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1) Title:

The Demography of Northern Spotted Owls (*Strix occidentalis caurina*) on the Willamette National Forest, Oregon.

2) Principal Investigator and Research Team:

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3) Abstract:

Survey and monitoring results for the 2016 field season are presented for the central Oregon Cascades northern spotted owl demography study area. All parameter estimates are consistent with a declining spotted owl population and an increasing barred owl population. Despite increased survey effort, the lowest numbers of single and paired spotted owl detections were recorded in 2016. Productivity also was extremely low with only one spotted owl pair fledging a single young. The proportion of spotted owl sites where barred owls detections occurred was the highest since the initiation of the study.

4) Introduction:

Background.

Spotted owl research has been conducted in and around the H.J. Andrews Experimental Forest since the 1970's. Early studies reflected graduate research projects that focused on spotted owl natural history, habitat selection, food habits, and home range size (Forsman 1976, 1980; Miller 1989, Swindle 1998). Beginning in 1987, technicians began banding spotted owls to provide mark-recapture data to estimate vital rates of the population in the west central Oregon Cascades. Initial banding efforts focused on pairs of spotted owls located in the course of project-related surveys conducted by Forest Service personnel. Nest locations, daytime roosts, and clusters of nocturnal detections were considered surrogates of spotted owl territories (hereafter referred to as "sites"). Each site was represented by a single point and assigned a master site number (MSNO) by the Oregon Department of Fish and Wildlife (Appendix A). By the mid-1990's more comprehensive surveys across the landscape were conducted. Survey stations in the areas between historic spotted owl sites were grouped by watershed and also treated as sites for use in occupancy analyses.

Potential benefit and utility of the study.

Studying the population demography, habitat selection, and ecology of northern spotted owls will continue to increase our understanding of the factors affecting spotted owl populations. A subset of the productivity and mark-recapture data for the HJA study area were combined with data from other northern spotted owl demographic studies during weeklong workshops in January of 1994, 1999, 2004, 2009, and 2014. During these workshops, the data from our study area was analyzed independently and combined with data from other study areas in meta-analyses of survival, fecundity, annual rate of population change, and recruitment for spotted owl populations across their range (Burnham *et al*. 1996, Franklin *et al*. 1999, Anthony *et al*. 2006, Forsman *et al*. 2011, Dugger *et al.* 2016). The most recent meta-analysis workshop also included a two-species occupancy analysis to evaluate the effects of barred owls on spotted owl site occupancy (Dugger *et al.* 2016).

The demographic parameters estimated for the HJA study area will continue to be an important part of the meta-analyses of northern spotted owl populations across their range. These analyses provide information that supports the validation and monitoring requirements of the NWFP (USDA and USDI 1994), were an important part of the 2004 species status review, the development of the Final Recovery Plan (USFWS 2011), and the designation of Critical Habitat for the species (USFWS 2012). Data from this study also have been used to study occupancy dynamics and to generate annual site occupancy rates (Olson *et al*. 2005) and predictive models that link demographic rates to vegetative characteristics in owl territories (Olson *et al*. 2004). Our data continue to be used to develop new analytical approaches to understand the effects of habitat (Ackers *et al*. 2015), climate (Glenn 2009, Glenn *et al*. 2010), and barred owl (*Strix varia*) presence (Olson *et al*. 2005, Anthony *et al*. 2006, Forsman *et al*. 2011, Dugger *et al*. 2016) on spotted owl demography.

Study objectives.

a. Estimate the proportion of territories where northern spotted owls are detected, determine sex and age composition, and the reproductive success of detected owls on the Northern Spotted Owl Demography Study Area in the Willamette National Forest, including estimates by land use allocation as designated under the Northwest Forest Plan (NWFP; USDA and USDI 1994; Appendix B).

b. Develop and maintain a capture history matrix of individually marked spotted owls to estimate detection rates, survivorship, recruitment, and the rate of population change using a mark-recapture modeling approach.

c. Create and maintain databases required for participation in the periodic meta-analyses of fecundity, survivorship and annual rate of population change across the range of the northern spotted owl.

d. Collaborate with other researchers examining northern spotted owl ecology throughout the Pacific Northwest.

5) **<u>Study Area</u>:**

The central Cascades northern spotted owl demographic study covers approximately 375,000 ac (151,763 ha) on the western slopes of the Oregon Cascades (Figure 1). The land is administered by the Willamette National Forest and includes the upper McKenzie River watershed, the upper Fall Creek watershed, and a portion of the South Santiam River watershed. The land west of the study area is a mixed ownership of Bureau of Land Management and private forestland. The Three Sisters and Mount Washington wilderness areas form the eastern boundary of the study area. The remainder of the Willamette National Forest lies to the north and south of the study area. Five land use allocations defined by the Northwest Forest Plan are represented (USDA and USDI 1994): matrix lands (26%), adaptive management areas (28%), four late successional reserves (34%), and several congressionally and administratively withdrawn areas (12%). The H. J. Andrews Experimental Forest is located approximately in the center of the study area.

Elevations on the study area range from approximately 1,300 ft (400 m) to just under 5,300 ft (1,600 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 non-forest or has been harvested (Miller *et al*. 1996). Of the remaining forested lands, approximately 51% is considered suitable habitat for spotted owls (S. Weber, Willamette National Forest, personal communication). This corresponds closely to the 51.2% of the western Oregon Cascades physiographic province classified as suitable and highly suitable habitat in the 20-year spotted owl habitat monitoring report (Davis *et al*. 2016).

Four historic spotted owl territories were within two wildfires that occurred in 2003. The Clark fire included three sites in the Slick Creek and Bedrock Creek watersheds in the Fall Creek late successional reserve. The B & B complex fire began late in the field season of 2003 and included only one site.

6) **<u>Methods</u>:**

Survey design and field methods.

The annual proportion of sites where owls were detected and reproductive success were calculated by monitoring all known northern spotted owl territories within the study area during the spotted owl breeding season (April – August). Sites with a recent and consistent history of spotted owl pair detections were visited during the day to identify color-banded spotted owls and determine their nesting status and reproductive status according to established protocols (Forsman 1995). If spotted owls were not located at these sites during the initial daytime visits, then nighttime surveys of the surrounding areas were conducted. All other sites were surveyed at night to locate spotted owls before initiating daytime visits. All unbanded owls located during either day or night visits were captured and fitted with a uniquely numbered USFWS band and a unique color band to facilitate individual identification.

Nesting status was determined for all pairs located by offering at least four mice to them on ≥2 visits prior to 1 June. A pair was considered to be "nesting" if any of the four mice were delivered to a nest. If the result of the first visit indicated nesting and was conducted before 15 April, then a second visit was required to confirm nesting status because females may sit on a nest without actually laying eggs early in the Spring (Forsman 1995). Nesting also was indicated if a female owl captured for banding had a brood patch, one or more juveniles were observed with one of the adults, or if the remains of nestlings or eggs are located under a known nest tree. Non-nesting was indicated if the adults ate or cached all mice taken on two visits conducted at least 3 weeks apart before 1 June, provided that at least 4 mice were offered during each visit. If the fate of a mouse was unknown, then that mouse did not count toward the minimum of four mice. Pairs also were classified as non-nesting if a female captured for banding between 15 April and 1 June did not have a brood patch or if the female was observed roosting away from a nest for greater than 60 minutes between 15 April and 15 May. Pairs and single females that met these criteria before 1 June provided estimates of the proportion of pairs that nested (*i.e.,* nesting attempts) and the proportion of nesting pairs that hatched ≥1 chick (*i.e.,* nest success rate). After 1 June, it was not possible to distinguish between pairs that nested and failed and pairs that did not attempt to nest (Forsman 1995).

Visits to determine the number of young fledged were conducted between 1 June and 31 August. A minimum of four mice were offered to each pair on ≥2 occasions to determine if any young were present. Owls previously determined to be non-nesting were considered to have produced no young, although we attempted to confirm this with at least one visit after 1 June. Owls that ate or cached all mice offered on ≥2 visits after 1 June also were considered to have not produced young. As with nesting status determinations, if the fate of a mouse was unknown, then that mouse did not count toward the minimum of four mice. For owls that delivered one or more mice to young, the number of young observed out of the nest tree were recorded as the number of young fledged. The highest number of fledglings observed on the two visits was the final reproductive status for that pair (Forsman 1995).

Analytical methods.

The numbers of sites where pairs of spotted owls were detected and sites where at least one spotted owl detection occurred were evaluated separately. Single owls that were detected at a particular site ≥3 times over one or two breeding seasons were considered resident, single owls (Forsman 1995). Given that per visit detection probabilities are less than 1.0 (Olson *et al*. 2005), estimates of occupancy rates that do not account for detection rates are negatively biased (MacKenzie et al. 2006). Thus, here we summarize the survey data as the proportion of sites where spotted owl detections occurred. See Olson et al. (2005) and Dugger et al. (2016) for estimates of spotted owl occupancy rates on this study area.

Spotted owl productivity was summarized at four levels: the proportion of pairs evaluated prior to 31 May that were nesting, the proportion of nesting pairs that fledged at least one young between 1 June and 31 August, the average number of young produced per pair, and the average number of young produced per successful pair. Annual variability in each parameter was examined by comparing the coefficient of variation at each level.

We continued to monitor sites where spotted x barred owl hybrids have been located.

These results were presented separately (Appendix C). Unless otherwise indicated, the following discussion is pertinent only to our analyses of spotted owl demography.

7) <u>Results</u>:

Proportion of sites where owls were detected

The number of sites surveyed in 2016 was similar to the number reported in the past (172 sites; Table 1). Most of the non-juvenile spotted owls detections in 2016 were pairs (56%) with substantially fewer resident single owls (15%) or single owls with unknown residency status (29%; Table 1). Between 2015 and 2016 the proportion of sites where either a pair or a single owl was detected decreased by 12% (Table 1) and the proportion of sites where pairs were detected decreased by 8%. This is the lowest proportion of territories where we detected pairs of spotted owls to date (Figure 2). The residency status of either the male or the female was unknown for 2 (6%) of the pairs detected. The percentage of sites where resident single owls were detected increased by 1% (Table 1) and the percentage of sites with no spotted owl detections increased in 2016 (Table 1).

Sex and age composition

One juvenile (*i.e.*, young of year) and 91 non-juvenile (≥1 year old) spotted owls were detected during our surveys in 2016 (Table 2). The majority of the non-juvenile owls of known age were at least three years old (78%). Seven male and four female spotted owls were identified as subadults (≤2 years old; 15%) in 2016. Of the owls that were not identified to age class (13%), most were only detected once at night and never relocated for identification, which suggested that many of them were transients that did not hold territories. All of the owls that were resighted and identified by unique, non-juvenile color bands (82) were assigned to an age class, as were all of the non-juvenile owls that were captured for initial banding or to replace a juvenile band (21).

Based on re-observations of known age, non-juvenile owls in 2016, the median age for males on the study area was 7 years ($\bar{x}$ = 7.7, SE = 0.98) and 9 years ($\bar{x}$ = 9.2, SE = 1.90) for females. The oldest owls located in 2016 were two 20-year-old females: one was originally banded as a fledgling in 1996; the other was banded as an adult in 1999. The oldest males were both 16 years old: one banded as a fledgling in 2000; the other banded as an adult in 2003. Both owls banded as adults may have been older as the exact age of an adult cannot be determined based solely on the coloration of the retrices (Forsman 1981).

The ratio of territorial subadults to adults has decreased since 1989, but the trend was not significant (R^2 = 0.60, p-value = 0.18, β = -0.001, 95% CI: -0.003 to 0.0005). Among paired owls, three males and three females were subadults in 2016. Subadults have been paired much less frequently than adults in every year of the study. The percentage of pairs with at least one subadult has varied widely from a high of 16% in 2016 to a low of 0.68% in 1995. There were no paired subadults in 1995, 2007, 2012, or 2013. A significant association between productivity (fledglings per pair) 2 years previous and increased proportion of pairs with at least one two-year-old subadult was observed (R^2 = 0.15, p-value = 0.04, β = 4.75, 95% CI: 0.61 to 8.88). There was no evidence of a time trend in the proportion of subadults in the population of territorial pairs (R^2 = 0.01, p-value = 0.60, β = -0.057, 95% CI: -0.26 to 0.15).

The sex ratio among adults (≥ 3-year-olds) identified in 2016 was higher than past estimates (males:females; 1.29:1 in 2016, 1.13:1 averaged over all previous years, n = 29). Among subadults, the sex ratio was more skewed toward males in most years (1.35:1 averaged over all years, n = 30). Small sample sizes in the subadult age class resulted in more annual variation in the sex ratios which ranged from 0:1 in 1994 to 5:1 in 2000. More subadult females than males were detected in 6 of the past 29 years (e.g., 0.33:1 for 2015). The average sex ratio among non-juveniles of unknown age was even more variable and heavily skewed toward males (2.28:1 averaged over all years, range: 0.75:1 - 14:1).

Reproductive Success

We were able to survey 15 spotted owl pairs to determine nesting status prior to 1 June 2016 (Forsman 1995; Table 3). Only one of these pairs (7%) initiated nesting prior to 1 June 2016; this pair produced one young (Table 3). The mean number of pairs surveyed during the nesting season that attempted to nest from 1988 through 2015 was 49% (SE = 5.1, n = 28). However, the long-term mean obscures the striking annual pattern in breeding propensity between consecutive years (high vs. low) observed during most of this study (Table 3). Of the pairs that were confirmed to be nesting in the past, most successfully fledged at least one young ($\bar{x}$ = 70%, SE = 4.7, n = 29; Table 3). The percentage of pairs that attempted to nest was more variable (CV = 0.55) than the percentage of nesting attempts that were successful (CV = 0.35). There was no relationship between nesting rates and nest success (r = 0.21, 95% CI:-0.17 to 0.53, p-value = 0.27).

Thirty spotted owl pairs were surveyed for reproductive status by 31 August 2016 (Table 3). This included 15 pairs that were surveyed for nesting status prior to 1 June 2016, as well as 15 additional pairs that were not located prior to 1 June. For all pairs surveyed for reproductive status, the average number of young produced per pair in 2016 (0.03 young/pair) was lower than the average across all previous years ($\bar{x}$ = 0.61, SE = 0.07, n = 28; Table 3). With the exception of 1993 when no young were fledged, there was little variation in the number of young produced by pairs that successfully nested ($\bar{x}$ = 1.59, SE = 0.04, n = 27, CV = 0.13).

Banding/re-observation

Twelve spotted owls were banded in the study area and at four nearby wilderness sites in 2016, including 1 fledgling, 5 subadults, and 6 adults (Table 4). Since 1987, 711 non-juvenile and 1,068 fledgling spotted owls (1,779 total) have been banded on the study area.

Movements

There were ten movements of spotted owls between site centers within the study area in 2016 (1990 – 2015 median = 16, range: 6 – 30). Two adult males and four adult females were recaptured or re-sighted at new locations within the study area. Two males and two females originally banded as fledglings on the study area were recaptured and fitted with an adult band; both males and one of the females were 2-year-olds, the other female was an adult originally banded in 2008. Since initiation of the study in 1987, 145 (14%) of the fledglings banded in our study area have been recaptured on the study area and marked with adult bands. Of the marked fledglings recaptured, most (77%) were recaptured within four years after initial banding. Nineteen fledglings (13%) were recaptured as one-year-olds, 36 (25%) as two-year-olds and 90 (62%) as adults. Among those recaptured for the first time as adults, most were recaptured after 3 or 4 years. The longest period of time between initial banding and recapture on the study area was 13 years (Figure 3).

Barred owl detections

Incidental barred owl detections have become increasingly common in the study area. The percentage of sites where at least one barred owl detection was recorded increased by 4% between 2015 (51%) and 2016 (55%). This is the highest rate of barred owl detections since the initiation of the study (Figure 4). Barred owls were detected at four sites with no previous history of barred owl detections. There are only 18 sites on the study area where barred owls have not yet been detected. Barred owl fledglings were observed at 15 of the 32 sites where barred owl pairs were detected.

Problems encountered

Relatively mild weather in the spring of 2016 did not delay our access to high elevation sites as severely as in past years. Still, the Horse Creek and South Santiam LSRs include most of our high elevation sites where more snow typically remains longer into the spring, which delayed the first surveys until late May. As a result, the productivity of more owls remained unresolved in these LSR sites than in the matrix or AMA sites. Deeper and a more persistent snow pack also may influence the productivity of spotted owls in these LSRs.

Noise associated with high stream flows and heavy rain frequently interfered with site visits and nighttime surveys. Several surveys had to be repeated due to the effect of such noise on the detectability of spotted owls (Kissling *et al*. 2010, Lengane and Slater 2002). This forced us to allocate more effort to repeated surveys at some sites which allowed less time to complete the surveys at other sites.

The number of downed trees blocking Forest Service roads continued to hinder our access to many of our sites. Despite the efforts of Forest Service personnel to clear the roads, we spent several days throughout the field season clearing the roads rather than conducting site visits. In addition, although survey effort was the same for all three land use allocations, road closures that occurred in previous years made access more difficult in the LSRs. Many of the secondary roads in the LSRs are no longer maintained and several have been decommissioned which means portions of the surveys in these areas must be conducted on foot, considerably increasing the time required to access these sites.

Decreased per-visit detection rates (Olson *et al*. 2005) associated with increased barred owl detections and continued declines of spotted owl populations (Dugger *et al*. 2016) have increased the amount of time and effort required to meet protocol requirements for data collection. Many of the pairs that were previously easy to locate near their historic activity centers now require us to conduct additional night surveys to either relocate them or confirm they are indeed no longer present (Figure 5). Increased night work has fundamentally changed the survey coverage across the study area from a territory-based, site visit approach to more uniform nighttime survey coverage over large portions of the study area. In 2016, we conducted more night surveys using more survey stations than in any previous year. While this improved our coverage of areas near nest sites and other activity centers, it has become more difficult to complete all site visits and nighttime surveys required by the effectiveness monitoring protocol (Forsman 1995).

8) Discussion:

Proportion of sites where owls were detected

Fewer spotted owls were detected on the study area in 2016 than in any previous year. This was in spite of increasing effort in both night surveys and daytime site visits in response to the lack of success in relocating banded owls early in the season. Throughout the 29 years of the study, survey effort has been frequently adjusted in response to several factors. The apparent increase in the proportion of sites where spotted owls were detected during the first three years of the study was related to increased survey effort by the demographic study combined with surveys conducted for Forest Service timber sales and other projects. From 1990 through 1996, a density study was attempted in the Blue River watershed as well as portions of the Deer Creek and South Santiam watersheds. Outside of these areas, surveys were focused on areas where pairs of spotted owls had been previously located during Forest Service surveys. From 1997 through 1999, we began more complete survey coverage in the four LSRs on the study area. Since 2000, the number of sites surveyed remained relatively constant although survey coverage of the landscape between historic spotted owl sites has increased as more night surveys became necessary to relocate spotted owls missing from historic site centers.

Since 1989, the proportion of sites where a spotted owl was detected (either a single or pair) decreased an average of 2.5% per year with most of the decline occurring in 18 of the past 24 years (Table 1). These estimates included any spotted owl response at a site including auditory detections from unidentified individuals that may have been from non-territorial owls. This may be an indication that both the territorial and non-territorial segments of the spotted owl population were declining. The negative linear time trend on colonization probability and overall decline in occupancy rates (taking into account detection rates) is consistent with an accelerated decline in detections of spotted owls on territories from 1992 through 2013 (Dugger *et al.* 2016). Since 1989, the proportion of sites where pairs of spotted owls were detected has decreased an average of 2.7% per year.

The proportion of sites where spotted owls were detected should not be interpreted as an index of population size or an estimate of occupancy rate for several reasons. Detection probability was not incorporated into these estimates, and it is clear from other research, that the presence of barred owls in the vicinity of a spotted owl territory decreases the detection rate of spotted owls even when they are present (Olson *et al.* 2005, Kroll *et al.* 2010, Dugger *et al.* 2011, Dugger *et al.* 2016); thus, declines in the proportion of sites where spotted owls were detected underestimated site occupancy and population size. Secondly, this proportion included detections of single owls and pairs combined, so sites where presently one owl was detected may have had a pair detected in previous years, but the loss of one of those individuals was not incorporated explicitly here. Finally, an unknown number of spotted owls may have been detected at more than one site, which would have inflated estimates of the number of individual owls detected.

Productivity

Productivity was far below average in 2016 with only one pair nesting and producing only one young. This is the lowest level of productivity observed on this study area with the exception of 1993 when no young were produced (Table 3). Environmental conditions can affect spotted owl productivity at several stages, but it was evident that the proportion of pairs that that attempted to nest every year and fledging success have been the primary sources of variability in productivity of spotted owls.

A biannual pattern (*i.e.*, even/odd year variation) in nesting attempts was observed from 1988 through 2005 (Table 3). This pattern has been broken three times: once during 2000 through 2002, when high rates of nesting were recorded three years in a row, in 2005 and 2006 when low rates of nesting were recorded for two consecutive years, and most recently with two consecutive years of high nesting rates between 2007 and 2008 and between 2014 and 2015. Climate has been suggested as the underlying factor driving this biannual variation through its effect on prey populations (Franklin *et al*. 2000, Glenn *et al.* 2011), but this has not yet been confirmed with long-term research on prey population dynamics. Anecdotal observations continue to suggest that pairs of spotted owls in the central Cascades of Oregon may be more likely to attempt to nest when conditions are warmer and drier than in years when late season storms occur during the early stages of nesting. Hypotheses regarding the negative effect of late nesting season rains on overall productivity and the negative effect of high precipitation and low temperature during the early nesting season on recruitment have received weak support, but the linkage between climate, the even/odd year effect and spotted owl productivity remains unclear (Glenn *et al*. 2010, Forsman *et al*. 2011.).

Fledging success has been highly variable among years, and it is not correlated with the annual number of nesting attempts. Given the strong territorial nature of this species, this is not a system where we would predict density dependent effects on fledging success or productivity, thus the fact that separate factors may be affecting a pair's decision to nest and their subsequent nest and fledging success is not surprising. Long-term prey cycles affecting the overall condition of breeding birds each year is likely responsible for patterns in breeding propensity (*i.e.*, proportion of pairs that attempt to breed). The demography of small mammal prey eaten by spotted owls is currently under investigation on our study area. We speculate that episodic storm events before, versus after nesting was initiated may in part, explain the variation in reproductive success, independent of the decision by a pair of birds to breed. Storm events during incubation could result in increased nest failures, whereas mild weather after nesting was initiated would allow the pairs that attempt to nest to successfully fledge young.

The number of young fledged per pair also may be affected by stochastic weather events, particularly when the fledglings are young and more vulnerable to chilling and exposure. Six post-fledging mortalities were confirmed in 2008. Five of these occurred during a week of cold temperatures and heavy rain in early June shortly after the young left the nest. A similar cluster of fledgling mortalities also was observed in 2004 when a period of unseasonably cold and wet weather occurred during the same period. In most years, weather conditions remained mild throughout June, and no post-fledging mortalities were documented. The weak negative effect of precipitation during the late nesting season (1 May – 30 June) on fecundity discussed above (Glenn *et al*. 2010, Forsman *et al*. 2011) may reflect the periodic loss of young in the nest, if weather is causing mortality of nestlings similarly to effects observed in some years on fledglings. Post-fledging mortalities did not affect our estimates of the number of young fledged or fecundity because juvenile mortalities documented during the post-fledging period are counted as having successfully fledged even if we discover that they did not survive long after fledging.

Predation may affect productivity both before and after fledging. Potential predators sighted on the study area within 1 mile (1.6 km) of active territories included great-horned owls (*Bubo virginianus*), northern goshawks (*Accipiter gentilis*), red-tailed hawks (*Buteo jamaicensis*), peregrine falcons (*Falco peregrinus*), and common ravens (*Corvus corax*). Barred owls also may directly impact productivity through predation on spotted owl nestlings or by causing nest abandonment by spotted owls. On two occasions in 2002, a dead nestling was found near a nest tree on the same day that a barred owl was observed aggressively interacting with the spotted owl pair. However, direct observations or evidence of predation have been rare (*e.g.,* Leskiw and Gutiérrez 1998) making it difficult to assess the magnitude of this effect.

Spotted owl - barred owl relationships

The overall percentage of sites with at least one barred owl detection increased slowly from 1988 – 1999. An accelerated increase was observed until 2003, primarily in detections of single barred owls while the rate of barred owl pair detections fluctuated at a low level. From 2003 through 2008, detections of pairs of barred owls increased at nearly the same rate as single barred owl detections.

Although detections of barred owls in spotted owl territories have increased in a manner consistent with an expanding barred owl population (Figure 4), data collected incidentally during spotted owl surveys have limited utility (Livezey 2007). Occupancy of spotted owl sites by barred owls was underestimated because we did not use survey techniques targeted specifically to barred owls, and we rarely located barred owls during the day following nocturnal detections. While barred owl fledglings were detected at 15 spotted owl territories in 2016, these incidental observations cannot be used estimate barred owl productivity at the population level on our study areas.

Despite the limitations discussed above, a number of associations have emerged between increased barred owl detections and spotted owl detection rate, annual site occupancy, and demographic parameters. Several banded spotted owls have not been relocated following barred owl detections in their historic core areas presumably because they have either died, been excluded from suitable habitat, or were inhibited from responding to our surveys. The presence of barred owls in the Oregon Cascades has been shown to negatively influence the probability of detecting spotted owls as well as affecting the probability that a pair of spotted owls would abandon occupied sites or recolonize an empty site (Olson *et al*. 2005, Dugger *et al*. 2011, Dugger *et al*. 2016). While mortality of displaced non-juvenile spotted owls has not been documented in this study, recent findings indicate that increased detections of barred owls throughout the study area were associated with decreased apparent survival (Forsman *et al*. 2011, Dugger *et al.* 2016.). Finally, barred owls may affect spotted owl productivity through their effect on site occupancy by pairs of spotted owls (Olson *et al*. 2005, Dugger *et al.* 2016). These effects are expected to become more pronounced as barred owl density increases (Dugger *et al*. 2011).

Early in the expansion of barred owls into the range of the northern spotted owl, there was concern over the potential for hybridization of barred and spotted owls (Hamer *et al.* 1994). Two scenarios have been proposed regarding the outcome of hybridization between spotted owls and barred owls (Hamer *et al*. 1994). If introgression of barred owl genes into spotted owl populations produces hybrids with greater fitness than spotted owls, hybrids could gradually replace spotted owls if increased barred owl abundance results in increased hybridization (Grant and Grant 1992). Alternatively, if hybridization is the result of scarcity of mates for barred owls and/or if hybrids are less fertile than spotted owls, then the frequency of hybridization may decline as barred owls become more abundant (Hamer *et al*. 1994, Randler 2006).

The first spotted owl x barred owl F1 hybrid was detected on the study area in 1999 (Appendix C). The number of hybrids detected increased through 2004, but has since declined to only 2 or 3 detections per year since 2007. As pointed out earlier, barred owl abundance has increased to the point that they are detected at nearly half of the spotted owl territories that we monitor. These observations are consistent with the hypothesis that behavioral mechanisms usually prevent mating between spotted and barred owls unless potential barred owl mates are scarce (Randler 2006).

For barred owl genes to be introduced into spotted owl populations, backcrossing between F1 hybrids and spotted owls must occur. Most backcrossing that has been reported has been between F1 hybrids and barred owls; successful backcrossing between F1 hybrids and spotted owls has been rare even when F1 hybrids are found paired with spotted owls (Haig *et al*. 2004, Kelly and Forsman 2004, Appendix C). From the information collected to date, it appears that little introgression of barred owl genes into spotted owl populations has occurred on our study area.

Current and future plans for timber harvest will provide an opportunity to evaluate the effects of different harvest strategies on spotted owl site occupancy and demography. A large-scale commercial thinning project in the Blue River watershed in the central Cascades AMA was recently completed as part of the Blue River Landscape Strategy (http://www.fs.fed.us/nepa/fs-usda-pop.php/?project=21779). This area contains several of the most productive pairs on the study area so it will be critical that additional projects in this watershed are planned to minimize impacts on these pairs. Site- and year-specific data will be required to adequately assess the long-term effects of these actions. For this reason, we continue to inform the Forest Service biologists of the most recent locations of the spotted owls in these areas.

There has been little habitat loss due to fire on the study area and the response of the spotted owls in the affected areas has been variable. The Clark Fire in 2003 seems to have had little effect on spotted owl detections or productivity in this area. The one site in the 2003 B&B fire remained occupied by a pair of spotted owls for two years and by a single spotted owl for an additional year following the fire. In the year that only a single spotted owl was detected, a pair of great horned owls was located during nighttime surveys of the area. Therefore, it is not possible to link habitat change due to the fire to the lack of spotted owl detections since the fire, particularly without a clear understanding of the effect of fire severity. Owls use forest stands that have burned under-stories or partially removed over-stories, but they tend to avoid areas of complete stand replacement for nesting and roosting (Clark 2007). Use of high severity burn areas for foraging has been documented for the California spotted owl (Strix occidentalis occidentalis) (Bond *et al*. 2009), and fire did not adversely affect spotted owl site occupancy in California (Lee *et al.* 2012), but much more research is needed to understand what appears to be a complex interaction between fire frequency and severity and owl habitat use (Clark 2007, Bond *et al*. 2009).

9) Acknowledgements:

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11) <u>Publications, Presentations, Data Transfer</u>:

Presentations

a) S. Ackers discussed spotted owl population trends and management with H. J. Andrews writer-in-residence John Farnsworth (November, 2016).
b) K. Dugger gave an invited lecture for the Department of Wildlife Seminar series at Humboldt State University entitled *The effects of habitat, climate and Barred Owls on the long-term demography of Northern Spotted Owls*, April 7, 2016, Arcata, CA.

Publications

Dugger, K. M., E. D. Forsman, A. B. Franklin, R. J. Davis, G. C. White, C. J. Schwarz, K. P. Burnham, J. D. Nichols, J. E. Hines, C. B. Yackulic, P. F. Doherty, Jr., L. Bailey, D. A. Clark, S. H. Ackers, L. S. Andrews, B. Augustine, B. L. Biswell, J. Blakesley, P. C. Carlson, Matthew J. Clement, L. V. Diller, E. M. Glenn, A. Green, S. A. Gremel, D. R. Herter, J. M. Higley, J. Hobson, R. B. Horn, K. P. Huyvaert, C. McCafferty, T. McDonald, K. McDonnell, G. S. Olson, J. A. Reid, J. Rockweit, V. Ruiz, J. Saenz, S. G. Sovern. 2016. The effects of habitat, climate and Barred Owls on long-term demography of Northern Spotted Owls. The Condor: Ornithological Applications 118: 57–116.

Technology transfer.

a) S. Ackers attended the USFWS spotted owl surveyor's meeting at the Willamette National Forest supervisor's office on 29 February 2016.
b) Project personnel coordinated spotted owl surveys with the district biologists of the Willamette National Forest and continued to provide information on spotted owl locations and demographics for their management needs.
c) S. Ackers provided data on occupancy and productivity of sites within 1.6 km of BLM and private land to the Eugene BLM, Westside Ecological (under contract with the Oregon Department of Forestry) and Weyerhaeuser Inc.
d) S. Ackers attended monthly H.J. Andrews staff meetings at the H. J. Andrews Experimental Forest.

12) **Tables.**

Table 1. Northern spotted owl detections and residency status [a] of northern spotted owl sites (territories) surveyed on the central Cascades study area, Willamette National Forest, Oregon, 1987 – 2016.

Year	Sites surveyed	Sites with pairs detected	Sites with resident single owls	Sites with unknown residency [b]	Sites with ≥1 owl detected (%)	Sites where owls were not detected [c]	Sites not surveyed to protocol [d]
1987	44	20	2	4	26 (59)	-	18
1988	65	51	2	1	54 (83)	-	11
1989	80	73	4	3	80 (100)	-	27
1990	85	76	0	3	79 (93)	6	27
1991	100	79	5	8	92 (92)	8	3
1992	121	96	4	14	114 (94)	7	28
1993	91	46	13	15	81 (89)	10	19
1994	100	69	7	22	98 (98)	2	19
1995	113	73	10	8	91 (80)	22	12
1996	115	73	11	6	90 (78)	25	5
1997	118	73	8	10	91 (77)	27	12
1998	146	90	8	14	112 (77)	34	17
1999	157	95	13	15	123 (78)	34	11
2000	161	93	8	25	126 (78)	36	0
2001	162	93	11	29	133 (82)	29	2
2002	161	87	12	28	127 (79)	34	3
2003	161	96	11	18	125 (78)	36	1
2004	164	95	6	23	124 (76)	40	3
2005	167	93	19	19	131 (78)	36	2
2006	168	83	12	23	118 (70)	50	0
2007	170	82	9	26	117 (69)	53	0
2008	155	73	5	18	96 (62)	59	15
2009	168	68	20	15	103 (61)	65	2
2010	165	70	8	19	97 (59)	68	5

2011	170	52	17	22	90 (53)	79	1
2012	169	53	5	29	87 (51)	82	2
2013	172	50	11	33	94 (55)	77	0
2014	171	51	9	15	75 (44)	96	1
2015	170	45	7	23	75 (44)	95	2
2016	172	31	8	16	55 (32)	116	0

[a] Residency status was determined by 1995 protocols (Forsman 1995).
[b] Sites where male and/or female owls responded, but criteria for pair or resident single status were not met.
[c] Sites surveyed at least three times at night with no responses or where owls from a neighboring site were detected.
[d] Sites not surveyed to protocol were not included in the total number of sites surveyed.

Table 2. Sex and age composition of northern spotted owls detected on the Central Cascades Study Area, Willamette National Forest, Oregon, 1987 – 2016.

Year	Adults (M, F)	Subadults [a] (M, F)	Age unknown (M, F)	Non-juveniles [b] (M, F)	Juveniles [c]
1987	53 (29, 24)	7 (4, 3)	15 (14, 1)	75 (46, 28)	12
1988	98 (49, 49)	18 (11, 7)	9 (4, 5)	125 (64, 61)	40
1989	135 (72, 63)	17 (10, 7)	14 (8, 6)	166 (90, 76)	27
1990	134 (72, 62)	9 (2, 7)	28 (17, 11)	171 (91, 80)	37
1991	152 (82, 70)	14 (8, 6)	44 (25, 19)	210 (115, 95)	30
1992	170 (88, 82)	10 (4, 6)	30 (17, 13)	208 (109, 101)	116
1993	122 (72, 50)	6 (4, 2)	23 (16, 7)	151 (92, 59)	0
1994	144 (77, 67)	8 (1, 7)	14 (8, 6)	166 (86, 80)	28
1995	151 (76, 75)	2 (2, 0)	19 (13, 6)	172 (91, 81)	22
1996	140 (71, 69)	9 (5, 4)	17 (13, 4)	166 (89, 77)	68
1997	139 (71, 68)	9 (5, 4)	21 (9, 12)	169 (85, 84)	24
1998	172 (86, 86)	8 (6, 2)	40 (27, 13)	220 (119, 101)	42
1999	169 (89, 80)	2 (2, 0)	56 (36, 20)	227 (127, 100)	21
2000	169 (85, 84)	6 (5, 1)	53 (36, 17)	228 (126, 102)	60
2001	189 (98, 91)	7 (4, 3)	38 (25, 14)	234 (127, 107)	83
2002	168 (89, 79)	11 (4, 7)	46 (26, 20)	225 (119, 106)	67

Year	Adults (M, F)	Subadults [a] (M, F)	Age unknown (M, F)	Non-juveniles [b] (M, F)	Juveniles [c]
2003	172 (93, 79)	17 (7, 10)	40 (21, 19)	229 (121, 108)	25
2004	187 (99, 88)	15 (7, 8)	29 (19, 10)	231 (125, 106)	105
2005	171 (92, 79)	12 (5, 7)	54 (33, 21)	237 (130, 107)	13
2006	149 (82, 67)	11 (6, 5)	37 (23, 14)	197 (111, 86)	20
2007	178 (90, 88)	2 (1, 1)	30 (24, 6)	210 (115, 95)	48
2008	154 (82, 72)	4 (2, 1, 1 Unk.)	18 (10, 8)	176 (93, 81, 1 Unk.)	31
2009	155 (82, 73)	5 (3, 1, 1 Unk.)	27 (19, 8)	187 (104, 82, 1 Unk.)	28
2010	134 (72, 62)	10 (6, 3, 1 Unk.)	37 (17, 19, 1 Unk.)	181 (95, 84, 2 Unk.)	56
2011	122 (63, 57, 2 Unk.)	4 (2, 2)	20 (15, 5)	146 (80, 64, 2 Unk.)	2
2012	119 (66, 53)	1 (0, 0, 1 Unk.)	22 (16, 6)	142 (82, 59, 1 Unk.)	25
2013	122 (65, 57)	2 (1, 0, 1 Unk.)	34 (23, 11)	158 (89, 68, 1 Unk.)	7
2014	113 (60, 53)	2 (1, 1, 0)	18 (14, 4)	133 (75, 58)	59
2015	95 (53, 42)	4 (1, 3)	23 (21, 2)	122 (75, 47)	45
2016	71 (40, 31)	11 (7, 4)	9 (7, 2)	91 (54, 37)	1

[a] One- and two-year-old age classes combined.
[b] Adults and subadults combined.
[c] Includes the total number of young located from 15 May to 31 August, including pre- and post-fledging mortalities.

Table 3. Breeding propensity and productivity for northern spotted owls in the Central Cascades Study Area, Willamette National Forest, Oregon from 1988 – 2016.

Nest status surveys (1 April – 31 May)				Reproductive status surveys (1 April – 31 August)			
Year	Pairs checked for nesting status [a]	Pairs nesting (%)	Successful nests (%)	Pairs checked for reproductive status [b]	Pairs fledging young (%)	Number of young fledged	Mean number of young per pair
1988	35	25 (71)	15 (60)	39	20 (51)	35	0.90
1989	40	9 (23)	6 (67)	49	10 (20)	17	0.35
1990	49	39 (80)	19 (49)	63	29 (46)	36	0.57
1991	45	13 (29)	10 (77)	58	16 (28)	30	0.52
1992	62	46 (74)	40 (87)	61	47 (77)	86	1.41
1993	29	2 (7)	0 (0)	50	0 (0)	0	0.0
1994	56	26 (46)	16 (62)	63	21 (33)	28	0.44
1995	54	13 (24)	12 (92)	73	13 (18)	22	0.30
1996	52	46 (88)	32 (70)	66	42 (64)	68	1.03
1997	58	20 (34)	14 (70)	63	15 (24)	24	0.38
1998	64	44 (69)	23 (52)	81	28 (35)	41	0.51
1999	41	10 (24)	7 (70)	76	11 (14)	21	0.28
2000	56	34 (61)	25 (74)	76	37 (49)	60	0.79
2001	60	31 (52)	25 (81)	86	48 (56)	81	0.94
2002	58	37 (64)	32 (86)	76	42 (55)	62	0.82

	Nest status surveys (1 April – 31 May)			Reproductive status surveys (1 April – 31 August)			
Year	Pairs checked for nesting status [a]	Pairs nesting (%)	Successful nests (%)	Pairs checked for reproductive status [b]	Pairs fledging young (%)	Number of young fledged	Mean number of young per pair
2003	58	13 (22)	7 (54)	76	14 (18)	25	0.33
2004	66	55 (83)	46 (84)	92	62 (67)	100	1.09
2005	53	16 (30)	7 (44)	67	12 (18)	13	0.19
2006	52	11 (21)	10 (91)	66	13 (20)	20	0.30
2007	57	33 (58)	26 (79)	70	31 (44)	48	0.69
2008	37	21 (57)	14 (67)	62	22 (35)	31	0.50
2009	34	11 (32)	10 (91)	63	16 (25)	28	0.44
2010	42	38 (90)	27 (71)	47	30 (64)	47	1.00
2011	16	0 (0)	0 (0)	43	1 (2)	2	0.04
2012	30	22 (73)	11 (50)	38	17 (45)	25	0.66
2013	31	3 (10)	3 (100)	48	4 (8)	7	0.15
2014	33	28 (85)	27 (96)	46	34 (74)	56	1.22
2015	32	23 (72)	21 (91)	39	26 (67)	44	1.13
2016	15	1 (7)	1 (100)	30	1 (3)	1	0.03
Average	46	23 (47)	17 (70)	62	24 (38)	38	0.59

[a] Includes pairs that were given at least four mice on two or more occasions before 31 May.
[b] Includes pairs that were given at least four mice on two or more occasions from 1 June to 31 August in addition to the pairs that were evaluated prior to 31 May.

Table 4. Numbers of new spotted owls banded, re-sighted, and recaptured in the central Cascades study area and in nearby wilderness sites in the Willamette National Forest, Oregon during 2016.

	New owls banded			Owls re-sighted			Owls recaptured		
Age Class	Males	Females	Unk.	Males	Females	Unk.	Males	Females	Unk.
Adult	3	2	0	36	26	0	2	4	0
Subadult	3	3	0	1	0	0	3	1	0
Juvenile	-	-	1	-	-	-	-	-	-

13) Figures.

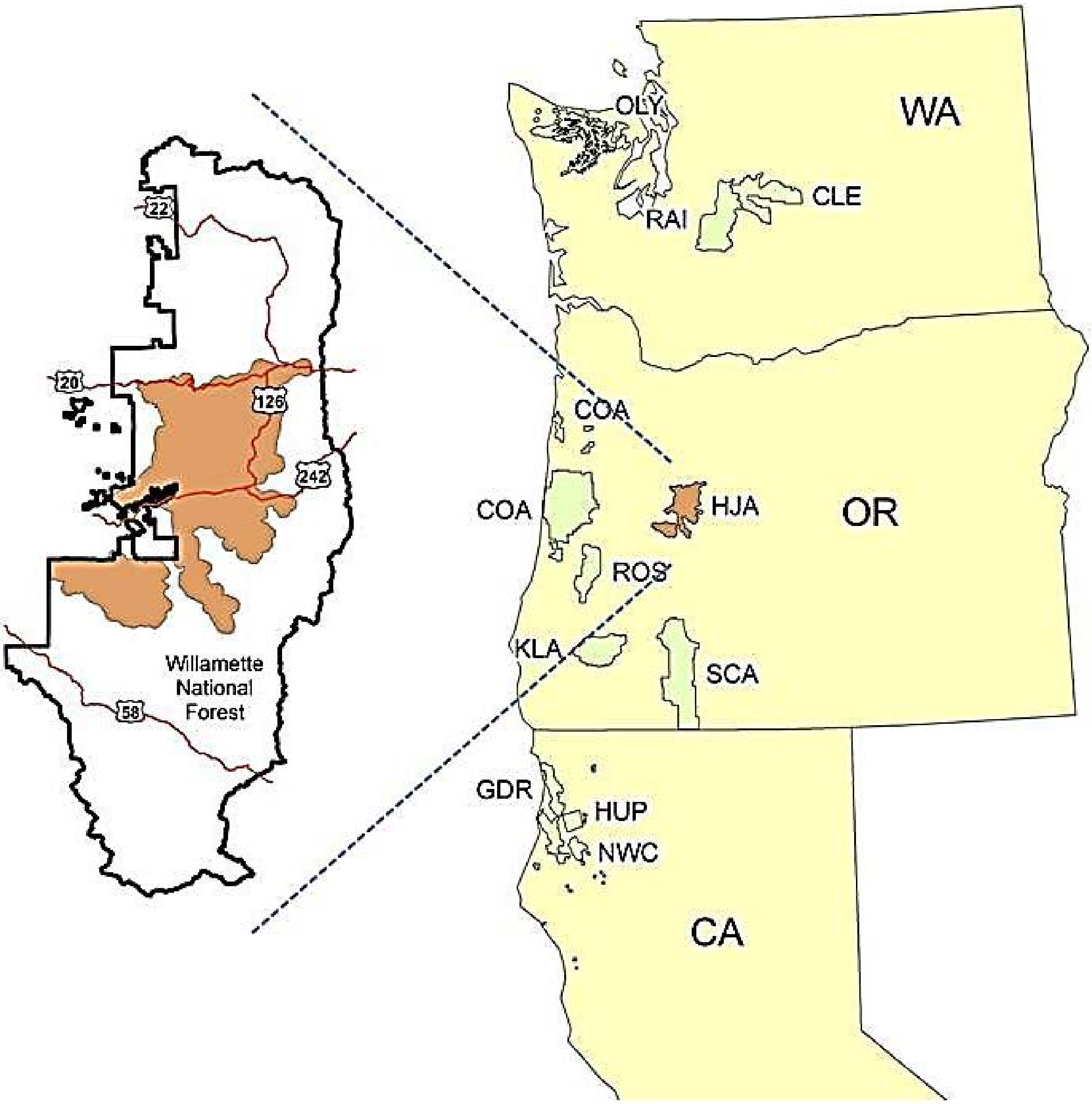

Figure 1. Location of the H.J. Andrews northern spotted owl demography study area relative to the study areas included in the 2014 meta-analysis (Dugger et al. 2016). The boundary of the study area was delineated by buffering all spotted owl site centers by 1.6 km to approximate the area covered by surveys.

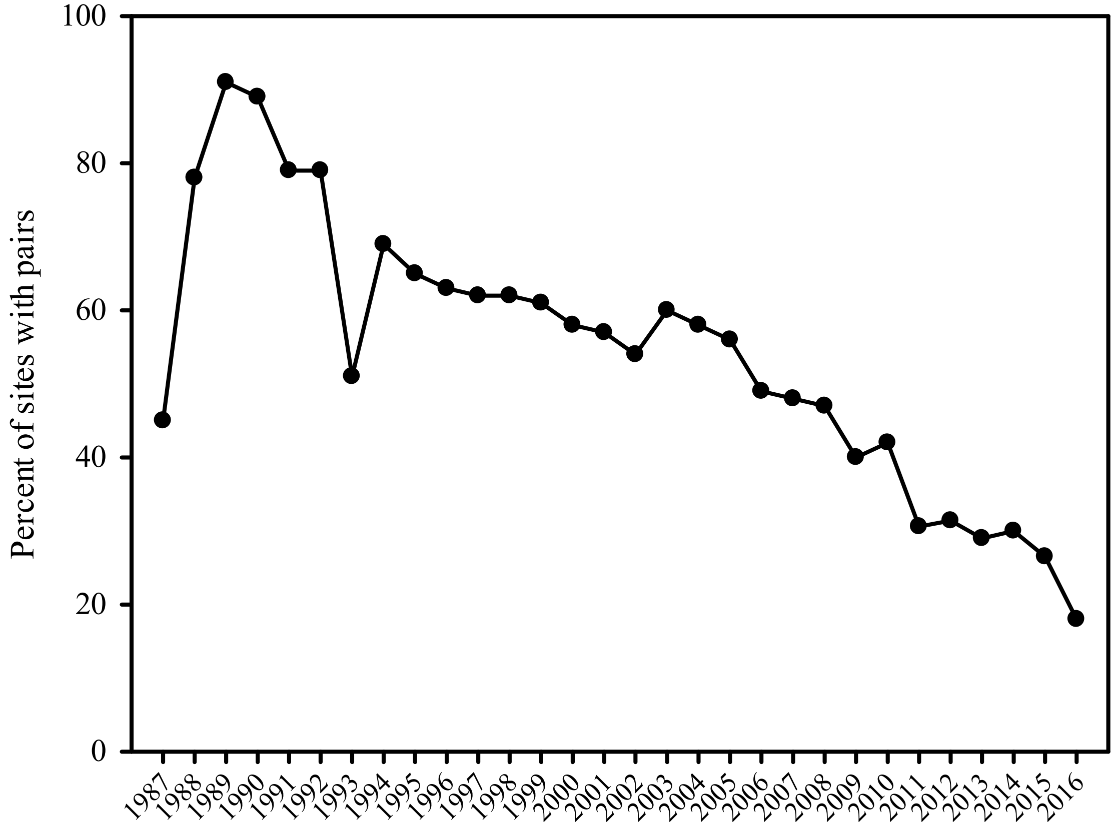

Figure 2. Percentage of sites surveyed for northern spotted owls where pairs of spotted owls were detected in the central Cascades study area, Willamette National Forest, Oregon from 1987 – 2016.

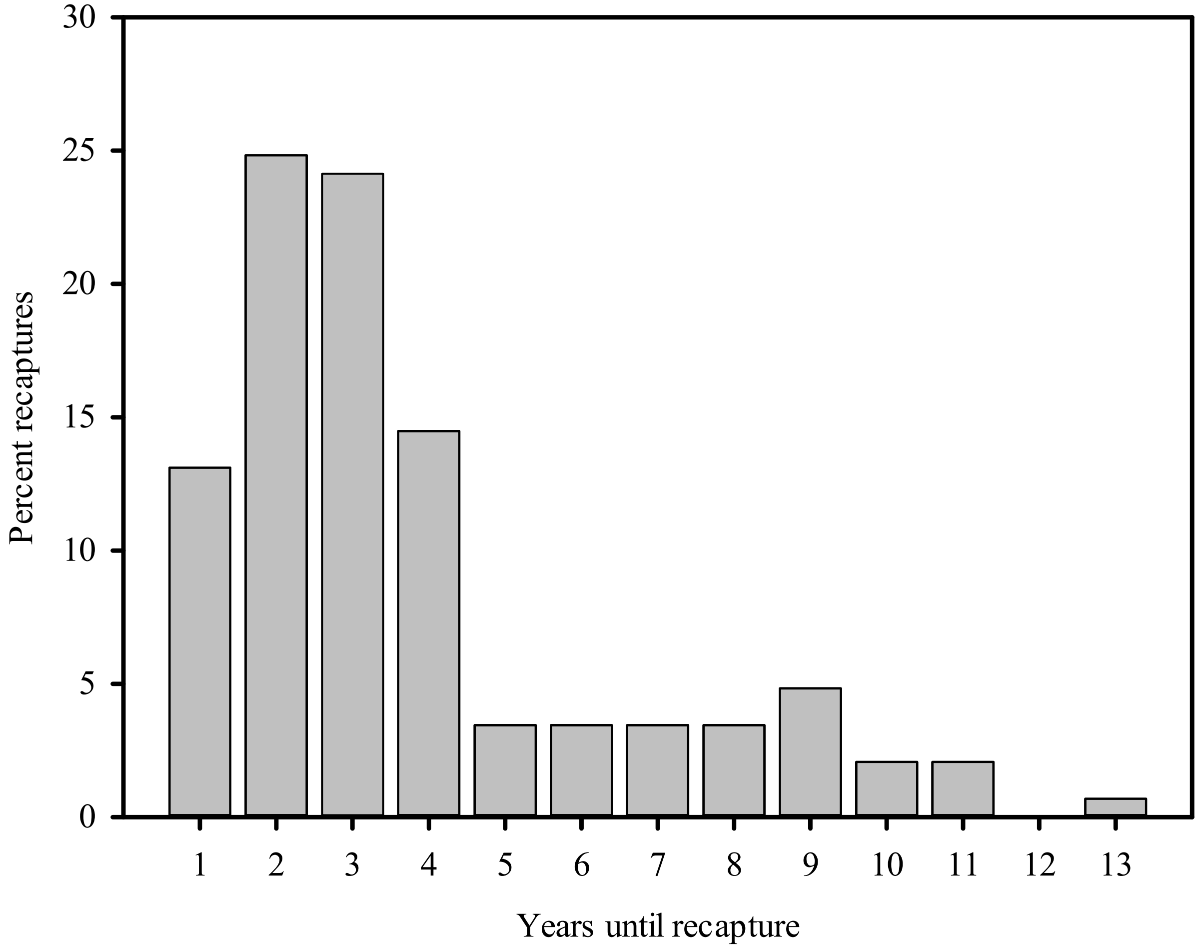

Figure 3. Years until the first recapture of 141 northern spotted owls banded as fledglings in the central Cascades study area, Willamette National Forest, Oregon from 1987 – 2016.

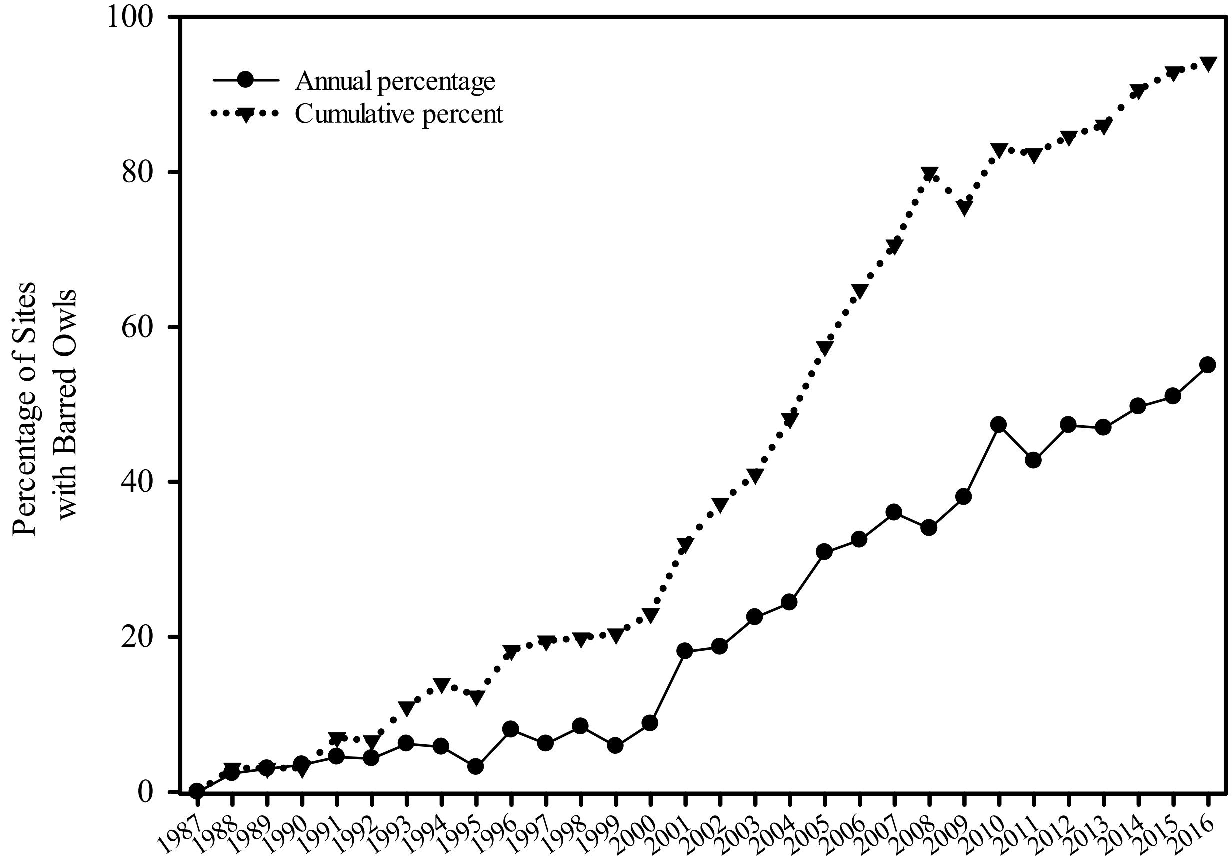

Figure 4. Annual and cumulative percentage of sites where incidental detections of barred owls (*Strix varia*) have occurred while surveying for northern spotted owls in the central Cascades study area, Willamette National Forest, Oregon from 1988 – 2016.

14) Appendices.

Appendix A. Master site number revisions.

In February 2009, the master site numbering system (MSNO) and the associated locations for the site centers maintained by the Oregon Department of Fish and Wildlife (ODFW) were reviewed and compared to the site center database maintained by the Willamette National Forest (WNF). The name and master site number of 44 sites in our database were revised to match the earliest site centers in the ODFW database (Table A1). In most cases, this required only a change in the name or MSNO of the sites that we monitored. In five instances, this required re-assignment of survey results to better reflect the survey effort at particular ODFW site centers.

Table A1. Master site number (MSNO) and site name revisions as of 26 October 2009.

District	ODFW MSNO	ODFW Site Name	Previous MSNO	Previous Site Name
McKenzie River	0032	Upper McRae Creek	0033	Middle McRae Creek
	0033	Lower McRae Creek	3025	
	0085	Lamb Butte		Lowder Mountain
	0111	NF Quartz Creek		N Fk Quartz Creek
	0113	East Fork McKenzie	5043	E Fk McKenzie River
	0119	Middle Horse Creek	0982	
	0750	Pasture Creek	0850	
	0818	Horsepasture Mount		Horsepasture Mtn
	0821	Great Spring		Great Spg-Clear Lake
	0836	Lost Creek	2442	White Branch Creek
	0850	Upper Horse Creek	2824	
	0851	Lower Roney Creek	2835	
	0857	Lowder Mountain		Upper East Fork
	0869	EF Augusta Creek		E Fk Augusta Creek
	0871	Wolf Rock	2844	Mann Creek
	2465	Hagan Block	5071	
	2477	Gate Creek	5070	
	2826	Indian Fork	1414	Indian Creek
	2827	Lost Branch	0836	Lost Creek
	2831	Castle Creek	1737	
	4085	Upper Cook Creek	3962	
Middle Fork	1015	Slick Creek	4549	West Slick Creek

District	ODFW MSNO	ODFW Site Name	Previous MSNO	Previous Site Name
Middle Fork	1017	Tiller Ninemile		Tiller-Ninemile Cr
	1020	West Delp Creek	4421	Upper Delp
	1028	Logan Creek	2858	Logan Creek
	1031	Briem Creek	4476	
	1032	Upper Pernot Creek	2888	
	1063	Delp Creek Tributary	1020	West Delp Creek
	2899	Upper Marine Creek	1028	Lower Logan Creek
	2463	Saturn Creek	1031	Saturn-Briem Creek
	2861	Little Fall Creek 2		Little Fall Creek Trib
	2867	South Puma Creek	4082	Pumarine
	4549	West Slick Creek	1015	Slick Creek
Sweet Home	0007	Burnside Creek	2956	Indian Tombstone
	0012	Indian Creek	4093	Indian Creek (Sweet)
	0013	Echo Creek		Echo Creek-Lost Prairie
	0064	Boulder Cr (Sweet)	0641	
	0668	Parks Creek	0664	
	0689	Upper Two Girls	5052	
	0694	Squaw Mountain	4098	
	1156	Gordon Meadows	0646	
	1322	Gordon Meadows West	5058	
	2964	East Wildcat Mount		East Wildcat Mountain
	4405	Squaw Headwaters		Squaw Creek Headwaters

Appendix B. Survey and monitoring results by land use allocation.

The first formal spotted owl reserve design recommended that 15 – 20 pairs of spotted owls would be necessary to support a stable population in a habitat reserve (Thomas *et al*. 1990). The Final 2008 Northern Spotted Owl Recovery Plan also recommended that category 1 managed owl conservation areas (MOCAs) be capable of supporting at least 20 pairs, and category 2 MOCAs should be capable of supporting 1 – 19 pairs while also providing connectivity between category 1 areas (U.S. Fish and Wildlife Service 2008). The Final Revised Recovery Plan released in 2011 (U.S. Fish and Wildlife Service 2011) has withdrawn the MOCA network and recommended that managers continue to consider the LSR land use allocation under the NWFP as the current reserve network. Here, we summarized the survey and monitoring results separately for the three primary land use allocations on the central Oregon Cascades northern spotted owl demography study area: late-successional reserves (LSR), adaptive management areas (AMA), and matrix habitats as defined in the Northwest Forest Plan (USDA and USDI 1994). We were particularly interested in the productivity (number of fledglings produced per pair) and detections of northern spotted owls in the four LSRs on the study area as this land use allocation was intended to provide the habitat base for recovery of the subspecies.

Detections compared among land use allocations.

In 2016, the highest proportion of sites where a territorial spotted owl was detected (either a single or pair) was in the matrix land allocation (41%), which was less than in 2015 (46%; Table B1). The proportion of sites where spotted owls were detected decreased by 19% in the AMA allocation and by 7% in the LSR allocation between 2015 and 2016 (Table B1). The proportion of territories where a pair was detected decreased in all three land use allocations between 2015 and 2016: 6% fewer in the LSR sites, 8% fewer in the MAT sites, and 12% fewer in the AMA sites (Figure B1). A pair was detected in one less territory in the Fall Creek LSR and four less territories in the Horse Creek LSR between 2014 and 2015 (Table B4). Within the other LSR units, the proportion of sites where pairs were detected remained the same in the South Santiam (3) and Hagan LSRs (0; Table B2). Overall, fewer pairs were detected on LSR sites (12%) relative to matrix (23%) and AMA sites (23%), and the trend since 1997 has been a decrease in pairs detected in all three allocations (Figure B1).

Spotted owl productivity was zero or below average in all three primary land use allocations in 2016 (matrix 2016: 0 young/pair, $\bar{x}$ = 0.59 young/pair, SE = 0.09, n = 20; AMA 2016: 0 young/pair, $\bar{x}$ = 0.57 young/pair, SE = 0.09, n = 20; LSR 2016: 0.10 young/pair, $\bar{x}$ = 0.57 young/pair, SE = 0.09 n = 19; Table B3). There was no productivity in the Fall Creek LSR in 2016 (Fall Creek 2016: 0 young/pair, $\bar{x}$ = 0.60 young/pair, SE = 0.10, n = 19). Productivity in the other three LSRs remained negligible due to low numbers of pair detections (Table B3).

Wilderness Area surveys.

Six sites located in the Three Sisters and Mount Washington Wilderness Areas within 2 km of the wilderness area boundary were surveyed on an irregular basis from 1989 through 1996. Since 1997, these sites have been surveyed annually. The data summarized here also includes a seventh site in the Three Sisters Wilderness Area where a pair was located initially in

2010 (also 2011 and 2012). The proportion of these sites where pairs were detected was initially high in the wilderness area sites (>80%) but has generally declined since 2000 (<60%; with the exception of 2005). Six sites were surveyed in 2016, but only one pair was detected and they did not reproduce (Table B4).

Thirty-five sites located in the Three Sisters and Mount Washington Wilderness Areas were surveyed irregularly from 1987 through 1999. Twenty-eight owls have been banded at these sites, although only one male owl was later relocated on the primary study area. One male and one female owl banded on the study area were re-sighted in the wilderness, but survey effort at these sites was inadequate to estimate dispersal across the wilderness boundary.

Discussion.

The proportion of sites where spotted owl pairs were detected decreased in all three primary land use allocations between 2015 and 2016 (Table B1). Decreases in pair detections in the LSR allocation are particularly pertinent to the effectiveness of the Northwest Forest Plan, as these areas were closely linked to the reserve designs for the recovery of the northern spotted owl. Our monitoring results suggest that not all LSRs were equally capable of supporting breeding pairs of spotted owls. The Fall Creek LSR lost 20 pairs from 2000 to 2016 and currently supports only 5 pairs of spotted owls. That LSR has virtually been rendered ineffective as a reserve. The South Santiam, Horse Creek, and Hagan LSRs were never likely to support more than 20 pairs of spotted owls but may still provide connectivity within the reserve network. This is because these LSRs are relatively small and contain a large proportion of mature forest (vs. old-growth) more suitable for foraging and dispersal than for roosting or nesting. It is also important to note that the LSR design was intended to preserve late-successional forest ecosystems rather than to directly benefit any one species (USDA and USDI 1994). Not all late-successional forests can be classified as old growth or as high-quality spotted owl habitat, but they may still be important in preserving ecosystem functions at the landscape level

From 2000 – 2004 and in 2007, the largest numbers of young were produced in the LSR allocation (Table B3). In 2005, 2006, and 2008 through 2015, productivity in the LSRs was lower than in the matrix and AMA allocations. With the exception of 2016 when the only young produced was in the South Santiam LSR, most of the young produced in the LSR allocation have been from the Fall Creek LSR. Very few young have been produced in the Horse Creek and South Santiam LSRs, and young were rarely produced at all in the Hagan LSR (Table B5). The wide fluctuations in productivity in the Fall Creek LSR and the relatively low numbers of young produced since 2005 suggest that this area may not be a reliable source of recruits in the future. One possible reason for this has been the relatively high numbers of barred owls in the Fall Creek LSR. Since 2000, an average of 36% of all barred owl detections each year has been in the Fall Creek LSR (range: 25% – 47%). In most years, there has been nearly as many barred owls in the Fall Creek LSR as have been detected in the matrix and AMA allocations combined. This may have been due to a greater abundance of low elevation, low slope, riparian habitats in the Fall Creek LSR relative to the rest of the study area which seems to be habitat most readily used by barred owls (reviewed in Livezey 2007). Although recent results do not support a negative effect of barred owls on fecundity in the HJA study area, declining survival in response to increasing barred owl populations obviously would impact overall population productivity through the loss of breeding spotted owls (Forsman *et al*. 2011).

Although the matrix and AMA allocations are subject to timber harvest, they still contain many productive spotted owl pairs that have made substantial contributions to population recovery. The 2012 critical habitat designation (U.S. Fish and Wildlife Service 2012) designates approximately 100,000 ha (69%) within the study area. This includes all four of the LSRs and over 50,000 ha of additional habitat, primarily in matrix and AMA allocations. Given that timber harvest may still occur in the matrix and AMA allocations (http://www.fs.usda.gov/resources/willamette/landmanagement/resourcemanagement), it will be critical to continue keeping management agencies informed of the most recent locations of these productive pairs as well as individuals newly recruited into the breeding population.

Table B1. Northern spotted owl detections and residency status at northern spotted owl sites by Northwest Forest Plan land-use allocation (USDA and USDI 1994) on the central Cascades study area, Willamette National Forest, Oregon, 1997 – 2016.

Land use allocation [a]	Year	Sites surveyed	Sites with pairs detected	Sites with resident single owls	Sites with unknown residency	Sites with ≥ 1 owl detected (%)	Sites where owls were not detected	Sites not surveyed to protocol
Matrix	1997	40	29	2	0	31 (78)	9	2
	1998	41	26	3	2	31 (76)	10	3
	1999	42	26	3	1	30 (71)	12	2
	2000	39	24	2	5	31 (79)	8	0
	2001	38	26	3	6	35 (92)	3	1
	2002	38	22	2	7	31 (82)	7	0
	2003	37	26	1	3	30 (81)	7	1
	2004	38	25	1	5	31 (82)	7	0
	2005	39	25	2	4	31 (79)	8	0
	2006	39	22	1	4	27 (69)	12	0
	2007	39	23	1	1	25 (64)	14	0
	2008	37	23	0	2	25 (68)	12	2
	2009	39	20	4	1	25 (64)	14	0
	2010	38	21	0	0	21 (55)	17	0
	2011	39	18	3	1	22 (56)	17	0
	2012	39	17	1	3	21 (54)	18	0
	2013	39	14	2	3	19 (49)	20	0
	2014	38	16	1	1	18 (47)	20	1
	2015	39	12	2	4	18 (46)	21	0
	2016	39	9	3	4	16 (41)	23	0
AMA	1997	45	31	4	1	36 (80)	9	3
	1998	44	33	1	4	38 (86)	6	1

Land use allocation [a]	Year	Sites surveyed	Sites with pairs detected	Sites with resident single owls	Sites with unknown residency	Sites with ≥ 1 owl detected (%)	Sites where owls were not detected	Sites not surveyed to protocol
AMA (cont.)	1999	43	30	2	4	36 (84)	7	1
	2000	43	30	2	1	33 (77)	10	0
	2001	44	27	4	5	36 (82)	8	0
	2002	42	27	4	5	36 (86)	6	2
	2003	43	30	2	4	36 (84)	7	0
	2004	45	26	2	4	32 (71)	13	0
	2005	45	26	9	5	40 (89)	5	0
	2006	45	24	4	7	35 (78)	10	0
	2007	47	22	4	11	37 (79)	10	0
	2008	44	21	1	4	26 (59)	18	3
	2009	44	19	5	5	29 (66)	15	1
	2010	48	22	3	6	31 (65)	17	0
	2011	48	16	4	3	23 (48)	25	0
	2012	48	12	2	10	24 (50)	24	0
	2013	48	14	4	12	30 (63)	18	0
	2014	48	16	2	3	21 (44)	27	0
	2015	48	17	1	6	24 (50)	24	0
	2016	48	11	2	2	15 (31)	33	0
LSR	1997	27	8	2	9	19 (70)	8	7
	1998	55	27	3	8	38 (69)	17	13
	1999	66	35	7	10	52 (79)	14	8
	2000	73	35	2	18	55 (75)	18	0
	2001	74	35	4	18	57 (77)	17	1
	2002	75	34	6	14	54 (72)	21	0

Land use allocation [a]	Year	Sites surveyed	Sites with pairs detected	Sites with resident single owls	Sites with unknown residency	Sites with ≥ 1 owl detected (%)	Sites where owls were not detected	Sites not surveyed to protocol
LSR (cont.)	2003	75	36	8	11	55 (73)	20	0
	2004	75	41	2 [b]	13	56 (75)	19	2
	2005	77	40	8	7	55 (71)	22	0
	2006	78	34	7 [b]	10	51 (65)	27	0
	2007	77	35	4 [b]	12	51 (66)	26	0
	2008	68	27	4 [b]	11	42 (62)	26	9
	2009	77	27	9 [b]	8	44 (57)	33	1
	2010	73	25	3 [b]	13	41 (56)	31	4
	2011	78	15	9 [b]	17	41 (53)	36	1
	2012	78	21	2 [b]	17	40 (51)	36	2
	2013	78	20	5 [b]	16	41 (53)	37	0
	2014	78	18	5 [b]	10	33 (42)	45	0
	2015	78	14	2 [b]	13	29 (37)	46	2
	2016	78	9	4 [b]	10	23 (30)	55	0

[a] Sites with LUA designation of “Other”, “Private”, and “Wilderness” are not included here.
[b] This total includes one resident male spotted owl that has been paired with a spotted x barred hybrid female owl.

Table B2. Summary of survey effort and spotted owl detections in the four late-successional reserves (LSR) in the Central Cascades Study Area, Willamette National Forest, Oregon from 1997 – 2016.

LSR	Year	Sites surveyed	Sites with ≥1 owl detected (%)	Sites with pairs detected (%)
Fall Creek (LSR-219)	1997	0	-	-
	1998	23	17 (74)	13 (57)
	1999	36	30 (83)	23 (64)
	2000	40	33 (83)	25 (63)
	2001	40	34 (85)	24 (60)
	2002	41	36 (88)	25 (61)
	2003	41	35 (85)	21 (51)
	2004	40	31 (78)	24 (60)
	2005	42	30 (71)	24 (57)
	2006	42	30 (71)	20 (48)
	2007	42	30 (71)	20 (48)
	2008	36	25 (69)	16 (44)
	2009	41	23 (56)	14 (34)
	2010	38	23 (61)	15 (39)
	2011	43	25 (58)	9 (21)
	2012	42	24 (57)	15 (36)
	2013	43	28 (65)	13 (30)
	2014	43	19 (44)	11 (26)
	2015	43	17 (40)	6 (14)
	2016	43	11 (26)	5 (12)
Hagan (LSR-215)	1997	3	2 (67)	1 (33)
	1998	4	3 (75)	2 (50)
	1999	5	3 (60)	0
	2000	5	3 (60)	1 (20)

LSR	Year	Sites surveyed	Sites with ≥1 owl detected (%)	Sites with pairs detected (%)
	2001	5	5 (100)	2 (40)
	2002	5	2 (40)	1 (20)
	2003	5	3 (60)	2 (40)
	2004	5	3 (60)	2 (40)
	2005	5	4 (80)	1 (20)
	2006	5	3 (60)	3 (60)
	2007	5	3 (60)	1 (20)
	2008	4	1 (25)	1 (25)
	2009	5	2 (40)	2 (40)
	2010	5	1 (20)	0
	2011	5	2 (40)	0
	2012	5	3 (60)	0
	2013	5	0	0
	2014	5	0	0
	2015	5	1 (20)	0
	2016	5	0	0
Horse Creek (LSR-218)	1997	12	8 (67)	3 (25)
	1998	14	9 (64)	7 (50)
	1999	13	9 (69)	7 (54)
	2000	13	8 (62)	7 (54)
	2001	13	9 (69)	4 (31)
	2002	14	8 (57)	3 (21)
	2003	14	10 (71)	7 (50)
	2004	14	11 (79)	8 (57)
	2005	14	10 (71)	4 (29)
	2006	14	8 (57)	5 (36)
	2007	14	9 (64)	6 (43)

LSR	Year	Sites surveyed	Sites with ≥1 owl detected (%)	Sites with pairs detected (%)
	2008	13	8 (62)	6 (46)
	2009	14	11 (79)	6 (43)
	2010	14	8 (57)	5 (36)
	2011	14	8 (57)	3 (21)
	2012	14	7 (50)	4 (29)
	2013	14	7 (50)	3 (21)
	2014	14	8 (57)	4 (29)
	2015	14	7 (50)	5 (36)
	2016	14	8 (57)	1 (7)
S. Santiam (LSR-217)	1997	12	9 (75)	4 (33)
	1998	14	9 (64)	5 (36)
	1999	12	10 (83)	5 (42)
	2000	15	11 (73)	2 (13)
	2001	15	8 (53)	4 (27)
	2002	15	8 (53)	5 (33)
	2003	15	8 (53)	6 (40)
	2004	15	10 (67)	6 (40)
	2005	16	11 (69)	11 (69)
	2006	16	9 (56)	5 (31)
	2007	16	9 (56)	8 (50)
	2008	15	8 (53)	4 (27)
	2009	16	8 (50)	5 (31)
	2010	15	9 (60)	7 (47)
	2011	16	6 (38)	3 (19)
	2012	16	6 (38)	2 (13)
	2013	16	7 (44)	4 (25)
	2014	16	5 (31)	3 (19)

LSR	Year	Sites surveyed	Sites with ≥1 owl detected (%)	Sites with pairs detected (%)
	2015	16	5 (31)	3 (19)
	2016	16	4 (25)	3 (19)

Table B3. Summary of reproductive success of northern spotted owls stratified by land use allocation on the Central Cascades Study Area, Willamette National Forest, Oregon from 1997 – 2016.

Land use allocation	Year	Number of pairs [a]	Number (%) of pairs fledging young	Number of young fledged	Average number of young per successful pair	Average number of young per pair (all pairs)
Matrix	1997	25	6 (24)	10	1.67	0.40
	1998	24	12 (50)	17	1.42	0.71
	1999	23	1 (4)	2	2.00	0.09
	2000	23	10 (43)	17	1.70	0.74
	2001	26	10 (38)	17	1.70	0.65
	2002	19	11 (58)	16	1.45	0.84
	2003	22	2 (9)	3	1.50	0.14
	2004	25	19 (76)	30	1.58	1.20
	2005	21	3 (14)	3	1.00	0.14
	2006	20	6 (30)	10	1.67	0.50
	2007	20	10 (48)	15	1.50	0.75
	2008	20	6 (30)	9	1.50	0.45
	2009	20	9 (43)	17	1.89	0.85
	2010	17	12 (71)	17	1.42	1.00
	2011	16	0 (0)	0	0	0
	2012	16	9 (56)	13	1.44	0.81
	2013	14	1 (7)	2	2.00	0.14
	2014	17	14 (82)	23	1.64	1.35
	2015	12	8 (67)	13	1.63	1.08
	2016	7	0 (0)	0	0	0
	Ave.	19	7 (38)	12	1.59	0.59

Land use allocation	Year	Number of pairs [a]	Number (%) of pairs fledging young	Number of young fledged	Average number of young per successful pair	Average number of young per pair (all pairs)
AMA	1997	28	8 (29)	13	1.63	0.46
	1998	32	7 (22)	9	1.29	0.28
	1999	29	5 (17)	9	1.80	0.31
	2000	25	12 (48)	20	1.67	0.80
	2001	24	14 (54)	24	1.71	1.00
	2002	25	10 (40)	13	1.30	0.52
	2003	23	4 (17)	8	2.00	0.35
	2004	26	19 (73)	32	1.68	1.23
	2005	19	7 (33)	8	1.14	0.42
	2006	20	5 (25)	8	1.60	0.40
	2007	16	4 (25)	6	1.50	0.38
	2008	17	10 (59)	15	1.50	0.88
	2009	17	3 (18)	5	1.67	0.29
	2010	14	11 (79)	15	1.36	1.07
	2011	14	1 (7)	2	2.00	0.14
	2012	8	3 (38)	5	1.67	0.63
	2013	13	0 (0)	0	0	0
	2014	15	9 (60)	16	1.78	1.07
	2015	14	10 (71)	17	1.70	1.21
	2016	11	0 (0)	0	0	0
	Ave.	20	7 (36)	11	1.61	0.60
LSR [b]	1997	5	0 (0)	0	0.00	0.00
	1998	21	7 (32)	12	1.71	0.57

Land use allocation	Year	Number of pairs [a]	Number (%) of pairs fledging young	Number of young fledged	Average number of young per successful pair	Average number of young per pair (all pairs)
LSR [b]	1999	20	5 (25)	10	2.00	0.50
	2000	24	14 (68)	22	1.57	0.92
	2001	32	22 (69)	37	1.68	1.16
	2002	28	19 (66)	31	1.63	1.11
	2003	27	5 (17)	9	1.80	0.33
	2004	38	22 (56)	34	1.55	0.89
	2005	26	2 (7)	2	1.00	0.08
	2006	24	2 (8)	2	1.00	0.08
	2007	32	15 (47)	23	1.53	0.72
	2008	23	6 (25)	7	1.17	0.30
	2009	24	4 (17)	6	1.50	0.25
	2010	16	7 (44)	15	2.14	0.94
	2011	13	0 (0)	0	0	0
	2012	14	4 (29)	6	1.50	0.43
	2013	20	3 (15)	5	1.67	0.25
	2014	14	10 (71)	15	1.50	1.07
	2015	12	8 (67)	14	1.75	1.17
	2016	10	1 (10)	1	1.00	0.10
	Ave.	21	8 (34)	13	1.54	0.54

[a] Includes only pairs that were given at least 4 mice on two or more occasions prior to 31 August.
[b] The LSR estimates computed for 1998 - 2016 included the Fall Creek LSR which was not surveyed in 1997.

Table B4. Wilderness boundary sites surveyed concurrently with the demographic study in the central Cascades study area, Willamette National Forest, Oregon from 1997 – 2016.

Year	Sites surveyed [a]	Sites with pairs	Number of pairs producing young	Number of young fledged
1997	5	4	1	2
1998	5	5	1	1
1999	5	5	0	0
2000	5	3	0	0
2001	5	4	0	0
2002	5	2	0	0
2003	6[b]	3	0	0
2004	6	2	0	0
2005	6	5	0	0
2006	6	3	1	2
2007	6	3	3	4
2008	5	2	0	0
2009	6	3	0	0
2010	7[c]	3	0	0
2011	7[c]	1	0	0
2012	7[c]	2	0	0
2013	6	2	0	0
2014	6	2	2	3
2015	6	1	1	1
2016	6	1	0	0

[a] Includes only sites that were surveyed at least 3 times at night.
[b] One site previously within an LSR has been re-assigned to the wilderness based on the 3 most recent owl locations.
[c] A second pair was located from an LSR site over 1 mile into the wilderness

Table B5. Summary reproductive statistics in the four late-successional reserves (LSR) in the Central Cascades Study Area, Willamette National Forest, Oregon from 1997 – 2016.

LSR	Year	Nesting surveys [a]	Pairs nesting	Reproductive surveys [b]	Pairs fledging young (%)	Young fledged	Young per successful pair	Young per all pairs
Fall Creek	1997	Fall Creek not surveyed by OCFWRU staff in 1997.						
(LSR-219)	1998	9	7	10	4 (40)	8	2.00	0.80
	1999	8	2	12	4 (33)	8	2.00	0.67
	2000	11	9	19	12 (67)	20	1.67	1.05
	2001	13	6	23	15 (65)	24	1.60	1.04
	2002	17	14	22	15 (71)	27	1.80	1.23
	2003	14	2	18	2 (11)	4	2.00	0.22
	2004	19	12	23	13 (59)	22	1.69	0.96
	2005	14	6	17	0	0	0	0
	2006	15	0	16	0	0	0	0
	2007	14	9	20	11 (58)	16	1.45	0.80
	2008	8	4	18	5 (29)	6	1.20	0.33
	2009	8	2	13	5 (38)	4	1.33	0.31
	2010	9	8	9	4 (44)	9	2.25	1.00
	2011	3	0	9	0	0	0	0
	2012	10	7	9	3 (33)	5	1.67	0.55
	2013	7	0	14	1 (7)	2	2.00	0.14
	2014	5	5	8	7 (88)	10	1.43	1.25
	2015	5	3	6	3 (50)	6	2.00	1.00
	2016	2	0	4	0 (0)	0	0	0
Hagan	1997	1	1	0	0	0	0	0
(LSR-215)	1998	1	1	1	0	0	0	0
	1999	0	-	0	-	-	-	-
	2000	0	-	0	-	-	-	-
	2001	1	1	2	2 (100)	3	1.50	1.50
	2002	1	0	1	0	0	0	0
	2003	1	1	1	0	0	0	0

LSR	Year	Nesting surveys [a]	Pairs nesting	Reproductive surveys [b]	Pairs fledging young (%)	Young fledged	Young per successful pair	Young per all pairs
	2004	2	1	2	0	0	0	0
	2005	0	-	0	-	-	-	-
	2006	1	0	1	0	0	0	0
	2007	1	0	1	0	0	0	0
	2008	1	0	1	0	0	0	0
	2009	1	1	2	0	0	0	0
	2010	0	-	0	-	-	-	-
	2011	0	-	0	-	-	-	-
	2012	0	-	0	-	-	-	-
	2013	0	-	0	-	-	-	-
	2014	0	-	0	-	-	-	-
	2015	0	-	0	-	-	-	-
	2016	0	-	0	-	-	-	-
Horse Cr.	1997	2	0	3	0	0	0	0
(LSR-218)	1998	2	0	6	2 (40)	2	1.00	0.33
	1999	4	2	4	1 (20)	2	2.00	0.50
	2000	3	2	3	1 (33)	1	1.00	0.33
	2001	2	1	4	3 (60)	6	2.00	1.50
	2002	2	1	3	1 (33)	1	1.00	0.33
	2003	3	1	5	2 (50)	3	1.50	0.60
	2004	2	2	8	5 (63)	7	1.40	0.88
	2005	3	0	4	1 (25)	1	1.00	0.25
	2006	2	1	2	1 (50)	1	1.00	0.50
	2007	3	1	6	2 (40)	4	2.00	0.67
	2008	1	0	2	0	0	0	0
	2009	1	1	5	1 (20)	2	2.00	0.40
	2010	3	3	3	2 (67)	5	2.50	1.67
	2011	1	0	5	0	0	0	0
	2012	1	0	3	0	0	0	0
	2013	1	1	3	1 (33)	1	1.00	0.33

LSR	Year	Nesting surveys [a]	Pairs nesting	Reproductive surveys [b]	Pairs fledging young (%)	Young fledged	Young per successful pair	Young per all pairs
	2014	1	0	3	1 (33)	1	1.00	0.33
	2015	2	2	3	3 (100)	4	1.33	1.33
	2016	0	-	2	0 (0)	0	0	0
S.Santiam	1997	4	2	5	0	0	0.00	0.00
(LSR-217)	1998	4	2	5	1 (25)	2	2.00	0.40
	1999	1	0	4	0	0	0.00	0.00
	2000	1	1	2	1 (50)	1	1.00	0.50
	2001	2	2	3	2 (67)	4	2.00	1.33
	2002	2	2	3	3 (100)	3	1.00	1.00
	2003	3	1	6	1 (17)	2	2.00	0.33
	2004	4	4	6	4 (67)	5	1.25	0.83
	2005	4	1	7	1 (14)	1	1.00	0.14
	2006	4	1	5	1 (20)	1	1.00	0.20
	2007	3	1	7	2 (29)	3	1.50	0.43
	2008	4	2	4	1 (25)	1	1.00	0.25
	2009	2	0	5	0	0	0	0
	2010	1	1	6	1 (17)	1	1.00	0.17
	2011	0	-	3	0	0	0	0
	2012	0	-	2	1 (50)	1	1.00	0.5
	2013	4	1	5	1 (20)	2	2.00	0.4
	2014	2	2	3	2 (67)	4	2.00	1.33
	2015	2	1	3	2 (67)	4	2.00	1.33
	2016	2	1	3	1 (33)	1	1.00	0.33

[a] Includes pairs and females given at least four mice on at least two occasions by 31 May and all females examined for a brood patch while in hand by 30 June.
[b] Includes all pairs and females given at least four mice on at least two occasions by 31 August.

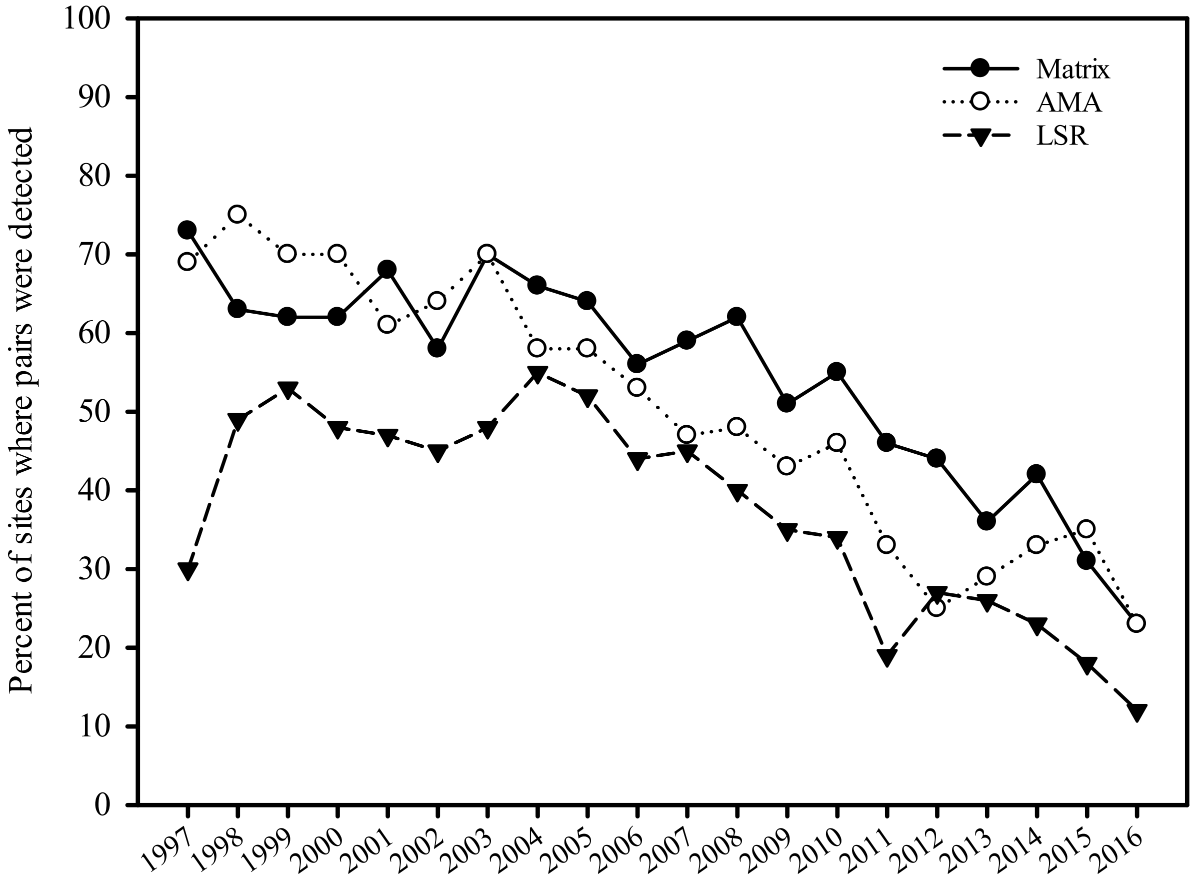

Figure B1. Percentage of sites where pairs of northern spotted owls were detected compared among land use allocations in the central Cascades study area, Willamette National Forest, Oregon from 1997 – 2016.

Appendix C. Hybridization between spotted and barred owls.

Since 1999, we have located 12 non-juvenile spotted-barred owl F1 hybrids at 17 different sites, and in 2016 we observed 1 hybrid female on the study area (Table C1). We observed eight cases involving a spotted owl paired with a hybrid or barred owl and five cases involving hybrid males paired with barred owl females. In addition, a male spotted owl was observed paired with a female barred owl (1 case) and with a female F1 hybrid owl (2 cases). A single case of a barred owl male paired with a female F1 hybrid also has been observed, although this pair did not attempt to nest.

The first F1 hybrid-barred owl pair was located west of the Fall Creek LSR in 1999. An F1 hybrid female was found near a historic spotted owl nest site within a Wild and Scenic River corridor along the McKenzie River in 2004. An F1 hybrid was detected in two neighboring matrix sites in 2006 and 2007. Most recently, an F1 hybrid originally banded in the Fall Creek LSR in 2004 was relocated in the AMA allocation in 2011. Six of the other nine F1 hybrid detections were in the Fall Creek LSR; another F1 hybrid was located in the Horse Creek LSR in 2002, and two F1 hybrid detections occurred in the South Santiam LSR in 2009 and 2010. Two of the F1 hybrids immigrated to the Fall Creek LSR from their initial banding locations in the Klamath and Roseburg study areas over 100 km away.

Reproduction was observed previously between a male F1 hybrid and a female barred owl (a total of 8 backcross young fledged by 2 different pairs from 1999 – 2006) and between a male spotted owl and a female barred owl (2 F1 hybrid young fledged in 2001). A female F1 hybrid has been paired with four different male spotted owls from 2003 to 2016, but reproduction was not documented for any pairing. To date, female spotted owls have not been observed pairing with male barred or hybrid owls in this study area (Table C1). This is consistent with other studies that indicated that female spotted owls rarely mate with barred or hybrid owls (Kelly 2001, Haig *et al*. 2004). This also may be a result of the male-biased spotted owl sex ratio; unpaired male spotted owls may pair with a barred owl or hybrid if a female spotted owl is not available. We typically have not been following up on detections of single male barred owls, so it is unknown how frequently female hybrid or spotted owls are also present. We banded five of the F1 hybrids and two of the backcross young produced from 2003 – 2005. One of the previously banded F1 hybrids was relocated in 2015; a female F1 hybrid that has remained paired with four successive spotted owl males. These pairs have not produced any young. A single male F1 hybrid previously banded in 2004 was relocated in 2011 paired with a barred owl female, but this hybrid has not been relocated since. Neither of the banded backcross young from the male F1 hybrid-female barred owl pair produced in 2004 and 2005 have been relocated.

Table C1. Summary of spotted x barred hybrid owl activity in the Central Cascades Study Area, Willamette National Forest, Oregon from 1999 – 2016.

Year	MSNO	Male species [a]	Female species	Number of young fledged	Additional STOC observations
1999	4549	STXX	STVA	1	Pair, reproduction unknown
2000	4549	STXX	STVA	Unknown	None
2001	1015	STOC	STVA	2	None
	4549	STXX	--	--	Female, 1 auditory detection
2002	2446	STVA	STXX	Unknown	Male, 1 auditory detection
	4549	STXX [b]	STVA	2	None
2003	1013	--	STXX [c]	Unknown	Resident male
	1031	STXX	--	--	Male, 1 auditory detection
	4549	STXX	--	--	None
2004	1015	STXX	--	--	None
	1031	STXX [d]	STVA	2 [e]	None
	2444	STOC	STXX [c]	Non-nesting	None
	2447	--	STXX	Unknown	Pair, 1 auditory detection
	2861	STXX	STVA	Unknown	Male, visual identification
	2897	--	STXX [f]	Unknown	Male, 1 auditory detection
	4392	STXX [g]	STVA	Unknown	Pair, 1 auditory detection
	4549	STXX	STVA	Unknown	Male, 1 auditory detection
2005	1031	STXX [d, h]	STVA	1 [i]	None
	2861	STXX	--	Unknown	Unk. sex, 1 auditory detection
	4392	STXX	--	Unknown	Pair, failed nesting attempt
	4549	STXX	STVA	Unknown	Unk. sex, 1 auditory detection
2006	1012	STXX [g]	--	Unknown	Male, visual, not identified
	4549	STXX	STVA	Unknown	Female, 2 auditory detections
	1016	STXX	--	Unknown	Male, visual identification
	1031	STXX [d]	STVA	2 [e]	None
	2410	--	STXX	Unknown	Pair, no young produced

Year	MSNO	Male species [a]	Female species	Number of young fledged	Additional STOC observations
	2444	STOC	STXX [c]	Non-nesting	None
2007	1013	STOC	STXX [c]	0	None
	2413	--	STXX	Unknown	Pair, non-nesting
	4392	STXX [g]	--	Unknown	None
2008	1013	STOC	STXX [c]	0	Male, 1 auditory detection
	4392	STXX [g]	--	Unknown	Male, 3 auditory detections
2009	1013	STOC	STXX [c]	0	Male, 2 auditory detections
	4196	STXX	--	Unknown	None
2010	1013	STOC	STXX [c]	0	None
	4196	STXX	--	Unknown	None
2011	1013	STOC	STXX [c]	0	None
	2427	STVA	STXX [f]	Unknown	Pair, no young produced
2012	1013	STOC	STXX [c]	0	None
2013	1013	STOC	STXX [c]	0	None
	4196	STXX	STVA	Unknown	None
2014	1013	STOC	STXX [c]	Unknown	None
	2427	STVA	STXX [f]	Unknown	Pair, 2 young fledged
2015	0007	STXX	--	Unknown	None
	1013	STOC	STXX [c]	Unknown	None
2016	1013	STOC	STXX [c]	Unknown	None

[a] STOC = northern spotted owl, STVA = barred owl, STXX = spotted x barred owl hybrid.
[b] Banded as an adult on 9 June 2002; orange/yellow tab, left leg.
[c] Banded 141 km SSW of the study area as a fledgling on 21 June 2001, color band replaced 30 April 2003: pink/white dots/orange tab, left leg. This owl was also re-sighted at site 1032 on 13 August 2003.
[d] Banded as an adult on 17 May 2004; green/white triangles, right leg.
[e] One backcross fledgling banded on 21 June 2004; white/red triangles, left leg.
[f] Banded as an adult on 26 May 2004; black/white dots/white tab, left leg.
[g] Banded 103 km SW of the study area as a 2-year-old on 11 March 2003, re-sighted on the study area on 19 May 2004; green/white diagonals/orange tab, left leg.
[h] Lost original color band. New band attached on 20 June 2005; pink/white dots/black tab, right

leg.

[i] Single backcross fledgling banded on 20 June 2005; red/white stripe, left leg.