APPENDIX F

Effects of Habitat Thinning on Northern Spotted Owls? Literature Summarized through 2005

Executive Summary

The intent of this white paper is to summarize the northern spotted owl (*Strix occidentalis caurina*) literature related to the issue: What are the effects of habitat thinning on northern spotted owls? This summary does not represent Fish and Wildlife Service policy. It is primarily focused on thinning of nesting, roosting, and foraging habitat, commonly referred to as "NRF." Where "dispersal-only" habitat thinning information is available, it is also included. There are four objectives that framed this summary, each is discussed below.

One of the objectives of this summary was to include literature covering spotted owl direct response to habitat thinning. Available literature suggests that light thinning/partial harvest does not necessarily lead to overall avoidance of treated stands. However, continued use of thinned habitat may be variable.

A second objective of this literature summary was to examine whether or not habitat thinned to approximately 60 percent canopy cover continues to support NRF function and 40 percent for dispersal function? Available information seems to indicate that 60 percent canopy cover does not necessarily preclude the function of NRF. Similarly, dispersal habitat thinned to 40 percent likely has similar results. However, there is an important qualification in interpreting these studies. For example, it does not appear that any of the studies attempted to determine the "lower" limits of canopy cover for NRF. Therefore, no lower threshold value and associated spotted owl response has been quantified.

The relationship between habitat thinning and effects to spotted owl prey was a third objective of this summary. Available literature suggests that variable-density thinning, as opposed to conventional thinning prescriptions, holds promise for the acceleration of the development of spotted owl habitat and dense prey populations especially when appropriate attention is paid to decadence (snags, cavity trees, and coarse woody debris).

The fourth objective of this literature summary covers the habitat structural features that should be considered when proposing northern spotted owl habitat thinning prescriptions. Available literature suggests that forest stand structural attributes positively associated with NRF habitat included vertical canopy layering, tree height or diameter diversity, high canopy closure, snags, log volume and hardwood presence. Therefore, thinning prescriptions in spotted owl habitat should generally account for these elements in stand development.

From this literature summary, the following broad themes emerged. First, the information base on this particular subject is somewhat limited and directed studies are still needed. Second, the limited available literature appears to support the concept that spotted owl habitat can be thinned, to some degree (i.e., lightly), and retain its biological function post-treatment. It is still incumbent on the administrative unit biologist to make the appropriate effects determination for each site specific action.

Effects of Habitat Thinning on Northern Spotted Owls?
Literature Summarized through 2005

The intent of this white paper is to summarize the northern spotted owl (*Strix occidentalis caurina*) literature as related to the issue: What are the effects of habitat thinning on northern spotted owls? This summary does not represent Fish and Wildlife Service policy. It is primarily focused on thinning of nesting, roosting, and foraging habitat, commonly referred to as "NRF." Where the information is available, thinning of dispersal-only habitat is also reviewed. The following objectives were established to guide the summarization.

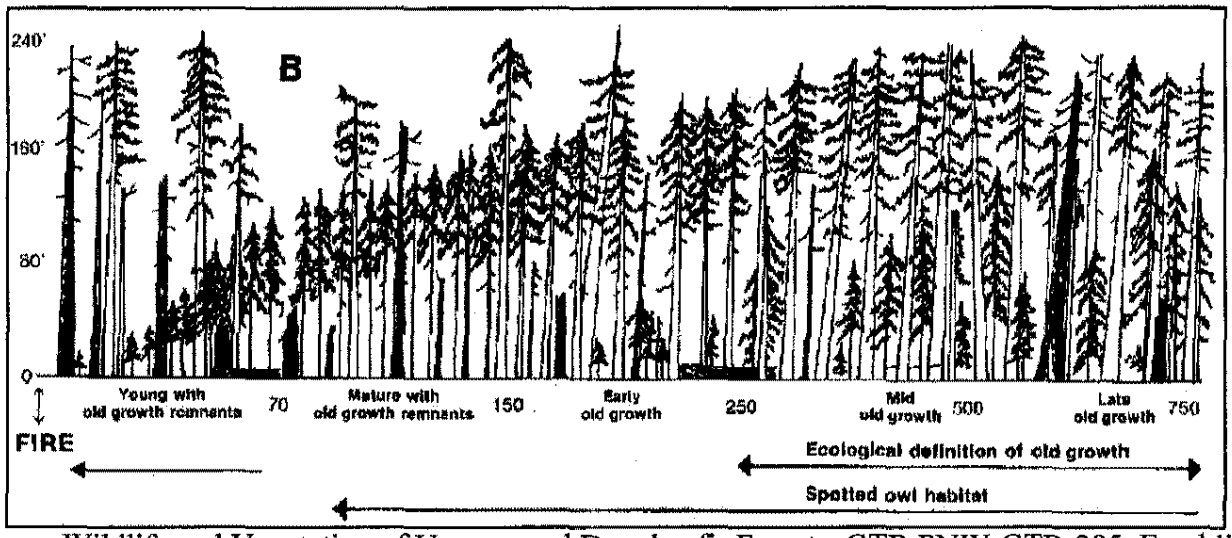
1) What is the direct response, if any, by northern spotted owls to thinned habitat?
2) Can we differentiate northern spotted owl responses to different types of thinning regimes based on the resulting canopy cover post thinning (e.g., 60 and 40 percent)?
3) What are the potential impacts to northern spotted owl prey species in thinned habitat?
4) When proposing northern spotted owl habitat thinning activities, what habitat structural features should be given primary consideration in silvicultural thinning prescriptions?

This literature summary is focused on the Coast, West Cascades and Klamath Physiographic Provinces in Oregon. Due to the complexities of forest ecosystems and paucity of information, a summary of habitat thinning for the East Cascades Province of Oregon will be developed at a later date. It is the intent of this summary to help inform the Section 7 consultation process. However, this document will not cover consultation affects (i.e., may affect likely to adversely affect or not likely to adversely affect) due to thinning. It is incumbent on the administrative unit biologist to make the appropriate effects determination for each site specific action.

In addressing the habitat thinning issue, an understanding of the characteristics of northern spotted owl habitat is needed. Thomas et al. (1990:164) characterized northern spotted owl habitat as follows: a multi-layered, multispecies canopy dominated by large (>30" dbh) conifer overstory trees, and an understory of shade-tolerant conifers or hardwoods; a moderate to high (60-80%) canopy closure; substantial decadence in the form of large, live coniferous trees with deformities – such as cavities, broken tops, and dwarf mistletoe infections; numerous large snags; ground cover characterized by large accumulations of logs and other woody debris; and a canopy that is open enough to allow owls to fly within and beneath it. Thomas et al. (1990:1) also concluded that: "these attributes are usually found in old-growth, but they are sometimes found in younger forests, especially those that contain remnant large trees or patches of large trees from earlier stands." Courtney et al. (2004) showed in their summary that spotted owl habitat use occurs in these younger stands, in particular when large trees from the earlier, older stands remain. It should be noted that NRF habitat meets some or all of the life needs of the spotted owl (USDI FWS 1992). Thomas et al. (1990) also defined spotted owl dispersal habitat as a forest stand having an average diameter of 11 inches and at least 40 percent canopy cover.

The following figure is a depiction of northern spotted owl habitat that occurs as a continuum across forest seral stages and conditions. Here, higher quality spotted owl habitat would include forest in the old growth condition whereas relatively lower quality habitat would most likely be in the young forest with remnants. It should be noted that this figure contains a time scale and associated spotted owl

habitat. However, in some areas, spotted owl habitat can be younger than 80 years old when the stands contain older forest remnants, as cited above.



Source: Wildlife and Vegetation of Unmanaged Douglas-fir Forests, GTR PNW-GTR-285, Franklin and Spies 1991.

Objective 1: What is the direct response by northern spotted owls to thinned habitat?

This literature summary includes whether or not northern spotted owls abandon their sites or alter their home range use patterns in response to thinning and/or partial harvest activities.

Solis (1983), using radio-telemetry, found that a northern spotted owl pair infrequently used a recently thinned unit that was in a pole/medium timber condition. The understory of the thinned unit burned and the owls did not use the unit post-burn. Solis also found a different spotted owl pair infrequently using partially logged pole/medium timber. Each spotted owl pair was radio-tracked for a little more than a breeding season. These stands retained 70 percent canopy closure post-thinning. However, Solis (1983) provide little information on pre and post treatment habitat information to adequately quantify a cause and effect response by the spotted owls.

Forsman et al. (1984) noted that of the spotted owl pairs found in old-growth or mixed old-growth and mature forests, four pairs occupied stands that had been selectively logged prior to the initiation of the study and nine pairs occupied stands that were selectively logged after they were first located. In their study, selective logging is a harvest method in which canopy density is reduced by removing some of the overstory trees. The understory is either left intact or thinned. Of the four pairs occupying previously logged sites, three nested in stands that had been logged 30-40 years earlier. The nest of the fourth pair was in an unharvested old-growth stand, 5 m from the edge of an area that had been selectively logged about 10 years earlier. In the former stands, young trees had since filled in many of the openings created by harvest, resulting in multilayered stands that were similar to unlogged old-growth stands except that the density of overstory trees was reduced.

Forsman et al. (1984) also found that of the nine sties that were selectively logged after the owls were located, seven sites were subjected to relatively light overstory removal and two were "heavily" thinned.

At six of the seven sites subjected to light overstory removal, timber sales were laid out so that a small patch (2.6-10 ha) of unlogged, old-growth was left around the nest tree of the resident owls. On the latter sites, three pair subsequently used their old nest trees in one or more years following harvest. The other three pairs remained in the same general areas after harvest, but the researchers were unable to document nesting. On the two sites where overstory and understory trees were heavily thinned, the spacing between the trees in the owl nest areas increased from 10-20 m as a result of the harvest. Canopy closure was reduced to < 50 percent. One of these owl pairs subsequently disappeared. The other pair shifted their activities to an unlogged old-growth stand bordering the harvested area; a new nest was located in the unlogged area four years after harvest of the original nest area.

Irwin et al. (1989) reported that many private forest managers in northern California observed owl pairs nesting successfully following partial harvest that retained relatively continuous forest canopies and important structures believed to influence owls and/or their prey. Unfortunately, Irwin et al. (1989) provided no information on the age or structure or canopy cover of the stands to ascertain the magnitude of the thinning or remaining structures.

Kerns (1989) monitored three spotted owls during the breeding season. One of the owls used a thinned, relatively more open stand. No data were provided on the structural condition of the stands.

King (1993) compared vegetation characteristics between owl use sites (foraging and roosting) and random sites in the Eastern Cascades, Washington on managed forests in the Yakama Indian Reservation. Nearly all stands in the study area had been selectively harvested a few years prior to the study (uneven age management). According to the authors, spotted owls used sites within the managed forests that retained higher canopy cover. However, the authors did not provide quantitative stand information to determine the extent of the thinning or retained structures.

Buchanan et al. (1995) reported that partial harvesting had occurred at 23 percent of 83 nest sites where northern spotted owl had reproduced successfully in prior years in the eastern Washington Cascades. The harvests there apparently occurred 40 or more years prior to the study, so it was unknown if the managed stands had been used by owls continually.

Hicks et al. (1999) documented through telemetry work on 14 northern spotted owls that the owls occasionally roosted in stands that had recently been managed, either through selective harvest or pre-commercial thinning. In both cases the owls were found in the managed stand within six months after ground operations. The partial harvest occurred in an older stand in which larger overstory trees were removed to release suppressed trees of moderate age. Pre-commercial thinning occurred over a large area immediately adjacent to the nest stand of one pair of owls. The male from this pair territory was observed in the thinned forest on several occasions. Very little stand information was provided by Hicks et al. (1999) to conclude the extent of the thinning.

Meiman et al. (2003) tracked the response of a single male spotted owl following commercial thinning in young (second-growth, 70-80 years old) Douglas-fir stands in the Oregon Coast Range. They recorded 13 percent of the male's locations in the thinned area prior to harvest. After harvest, they recorded 3.8 percent of the locations in the thinned area. Use of the thinned stand was statistically significantly greater before than after harvest. Unfortunately, limited thinning information was

provided by Meiman et al. (2003) to evaluate the magnitude of stand alteration, although, it was characterized as a relatively heavy thin.

Irwin et al. (2005) is in the progress of evaluating spotted owl fidelity to home ranges following silvicultural treatments and relative use of specific forest stands that received silvicultural treatments. To date, at least 19 thinning and partial harvest (implemented with varying landowner objectives and densities of retained trees) treatments in young stands, foraging habitat, have occurred in spotted owl home ranges within their study area(s). Preliminary results suggest that while some seasonal movements occurred outside of breeding season home ranges, Irwin et al (2005) found that no spotted owls vacated their home ranges after treatments were applied. For the only two case examples provided in Irwin's progress report, spotted owl use frequency of stands pre- and post-treatment remained similar. The pre- and post-harvest conditions have not yet been measured for most of their study areas, although, canopy retention was above 60 percent.

Summary: Northern spotted owl direct response to thinned habitat.
From the available information presented above, there seems to be mixed – direct- responses by spotted owls to thinned habitat. The case study by Meiman et al. (2003) suggests that to some degree, thinning, particularly relatively heavy thinning reduces spotted owl use of stands. Data provided by Forsman et al. (1984) (late-successional forest) and Irwin et al. (2005) (younger aged forest) offer somewhat different insights relative to Meiman et al. (2003), where there seems to be moderate to high use of relatively more "lightly" thinned stands. However, continued use of thinned habitat may be variable. A couple of limitations exist in interpreting the above studies. First, the avoidance and/or use of thinned stands by spotted owls is an area in need of more information, in particular, experimental treatments. Second, the pre- and post- harvest stand conditions are not well presented, thus making interpretation somewhat difficult.

Objective 2: Can we differentiate northern spotted owl response to habitat thinning based on resulting canopy cover? A fundamental question here is, does habitat with 60 percent canopy cover continue to support NRF function, or 40 percent continue to support dispersal function?

Thomas et al. (1990) characterization of spotted owl habitat includes canopy cover usually ranging from 60-80 percent. The federal land management agencies and the USFWS utilize a 60 percent canopy cover standard to differentiate the consultation effects determination between a light and heavy thinning. A light thin maintains canopy cover above 60 percent. This value is likely a result of the Thomas et al. (1990) habitat definition. What follows is a summary of the relationship between canopy cover amount and spotted owls habitat use. Please see Table 1 for specific studies and their resulting values of canopy cover.

Solis (1983) monitored radio-tagged spotted owls and found that stands that had relatively higher canopy cover (>70 percent) (along with higher amounts of other structural elements) received greater use by spotted owls. Whereas, forest stands receiving relatively lower foraging use were described by further decreases in canopy closure (and decreases in other structural elements).

Forsman et al. (1984) found that in heavily thinned stands, where canopy cover was reduced to less than 50 percent the owl pairs disappeared or shifted their activity area to unlogged areas. It should be noted

that in this study that the sample sizes were small and the results were not based on an experimental design.

The USDI Draft Recovery Plan (1992), Tables B 12-14, show numerous studies and the relationship of canopy cover and stem density to spotted owl nesting, roosting and foraging habitat. Overall, mean canopy closure was around 80 percent for all of these activities.

Hanson et al. (1993) found in a telemetry study located in the eastern Washington Cascades that forest with less than 50 canopy cover is rarely used by spotted owls for roosting or foraging.

North et al. (1999) found that overstory canopy cover was typically above 90 percent for foraging locations. This value occurred from low, moderate, to high owl-use intensity foraging locations.

Hicks et al. (1999) documented that spotted owls occasionally roosted in stands that recently had been managed, either through selective harvest or pre-commercial thinning. The post-selective harvest canopy cover value was 56 percent whereas the pre-commercial thinning canopy cover value was 35 percent.

Herter et al. (2002) in their Washington Cascades study found spotted owls using mature/old forest for roosting with over 60 percent canopy cover more than expected during the non-breeding season. No ranges in canopy cover were provided in the study.

Courtney et al. (2004) in their review of the northern spotted owl literature found that high canopy closure was positively associated with NRF habitat. The authors did not provide nor recommend a specific value of canopy cover.

Table 1. Canopy cover values for northern spotted owl habitat from various study areas. Values are expressed as a mean as reported in the respective publications. When available, ranges (%) are reported with the means. The authors provided the categories of nesting, roosting, or foraging habitat.

Washington Westside (West Cascades and Olympic Provinces)

Source	NRF Habitat
Buchanan 1991	75%
Hershey 1995	79% (68-87%)
North et al. 1999	92%
Herter et al. 2002	84%

Oregon Westside (Coast Range and West Cascades Physiographic Provinces)

Source	NRF Habitat
Irwin et al. 2000	80%
Thrailkill et al. 1998	78%
Forsman et al. 1984	69% (35-91% - only 2 nests were <55%)
Hershey 1995	75% (62-85%)

Klamath Province (Oregon and California)

Source	N/R Habitat	Foraging Habitat
LaHaye 1988	81% (69-94%)	
Hershey 1998	74% (54-84%)	
White 1996	70%	
Solis 1983 & Solis & Gutierrez 1990	93% (64-98%)	88% (73% low use areas) (67-93%)
Bingham et al. 1991	83%	84%
Self et al. 1991		> 25%
Gutierrez et al. 1992	70-95%	50-90%
Gutierrez et al. 1998	95%	

Northern spotted owl dispersal-only habitat

Dispersal habitat for the northern spotted owl generally consists of mid-seral stage stands between 40 and 80 years of age with canopy cover of 40 percent or greater and an average dbh of 11". Dispersal habitat may have roosting and foraging components, enabling spotted owls to survive, but lack structure suitable for nesting. The unit wildlife biologist makes site-specific determinations and delineations of dispersal habitat with a landscape context usually part of this determination.

Studies by Miller 1989 and Miller et al. (1997) provide information on habitat use by dispersing juvenile northern spotted owls; these studies were conducted in the Oregon Coast Range, Klamath Province and Western Cascades. Old-growth and mature forest were combined in analyses and defined as forest dominated by trees > 53 cm dbh, generally 100% canopy cover, at least two height classes of trees, and decayed living trees, snags and downed woody material. Other cover types defined were closed sapling-pole-sawtimber stands (2.5 to 53 cm dbh and > 60% canopy cover), open sapling-pole stands (2.5 to 53 cm dbh and > 40 % and < 60% closure) and clearcuts (< 40 % cover). Mature and old-growth forest was used slightly more than expected based on availability during the transience phase and nearly twice its availability during the colonization phase. Closed pole-sapling-sawtimber habitat type was used roughly in proportion to availability in both phases; open sapling and clearcuts were used less than

expected based on availability during colonization. Miller's study does not directly address the relationship between habitat thinning and dispersal. Although his work does provide limited insights into a lower canopy value utilized by dispersing spotted owls.

Summary: Northern spotted owl - canopy cover relationship.
As stated at the start of this section, a fundamental question here is, does habitat with 60 percent canopy cover continue to support NRF function? From the available literature, the answer to this question seems to indicate that a lower canopy cover value of 60 percent does not necessarily preclude NRF function. However, there are some important caveats in this interpretation. First, it does not appear that any of the studies attempted to determine the "lower" limits of canopy cover need to support NRF function. Therefore, no lower threshold value and associated spotted owl response has been quantified. The studies are merely the spotted owls' association with habitat and a measure of canopy cover. Second, in the above studies we assume that the other habitat parameters (see discussion below) are adequate because there is no mention of their deficiencies. For example, two studies (i.e., Solis 1983 and North et al. 1999) found that spotted owl use corresponded to increases in canopy closure as well as several other habitat structural elements.

Objective 3: What are the potential impacts to spotted owl prey species in thinned habitat?

Thinning has short-term negative effects on understory plants (mechanical destruction) and below-ground fungi (death of host trees and mechanical destruction) (Courtney et al 2004). Due to these effects, spotted owl prey species are likely affected because of reduced food availability and reduction of cover. Logging methods that minimize ground disturbing activities/area could minimize detrimental impacts to prey habitat and food resources.

Conventional thinning (e.g., uniform spacing and density) in the Western Hemlock Zone may result in low flying squirrel populations through negative effects on truffle production and arboreal travel ways (Summary by Carey *in* Courtney et al. 2004) for a long period of time while increasing numbers of forest floor rodents (Wilson and Carey 2000). Carey (2000) found that 70 year old un-thinned stands had more flying squirrels than similarly aged stands that had been commercially thinned twice. However, the un-thinned stand had numerous residual large snags and live trees, which were absent or few in the thinned stands. Conventional thinning may result in unfavorable spotted owl foraging conditions in the midterm due to uniformly dense understories (Carey *in* Courtney et al. 2004). The authors did not provide a time frame related to "midterm." or an indication of the type of spotted habitat (NRF or dispersal) that the study was conducted in.

Gomez et al. (2005) investigated the effects of thinning young (35-to-45 year old) Douglas-fir forests on density, movements, and diets of northern flying squirrels in the northern Coast Range of Oregon. Densities of flying squirrels were variable in space and time, but they were positively correlated to biomass and frequency of fungal sporocarps, suggesting they were responding to food resources rather than forest structure. The authors hypothesized that flying squirrel densities would be relatively low in these young, structurally simple forests; however, densities on some grids were >1.5 squirrels/ha, which was comparable to densities described for the species in late-successional forests. Gomez et al. (2005) results indicated that commercial thinning of young forests (from the article, FWS interprets this as

dispersal habitat) did not have measurable short-term effects on density or survival of flying squirrels. They speculated that leaving large trees and logs could further reduce the potential negative impacts of thinning operations on flying squirrel populations.

Manning and Edge (2004) studied the habitat associations of deer mice and creeping vole, both prey species of the spotted owl, in what probably was spotted owl foraging habitat (FWS interpretation of the habitat from the article). They found that these species are habitat specialists and tied to specific amounts of particular habitat components, in particular patches of downwood and possibly its interaction with shrub cover. The authors conclude that small-scale spatial heterogeneity in vegetation is important to small mammals.

Waldien (2005) examined differences in densities of small mammals in mature unharvested control stands and mature stands 8-10 years following each of three silvicultural treatments (group-selection, two-story, and clearcut harvest). In general, they found most species of small mammals were similar between unharvested stands and all three treatments, with a trend for greater densities in harvested stands. Densities of deer mice (*Peromyscus maniculatus*) were greatest in harvested stands although other measures of deer mice and Townsend's chipmunks (e.g., densities of male deer mice and male chipmunks), and densities of Oregon voles (*Microtus oregoni*) and Pacific shrews (*Sorex pacificus*) were similar among all stand conditions. Although limited data precluded statistical analysis, northern flying squirrel (*Glaucomys sabrinus*) and western red-backed vole (*Clethrionomys californicus*) abundances were similar between uncut control stands and group-selection stands suggesting that populations of these species my be maintained under a group selection harvest system, whereas two-story and clearcut stands do not appear to provide habitat for these species.

Prey species may also be negatively affected by incidental loss of hardwoods and hazard trees or snags during harvest. Because availability of large prey species, particularly dusky-footed woodrats and northern flying squirrels, have been shown to be important for spotted owl reproductive success (Barrows 1985; Zabel et al. 1995), activities that reduce prey populations could lower spotted owl recruitment. Therefore, silvicultural prescriptions that maintain snags and hardwoods should benefit spotted owls and their prey.

It should be noted that no one has yet demonstrated successful on-the-ground intentional acceleration of the development of diverse and abundant spotted owl prey or spotted owl habitat – too little time has passed since attempts to do so were begun (Carey *in* Courtney 2004). However, several studies have modeled results that hasten development of northern spotted owl habitat (Andrews et al. 2005)

Summary: Thinning and spotted owl prey habitat relationships.
Variable-density thinning, as opposed to conventional thinning prescriptions holds promise for acceleration of the development of spotted owl habitat and dense prey populations (Carey 1995, 2001) especially when appropriate attention is paid to decadence (snags, cavity trees, and coarse woody debris) (Bunnell et al. 1999; Carey et al. 2002). There may be short-term impact on truffle production, flying squirrel abundance, and owl foraging. However, the ecosystem recovers more quickly and begins to develop more quickly and completely than following conventional thinning (Carey *in* Courtney et al. 2004). Variable density thinning has all of the positive effects of conventional thinning, such as increased growth of trees, crown differentiation, development of understory, and increased flowering and fruiting of understory plants (Carey *in* Courtney et al. 2004) that provide important ancillary foods to spotted owl prey (Carey 2000) without the same extent of negative mechanical impacts, loss of canopy connectivity, loss of spatial heterogeneity, and loss of woody plant diversity. This is because variable density thinning emphasizes multi-species management. Therefore, variable density treatments are likely the most favorable prescriptions for providing key habitat structural elements for spotted owl prey. However, as mentioned previously, current results on northern spotted owl foraging responses to variable density, or other thinning regimes, is limited.

Objective 4: When proposing northern spotted owl habitat thinning activities, what habitat structural features should be given consideration in silvicultural thinning prescriptions?

Courtney et al. (2004) in their summarization of spotted owl habitat use studies found that forest stand structural attributes positively associated with NRF habitat included vertical canopy layering, tree height or diameter diversity, canopy volume, canopy closure, snag diameter, snag basal area or volume, tree diameter and log volume. Notably, positive relationships were found with the aforementioned attributes whether the samples of owls and random locations were within old growth forest, non-old growth forest, National Parks, public lands, private land, or tribal. Each attribute is further discussed below. Therefore, habitat thinning prescriptions should account for most of these elements so as to maintain some function of the habitat.

Canopy Cover
Solis (1983) monitored radio-tagged spotted owls and found that stands that had relatively higher canopy cover (>70 percent), along with higher amounts of other structural elements, such as snags in a greater state of decay, density of hardwoods and ground cover of herbs received greater use by spotted owls. Whereas, forest stands receiving relatively lower foraging use were described by further decreases in canopy closure (and decreases in structural elements).

The question of spotted owl demographic (survival and reproduction) response to thinned habitat is an area that has not been studied. Also, there are few studies where inferences can be made regarding stand structural elements and their relationship to spotted owl demography. In one such study, for example, Ripple et al. (1997) found that an index to reproductive rates at 20 owl sites in the Klamath Province, Oregon, increased with increasing proportion of old conifer forest in the landscape ($r = 0.64$, $P = 0.03$). Old conifer forest included open (40 to 59%) and closed ($\geq$ 60%) canopy stands dominated by conifers $\geq$ 50 cm dbh. As discussed in an earlier section of this review, habitat with at least 60 percent canopy cover and sufficient amounts of other habitat strucutural features appear to not preclude NRF function. Although, there are limitations to these interpretations as discussed above.

Snags

Snag volume is correlated with increased foraging use (North et al. 1999). Therefore, a prescription priority could include the retention of all of the largest diameter snags, including legacy snags from past disturbance events. Large rot resistant snags like western red cedar or Douglas-fir should be given preference. Snag volume is important to owl foraging sites because it influences local prey abundance (Carey 1995). Snags, particular large intact snags, are likely to have excavated cavities used by the northern flying squirrel, a primary prey item of the owl. Study results from experiments with cavity nesting boxes (Witt 1992) suggest that the density of flying squirrels may be influenced by cavity availability. Consequently, stands with high snag volumes could provide the structures needed to support higher prey populations for the owl. Logging/safety concerns will have to be considered when leaving snags.

Down Wood

In many cases, the northern spotted owl habitat elements also serve as the habitat needs for the owl's prey. For example, studies (Carey et al. 1999) conducted in the Oregon and Washington Cascades and Coast Ranges have demonstrated a direct relationship between increasing levels of coarse woody debris (CWD) in a stand and the abundance of small mammals (e.g., northern flying squirrel) in those stands. The relationship is very clear up to a point where the study sites possessed 10-15 percent cover of coarse wood. Capture rates of flying squirrels are positively associated with the amount of coarse woody debris in the stand (Carey et al. 1999). However, the relationship between CWD amounts and small mammal abundance wasn't as clear as it is in the stands with 15 percent or less CWD cover. Basically, the more the better, up to a point, but where that point is, is unclear.

Based on the prey-down wood relationship, the retention of existing down wood, in a variety of diameter and decay classes in thinned spotted owl habitat is needed. In addition, the thinning prescription should take advantage of creating conditions where coarse wood debris recruitment can be hastened.

Tree Height Class Diversity

Tree height class diversity is a measure of how much diversity there is between height classes for all trees. As height class diversity increases, the canopy is less dominated by trees of similar height and heterogeneity increases. Stands with a wide range of tree heights usually have greater number of foliage layers. In southwest Oregon, Carey et al. (1992) found that foliage height diversity as an important feature of owl roost and foraging sites. Hunting success should be improved by stands with a canopy that facilitates location and capture of prey. Generally, owls fly to a perch and wait for prey (Forsman et al. 1984). Good foraging might be found in stands that are open enough for unobstructed flight yet provide spotted owls with perches at all levels in the canopy. Stands with high tree height diversity would have low perches available for hunting and yet enough open space to facilitate subcanopy flight and capture prey. Tree height diversity is dependent on having large diameter trees. Anthony and Wagner (1998) showed a relationship between increasing canopy layers and spotted owl foraging use in their southwest Oregon study area. Variable density prescriptions should generally retain a mix of diameter classes, including favoring large diameter trees, as well as areas left un-thinned in both old and

young stands. This approach would likely promote overall tree height class diversity benefiting spotted owl foraging.

Maintaining older hardwoods

Numerous studies have cited the importance of hardwoods as an element of spotted owl habitat (Hershey 1998, Thrailkill et al. 1998, Solis 1983, Glenn et al. 2004, Forsman et al. 1984 and others). Hardwood growth patterns increase the horizontal and vertical complexity of stands benefiting roosting and foraging spotted owls. Thinning prescriptions should favor the retention of older hardwoods along with some shade tolerant conifers when appropriate. Where possible, prescriptions should favor maintenance of conifer-hardwood ecotones.

Summary: Structural Features

The features mentioned above were the ones most frequently positively associated with northern spotted owl habitat at the stand level (Courtney et al. 2004). Therefore, thinning prescriptions should consider these elements post-harvest.

Document written by Jim Thrailkill, OFWO
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BIOLOGICAL ASSESSMENT OF HABITAT MODIFICATION PROJECTS PROPOSED DURING FISCAL YEARS 2011 AND 2012 IN THE NORTH COAST PLANNING PROVINCE, OREGON, THAT ARE NOT LIKELY TO ADVERSELY AFFECT (NLAA) NORTHERN SPOTTED OWLS OR MARBLED MURRELETS AND THEIR CRITICAL HABITATS

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