stand structures (early, intermediate, advanced, and other iterations of advanced - inclusive of mapped marbled murrelet habitat) as identified in the Elliott State Forest Habitat Conservation Plan (HCP).

J.2.2. Structure Report – Annual Updating Process

The structure report relies on the following data sources:

- SLI stand polygon boundaries (GIS data)
- SLI attribute data
- Management basin boundaries (GIS data)
- Riparian management area (RMA) boundaries (GIS data)
- Steep, unique, and visual land (SUV) area boundaries (GIS data)
- Threatened and endangered core (T&E core) areas (GIS data)
- Marbled murrelet habitat areas (GIS data)

J.3. PREPARING THE BASE DATA

J.3.1. Stand Level Inventory Stand Polygon Boundaries (GIS Data)

The district's stand boundaries will be updated to reflect any changes that have occurred in the previous year. Stand boundaries may change due to harvesting, fire, insects, diseases, improved knowledge of correct boundary locations, and other factors.

J.3.2. Stand Level Inventory Database Attribute Data

1. The SLI attribute data will be updated to reflect changes that have occurred in the previous year. (Examples of SLI changes include incorporating harvesting activities, importing newly collected information, and growing the previously collected stand data to the current year.) The update process is documented in detail in the Reforestation Organization Operations Tracking System (ROOTS) Manual (Oregon Department of Forestry 2006b).
2. The SLI data will be re-compiled.
3. The older SLI data will be grown forward to the current year.
4. For stands that have not yet been inventoried, data from similar SLI inventoried stands will be assigned.
5. The stand structure for all stands will be calculated.

J.3.3. Structure Data Theme

A GIS theme will be created that contains the stand polygon boundaries, joined with the associated structure information for the stand (from the SLI database). Using GIS software, the SLI stand polygon boundaries theme will be intersected with the management basin boundaries theme. The resulting structure data theme will contain the stand ID, the stand structure, and the management basin where the stand is located.

Because stands can and do straddle basin boundaries, this process splits boundary-crossing stands into pieces, one for each management basin into which they fall.

J.3.4. Other GIS Data

If any changes have occurred to the following information during the year, those changes will be incorporated into the appropriate GIS data:

- Management basin boundaries (GIS data)
- RMA boundaries (GIS data)

- SUV area boundaries (GIS data)
- T&E species core areas (GIS data)
- Mapped marbled murrelet habitat areas (GIS data)

If changes are made, they will usually be based on improved knowledge of correct boundary locations.

J.4. GETTING DATA FOR THE STRUCTURE REPORT

J.4.1. Report Structure

The report will contain the following ten columns (see Table J-1):

1. Basin number and name (Basin)
2. Acres in basin
3. Acres of conservation areas (CAs)
4. Acres of advanced structure outside of CAs
5. Acres in advanced structure and CAs
6. Advanced structure percent
7. Advanced structure target percent
8. Acres of intermediate structure
9. Acres of early structure
10. Acres of mapped marbled murrelet habitat

J.4.2. Data Sources and Calculations

1. Basin number and name (Basin) (column 1)

   Basin number and name will come from the management basin boundaries (GIS data) data source.

2. Acres in basin (column 2)

   Basin acres will come from the management basin boundaries (GIS data) data source. The **acres in basin** will be calculated using GIS software, and are the total acres in the basin.

3. Acres of CAs (column 3)

   A. The following three data sources will be joined into one GIS theme using GIS software:

      - RMA boundaries (GIS data)
      - SUV area boundaries (GIS data)
      - T&E species core areas (GIS data)

      (Note: The GIS union process ensures that no "double-counting" of conservancy areas occurs.)

B. The resulting unionized GIS theme will be used to erase the CAs from the management basin boundaries (GIS data) data source. The resulting theme will be the management basin theme minus the CAs.

C. The acres in each basin will be recalculated.

D. The **acres of CAs** in each basin will be calculated as follows: the **acres in basin** (column 1) minus the recalculated acres from step 3B.

4. Acres of advanced structure outside of CAs (column 4)

   A. The unionized CAs theme created in step 3A will be used to erase the CAs from the structure data theme (GIS data) data source. The resulting theme will contain the stand structures outside the CAs.

   B. Re-calculate the acres of the structure data theme resulting from step 4A.

   C. GIS software will be used on the recalculated theme (step 4B) to summarize the acres by management basin and structure classification.

   D. The acres in the three advanced structure classifications for each basin will be added together. This will be the **acres of advanced structure outside of CAs**.

5. Acres in advanced structure and CAs (column 5)

   column 5 = column 3 + column 4

6. Advanced structure percent (column 6)

   column 6 = (column 5 / column 7) x 100

7. Advanced structure target percentage (column 7)

   This will come from the basin-specific percentage targets documented in the HCP.

8. Acres of intermediate structure (column 8)

   The acres of intermediate structure for each basin will be derived from the output of step 4C.

9. Acres of early structure(column 9)

   The acres of early structure for each basin will be derived from the output of step 4C.

10. Acres of mapped marbled murrelet habitat (column 10)

Table J-1
Reporting Format for Coos District State Forest Program's Annual Updating Process

Basin	Acres in Basin	Acres of Conservation Areas (CAs)	Acres of Advanced. Structure outside CA	Acres in Advanced Structure and CA[a]	Advanced Structure %[b]	Advanced Structure Target %	Acres of Intermediate Structure	Acres of Early Structure[c]	Acres of Mapped Marbled Murrelet Habitat
1 – Mill Creek	5,356	2,654	516	3,170	59%	50%	3,256	60	939
2 - Charlotte-Luder	6,422	2,514	2,711	5,225	81%	40%	1,886	248	1,609
3 - Dean-Johanneson	7,296	1,044	3,138	4,182	57%	50%	3,430	24	1,766
4 – Scholfield Creek	4,990	774	1,583	2,357	47%	60%	2,971	101	1,185
5 - Big Creek	7,823	1,227	3,551	4,778	61%	50%	3,191	174	2,420
6 - Benson-Roberts	7,417	1,669	3,262	4,931	66%	60%	2,698	319	1,726
7 – Johnson Creek	6,322	745	2,954	3,699	58%	60%	2,680	219	1,119
8 - Palouse-Larson	6,541	1,561	1,915	3,476	53%	50%	3,287	450	841
9 - Henry's Bend	8,284	2,344	1,194	3,538	43%	30%	4,772	1,004	828
10 - Marlow-Glenn	6,512	1,654	663	2,317	35%	30%	4,269	847	462
11 - Millicoma Elk	10,873	2,400	3,860	6,260	57%	50%	4,036	1,256	1,846
12 - Trout Deer	11,314	2,806	2,333	5,139	45%	40%	,5388	1,994	1,466
13 - Ash Valley	4,132	1,206	877	2,083	50%	50%	2,226	202	473
Forest Total	**93,282**	**22,598**	**21,183**	**51,155**	**54%**	**47%**	**45,740**	**7,000**	**16,680**

[a] This column is the sum of advanced structure outside of CAs and all CA acres.

[b] No clearcut harvesting can occur in a basin unless this percentage exceeds the percentage in the adjacent column to the right.

[c] Acreage not to exceed a Forest Total of 13,992 (15 percent of 93,282).