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Long-Term Population Monitoring of Northern Spotted Owls: Recent Results and Implications for the Northwest Forest Plan

Steven H. Ackers

Most of the other chapters in this book discuss the broad changes in forest management, economics, and public perceptions of the values and uses of Pacific Northwest (PNW) forests that have occurred over the past ten years. Here, I narrow the focus considerably to an important player in the events of the past decade, the northern spotted owl (NSO) (*Strix occidentalis caurina*). In addition to presenting a review of past research and an update of the present state of knowledge of this species, I also discuss the prospects for recovery and long-term persistence of this species under the Northwest Forest Plan (NWFP). Most importantly, I hope the reader comes away from this chapter reflecting upon some of the central questions surrounding the management of threatened and endangered species: What are the public's expectations and values that led to the creation of the Endangered Species Act (ESA) and the NWFP? Have these expectations and values changed with the hard lessons learned as a result of the spotted owl controversy? Is there a better way to proactively preserve our biological heritage than to respond to a rapidly accumulating list of species that are jeopardized by our actions? Admittedly, none of these questions will be definitively answered here. Indeed, these and related questions may not have definitive answers. But the questions themselves provide the impetus to reflect upon how we view our place in the world.

In many respects, the northern spotted owl has been a kind of "poster child" for the inevitable conflict between resource extraction by an ever-increasing human population and the requirements of plants and animals that occupy the habitats containing these resources. The lessons we have learned, and are continuing to learn, are broadly applicable to many situations in which meeting the demands of society alters the structure and function of ecosystems. The species that are found in one or a few unique habitats generally are the most vulnerable to the impacts of human activities (see Ruggiero et al. 1988, Lehmkuhl and Ruggiero 1991). These species developed their particular specializations and varying degrees of habitat dependence over many centuries while human technology developed the capability of permanently altering or destroying habitats over the course of a few decades.

The conflict surrounding the northern spotted owl and timber harvest illustrates this point quite well. In less than half a century, we developed the technology to quickly remove centuries-old timber from seemingly inaccessible locations. Recognition of the association between the northern spotted owl and late successional forests in the context of an accelerating rate of harvest resulted in the listing of the owl as a threatened species and subsequently severely affected the timber industry. This in turn created the need for a comprehensive management plan that crossed land ownership boundaries and considered many different species found in the forests of the Pacific Northwest. The NWFP was created in response to this need. Whether the NWFP becomes a model for addressing conflicts between resource use and habitat values in other systems or is eventually replaced by a plan with a different focus remains to be seen. In either case, the spotted owl controversy has presented an opportunity for adaptive management at a scale rarely, if ever, seen before.

Background

Research on the natural history of the northern spotted owl began in the central Oregon Cascade Mountains in the early 1970s (summarized in Forsman et al. 1984). Several literature reviews of the basic biology of spotted owls have been published elsewhere (see Gutiérrez 1985, Gutiérrez 1996), so I will not go into great detail here. Several life-history characteristics of spotted owls are relevant to their response to timber harvest, including their long life span, age at first breeding, and fecundity. Northern spotted owls can live fifteen to twenty years but generally do not reproduce every year. They typically produce only one or two (occasionally three) young and usually do not breed for the first time until after their second year of life. As a result of spreading out their reproductive effort over many years, fluctuations in density and population responses to environmental change may show a substantial time lag. The obvious implication for land managers is that the results of changes in management policy may not be apparent for many years.

The results of the initial studies of northern spotted owls also suggested that the subspecies was closely linked to the older stands of forest that provided much of the timber harvested from federal lands (reviewed in Gutiérrez and Carey 1985). Further research into habitat selection by spotted owls provided evidence that the harvest of old-growth forests negatively affected their populations (reviewed in Thomas et al. 1990). In response to these findings, several agencies and private organizations initiated demographic studies of northern spotted owl populations in the mid-1980s. A review of the evidence available as of 1990 led the Interagency Scientific Committee (ISC) to conclude that continued loss of habitat would put the spotted owl in jeopardy of extinction (Thomas et al. 1990). After the northern spotted owl was listed as a threatened species under the ESA in 1990 (USDI 1990) and the passage of the NWFP in 1994 (USDA/USDI 1994a), eight demographic study areas were identified to provide long-term data on spotted owl population trends (Lint et al. 1999). Each study area was intended to represent different physiographic provinces within the range of the northern spotted owl (defined in USDI 1992). In the sections that follow, I discuss the results of demographic research conducted from the H. J. Andrews Experimental Forest in the western Cascades province of Oregon.

The Demographic Studies

This research is fundamental to fulfillment of federal obligations under the ESA. The ESA requires that a recovery plan be developed for all species that are listed as threatened or endangered. The ultimate goal of the recovery plan for the northern spotted owl is to remove the subspecies from the list of threatened species when sufficient evidence is presented that indicates that northern spotted owls no longer require the protections provided under the ESA (USDI 1992). The evidence must consist of scientifically credible information that demonstrates a stable or increasing population across the range of this subspecies. The primary objective of the spotted owl demography studies is to estimate survivorship, fecundity, and the population rate of change as mandated by the recovery plan and the Effectiveness Monitoring Plan (EMP) (Lint et al. 1999). These parameters represent the vital rates of populations and as such are essential for accurately monitoring the status of spotted owl populations both among physiographic provinces and throughout their range.

An additional requirement of the recovery plan for the northern spotted owl is that land management agencies and landowners must make long-term commitments to provide the necessary habitat for spotted owls. A system of habitat reserves was initially proposed by the ISC to address the habitat needs of the northern spotted owl, but it was recognized early in the planning process that some of the reserves would contain a substantial amount of habitat in earlier seral stages than the owl typically uses (Thomas et al. 1990). These Late-Successional Reserves (LSRs) were expected to develop late-successional characteristics over time and provide additional habitat at a rate comparable to the rate of habitat loss through timber harvesting in the matrix lands. Additional small LSRs also were established to maintain connectivity between

LSRs (Thomas et al. 1990; see also Perry, this volume). Since 1990, the plan evolved to include other species associated with late-successional forests (USDA/USDI 1994a). The current system of LSRs specified in the NWFP are the result of this iterative process and are intended to provide the habitat base for the recovery of the northern spotted owl. The underlying principle is that the reserves should contain a sufficient number of spotted owls to produce enough offspring to replenish locally extirpated populations and sustain the populations within the LSRs (USDA/USDI 1994a).

An ancillary objective of the demography studies at the province level is to provide site-specific information to U.S. Forest Service (USFS) biologists about spotted owls in areas potentially affected by proposed management activities. In 1987, we monitored 52 activity centers in the H. J. Andrews study area. We increased the number of activity centers to 162, as new pairs were located and the scope of the project broadened to address the growing need for demographic information on spotted owls. Ideally, activity centers were to be based on the locations of historic nest trees, although locations of adults with young, pairs without young, or territorial single owls also were used as the basis of defining many activity centers. Continued monitoring since 1994 has shown that most activity centers correspond reasonably well to spotted owl territories, although many were established based on locations of nonterritorial owls or represent territories that are presently unoccupied. Because our focus is on annually locating and assessing the status of individually marked spotted owls, we are able to provide comprehensive information about the occupancy and productivity associated with each activity center. Our data allow USFS biologists to better assess the potential effects of proposed activities on spotted owl populations within the study area than if monitoring is restricted to only a few years prior to implementing a project.

Study Design

General Approach

Early attempts to assess the status of spotted owl populations focused on nocturnal calling surveys to obtain an index of population density based on response locations. However, it became apparent that density studies could provide only a rough assessment of population status. For example, nonterritorial owls (i.e., "floaters") generally are less responsive to calling surveys and are underrepresented as a result. Nonterritorial owls serve as a pool of individuals ready to replace the territorial breeding owls as they die. Unless individuals are distinguished, replacement of breeding owls by floaters or owls immigrating from outside of the study area cannot be detected. As a result, our ability to detect a population decline was hindered because a decrease in the number of breeding individuals is obscured by replacement of these individuals by the nonbreeding segment of the population (Franklin 1992).

Given the difficulties involved in obtaining an accurate estimate of population density, federal agencies began employing a mark-recapture approach in 1985 in which the survivorship and reproductive output of known individuals were used to estimate the rate of population change (see Franklin et al. 1996 for a more comprehensive review of the techniques involved). Spotted owls were captured and fitted with colored leg bands to facilitate identification of individuals during future breeding seasons. To determine the rate of change of the population, we focused on the breeding females in particular because this segment of the population drives the population growth rate. If the breeding females are not replaced through sufficient reproduction and subsequent recruitment into the breeding population, the population will be in decline (Anderson and Burnham 1992). By uniquely marking individual owls, we can account for the loss of a particular breeding female even if she is immediately replaced the following spring.

Population Parameters

Three parameters are central in assessing population trends in each of the long-term monitoring areas as well as throughout the range of the northern spotted owl. Fecundity, defined as the average number of female offspring fledged per non-juvenile female, is the parameter used to measure the amount of reproduction in the population. Next, age-specific survival probabilities are estimated for juveniles, 1-year olds, 2-year olds, and adults (i.e., individuals 3 years old or older) using methods developed for mark-recapture studies (see Franklin et al. 1996 for a review). Because emigration from the study area is indistinguishable from mortality, the actual parameter that is estimated is *apparent* survival, defined as the probability that an individual marked in a given year is still alive *and present on the study area* during the following year (Forsman et al. 1996). Fecundity and the age-specific survival probability for females are used to calculate the third parameter: the finite population rate of change, or lambda (λ). This parameter represents a quantitative assessment of the status of a population over a specified time interval. Confidence intervals of λ that include 1.0 indicate that a population is stable, while intervals above or below 1.0 indicate an increasing or decreasing population, respectively. Fecundity is calculated annually while the survivorship and population rate of change are calculated during periodic meta-analysis workshops in which all of the researchers meet to pool the results from all of the long-term monitoring areas to evaluate long-term, large-scale trends (Anderson and Burnham 1992, Burnham et al. 1994, Forsman et al. 1996, Franklin et al. 1999).

Study Area

Located in the central portion of the Willamette National Forest, the H. J. Andrews spotted owl demography study area encompasses over 152,000 hectares (377,000 acres) of land managed by the USFS (figure 10.1). Elevations range from approximately 400 m to just over 1,500 m. The predominant forest type is Douglas fir (*Pseudotsuga menziesii*)–western hemlock (*Tsuga heterophylla*), with stands of Pacific silver fir (*Abies amabilis*) and mountain hemlock (*Tsuga mertensiana*) at high elevations. Over half of the study area is either nonforest or has been harvested (Miller et al. 1996). Of the remaining forested habitat, approximately 60 to 65 percent is considered suitable habitat for spotted owls (L. Lyon, personal communication).

With the passage of the NWFP, the land within the study area was classified into several land-use allocations that allow for different levels and types of timber harvest near spotted owl

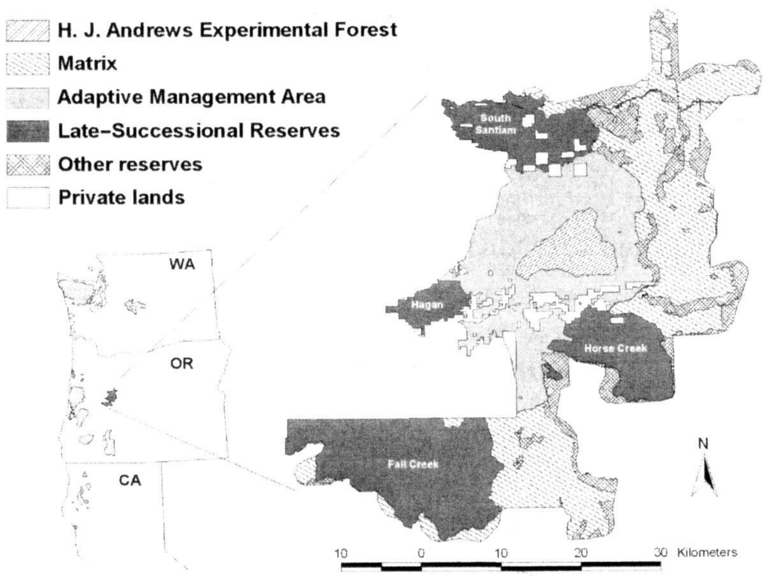

Figure 10.1. The H. J. Andrews Study Area for the Central Cascades Northern Spotted Owl Demography Project. The lower left portion shows the relative positions of the long-term monitoring areas. The right side shows the approximate boundary of the H. J. Andrews study area and the various land-use allocations under the Northwest Forest Plan. The H. J. Andrews Experimental Forest is located roughly in the center of the study area.

territories. To date, there has been little implementation of the timber harvest allowed under the plan. Therefore, the results discussed in the next section can be thought of as a "snapshot" of the current conditions that potentially could be affected by full implementation of the NWFP.

Approximately 32 percent of the land within the study area has been designated as matrix and will be available for harvest pending full implementation of the NWFP. Spotted owl management within the matrix allocation consists of protecting 40-hectare (100-acre) parcels surrounding activity centers together with riparian reserves that provide connectivity among the activity centers. We monitored forty-three spotted owl activity centers within the matrix allocation, accounting for approximately 24 percent of the total number of activity centers on the study area.

The Adaptive Management Areas (AMA) represent a second land-use allocation that will be subject to a variety of timber har-

vest practices. AMAs are intended for developing and testing alternative means of managing forests for multiple uses. Each AMA has a unique focus, making generalizations about the potential effects of AMAs on spotted owls difficult. The Central Cascades AMA represents 27 percent of the H. J. Andrews study area, which is substantially more than the 6 percent of the land area allocated to AMAs encompassed by the NWFP. The focus of much of the Central Cascades AMA is landscape-level management based on natural disturbance regimes (Cissel et al. 1999). The H. J. Andrews Experimental Forest is contained within this AMA. Between 43 and 47 spotted owl activity centers have been monitored in the AMA—some of which have been monitored since the earliest days of spotted owl research.

There are four LSRs within the H. J. Andrews study area that vary considerably in size and in the quantity of late-successional habitat, and have differing spotted owl occupancy and reproduction rates, suggesting that they are not at present equally valuable as spotted owl habitat. A key element in the potential for the LSRs to provide for the habitat requirements of spotted owls is the likelihood that reserves containing large proportions of early-successional habitat will remain undisturbed long enough for late-successional characteristics to develop. Large-scale disturbances such as stand-replacing fires, windthrow, or pathogen outbreaks could easily set back succession and delay the development of late-successional characteristics for several decades. This calls into question the likely effectiveness of the NWFP in bringing about the recovery of the northern spotted owl and forces us to reexamine our priorities and expectations regarding forest management.

These four LSRs account for 34 percent of the H. J. Andrews study area and 30 percent of the area affected by the NWFP. The largest amount of low-elevation, late-successional habitat is found in the Fall Creek LSR while the Horse Creek LSR contains a large proportion of high-elevation, late-successional habitat. The Hagan and South Santiam LSRs represent earlier seral stages at low and high elevations, respectively. The owl activity centers in the three LSRs included in the study prior to 1998 (Hagan, Horse Creek, and South Santiam) had considerably lower rates of occupancy and fecundity than the activity centers within he matrix and AMA allocations (see "Results and Discussion"). Ve began adding the activity centers in the Fall Creek LSR in 998 when it became apparent that the other three LSRs were not providing an adequate sample to evaluate the effectiveness of hese reserves. By 2000, we were monitoring all known activity enters in Fall Creek. Among all of the LSRs, we currently monitor 75 activity centers.

The remaining 12 percent of the study area consists of congressional and administrative reserves, which is considerably ess than the 36 percent allocated range-wide by the NWFP. These reserves include wilderness areas, wild and scenic river corridors, research natural areas, and other areas previously excluded from timber harvest for reasons unrelated to spotted owl management. Only six spotted owl activity centers in the H. J. Andrews study area are located within these reserves, and much of the habitat is unsuitable for spotted owls. The importance of these types of areas to spotted owl conservation is a topic of considerable debate, but because they are underrepresented in the H. J. Andrews study area, the following discussion focuses on the matrix, AMA, and LSR allocations.

Results and Discussion

Activity Center Monitoring

The proportion of activity centers occupied by pairs increased sharply during the initial two years of the study, as the field crews learned the locations of nests and favored roosts. Since 1989, pair occupancy has shown a steady decline over time (figure 10.2). This is a cause for concern especially in light of the results of the 1998 meta-analysis that indicated a decline in the overall population of female spotted owls (Franklin et al. 1999). Most previous analyses have implicated habitat loss as the cause of this decline (see Bart and Forsman 1992). That the decline would continue beyond the near-cessation of timber harvest on public lands in the early 1990s is not unexpected, given the long life span of spotted owls. Pairs of owls may very well be capable

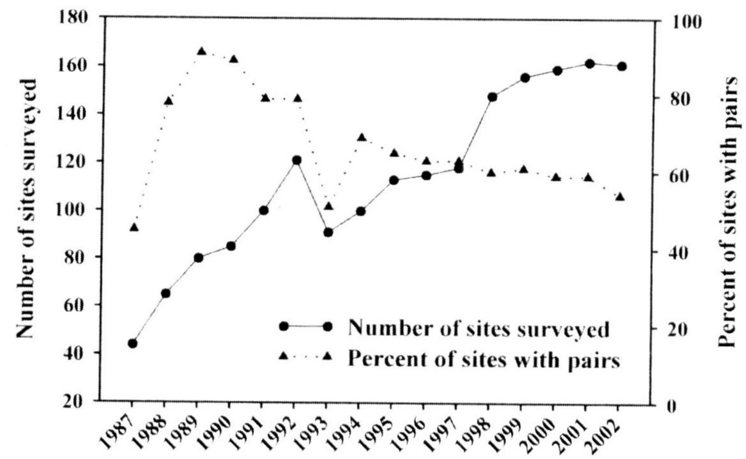

Figure 10.2. Pair Occupancy of Spotted Owl Activity Centers, 1987–2002. The number of spotted owl activity centers ("sites") surveyed in the H. J. Andrews study area from the beginning of the demography project to the present is shown by the solid line with circular symbols. The percentage of activity centers occupied by pairs is shown by the dotted line with triangles. Despite the increase in survey effort over time, the percentage of activity centers occupied by pairs of spotted owls has declined over time. (Source: *Oregon Cooperative Fish and Wildlife Research Unit 2002.*)

of surviving and reproducing even when a portion of the habitat within their home ranges has been removed. But if the young that are produced do not survive to eventually enter the breeding segment of the population, then the population will continue to decline as the older owls die.

The level of reproduction in the population is assessed annually in three ways: fecundity, previously defined as the average number of female offspring produced per female; the percentage of pairs that attempt to nest; and the percentage of nesting pairs that successfully fledge at least one young. Fecundity includes variation in the number of females that are paired, the number of paired females that nest, and the number of pairs that successfully fledge at least one young. This measure of productivity, along with female survivorship, is required to estimate the population rate of change, but offers few clues as to the underlying sources of variation. The percentage of pairs that attempt to nest shows considerable annual variation (figure 10.3). This may be due to fluctuations in prey availability and/or the severity of winter weather conditions. The percentage of nesting pairs that successfully fledge at least one young does not follow the same pattern and has shown a gradual increase since 1998 (figure 10.3). The cause(s) of this pattern are not yet known, but increased nest success and a possible dampening of the annual variation in nest attempts are encouraging. Whether these results will produce a stabilizing effect on the population growth rate will depend upon increased survivorship of the breeding females. The decline in pair occupancy mentioned earlier is not consistent with increased levels of survivorship, however. Updated survivorship and the population rate of change estimates will be calculated during the next meta-analysis workshop, expected to occur in the winter of 2003.

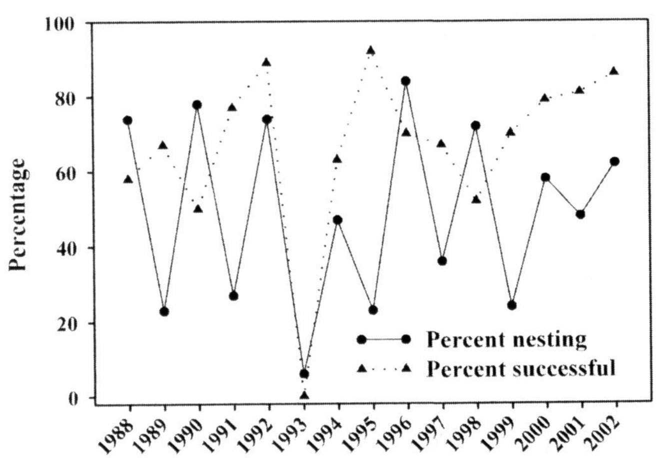

Figure 10.3. Spotted Owl Nesting and Fledging, 1989–2002. The percentage of spotted owl pairs that attempted to nest and the percentage of nesting pairs that successfully fledge at least one young in the H. J. Andrews study area have varied considerably from year to year. The rate of nesting attempts shows a strong biannual cycle; the amplitude of this cycle may be decreasing in recent years. The rate of nesting success does not seem to follow the same pattern and has risen steadily since 1998. (Source: *Oregon Cooperative Fish and Wildlife Research Unit 2002.)*

Meta-Analyses

The most recent meta-analysis conducted in 1998 included the eight long-term monitoring areas as well as seven studies of shorter duration (Franklin et al. 1999). Survivorship was modeled for all fifteen study areas and combined with the corresponding fecundity estimates to estimate the population rate of change for all of the study areas as well as across the range of the subspecies. Both the analysis of the H. J. Andrews study area and the meta-analysis across all study areas indicated that spotted owl populations were declining during the period included in the data. Within the H. J. Andrews study, the spotted owl population declined at an estimated average annual rate of 7.5 percent (95 percent confidence interval: 4.7–10.3 percent); the meta-analysis of all fifteen study areas indicated an average range-wide annual decline of 3.9 percent per year (95 percent confidence interval: 0.5–7.3 percent). It is important to note that the rate of decline across all study areas included a correction for juvenile emigration based upon radio telemetry data, while the rate for the H. J. Andrews study area did not. This suggests that the actual rate of decline for the H. J. Andrews study area was probably closer to the range-wide estimate. An additional consideration in interpreting the H. J. Andrews results is that these rates are point estimates (an average over the years of the studies). This implies that survivorship and fecundity have remained constant during the years of the study, which is not consistent with the results from several of the study areas that showed considerable variation in the vital rates over time.

Although the exact rate of decline is difficult to ascertain, these results provide a strong argument that spotted owl populations declined and are in agreement with the results from previous meta-analyses (Anderson and Burnham 1992, Forsman et al. 1996). Whether the decline will continue toward extinction, stabilize at a lower population density corresponding to the remaining amount of habitat, or is part of a long-term population cycle remains to be seen (Thomas et al. 1990). Unfortunately, differences in demographic parameters among land-use allocations cannot be inferred from the results of the 1998 meta-analysis because land-use allocations were not included as covariates.

Possible Effects of NWFP Land-Use Allocations

Since the 1998 meta-analysis, the H. J. Andrews study has begun to evaluate the potential effect of the NWFP land-use allocations on the demography of spotted owls. Because the number of years represented by these data is too small to effectively analyze the mark-recapture data, the following discussion is restricted to comparisons of pair occupancy and fecundity among land-use allocations since 2000.

The land area encompassed by the study is divided nearly equally among the matrix, AMA, and LSR allocations (figure 10.4). The number of activity centers monitored in each allocation has varied somewhat from year to year as more effort was invested in the Fall Creek area. Pair occupancy, defined as the percentage of activity centers occupied by pairs, is similar between the matrix and AMA allocations but lower among the activity centers in LSRs (figure 10.4). The low rate of pair occupancy in the LSRs is strongly affected by very low numbers of pairs in the

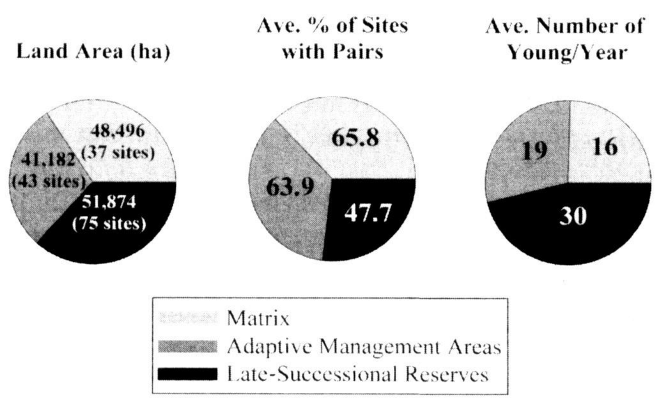

Figure 10.4. Northern Spotted Owl Demographics by Land Use in H. J. Andrews Study Area. The relative amounts of land in matrix, Adaptive Management Areas (AMA), and late-successional reserve (LSR) land-use allocations are roughly equal in the H. J. Andrews study area. A larger proportion of activity centers are located in LSRs, although lower rates of pair occupancy have been observed in LSRs from 2000 through 2002. Over half the average numbers of young produced annually during this period are from matrix and AMA lands that may be subject to timber harvest should the NWFP be fully implemented.

Hagan, Horse Creek, and South Santiam LSRs. At the same time, the total contribution of young is highest in the LSRs, largely as a result of high reproductive rates in Fall Creek.

The four LSRs vary considerably with respect to the amount of old growth and mid- to late-successional habitat (as defined in USDA/USDI 1998). Although spotted owls use mid- to late-successional habitat for roosting, foraging, and dispersal, the majority of nest and roost locations in the H. J. Andrews study area are in old-growth stands (i.e., stands greater than 200 years old). The Horse Creek LSR contains the highest proportion of old growth, but much of this is at or above 1,500 m, which is near the upper elevation limit for spotted owls in the western Cascades province. The South Santiam LSR also includes a large proportion of high-elevation habitat, most of which is too young to support many nesting pairs of spotted owls. Extensive stand-replacing fires occurred in the Hagan LSR approximately 100 and 150 years ago (Klopsch 1985) that left little old growth except in narrow, linear patches along the major streams. The Fall Creek LSR is as large as the other three LSRs combined and contains the best habitat for spotted owls because of the large amount of low-elevation old growth.

The overall contribution to the population of spotted owls in the H. J. Andrews study area is considerably greater from the Fall Creek LSR than from the other LSRs (figure 10.5). The average number of pairs and young found each year in Fall Creek is nearly three times that found in the other LSRs. This represents a 50 percent greater contribution to the population than would be expected based on relative size alone. Although the number of years that Fall Creek has been intensively monitored is inadequate to estimate survivorship and population rate of change, the high levels of pair occupancy and fecundity suggest that Fall Creek is much more likely to serve as an effective reserve for spotted owls.

Broader Implications

Two central issues affect the probability of recovery of the northern spotted owl under the NWFP. The first is whether the habitat in the LSRs is adequate to support a sufficient number of

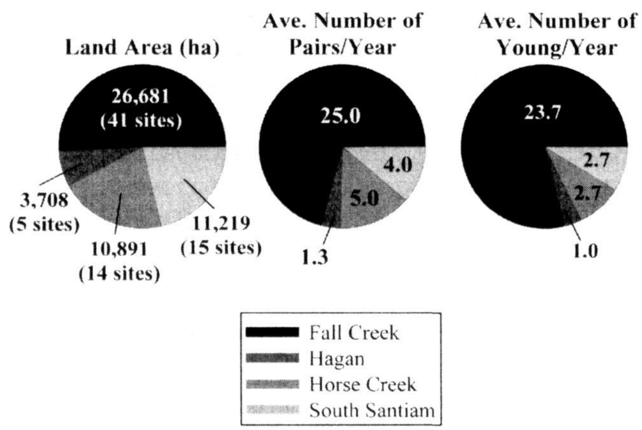

Figure 10.5. Northern Spotted Owl Demographics in the Fall Creek Late-Successional Reserve (LSR). Within the lands allocated as LSRs, approximately half of the land area and over half of the activity centers are located in the Fall Creek LSR. The average number of pairs and the average production of young have been disproportionately higher in the Fall Creek reserve from 2000 through 2002.

spotted owls and a sufficiently high level of reproduction to carry the populations through the period required for younger stands to develop suitable habitat characteristics. The second, closely related, issue is whether the impact on the population of lost reproduction and displaced pairs in the matrix and AMA allocations will be balanced by spotted owl reproduction in the LSRs, should timber harvest be fully implemented. Both will depend to a large extent on the time frame involved.

Prior to the increase in harvest rates in the 1940s and 1950s, it is likely that habitat quality varied among physiographic provinces over periods of many decades. Spotted owl populations in some provinces may have experienced moderate to severe declines in response to natural disturbances, while other provinces may have produced surplus numbers of offspring. This balance probably shifted across the landscape as large-scale disturbances affected the habitat within a particular province (F. Swanson, personal communication). The current conservation strategy for the northern spotted owl is based on a similar principle with regard to timber harvest and the devel-

opment of late-successional characteristics in the LSRs. In the case of the NWFP, disturbances (i.e., timber-harvesting operations) are planned in the matrix land allocations, and the LSRs will be relied upon to provide the habitat for stable or increasing owl populations. If the rate of harvest exceeds the rate of habitat recovery in LSRs that currently lack sufficient amounts of suitable spotted owl habitat, then it is unlikely that spotted owls will persist. Current silvicultural research into possible ways to accelerate the development of late-successional characteristics is promising, but the success or failure of these experimental treatments will not be fully apparent for several years. Given that the development of late-successional characteristics is affected by the rate of natural disturbances, the rate of harvest may easily exceed the recruitment of habitat for spotted owls should a large-scale disturbance—such as a stand-replacing fire—set back succession in an LSR. Therefore, it may not be realistic to expect the rate of harvest to match the rate of habitat recovery; such a rate may be so slow that harvest on public lands would be economically negligible.

Because the results to date do not tell us anything about the extinction threshold for spotted owls, we are faced with choices based on relative levels of risk rather than empirical information. The risk of local extinction in portions of the owl's range with large areas of matrix already in harvest rotation and little high-quality owl habitat in LSRs may be higher than in regions with more old-growth forest encompassed by LSRs. Given that strong evidence has been presented that spotted owl populations are in decline (Franklin et al. 1999) and that the pair occupancy rate is declining (at least in the H. J. Andrews study area), the risk of extinction is likely to increase through time even without further habitat loss. Recently observed high levels of reproduction in the H. J. Andrews study area are encouraging; but it is impossible to predict if these levels will be maintained, or if fecundity has been high enough to halt or reverse the overall decline. We are essentially faced with a gamble based on observations of past patterns. Unfortunately, these patterns are contingent upon conditions remaining the same through time. This is highly unlikely given the complexity of forest ecosystems and the stochastic nature of the factors affecting them.

Furthermore, not all activity centers represent spotted owl territories, and not all owl territories contribute equally to the overall population. Intensive, long-term monitoring of individual activity centers is required to fully assess the contribution of these areas to the spotted owl population. Areas with a history of pair occupation and successful reproduction for more than five years should receive greater protection than activity centers that do not correspond as well to spotted owl territories. Many of the most highly productive owl pairs happen to be located in matrix and AMA land allocations. Conversely, many of the least-productive territories are located in LSRs. As noted earlier, the reason that some LSRs contain few spotted owls is that habitat quality and/or land area is inadequate to support more than a handful of pairs. LSRs that contain relatively few pairs of owls or pairs that seldom reproduce may not contain enough habitat to accommodate owls displaced during timber harvest in adjacent matrix and AMA lands.

Finally, it is worth noting that data from one physiographic province cannot be used to infer potential outcomes in other provinces or at a range-wide scale. Differences in past levels of timber harvest have had an effect on both the amount of remaining habitat and on the placement of LSRs within different study areas. In addition, forest ecology varies considerably throughout the range of the northern spotted owl, and this variation is reflected in the natural history of the owl. Differences in spotted owl biology and forest ecology have been overlooked or obfuscated in recent initiatives to increase the rate of timber harvest on public lands. For forest managers to successfully conserve our native forests and bring about the recovery of the northern spotted owl, public perception of forest ecology must be accurate so that society can make responsible decisions based on the best available science. Forest management policies that change with each new administration are unlikely to be successful or to teach us anything about how we might meet the needs of society while maintaining healthy and productive ecosystems.

Note

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