Appendix F
Wildlife Information

This appendix includes additional information about research on marbled murrelets and northern spotted owls residing in the Elliott State Forest. It summarizes studies conducted over the past ten years on these two species and their habitat use. Copies of the full reports are available from the Oregon Department of Forestry (ODF). Results from these studies were used in development of the strategies in this Forest Management Plan (FMP).

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Marbled Murrelet Studies

A Predictive Model of Habitat Suitability for the Marbled Murrelet and Habitat Rating Strategy for the Elliott State Forest (Hamer and Meekins 1996)

The 1995 Elliott State Forest Habitat Conservation Plan (HCP) (Oregon Department of Forestry 1995a) used a habitat rating procedure (Appendix K) to minimize the risk of harvesting occupied marbled murrelet habitat. The procedure used six habitat characteristics thought to be important to marbled murrelets to assess the suitability of a stand as nesting habitat; stands were rated low, medium, or high as potential habitats, with timber harvest within a basin allocated to the lowest quality habitat to minimize take. The HCP states that Appendix K would be tested and validated in the forest and modified if necessary. In 1995, the ODF contracted with Hamer Environmental to test and validate Appendix K.

To test and validate Appendix K, data on the six forest characteristics used to rank habitat quality were collected from a sample of occupied and unoccupied stands. Sample collection required the development of a standardized method that would adequately sample the patchy and discontinuous habitat in the Elliott State Forest. A line transect method was developed that allowed biologists to uniformly sample every acre of a stand in an unbiased manner without missing small inclusive patches of suitable habitat. Forty-one forest variables were measured (including Appendix K variables) at a sample of 21 occupied and 21 unoccupied stands. Data from occupied and unoccupied stands were analyzed using a t-test for independent sample, forward stepwise logistic regression procedures, and a cross validation technique that tested the results of the model on an independent sample of stands.

An independent samples t-test conducted on each of the 41 variables resulted in 18 habitat variables showing significant differences between occupied and unoccupied stands. These variables included the availability of potential nesting platforms (five variables), the density of conifer trees with platforms (four variables), percent moss cover and moss depth on the surface of tree limbs (five variables), average percent slope, and the presence of multiple canopy layers (two variables). The most significant tests were associated with variables that measured platform density, moss cover, and moss depth.

Logistic regression was used to test if the six habitat variables used in Appendix K would accurately predict stand occupancy. Unlike the t-test approach, logistic regression is able to examine interactions between variables, and thus can be used to predict which combination of variables would best predict occupancy of a stand by murrelets. The accuracy of the Appendix K model in correctly predicting stand occupancy for those stands with a low probability of occupancy (less than 0.25 probability) was poor, with only 9 of 12 stands (75 percent) correctly predicted to be unoccupied. For stands with a medium probability of occupancy (equal to or greater than 0.25 to less than or equal to 0.75) accuracy was also poor, with only 11 of 20 stands (55 percent) correctly predicted to be unoccupied. Prediction accuracy for stands with a high probability of occupancy (greater than 0.75) was good, with 10 of 11 stands (91 percent) predicted to be occupied.

The accuracy of Appendix K was further tested using a cross-validation approach that removed one stand at a time from the sample of 42 stands, developed a new independent model using the remaining 41 stands, then tested to see if the removed stand was correctly classified by the new model. The cross validation procedure revealed that the prediction accuracy of Appendix K was less than satisfactory. In testing the overall accuracy of various models, researchers found that models with many (greater than four) variables held up poorly under cross-validation compared to models with a few (two to three) highly significant variables. The six variables used in Appendix K, often not significant to the model, had high standard error values, and in some cases contributed little to the overall predictability of the model.

A less complex model was developed to replace Appendix K. This model had higher predictability, consisted of a few significant variables that were easily measured in the field, performed well under cross validation, and made biological and intuitive sense. The two variables in the model positively related to occupancy included the density of five-inch-diameter platforms and percent slope. Moss depth or moss cover variables were not included in the model, although they were important variables from the results of the t-test, because platform diameters and counts are made with the moss cover included in the estimate of diameter. Thus, platform counts take into account the presence and depth of moss of the tree limbs.

A three-variable model was developed using platforms per acre, percent slope, and adjacent stream order (size of the nearest stream); this model was similar in accuracy to the two-variable model described above. The three-variable model also held up well under cross validation. A further examination of stream order revealed that this variable did not show significant trend differences between occupied and unoccupied sites. In addition, the three-variable model was highly sensitive to the variable stream order when calculating the probability of occupancy from field data, and not as intuitive as the two-variable model. Because predictability was similar between the two models, the two-variable model was chosen as the final model to use for the HCP habitat rating strategy.

Finally, tests were conducted to determine if stands could be sampled using a lower density of transects that would save time and money in future field data collection. Results of the these tests indicated that the variability in the measurement of platform density between transects was high, and that subsampling of transects was unlikely to be successful. A final test was conducted by building a model using data on platform density and percent slope that was derived using data from every other transect (five percent sampling intensity) in the database. This model had low predictability and few stands calculated to have medium and high probability of occupancy. The researchers concluded that rating stands as low, medium, or high using a method of subsampling transects would not be possible.

The results of the study indicated that the original Appendix K rating system for marbled murrelet habitat could be significantly improved. The study produced a new habitat rating strategy for the HCP that had high accuracy and reliability, and could be used to minimize the take of potential breeding sites. With the new model results, an assessment of the amount of potential take occurring from the activities proposed in the HCP was possible. In addition, a standardized, repeatable, and reliable field method of measuring the variable habitat conditions in the Elliott State Forest was developed that could be used to rate future stands. The study produced information on the forest characteristics associated with marbled murrelet breeding habitat in the Oregon Coast Range that could be used for future management direction, and led to an increased understanding of murrelet nesting ecology.

Marbled Murrelet Habitat Characteristics on State Lands in Western Oregon: Final Report (Nelson and Wilson 2002)

A study of the characteristics of marbled murrelet nesting habitat on state lands in the Clatsop, Tillamook, and Elliott State Forests was conducted from 1995 to 1999, in cooperation with U.S. Fish and Wildlife Service (USFWS) and the Oregon Department of Fish and Wildlife. The scale of the study focused on the nest, nest tree, and microsite attributes selected by murrelets for nesting. Using four climbing plot sampling methods (intensive, paired-plot, grid-acre, and cluster) and dawn surveys, a total of 37 nests (27 old and 10 active) were located in 33 study sites. Twelve of these nests were located in the Elliott State Forest. The characteristics of nests and nest trees, nest and random platforms, successful and failed nests, and nest and non-nest plots were summarized in 25-meter-radius plots centered on the nest trees or climbing plots.

In the Elliott State Forest, murrelets selected large conifer trees (average diameter breast height [DBH] of 55 inches) with numerous platforms (average 35 platforms per tree) for nesting. Nest platforms were larger in diameter, width and length, with more horizontal cover and closer vertical cover than other random platforms available in nesting stands. Nest characteristics were similar between the North Coast forests (Clatsop and Tillamook) and the Elliott State Forest, and any differences were related to forest type rather than murrelet selection.

In the Elliott State Forest, nest limbs generally were larger and higher than other platforms in the nest plot, with fairly deep (two inch) moss covering most of the nest platform. Nest trees were most often part of the dominant overstory, and were larger in diameter than both the plot average and the average tree with platforms. Nest trees also had more and deeper moss on the tree overall than the average for all plot trees; however, the substrate (mostly moss) was actually deeper on random platforms than platforms where nests were found. Nest plots can be characterized as having several large, platform-bearing trees per acre (the exact number dependent on whether 25- or 40-meter-radius plots are considered), with both overstory and midstory trees hosting potential platforms. Overall moss cover on trees in nest plots was high, and the slope fairly gentle. These characteristics may be a result of the location of murrelet habitat in the Elliott State Forest along stream and river courses. In the Elliott State Forest, higher humidity levels, higher soil site class, local topography, and lower initial stocking have promoted large trees with deep crowns and lush moss growth, and have protected large, mature, and old-growth trees from catastrophic fires. Good horizontal and vertical cover are essential for turning good platforms into good nesting sites, as they help conceal the nests from depredation. Western hemlock, where present, appears to offer larger limbs and better cover at a younger age than Douglas-fir, even in the absence of dwarf mistletoe. Table F-1 presents the habitat characteristics of the marbled murrelet at the limb, tree, and plot levels.

A key finding for the murrelet's short-term conservation needs in the Elliott State Forest is that nests were predominately found in trees greater than 200 years old, with two or three found in 140 to 170 year old trees. These nest trees are part of the dominant cohort of the stands in which they occur.

Radar Surveys for Marbled Murrelets in the Elliott State Forest, Oregon, 2001 (Cooper and Augenfeld 2001)

Radar surveys of marbled murrelets (*Brachyramphus marmoratus*) were conducted in the Elliott State Forest during summer 2001, in an attempt to better understand murrelet abundance, distribution, and habitat use. Ornithological radar was used to obtain indices of abundance of marbled murrelets at six drainages in the Elliott State Forest. The specific objectives of the 2001 study were to:

- Obtain information about the inland abundance and distribution of marbled murrelets by conducting radar-based counts in several management basins
- Determine general flight patterns of murrelets over the Elliott State Forest
- Collect baseline data that could be used as part of a long-term data set to examine population trends for marbled murrelets on the Elliott State Forest
- Locate additional radar sampling sites in the Elliott State Forest
- Provide preliminary information on the relationship between murrelet abundance and nesting habitat on the Elliott State Forest and on the applicability of using radar for inventory and monitoring of murrelets on other State Forest lands

Table F-1. Marbled Murrelet Habitat Characteristics (mean) at the Limb, Tree, and Plot Level in the Elliott State Forest, 1995–1999

Description	Mean Value	Comments
Limb Characteristics		
Diameter at nest	8.5"	Generally larger than diameter at bole
Height	120'	
Distance from bole	40"	
Horizontal cover	42%	Lower in Elliott State Forest than North Coast—Douglas-fir vs. western hemlock
Vertical cover	74%	Lower in Elliott State Forest than North Coast—Douglas-fir vs. western hemlock
Moss on nest platform	84%	Averaging 2 inches deep
Tree Characteristics		
DBH	55"	
Height	211'	On mostly site class II ground
Number of platforms	35	No relationship between platform number and DBH
Moss coverage on limbs	68%	8 percent less than North Coast nest trees
Plot Characteristics		
Trees per acre <18” DBH	68	
Trees per acre ≥18” and <32” DBH	13	
Trees per acre ≥ 32” DBH	16	
Diameter breast height	20"	
Tree height	203'	
Midstory tree height	122'	
Trees per acre with platforms	15	Based on 25-meter radius plot (40-meter plot had 8 trees per acre)
Platforms per acre, ground count	175	Based on 25-meter radius plot (40-meter plot had 49 trees per acre)
Platform tree DBH	62"	
Moss coverage on limbs	86%	Overall in plot
Platform diameter	6.7"	
Platform height	75'	
Slope	38.6°	

The researchers found a total of 62 potential radar sampling sites in the Elliott State Forest, 17 of which required a lift-assisted radar. It was nearly impossible to find sites that provided radar coverage all the way to the valley floors, because of the steep topography and narrow valleys. Fourteen of the sites were sampled during the pilot study. Nearly 2,000 radar targets were recorded with flight speeds above the 64 kilometer per hour cutoff that researchers normally use to identify murrelets on radar. Only one species with a radar signal similar to murrelets, the band-tailed pigeon, was identified, and its presence was minor.

Overall, 81.6 percent of flights went over ridges, making it impossible to obtain an index of murrelet abundance for any specific drainage in the Elliott State Forest, because topography did not restrict flight paths of murrelets. Thus, no comparisons could be made between murrelet abundance and the amount of habitat estimated for each drainage sampled. Further, because murrelet habitat exists east of the Elliott State Forest, some proportion of the radar targets observed over the forest could have been in transit to or from that habitat.

The researchers conducted a series of power analyses to examine the effects of certain variables—number of sampling sites, sampling visits per year per site, and number of years—on the power to detect changes in landward and seaward radar counts. The researchers estimate that annual changes in murrelet counts as small as three percent could be detected in the Elliott State Forest within 10 years by sampling only 20 sites, due to a moderate level of variation among samples at a site. The power analyses also revealed that increasing the numbers of sites or number of survey years likely would be more cost effective in increasing power than would adding to the number of survey visits per year per site. Further, the analyses showed that it would be more difficult to detect a decreasing trend than an increasing trend.

Radar appears well suited for monitoring changes in the local murrelet population overall. The primary difficulty with using radar counts to evaluate management strategies in the Elliott State Forest is that murrelet counts may be influenced by management activities on non-state adjacent lands, where some of the birds sampled may have been headed.

Northern Spotted Owl Studies

In 1993, the ODF and researchers from Oregon Cooperative Fish and Wildlife Research Unit and Oregon State University (OSU), College of Forestry developed a multi-year study that examined spotted owl populations and habitat on two study sites on ODF lands: state forest lands in the northern Oregon Coast Range, and the Elliott State Forest in the central Oregon Coast Range. The Elliott State Forest contained more mature forest than the state forest lands in the northern Coast Range, and was similar to other areas used by spotted owls in the Oregon Coast Range; this provided a basis for comparison with the young habitat found in the northern study area. Ultimately, this research was designed to provide the ODF with a better understanding of which patterns of nesting, roosting, and foraging habitat on the landscape could sustain populations of spotted owls in younger forests. Data obtained would be used to develop and implement silvicultural strategies to provide habitat for spotted owl populations within managed forests. Three separate field studies were established to meet the research objectives, and a synthesis report tying the three studies together and relating back to the objectives was produced.

Demographic Characteristics of Northern Spotted Owls on Lands Managed by Oregon Department of Forestry (Anthony et al. 2000b)

Demographic characteristics of northern spotted owls were studied in two areas managed by the ODF in the Oregon Coast Range: the North Coast and the Elliott State Forest. In the Elliott State Forest study area, the total number of territories located decreased from 26 in 1993 to 12 in 1998. The number of pair sites located during this time period decreased from 13 to 7.

In two related measurements of density, the number of owls per square kilometer and territories per square kilometer significantly declined during the course of the study—from 0.106 owls per square kilometer and 0.055 territories per square kilometer in 1993 to 0.061 owls per square kilometer and 0.034 territories per square kilometer in 1996, the last year in which all suitable habitat in the Elliott State Forest was surveyed. The number of female young produced per female spotted owl over the course of the study was 0.30 (confidence interval of 0.21 to 0.39), which is similar to the mean fecundity calculated in other demographic study areas, while the number of young produced per female that produced at least one young was fairly constant over the course of the study, with a mean of 1.53. Young were produced in the Elliott State Forest every year of the study, exhibiting more stable annual productivity than in other study areas. Adult survival rates in the Elliott State Forest appeared to be declining over the course of the study. The mean overall adult survival rate was estimated at 0.85 (confidence interval of 0.77 to 0.90), similar to rates found on other studies, and juvenile survival rates were higher than rates found on most other studies, averaging 0.54 (confidence interval of 0.34 to 0.72). Annual rate of population change was 0.972 (confidence interval of 0.890 to 1.054), slightly higher than the mean estimate from several other studies (Franklin et al. 1999). Because the confidence intervals on the estimate include 1.0, it cannot be determined whether the population is declining, remaining the same, or increasing.

Because owl sites in the Elliott State Forest are not isolated from one another or from adjacent populations, immigration into the area should contribute to population stability. However, the declining trends in density and adult survival over this five-year period are cause for concern in this study area.

Home Range and Habitat Use of Northern Spotted Owls on State Forest Lands in the Oregon Coast Range (Anthony et al. 2000a)

Home range and habitat use of 16 of the northern spotted owls monitored for the demographic study were studied in the Elliott State Forest between 1997 and 1998. Mean home ranges associated with owls in the Elliott State Forest were smaller than those previously reported for other study areas in the Oregon Coast Range and Cascades. Using a 100 percent minimum convex polygon method, the mean home range size on the Elliott State Forest was 2,735 acres, compared to mean home range sizes in other study areas ranging from 3,620 acres to 6,057 acres. The range of home range sizes on the Elliott State Forest was 1,425 acres to 5,555 acres. In comparison, a 1.5-mile circle (the area recommended for management for spotted owls in the Oregon Coast Range province by the USFWS in the rescinded “incidental take guidelines”) contains 4,520 acres. A different method for estimating home range size, the 95 percent fixed kernel, estimated home range size in the Elliott State Forest of 2,088 acres and a mean “core use area” (50 percent fixed kernel) of 214 acres.

Spotted owls in the Elliott State Forest selected mature, old, and “mixed age” coniferous habitats, but also selected hardwood habitats. Hardwoods appear to be providing some of the habitat attributes needed to sustain owls in these forests. An analysis of habitat edge types showed that owls also selected the edge (or ecotone) between hardwood and conifer stands. This includes hardwood trees with relatively complex canopies, such as bigleaf maple and myrtlewood. Spotted owls avoided habitat types with no apparent ecotone, or “edge.” Owls also avoided certain edge types that contained pole or open components. These results suggest that hardwood/conifer edge habitat may be promoting a healthy prey base or enhancing access to prey.

Characterizing Northern Spotted Owl Habitat on State Forest Lands in the Oregon Coast Range (Tappeiner et al. 2000)

Within nine of the known spotted owl home ranges in the Elliott State Forest, density, structure, and species composition of forest stands in nesting and foraging habitat were measured and compared to stands within the home ranges that received little or no use (low-use areas). There was no difference in tree size or density among nesting, foraging, and low-use areas, and no relationship between these characteristics and the relative success of owl sites (as measured by owl reproduction and occupancy) in the Elliott State Forest. Similarly, downed woody debris was equally common between nest, forage, and low-use areas, suggesting that it is not a limiting factor in the Elliott State Forest. Some of the habitat characteristics that did differ among habitat types related to the abundance of large trees and snags. Of the 100 biggest trees measured in the study plots in the Elliott State Forest, nest and foraging areas tended to have a greater abundance of these large trees than did low use areas. In addition, the number and size of snags was greater in nest areas than in forage and low-use areas in the Elliott State Forest. Within nest areas, nest trees tended to be larger than the mean tree and snag size.

In addition to measuring characteristics of habitat within owl home ranges, the investigators studied tree growth rates adjacent to known owl sites by examining tree stumps. The results of this work indicated that initial stocking densities likely were low in some stands. The investigators also noted that 10 to 15 percent of the foraging plots had been thinned 15 to 40 years prior to the study. These results suggest that lower tree density contributes to owl habitat, whether created naturally or through management. Various ways of accelerating habitat development through active management were modeled.

Synthesis Findings (Glenn et al. 2000)

Areas used by spotted owls in the Elliott State Forest were generally older, with larger trees and lower tree densities than in the North Coast. The spotted owl population in the Elliott State Forest was larger and appeared to be more stable than the North Coast population, suggesting that habitat for spotted owls in the Elliott State Forest was higher quality than at the North Coast. Although spotted owls in the Elliott State Forest were not as isolated from other populations and density of owls in the Elliott State Forest was higher than at the North Coast, declining trends in adult survival and density over the course of the study remain areas of concern. Preserving the most productive spotted owl territories and maintaining connectivity among spotted owl sites in the Elliott State Forest and on adjacent lands may help stabilize the population and increase the number of productive owl pairs in the Elliott State Forest.

Northern Spotted Owl Surveys, Elliott State Forest, 2003 (Perkins and Ellingson 2003)

In 2003, the ODF contracted with Kingfisher Ecological to conduct a single-year, six-visit survey of the Elliott State Forest. The objectives of this survey were to obtain a density estimate to compare to previous estimates (Anthony et al. 2000b) and to determine the status of activity centers that were last visited in 1998.

Twenty-five owls at 13 activity centers (12 pairs and a single owl) were located. The density of owls was 0.066 per square kilometer, and the density of activity centers was 0.034 per square kilometer. These estimates were virtually unchanged from the last six-visit survey of the entire Elliott State Forest in 1996. In addition, 11 of the sites that had residency status according to USFWS survey protocol in 1998 had responding owls in 2003. Four sites that had status in 1998 had no owls respond in 2003; however, these were sites that had begun to decline prior to 1998. One new pair and one new resident single site were found. Barred owls were found to be present at several sites, a new development since surveys were last conducted, including some of the historically reproductive pair sites. While these sites were not abandoned, in several cases the spotted owls appeared to have shifted slightly away from their historic activity center locations. No nests were located during the 2003 survey. Very few nests were found over the entire range of the owl in Oregon in 2003, however, so this situation was not unique to the Elliott State Forest.