ANNUAL RESEARCH REPORT
FY 2012
21 December 2012

1. Title:

Demographic Characteristics and Ecology of Northern Spotted Owls (*Strix occidentalis caurina*) in the Southern Oregon Cascades.

2. Principal Investigators and Organizations:

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3. Study Objectives:

a. Estimate population parameters (proportion of territories where owls were detected, fecundity, survival rates, and annual rates of population change) of northern spotted owls on the Rogue River-Siskiyou and Fremont-Winema National Forests.

b. Examine northern spotted owl diets, nesting habitat, and interspecific interactions with barred owls.

c. Communicate results to other researchers examining northern spotted owl ecology.

4. Potential Benefit or Utility of the Study:

Studying the population dynamics, diet and habitat characteristics associated with breeding spotted owls will increase our understanding of factors affecting spotted owl populations. This study offers insights into spotted owl ecology while concurrently addressing the validation and effectiveness monitoring requirements of the Northwest Forest Plan (USDA and USDI 1994). The Southern Oregon Cascades Study Area is one of eight Federally-sponsored study areas that represent the Effectiveness Monitoring Program for Spotted Owls under the Northwest Forest Plan (Lint *et al*. 1999). Demography data from this study area has been included in five meta-analyses of spotted owl vital rates across the species range (Burnham *et al*. 1996, Franklin *et al*. 1999, Anthony *et al*. 2006, Forsman *et al*. 2011). These data were important for the 2004 review of the species' threatened status (USFWS 2004), the Final Revised Recovery Plan for the Northern Spotted Owl, the generation of the Critical Habitat Rule, and the Experimental Removal of Barred Owls to Benefit Threatened Northern Spotted Owls Draft Environmental Impact Statement (USDI 2011, 2012a, 2012b).

5. Study Description and Survey Design:

The design of this project follows the framework of a demographic study that monitors a collection of known owl sites within a bounded area. To meet the objectives of this study, we gathered annual data that allowed us to estimate survival, reproductive rates, and annual rate of population change (Forsman *et al.* 2011). This study utilized a sample of northern spotted owls within Late-Successional Reserve (LSR), Matrix Land-use Allocations (LUA) (USDA and USDI 1994) and Wilderness Areas. We followed survey protocol and data collection procedures as outlined in Forsman (1995).

6. Study Area

The Southern Cascades Study Area incorporates approximately 2,400 km^2 of primarily Federal forest land. The area is geographically situated on lands administered by the Rogue River-Siskiyou National Forest (High Cascades Ranger District), the Fremont-Winema National Forest (Klamath Ranger District), and the Umpqua National Forest (Diamond Lake Ranger District) (Figure 1). The study area occupies the southern terminus of the Oregon Cascades including portions of both the western and eastern provinces. Landforms are primarily volcanic in origin and consist of plateaus and moderately dissected terrain (USDA and USDI 1994). The study area lies within the Mixed-Conifer, *Abies concolor*, *Abies magnifica* var. *shastensis*, and *Tsuga mertensiana* zones at elevations ranging from 900-2000 meters (Franklin and Dyrness 1973).

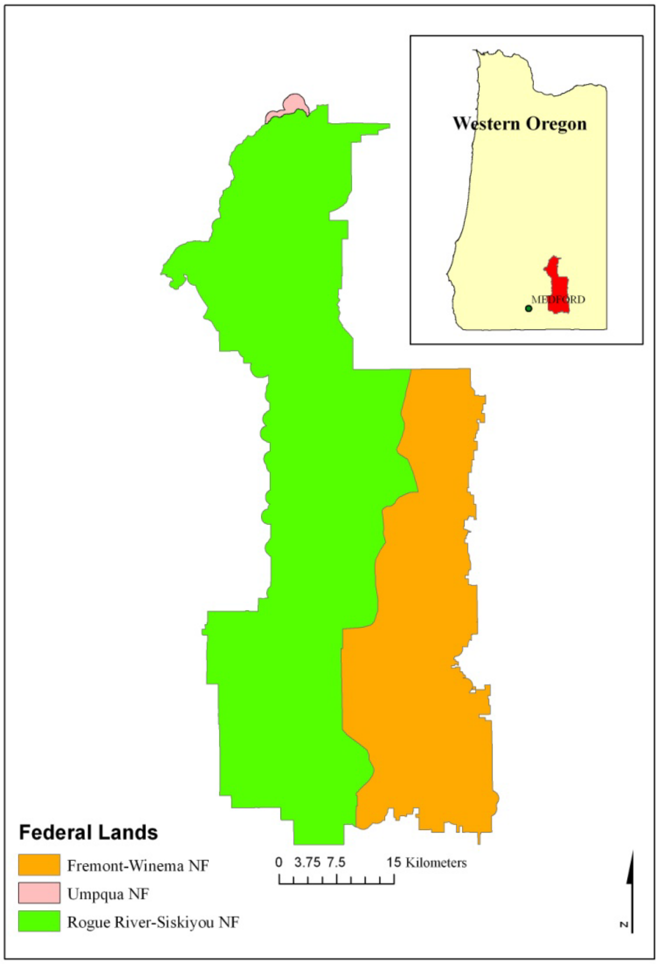

Figure 1. The Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2012.

The Southern Cascades Spotted Owl Study Area was established in 1990 and is one of the eight long-term monitoring sites in the Effectiveness Monitoring Program for Northern Spotted Owls under the auspices of the Northwest Forest Plan (Lint *et al.* 1999). The total number of surveyed spotted owl sites has increased over time, as new sites are added when previously unmonitored owls are detected and a total of 170 sites were surveyed in 2012 (Figure 2).

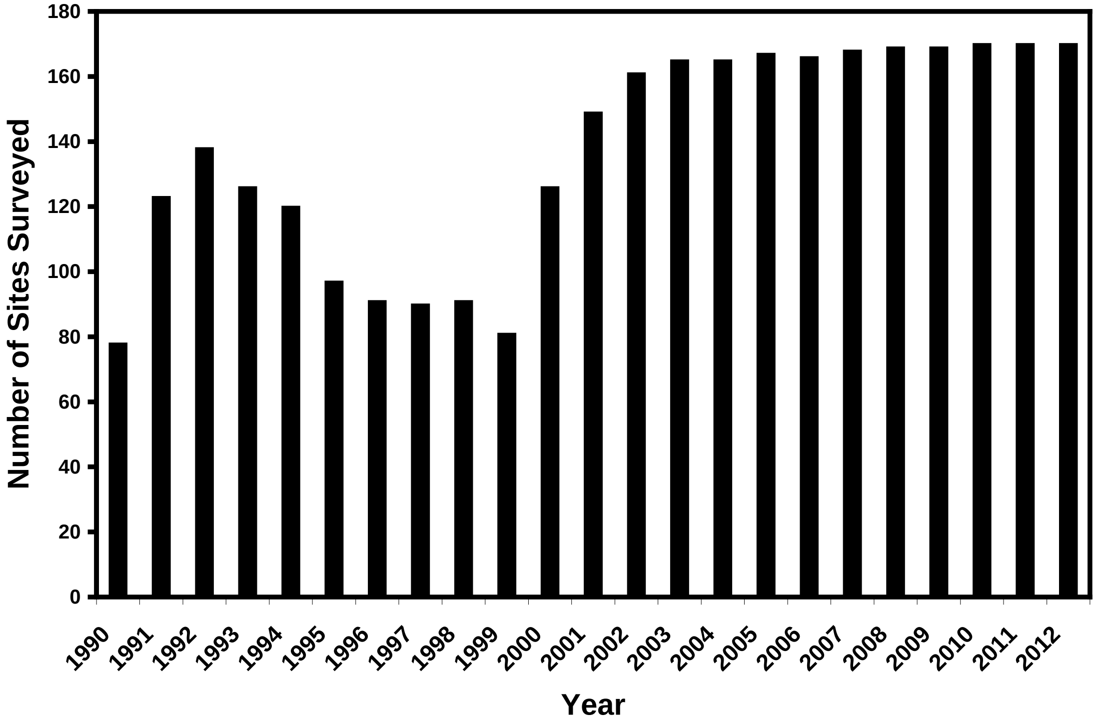

Figure 2**.** The number of historic spotted owl territories surveyed annually on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1992-2012.

There are 89 sites within the boundaries of the study that have been surveyed continuously from 1992 to 2012 and this subset of owl territories were among those used to estimate the annual rate of population change in the last two meta-analyses (Anthony *et al.* 2006, Forsman *et al.* 2011).

The Late-successional Reserves (LSRs) are an important component of the Southern Cascades Northern Spotted Owl Study Area: Rogue-Umpqua Divide (LSR 225), Middle Fork (LSR 226), Dead Indian (LSR 227), Clover Creek (LSR 228), and Sevenmile Creek (LSR 229). Of these reserves, Rogue-Umpqua Divide, Middle Fork, and Dead Indian are large encompassing 16,050, 20,080, and 41,310 ha, respectively, and projected to support 15-20 pairs of owls (USDA 1998). Clover Creek and Sevenmile Creek LSRs are smaller, incorporating 1,130 and 3,710 ha (USDA 1997). The LSRs are situated entirely within the study area. Dead Indian LSR spans the crest of the southern Oregon Cascades and is jointly administered by the Rogue River-Siskiyou and Fremont-Winema National Forests. Three Congressionally Reserved Wilderness Areas are also located within the study area. Owl territories were found in the Sky Lakes (45,800 ha), Mountain Lakes (9,300 ha) and a portion of the Rogue-Umpqua Divide Wilderness Areas (2,064 ha) (Figure 3).

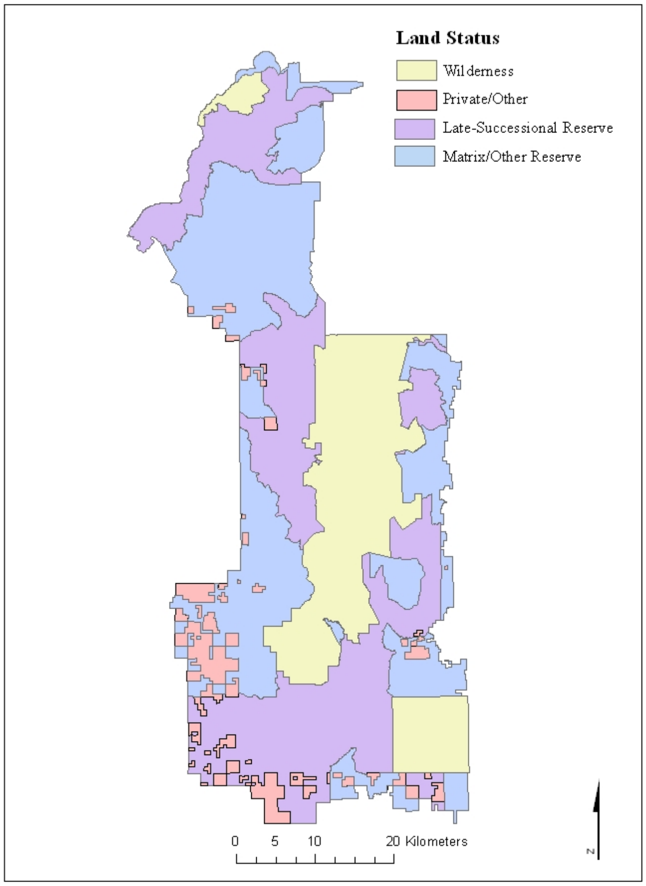

Figure 3. Land-use Allocations within the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2012.

7. <u>Research Accomplishments</u>:

Proportion of territories where spotted owls were detected

Spotted owls were detected at 71 of the 170 sites we visited in 2012 (Figure 4). Among the sites that were surveyed to protocol, pairs were detected at 44 sites, single owls were detected at 11 sites, and owls of unknown social status were detected at 15 sites (Appendix 1). The percentage of sites where spotted owls were detected on the study area (42%) represented a 3.5% increase from 2011 ($\bar{x}$ = 68.8%, SE = 3.66, n = 23 years), however, the number of pairs located was the fewest recorded during the study ($\bar{x}$ = 53.6%, SE = 3.29, n = 23 years). There were 89 sites with continuous survey effort between 1992 and 2012, and banded spotted owls were detected at 40% of these sites in 2012 ($\bar{x}$ = 54.9%, SE = 2.65, n = 21 years).

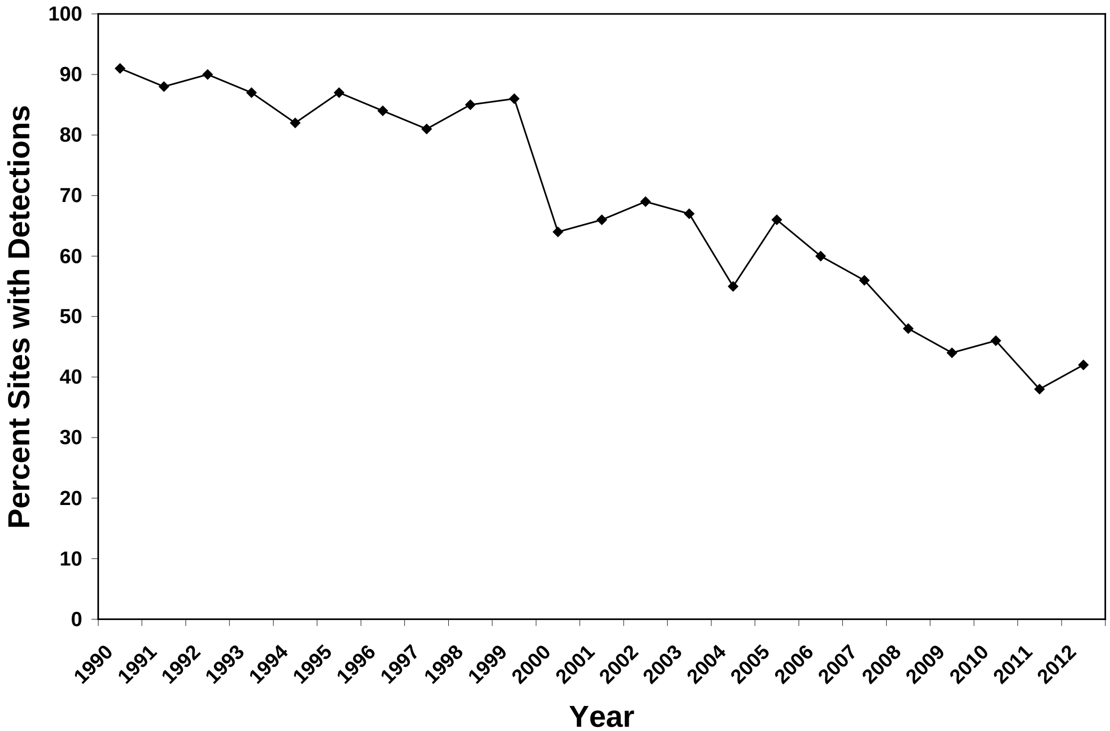

Figure 4. Percentage of all sites surveyed annually with ≥ 1 spotted owl detected on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2012.

Spotted owls were detected at 7 Wilderness, 44 LSR, and 20 Matrix sites in 2012 (Appendix 2). The percentage of sites where spotted owls were detected (either single or paired) in Wilderness increased from 22% in 2011 to 39% ($\bar{x}$ = 58.6.0%, SE = 5.08, n = 16 years), and the percentage of sites where pairs were located was 22% ($\bar{x}$ = 46.7%, SE = 4.91, n = 16 years). In the LSRs, the percentage of sites where owls were detected equaled 44% ($\bar{x}$ = 62.6%, SE = 3.52, n = 16 years), while the percentage of sites where owl pairs were detected declined from 32% in 2011 to 26% ($\bar{x}$ = 47.8%, SE = 3.45, n = 16 years). Owls were detected on 38% of Matrix owl territories ($\bar{x}$ = 58.9%, SE = 4.38, n = 16 years), with pairs located at 28% of Matrix sites in 2012 ($\bar{x}$ = 47.0%, SE = 4.37, n = 16 years). Overall, the mean percentage of sites with owls detected and the mean percentage of sites with pairs is very similar for the three land management categories and continues to decline over time but with some annual variation (Appendix 2).

The number of spotted owl pairs detected in 2012 at the five LSRs declined compared to previous years. The number of owl pairs located in the Rogue-Umpqua Divide LSR fell from 12 pairs in 2011 to 10 ($\bar{x}$ = 11.9, SE = 0.61; n = 16 years; min. = 7, max. = 15). The number of pairs located in the Middle Fork LSR (8) was unchanged from 2011 ($\bar{x}$ = 11.3, SE = 0.66, n = 16 years; min. = 6, max. = 15). In the Dead Indian LSR the number of pairs detected decreased by 36% to 7 compared to 2011 equaling the minimum located during the study ($\bar{x}$ = 13.5, SE = 1.08, n =16 years; min. = 7, max. = 20). A pair of spotted owls were located at the Sevenmile Creek LSR ($\bar{x}$ = 2.56, SE = 0.33, n = 16 years; min. = 0, max. = 4) and no owl pairs were detected at the Clover Creek LSR which was unchanged from 2011 ($\bar{x}$ = 0.73, SE = 0.18, n = 15 years; min. = 0, max. = 2).

The Northwest Forest Plan anticipated that the LSRs would provide a network of suitable habitat distributed across the range of old forest associated species sufficient to endure stochastic events resulting in localized species extirpation (USDA and USDI 1994). The large LSRs within the study area were designed to meet the objectives of the Northwest Forest Plan and be able to support 15-20 spotted owl pairs (USDA 1998). No LSR within the study area boundary has met that objective for the last three years.

Nest Success

Thirty-three owl pairs were surveyed to protocol to determine nesting status (Forsman 1995), and 17 of these pairs exhibited nesting behavior (52%). On average, 54% (SE = 5.15, n = 23 years; min. = 3%; max = 86%) of pairs detected each year attempted to nest. Four owl pairs which exhibited nesting early in the breeding season failed to fledge young. The mean rate of nest failure overall years (1990-2012) was 16% (SE = 1.85; min. = 0.0, max. = 26.9).

Productivity

Of the sites where owls were detected in 2012, 44 pairs were located and 15 of these successfully reproduced as determined by the productivity protocol ($\bar{x}$ = 24.6, SE = 3.23, n = 23 years; min. = 1; max. = 56) (Forsman 1995). The average number of young fledged per pair (0.50) was less in 2012 than the mean for all years ($\bar{x}$ = 0.67, SE = 0.09, n = 23 years) (Figure 5). The number of young produced per successful pair (1.46) in 2012 was similar to the average during the study ($\bar{x}$ = 1.60, SE = 0.046, n = 23 years) (Appendix 3).

In 2012, the average number of fledglings per pair in all three land-use categories was 0.50. Between 1997 and 2012 the average number of young produced per pair in Matrix ($\bar{x}$ = 0.67, SE = 0.095, n = 16 years; min. = 0.00, max. = 1.46) and LSRs ($\bar{x}$ = 0.64, SE = 0.113, n = 16 years; min. = 0.04, max. = 1.40) was similar and slightly better than in Wilderness areas ($\bar{x}$ = 0.51, SE = 0.145, n = 16 years; min. = 0.0, max. = 1.67) (Appendix 4).

Average productivity in 2012 on the Rogue-Umpqua Divide LSR was 0.20 fledglings per pair ($\bar{x}$ = 0.68, SE = 0.134, n = 16 years; min. = 0.00, max. = 1.83). On the Middle Fork LSR there were 0.63 young fledged per pair ($\bar{x}$ = 0.66, SE = 0.131, n = 16 years; min. = 0.0, max. = 1.64). There were 0.57 fledglings per pair ($\bar{x}$ = 0.58, SE = 0.098, n = 16 years; min. = 0.0, max. = 1.39) on the Dead Indian LSR. Two young were fledged per pair on the Sevenmile Creek LSR ($\bar{x}$ = 0.68, SE = 0.206, n = 16 years; min. = 0.0, max. = 1.67). No owl pairs were located at the Clover Creek LSR in 2012.

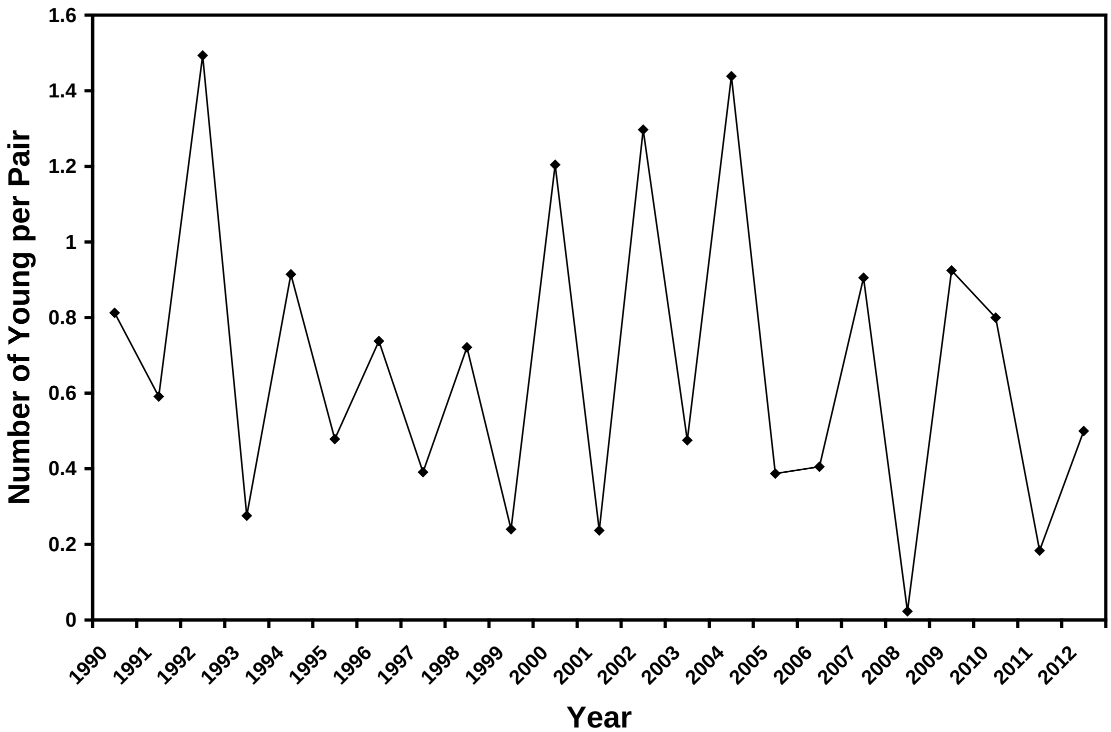

Figure 5. The number of young produced per total number of sites where spotted owl pairs were detected when surveyed to protocol for reproduction on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2012.

We calculated fecundity as the mean number of young fledged per female checked for reproductive success divided by 2, assuming a 1:1 sex ratio of young at birth for 2012 (i.e., mean number of female young fledged per female). The mean fecundity for owl pairs we located in 2012 (age classes combined) was 0.25 ($\bar{x}$ = 0.31, SE = 0.056, n = 16 years, min. = 0.02, max. = 0.67) for territories in the LSR, 0.27 ($\bar{x}$ = 0.32, SE = 0.044, n = 16 years, min. = 0.00, max. = 0.66) for territories in the Matrix, and 0.20 ($\bar{x}$ = 0.25, SE = 0.073, n = 16 years, min. = 0.00, max. = 0.67) for territories in the Wilderness (Appendix 4). Over the course of the study, annual mean fecundity for spotted owl territories in the LSR and Matrix tended to be greater than for Wilderness sites. Average fecundity was 0.24 (SE = 0.056, n = 45) for adult and age unknown females in 2012 ($\bar{x}$ = 0.34, SE = 0.046, n = 23; min. = 0.01, max. = 0.74) (Figure 6). There were no subadult females observed in 2012.

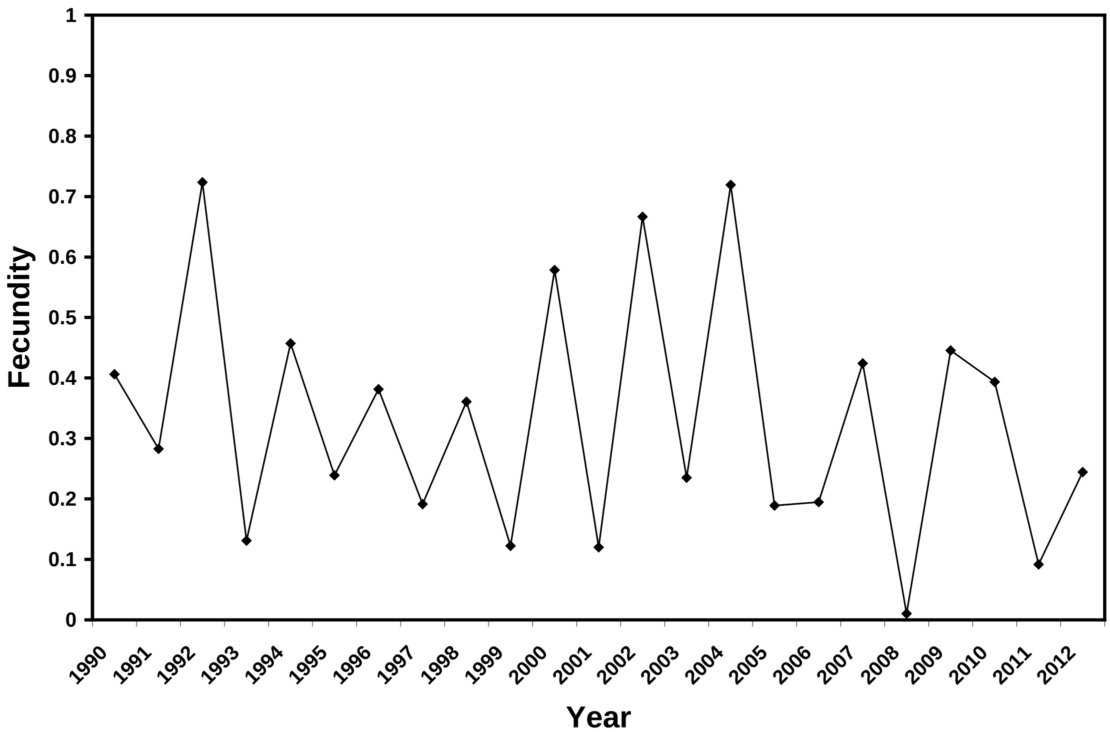

Figure 6. Mean annual fecundity (number of female fledglings per female) on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2012.

Age and Sex Composition

In 2012, 98 non-juvenile owls of known age class were detected, which is less than in most years of the study (Appendix 5). Of the owls we could assign to an age class, 93.5% were adults (≥ 3 years old) and 6.5% were subadults (Appendix 5). We could not ascertain the age of 19% of the study population, which were slightly more owls of unknown age than the long-term average across all years ($\bar{x}$ = 18.3%, SE = 2.67, n = 23 years). The majority of unknown aged owls represented auditory detections usually during nighttime surveys without visual observation. On average 54% of the owls detected each year on the study area population are males, and males constituted a majority of the owls detected (54%) in 2012 (Appendix 5).

A total of 123 female and male owls were detected in 2012 ($\bar{x}$ = 168.4, SE = 6.7, n = 22), and while this was fewer than the long-term average, it was an increase relative to 2011 (Appendix 5). The relative proportions of female to male owls and age-class representation appears to have remained constant through time (Dugger *et al.* 2010).

Banding and Resighting

In 2012, we banded 22 owls (14 fledglings and 8 adults) on the study area and a total of 91 banded, non-juvenile owls of known identity (including newly banded owls) were seen at least once during the season, the same number as in 2011. The minimum average age for all males was 7.2 years (SE = 0.60, n = 58) and 8.9 years (SE = 0.71, n = 43) for all females. The oldest owl in the sample (a female), banded as an adult (≥ 3 years old) was at least 20 years of age.

There were 17 inter-territory movements of banded owls documented in the demographic study in 2012. Three owls banded as juveniles (2002, 2009 and 2010) were reobserved as emigrants outside of the study area. One owl banded outside the study area in 2005 as a juvenile was located as an immigrant on the study area. Two owls banded as juveniles (2010 and 2011) were located at non-natal sites within the study area. One owl banded as an adult immigrated onto the study and ten owls banded as adults were relocated as internal emigrants (moved between territories within the study area boundaries) in 2012. The number of internal emigrant movements in 2012 was the highest recorded during a single year on the study.

A total of 271 movements have been recorded from 1990-2012 and the mean movement distance was 24.4 km for females (SE = 1.89, n = 126; min. = 0.9, max. = 95.4) and 15.2 km (SE = 1.52, n = 146; min. = 0.8, max. = 128.6) for males.

Barred Owls

The range of northern barred owls (*Strix varia*) has expanded during the last century and now overlaps that of the northern spotted owl (Livezey 2009). Barred owls were first detected within the boundaries of the Southern Cascades Study Area in 1981 (*Pers. comm.* Rick Hardy, Wildlife Biologist (Ret.), U.S. Forest Service). This study was not designed to systematically follow trends in barred owl occupancy but it has gathered a significant number of incidental detections of barred owls during the course of spotted owl surveys. The annual percentage of barred owl detections at the 170 historic spotted owl territories on the study has increased from a low of 4.1% to a high of 30.1% in 2012 (Figure 7). Cumulatively, barred owls have been detected at 68% of the spotted owl territories during at least one breeding season over the course of this study. The proportion of surveyed areas with spotted owl detections during the study exhibits a strong negative association with the proportion of surveyed areas with barred owl detections ($r = -0.920$, $p \leq 0.001$). This proportion is likely still an underestimate of the number of spotted owl territories being influenced by barred owls, as some barred owls are likely missed during surveys for spotted owls. However, a study in the Oregon Coast range suggests that over the course of a season, spotted owl surveys to protocol (≥ 3 visits) allow ~85% of the barred owls present in the area to be detected (Wiens *et al.* 2011). In addition, we have been able to document the strong negative effects of barred owl detections on spotted owl detection rates, as well as extinction and colonization rates on this study area (Dugger *et al.* 2011).

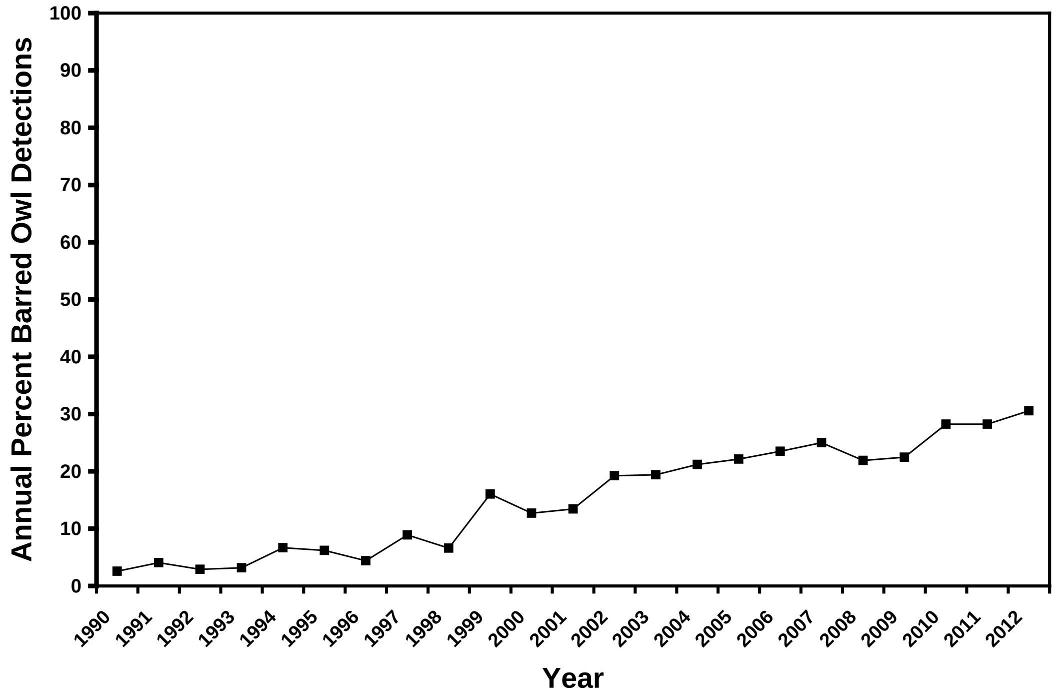

Figure 7. The annual percentages of historic spotted owl territories surveyed where barred owls were detected on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2012.

Spotted Owl Diets

A total of 6,109 prey specimens in regurgitated pellets from 130 owl sites were collected and identified between 2000-2010. Samples were collected opportunistically at spotted owl nesting or roosting sites with most pellets collected from breeding spotted owls. The sample consists primarily of northern flying squirrels (*Glaucomys sabrinus*), woodrat species (*Neotoma cinerea* and *N. fuscipes*) and Lagomorphs (Figure 8).

Pocket gophers (*Thomonys mazama and T. talpoides*), red-backed voles (*Clethrionomys californicus*) and moles (*Scapanus orarius* and *S. latimus*) in pellets were low in biomass but higher in absolute numbers (Figure 9).

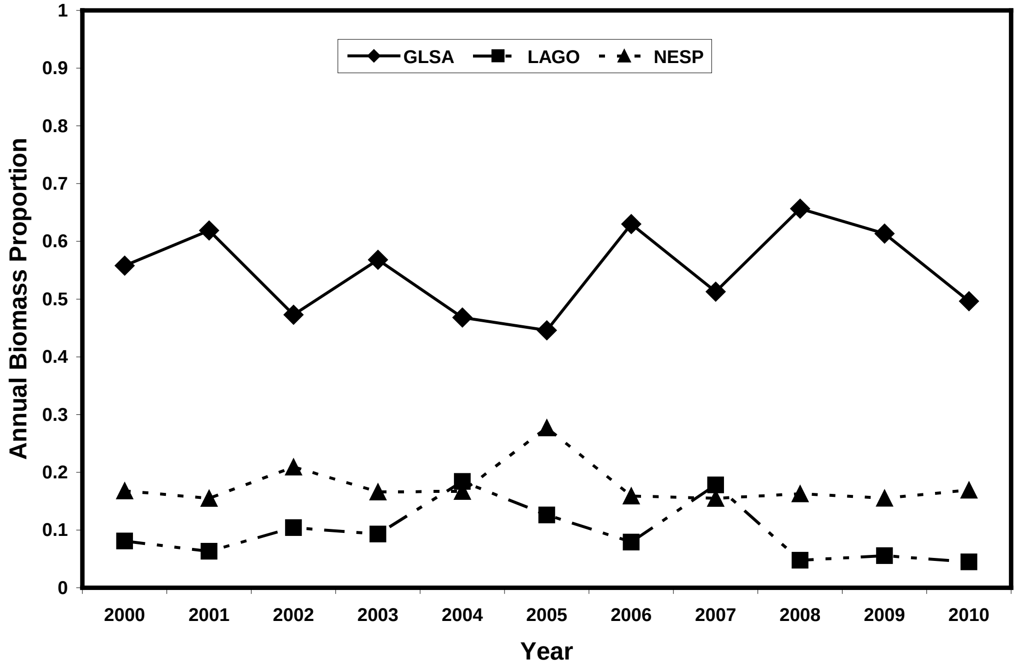

Figure 8. The annual biomass proportion of flying squirrels (GLSA = *Glaucomys sabrinus*), woodrats (NESP = *Neotoma* species) and Lagomorphs (LAGO) in regurgitated spotted owl pellets on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 2000-2010.

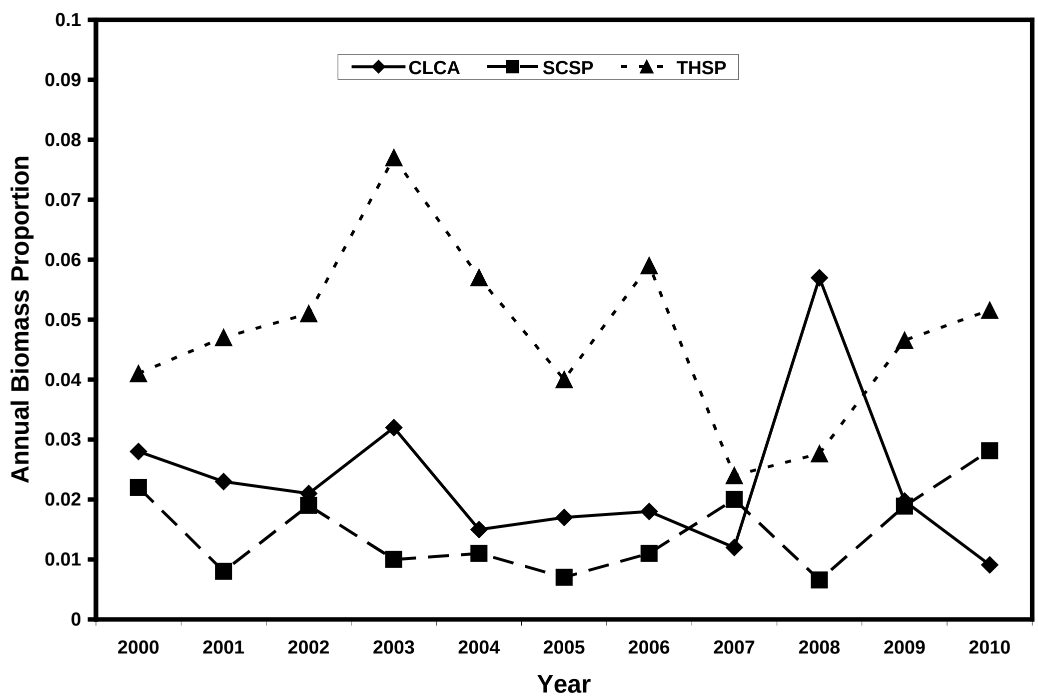

Figure 9. The annual biomass proportion of red-backed voles (CLCA = *Clethrionomys californicus*), moles (SCSP = *Scapanus* species) and pocket gophers (THSP = *Thomomys* species) in regurgitated spotted owl pellets on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 2000-2010.

Survey Effort

By 1994 more than 90% of the sites currently visited in the demographic study had been identified. The number of visits conducted to spotted owl territories on the study area varies between years based on the requirements of the survey protocol relative to detecting single owls and pairs, and determining annual productivity. The proportion of day and night visits is also influenced by snowpack with more night visits being conducted in years where early season access to owl sites is limited. The majority of the visits required to determine whether an owl was present on a site are conducted as nighttime surveys. From 1994 to 2012, as the proportion of territories where owls are detected has declined, the amount of survey effort dedicated to productivity assessments has also declined and the effort for determining whether owls are present or not, has gradually increased (Figure 10). Across all visits, the proportion of nighttime surveys has varied annually but has generally increased (min. = 24%; max. = 59%) (Figure 12).

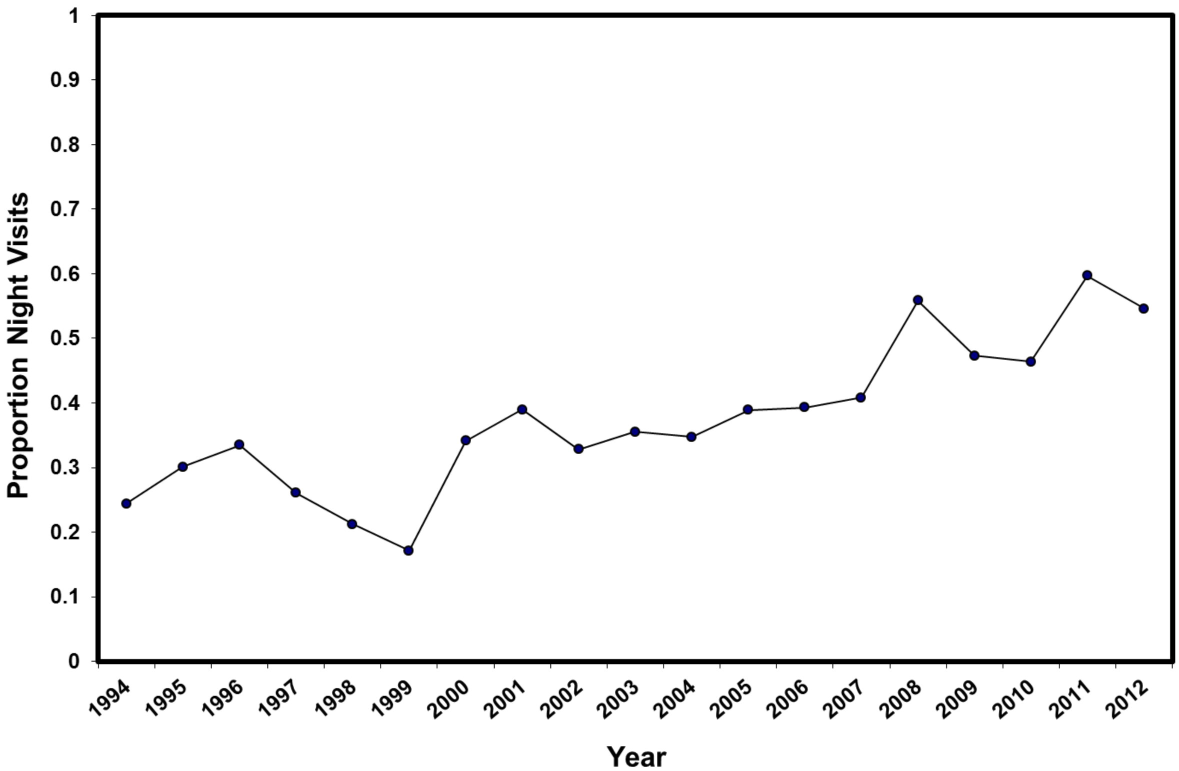

Figure 10. The annual proportion of total visits conducted as nighttime surveys of historic spotted owl territories on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1994-2012.

Apparent Survival, Fecundity, and Population Trend

A workshop was conducted to analyze range-wide demographic data of northern spotted owls in January 2009 (Forsman *et al.* 2011). The workshop was held as a requirement of the *Northern Spotted Owl Effectiveness Monitoring Plan for the Northwest Forest Plan* (Lint *et al.* 1999). Fecundity, apparent survival, and rates of population change were estimated for the southern

Oregon Cascades.

Mean apparent annual survival was estimated using model averaging, which produced estimates of 0.692/0.697 for first year subadults, 0.733/0.737 for second year subadults and 0.851/0.853 for adults (female/male, respectively; Forsman *et al.* 2011). Overall, annual survival appears to be declining in the southern Oregon Cascades, and this decline accelerated between 2003-2008.

The best model for fecundity for adult females was 0.35 (SE = 0.052, n = 1,176), 0.21 (SE = 0.064, n = 68) for 2-year-old subadult females, and 0.06 (SE = 0.038, n = 37) for 1-year-old subadult females (Forsman *et al.* 2011). Of the models containing a time trend, the best model suggested that fecundity was declining for spotted owls on the southern Cascades.

The rate of population change (λ) was estimated using a reparameterized Jolly-Seber (RJS) method in program MARK (Pradel 1996, Hines and Nichols 2002). The best model for the southern Cascades suggested the population was stationary during the period of the study [λ = 0.982, SE = 0.030, 95% CI = (0.923 to 1.040)] (Forsman *et al.* 2011). The annual realized rate of population change ($\Delta\lambda$) exhibited large annual fluctuations, but confidence limits broadly overlapped zero, also supporting the conclusion the population was stable (Forsman *et al.* 2011).

For additional information regarding the methodology and results of the 2009 meta-analysis please refer to Forsman *et al.* 2011.

Discussion

In 2012 field work was slowed by late season snow and cool temperatures which delayed access to some of the higher elevation sites on the study area. Limited access had the effect of extending the time frame of day-only effort. The delay in the onset of wide-ranging night work likely reduced our ability to detect territorial owls and may have increased the rate of detection for owls at the periphery of their home range later in the season. Consequently, in some cases we may have not only missed resident owls but double counted owls where there was overlap in the home range of historic owl sites.

The number of spotted owl pairs we located in 2012 was the fewest detected during the study. In actual numbers, there were more spotted owls detected in 2012 relative to 2011, but fewer sites where pairs were located. More spotted owls may have been paired than we could determine by protocol, however, since there were a large number of sites where single owls were detected or owls were detected but social status could not be assigned by protocol. In 2011, there was a heavy snowpack that persisted late into the field season and there was a large decline in spotted owl detections compared to 2010. Some owls which had gone undetected or were banded but not identified in 2011 were reobserved in 2012. The results from 2011-2012 followed a pattern we have observed following previous years with unusually hard winters like 2011. It is likely that marked owls were missed in 2012 given the large number of age unknown owls detected since most of these owls were heard during night surveys but could not be located during the day. Imperfect detection probability for marked individuals is accounted for in the methodology of the demographic models used in the population Meta-analysis.

In 2012 productivity was much higher than in 2011, however, approximately 25% of the owls which nested appeared to have failed. There were extended periods of cool and wet weather in the higher elevations that extended into mid-Spring. Higher levels of precipitation and cooler temperatures in the early nesting season are both associated with decreased productivity in the southern Cascades so weather might have been a factor in the nest failures that we documented (Dugger *et al.* 2006, Forsman *et al.* 2011). Another possible influence on nest failures is that barred owls are known to have disrupted spotted owl nesting at individual territories on the study area in the past and more barred owls were detected in 2012 than in previous years. We have anecdotally observed that spotted owl nesting failure has often occurred at sites where barred owls are displacing spotted owls. Long-term declines in the productivity of spotted owl pairs may in part be attributable to barred owl interference.

During the course of the study productivity has periodically followed a strong biannual pattern of alternating high and low years, disrupted by low productivity in both 2005-2006 and relatively high reproduction in both 2009-2010. Productivity in 2012 was similar to that observed in 2005-2006. If the biannual pattern is reestablished in 2013 productivity would be expected to be very low or very high.

The 2009 workshop and additional analyses can be synthesized in a review of the information specific to the spotted owl population in the southern Oregon Cascades. The apparent decline in the number of spotted owls has been attributed to different spatial and temporal factors including habitat loss and competition by barred owls (USDI 2010, Forsman *et al.* 2011). Since our surveys do not target barred owls specifically there may be more sites occupied by barred owls than we identified, and conversely spotted owls may have gone undetected where barred owls were present. In addition, a recent occupancy analysis for a subset of spotted owl territories within the study area during the time frame from 1991 and 2006 reported that the presence of barred owls at a specific site increased the probability of local site extinction and decreased site recolonization probabilities by spotted owls (Dugger *et al.* 2011). The best models incorporating the barred owl covariate from the meta-analysis indicated some support for decreased survival and fecundity in association with an increased proportion of sites where barred owls were detected on this study area (Forsman *et al.* 2011).

Habitat did not appear to directly influence spotted owl survival and fecundity on the Southern Oregon Cascades study area between 1991-2003 (Dugger *et. al*. 2006). However, habitat characteristics did affect occupancy dynamics, as greater amounts of habitat in owl core areas as well as reduced fragmentation were associated with increased colonization rates and reduced extinction rates of spotted owl territories on the study area (Dugger *et al.* 2011). However, the amount of older forest surrounding spotted owl annual core areas was associated with increased survival and fecundity across all study areas in the recent meta-analysis, which incorporated a longer time series (through 2008; Forsman *et al.* 2011). It's most likely that habitat characteristics affect occupancy rates more strongly than subsequent survival and productivity, and it required the increased power of the meta-analysis across multiple study areas to detect the effect of habitat characteristics on survival and productivity (Forsman et al. 2011). A range-wide habitat suitability map for northern spotted owls has recently been developed, which may facilitate our understanding of habitat and demographics for spotted owls across their range (Davis et al. 2011).

Climatic and weather effects in the southern Cascades were incorporated in demographic analyses by Dugger *et al.* (2006), Glenn (2009), Glenn *et al.* (2010) and in the 2009 meta-analysis (Forsman *et al.* 2011). These analyses have all noted some relationship between climate and one or more demographic parameters, but the climate variables found to be important have varied by analysis. Early nesting season precipitation tended to reduce productivity on the west side of the Cascades (Dugger *et al.* 2006), while higher early nesting season temperatures were associated with increased productivity (Forsman *et al.* 2011). In addition, a quadratic relationship between annual precipitation and productivity where the number of young fledged decreased following years of less than or greater than normal precipitation has also been observed (Glenn *et al.* 2010). Fewer relationships between climate and survival have been reported for the south Cascades, however annual survival was positively associated with higher winter temperatures and years with average winter storm frequency, but negatively associated with the number of days with temperatures >90^{o}F (Glenn *et al.* 2010). The separate survival and recruitment components were also related to climate, with survival negatively associated the number of days with temperatures >90^{o}F (hot summers) and recruitment highest two years after years with higher than average precipitation (lag effect) (Glenn *et al.* 2010). Thus, while climate seems to have a consistent effect on productivity, and possibly survival in the south Cascades, the climate variable that best reflects these effects is still unclear.

Whereas the direct effect of climate on productivity in particular has been hypothesized (i.e., negative effects on thermoregulation of young), climate has also been considered a proxy for fluctuations in annual prey abundance. We have observed significant associations between the proportion of nesting pairs and the biomass of several prey items in spotted owl diets, particularly flying squirrels, woodrats and rabbits. During seasons with higher numbers of breeding birds, more owl pellets are collected under nest trees and these pellets reflect the diets of nestlings. However, a relationship between the proportion of breeding pairs and annual diet proportions may actually reflect sampling bias, rather than true diet shifts (Dugger *et al.* 2010).

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9. Research Plans for FY 2013:

a. Continued monitoring effort in preparation for the next meta-analysis of spotted owl demographic rates scheduled for January 2014.

b. Continue the collection of pellets and analysis of spotted owl diets.

c. Continue to assist personnel from Crater Lake National Park with their banding program.

10. Publications in FY 2012:

Clark, D.A., R.G. Anthony, and L.S. Andrews. 2012. Relationship between Wildfire, Salvage Logging and Occupancy of Nesting Territories by Northern Spotted Owls. Journal of Wildlife Management. *In press*.

11. Technology Transfer Completed in FY 2012:

a. K. Dugger and S. Andrews participated in data coordination efforts with personnel from other demographic studies.

b. Project personnel provided the USDA-USFS Ranger Districts, USDI-BLM Resource Areas, and USDI-Crater Lake National Park with information and have coordinated surveys.

13. Duration of the Study:

a. Initiated in 1990.

b. This project is part of the long-term Northern Spotted Owl Effectiveness Monitoring Program for the Northwest Forest Plan (Lint *et al.* 1999).

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Appendix 1. Number of northern spotted owl sites surveyed and their respective occupancy on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2012[a].

Year	# Sites Surveyed	# Sites w/ Pairs	# Sites w/ Single Owls	# Sites w/ Social Status Unknown[b]	Total Occupied Sites	# of Sites Unoccupied[c]	% Sites Occupied
1990	78	54	6	11	71	7	91
1991	123	81	5	22	108	15	88
1992	138	107	3	14	124	14	89
1993	126	78	9	22	109	17	86
1994	120	80	4	14	98	22	81
1995	97	62	8	14	84	13	87
1996	91	65	4	7	76	15	84
1997	90	58	4	11	73	17	81
1998	91	67	2	8	77	14	85
1999	81	58	7	5	70	11	86
2000	126	55	10	16	81	45	64
2001	149	80	1	18	99	50	66
2002	161	83	11	17	111	50	69
2003	165	91	5	14	110	55	67
2004	165	73	1	17	91	74	55
2005	167	87	7	17	111	56	66
2006	166	76	9	15	100	66	60
2007	168	79	4	11	94	74	56
2008	169	48	10	23	81	88	48
2009	169	57	5	13	75	94	44
2010	170	60	2	17	79	91	46
2011	170	51	3	11	65	105	38
2012	170	44	11	15	71	99	42

[a] All sites which were surveyed to protocol; status as determined by protocol (Forsman 1995).
[b] Sites with a response by a male and/or female that did not meet pair or single status with $\geq$ 3 night visits.
[c] A minimum of 3 nighttime visits without a response was needed to infer unoccupied status.

Appendix 2. Number of spotted owl sites surveyed to protocol and their respective occupancies by Land-use Allocation on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1997-2012[a] .

Land-Use Allocation[b]	Year	# Sites Surveyed	# Sites w/ Pairs	# Sites w/ Single Owls	# Sites w/ Social Status Unknown	Total Occupied Sites	# Sites Unoccupied	% Sites Occupied
Matrix								
	1997	28	20	0	4	24	4	86
	1998	24	18	0	1	19	5	79
	1999	20	17	0	2	19	1	95
	2000	38	17	1	5	23	15	61
	2001	46	22	1	5	28	18	61
	2002	50	24	4	7	35	15	70
	2003	52	28	0	6	34	18	65
	2004	53	22	0	8	30	23	57
	2005	53	28	1	5	34	19	64
	2006	53	23	0	4	27	26	51
	2007	53	23	3	2	28	25	55
	2008	53	15	4	8	27	26	51
	2009	53	17	1	2	20	33	38
	2010	53	15	2	4	21	32	40
	2011	53	15	2	2	19	34	36
	2012	53	15	2	3	20	33	38
LSR								
	1997	53	34	3	6	43	10	81
	1998	58	40	2	7	49	9	84
	1999	52	37	6	2	45	78	87
	2000	79	32	9	9	50	29	63
	2001	86	49	0	12	61	25	71
	2002	94	51	6	10	67	27	71
	2003	95	52	4	6	62	33	65
	2004	95	42	0	9	51	44	53
	2005	96	51	4	9	64	32	67
	2006	96	45	8	10	63	33	66
	2007	98	47	1	9	57	41	58
	2008	98	26	5	14	45	53	46
	2009	98	36	2	11	49	49	50
	2010	99	40	0	11	48	51	52
	2011	99	32	1	9	42	57	42
	2012	99	26	7	11	44	55	44

Cont.

Land-Use Allocation	Year	# Sites Surveyed	# Sites w/ Pairs	# Sites w/ Single Owls	# Sites w/ Social Status Unknown	Total Occupied Sites	# Sites Unoccupied	% Sites Occupied
Wilderness								
	1997	9	4	1	1	6	3	67
	1998	9	9	0	0	9	0	100
	1999	9	4	1	1	6	3	67
	2000	9	6	0	2	8	1	89
	2001	17	9	0	1	10	7	59
	2002	17	8	1	0	9	8	53
	2003	18	11	1	2	14	4	78
	2004	17	9	1	0	10	7	59
	2005	18	8	2	3	11	5	71
	2006	17	8	1	1	10	7	59
	2007	17	9	0	0	9	8	53
	2008	18	7	1	1	9	9	50
	2009	18	4	1	1	6	12	33
	2010	18	5	0	2	7	11	39
	2011	18	4	0	0	4	14	22
	2012	18	4	2	1	7	11	39

[a] See Table 1 for column heading definitions.

[b] See the Northwest Forest Plan (1994) for a description of Matrix and LSR Land-use Allocations.

Appendix 3. Summary of reproductive success of northern spotted owls on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2012[a].

Year	# Pairs Checked	# Pairs Fledging Young	# Young Fledged	% Pairs Producing Young	Average # of Young/ Successful Pair	Average # of Young/Pair
1990	32	18	26	56	1.44	0.81
1991	44	17	26	39	1.53	0.59
1992	75	55	112	73	2.04	1.49
1993	58	11	16	19	1.45	0.28
1994	70	35	64	50	1.83	0.91
1995	46	14	22	30	1.57	0.48
1996	61	30	45	49	1.50	0.74
1997	46	12	18	26	1.50	0.39
1998	61	32	44	53	1.38	0.72
1999	50	7	12	14	1.71	0.24
2000	49	34	59	69	1.74	1.20
2001	76	11	18	15	1.64	0.24
2002	74	51	96	69	1.88	1.30
2003	82	23	39	28	1.70	0.48
2004	73	56	105	77	1.88	1.44
2005	80	23	31	29	1.35	0.39
2006	74	19	30	26	1.58	0.41
2007	74	41	67	55	1.63	0.91
2008	44	1	1	2	1.00	0.02
2009	53	27	49	51	1.81	0.92
2010	60	29	48	48	1.66	0.80
2011	49	6	9	12	1.50	0.18
2012	44	15	22	34	1.47	0.50

[a] All sites which were surveyed to reproductive protocol (Forsman 1995).

Appendix 4. Summary of reproductive success for northern spotted owls, by Land-use Allocation, on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1997-2012[a].

Land-Use Allocation	Year	Number of Pairs Checked	Number of Pairs Fledging Young	Number of Young Fledged	Percentage of Pairs Producing Young	Average Young/ Successful Pair	Average Number of Young/Pair	Mean Fecundity[b], # Females
Matrix								
	1997	17	6	9	35	1.50	0.53	0.264 (17)
	1998	16	10	13	63	1.30	0.81	0.375 (16)
	1999	15	6	10	40	1.67	0.67	0.333 (15)
	2000	14	7	11	50	1.57	0.79	0.393 (14)
	2001	20	4	6	20	1.50	0.30	0.143 (21)
	2002	22	12	24	55	2.00	1.09	0.545 (22)
	2003	23	6	11	26	1.83	0.48	0.229 (24)
	2004	22	18	32	82	1.78	1.46	0.659 (22)
	2005	28	8	10	29	1.25	0.36	0.167 (30)
	2006	22	6	10	27	1.67	0.46	0.217 (23)
	2007	20	11	19	55	1.72	0.95	0.452 (21)
	2008	14	0	0	0	0.00	0.00	0.000 (17)
	2009	17	11	20	65	1.82	1.18	0.556 (18)
	2010	15	7	12	47	1.71	0.80	0.375 (16)
	2011	15	3	4	20	1.33	0.26	0.133 (15)
	2012	14	5	7	37	1.40	0.50	0.269 (13)
LSR								
	1997	27	6	9	22	1.50	0.33	0.167 (27)
	1998	37	21	30	57	1.43	0.81	0.405 (37)
	1999	32	1	2	3	2.00	0.06	0.031 (32)
	2000	29	23	40	79	1.74	1.38	0.667 (30)
	2001	47	7	12	15	1.71	0.26	0.128 (47)
	2002	45	33	60	73	1.82	1.33	0.667 (45)
	2003	48	15	25	31	1.67	0.52	0.276 (49)
	2004	42	30	58	71	1.93	1.38	0.674 (43)
	2005	45	12	18	27	1.50	0.40	0.202 (47)
	2006	44	12	18	27	1.50	0.41	0.191 (47)
	2007	46	28	45	61	1.61	0.98	0.450 (50)
	2008	23	1	1	4	1.00	0.04	0.020 (25)
	2009	32	14	26	44	1.86	0.81	0.394 (33)
	2010	40	21	32	53	1.52	0.80	0.425 (40)
	2011	30	3	5	10	1.67	0.17	0.083 (30)
	2012	26	9	13	35	1.44	0.50	0.250 (26)

Cont.

Land-Use Allocation	Year	Number of Pairs Checked	Number of Pairs Fledging Young	Number of Young Fledged	Percentage of Pairs Producing Young	Average Young/ Successful Pair	Average Number of Young/Pair	Mean Fecundity[b], # Females
Wilderness								
	1997	3	0	0	0	NA	0.00	0.000 (3)
	1998	8	2	2	25	1.00	0.25	0.125 (8)
	1999	3	0	0	0	NA	0.00	0.000 (3)
	2000	6	4	8	67	2.00	1.33	0.667 (6)
	2001	8	0	0	0	NA	0.00	0.000 (8)
	2002	7	6	12	86	2.00	1.71	0.857 (7)
	2003	11	2	3	18	1.50	0.27	0.125 (12)
	2004	9	9	15	100	1.67	1.66	0.833 (9)
	2005	7	3	3	43	1.00	0.43	0.188 (8)
	2006	8	1	2	13	2.00	0.25	0.143 (8)
	2007	8	2	3	25	1.50	0.38	0.188 (8)
	2008	6	0	0	0	0.00	0.00	0.000 (7)
	2009	4	2	3	50	1.50	0.75	0.375 (4)
	2010	5	1	2	20	2.0	0.40	0.200 (5)
	2011	4	0	0	0	0	0.00	0.000 (4)
	2012	4	1	2	25	2.0	0.50	0.200 (5)

[a] All sites which were surveyed to reproductive protocol (Forsman 1995).
[b] Average fecundity estimate = number of female young produced per female owl (assume a 1:1 sex ratio of young at birth).

Appendix 5. Age and sex of northern spotted owls detected on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2012.

Year	Adults (M,F)	Subadults (M,F)	Age Unknown (M,F)	Age Combined (M,F)	All Juveniles	Subadults (%)	Males (%)
1990	54 (30,24)	2 (1,1)	96 (53,43)	152 (84,68)	26	4	55
1991	112 (58,54)	7 (3,4)	84 (46,38)	203 (107,96)	33	6	53
1992	139 (77,62)	8 (4,4)	97 (46,51)	244 (127,117)	121	5	52
1993	136 (76,60)	12 (5,7)	46 (24,22)	194 (105,89)	16	8	54
1994	139 (73,66)	11 (7,4)	31 (17,14)	181 (97,84)	66	7	54
1995	126 (64,62)	9 (7,2)	16 (12,4)	151 (83,68)	24	7	55
1996	123 (61,62)	5 (4,1)	17 (10,7)	145 (75,70)	46	4	52
1997	114 (63,51)	7 (2,5)	16 (9,7)	137 (74,63)	18	6	54
1998	133 (70,63)	4 (3,1)	22 (14,8)	159 (87,72)	45	3	55
1999	122 (71,51)	7 (1,6)	15 (9,6)	144 (81,63)	12	5	56
2000	111 (65,46)	10 (2,8)	22 (16,6)	143 (83,60)	59	8	58
2001	151 (80,71)	10 (4,6)	25 (20,5)	186 (104,82)	18	6	56
2002	157 (86,71)	13 (5,8)	27 (17,10)	197 (108,89)	98	8	55
2003	168 (90,78)	13 (2,11)	21 (15,6)	202 (107,95)	39	7	53
2004	140 (71,69)	11 (5,6)	23 (15,8)	174 (91,83)	106	7	52
2005	157 (78,79)	19 (11,8)	30 (20,10)	206 (109,97)	32	11	53
2006	145 (78,67)	18 (9,9)	21 (13,8)	184 (100,84)	31	11	54
2007	151 (76,75)	7 (2,5)	20 (13,7)	178 (91,87)	67	4	51
2008	101 (55,46)	7 (2,5)	23 (13,10)	131 (70,61)	1	6	54
2009	115 (60,55)	2 (1,1)	16 (7,9)	133 (68,65)	49	2	51
2010	116 (58,58)	10 (7,3)	22 (13,9)	147 (78,70)	48	7	53
2011	97 (50,47)	4 (3,1)	15 (8,7)	116 (61,55)	10	3	53
2012	98 (55,43)	3 (3,0)	22 (12,10)	123 (70,53)	22	5	54