ANNUAL RESEARCH REPORT
FY 2015
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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) Conduct annual monitoring surveys and banding of individual owls on historic spotted owl territories on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area following established protocols (Forsman 1995, Lint et al. 1999).
b) Use these data to determine the proportion of historic territories where northern spotted owls are detected, and to determine sex and age composition, and the reproductive success of detected owls.
c) Use these data to develop and maintain capture history databases of individually marked spotted owls and detection histories for historic owl territories required for participation in periodic analyses to estimate fecundity, survivorship, recruitment, the rate of population change, and occupancy dynamics using a mark-recapture modeling approach.
d) Examine northern spotted owl diets, nesting habitat, and interspecific interactions with barred owls.
e) Communicate results to other researchers examining northern spotted owl ecology.

4. Potential Benefit or Utility of the Study:

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 Northern Spotted Owl Demography Study Area (CAS) 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 six meta-analyses of spotted owl vital rates across the species range (Anderson and Burnham 1992, Burnham et al. 1994, 1996, Franklin et al. 1999, Anthony et al. 2006, Forsman et al. 2011, Dugger et al. 2016), with the most recent held in January 2014. These data were important for the 2004 review of the species' threatened status (USFWS 2004), the Revised Recovery Plan for the Northern Spotted Owl, the Designation of Revised Critical

Habitat for the Northern Spotted Owl, and the Experimental Removal of Barred Owls to Benefit Threatened Northern Spotted Owls Final Environmental Impact Statement (USDI 2008, 2011, 2012, 2013).

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 then allows us to periodically estimate survival, reproductive rates, and annual rate of population change, as well as occupancy dynamics (Wagner et al. 1996, Franklin et al. 1999, Anthony et al. 2006, Forsman et al. 2011, Dugger et al. 2011, Dugger et al. 2016). 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 CAS was established in 1990 and 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).

The total number of surveyed spotted owl sites has increased over time, as new sites were added when previously unmonitored owls are detected and a total of 171 sites were surveyed in 2015 (Figure 2). There are 90 sites within the boundaries of the study that have been surveyed continuously from 1992 to 2015 and this subset of owl territories were among those used to estimate the annual rate of population change (λ) in the last 3 meta-analyses (Anthony et al. 2006, Forsman et al. 2011, Dugger et al. 2016).

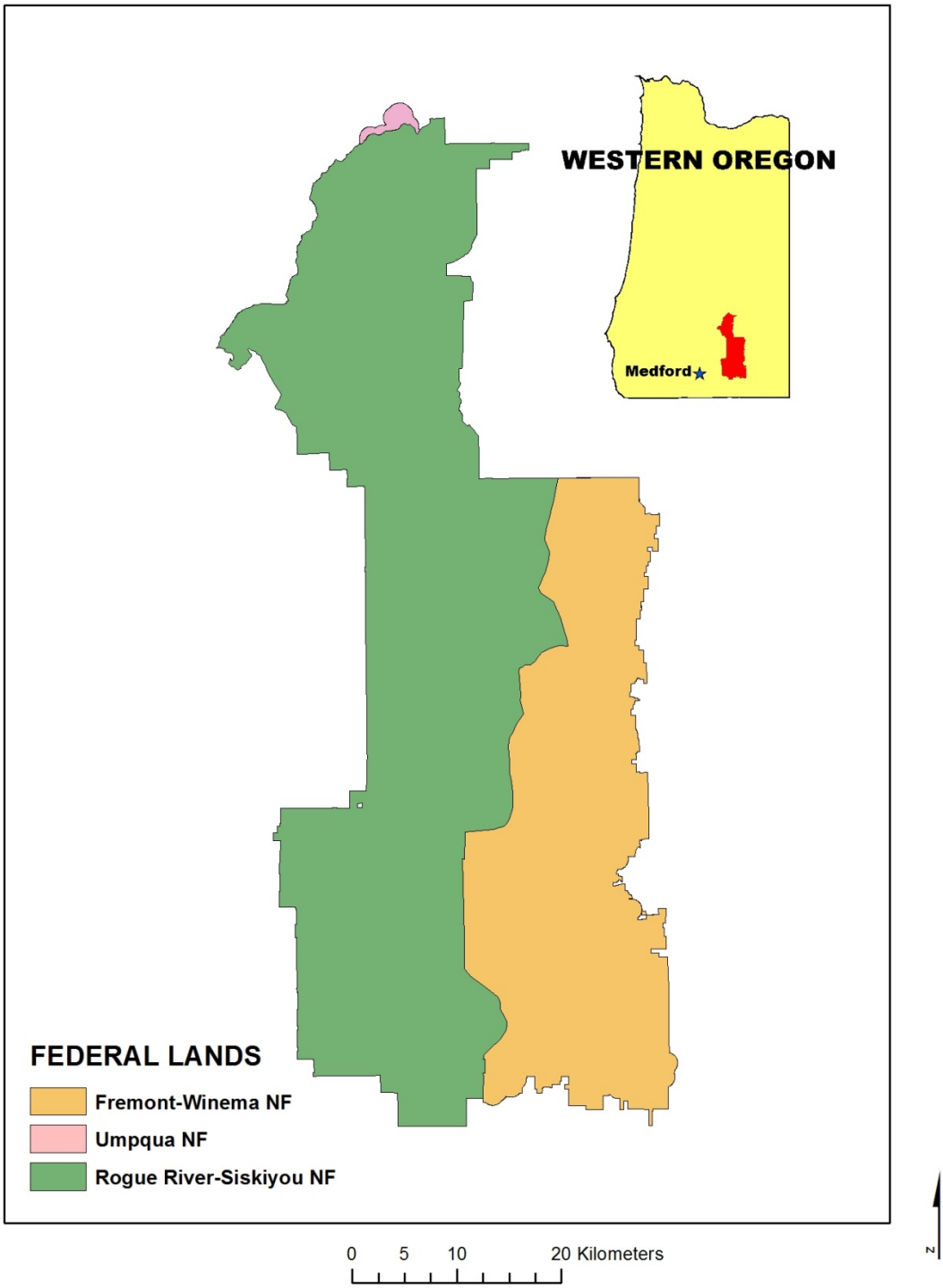

Figure 1. The Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2015.

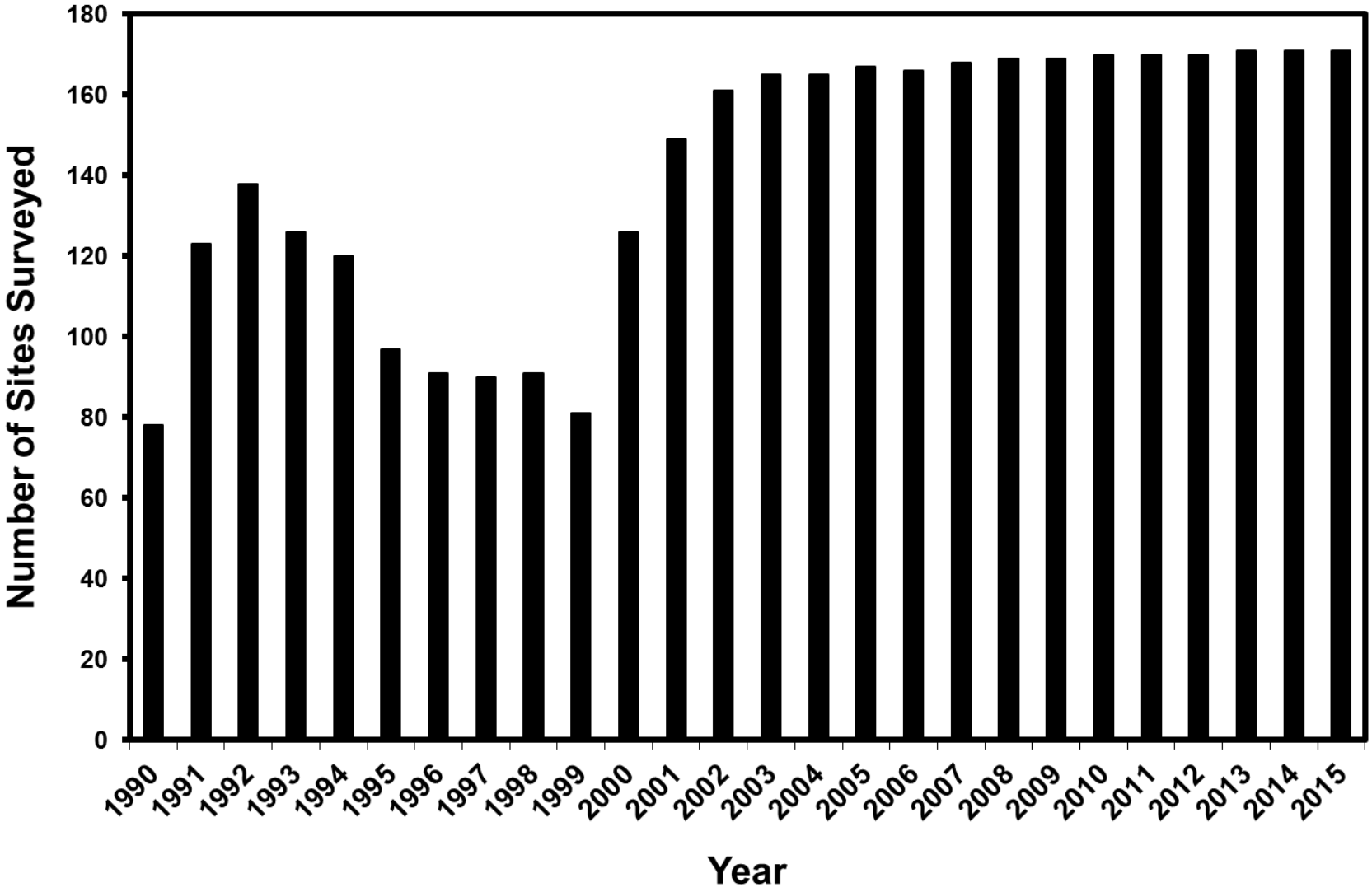

Figure 2. The number of historic spotted owl territories surveyed annually on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2015.

Beginning in 1997 we compare spotted site occupancy and breeding propensity between NWFP Land-use Allocations and Wilderness Areas. An important component of the CAS study area are the LSRs: Rogue-Umpqua Divide (LSR 225), Middle Fork (LSR 226), Dead Indian (LSR 227), Clover Creek (LSR 228), and Sevenmile Creek (LSR 229). Of these, 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).

7. <u>Annual Survey Results</u>:

Proportion of territories where spotted owls were detected

Spotted owls were detected at 52 of the 171 sites we visited in 2015 (Figure 4). Among the sites that were surveyed to protocol, pairs were detected at 36 sites, single owls were detected at 8 sites, and owls of unknown social status were detected at 8 sites (Appendix 1). The percentage of sites where spotted owls were detected on the study area (30%) represented a 1.0% decrease from 2014 (31%; $\bar{x}$ = 64.5 %, SE = 4.00, n = 26 years). Of the 171 sites visited during 2015, spotted owl pairs were located at 36 (21%) of the sites equaling the proportion of pairs located at these same sites in 2013 and 2014, but much lower than the long-term average ($\bar{x}$ = 49.8%, SE = 3.57, n = 26 years). At the 90 sites with continuous survey effort between 1992 and 2015 (and used in the λ analysis) banded spotted owls, either single or paired, were detected at 24% of the sites in 2015 (22 sites) which equaled the proportion of sites where banded owls were detected in 2014 (24%; $\bar{x}$ = 51.1%, SE = 3.02, n = 24 years).

Spotted owls were detected at 8 Wilderness, 31 LSR, and 13 Matrix sites in 2015 (Appendix 2). The percentage of sites where spotted owls were detected (either single or paired) in Wilderness increased from 28% in 2014 to 44% in 2015 ($\bar{x}$ = 54.9%, SE = 4.75, n = 19 years), and the percentage of sites where pairs were located in 2015 was 28% ($\bar{x}$ = 43.4%, SE = 4.49, n = 19 years). In the LSRs, the percentage of sites where owls were detected decreased from 34% in 2014 to 31% in 2015 ($\bar{x}$ = 58.0%, SE = 3.88, n = 19 years), and the percentage of sites where owl pairs were detected in 2015 was 21% ($\bar{x}$ = 43.4%, SE = 3.76, n = 19 years). Owls were detected on 24% of Matrix owl territories in 2015, a decline of 2% from 2014 ($\bar{x}$ = 54.1%, SE = 4.51, n = 19 years), with pairs located at 19% of Matrix sites in the current study year ($\bar{x}$ = 43.0%, SE = 4.27, n = 19 years). Generally, the mean percentage of sites with owls detected has remained similar for the Wilderness and LSR, so the increase in owl detections for Wilderness territories in 2015 was noteworthy. In 2015 the decline in sites where spotted owls were detected in the Matrix and LSRs was similar. The mean percentage of sites with pairs declined on Matrix territories, increased slightly on the LSRs, and was unchanged for Wilderness in 2015 compared to 2014 (Appendix 2).

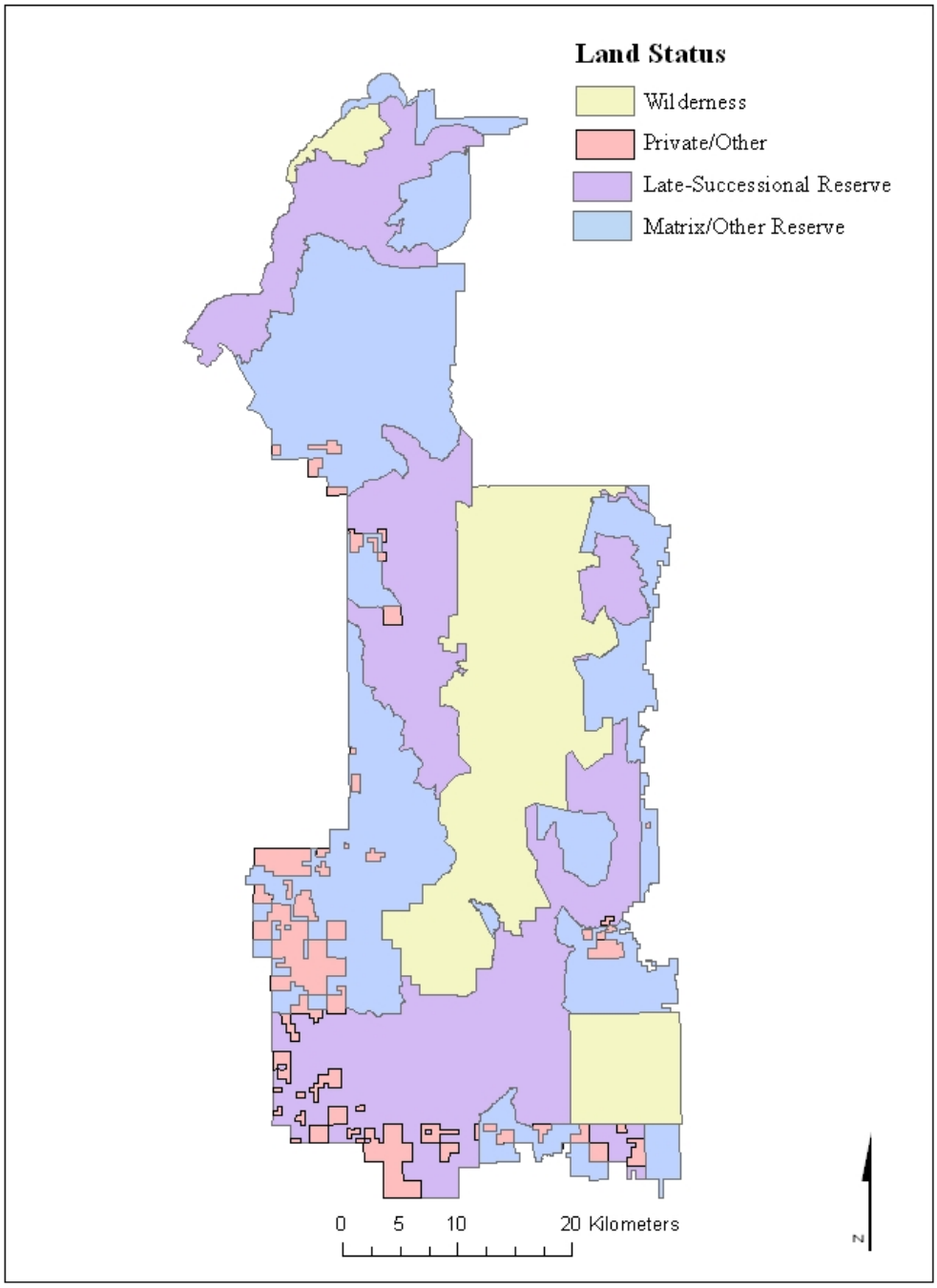

Figure 3. Land-use Allocations within the Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2015.

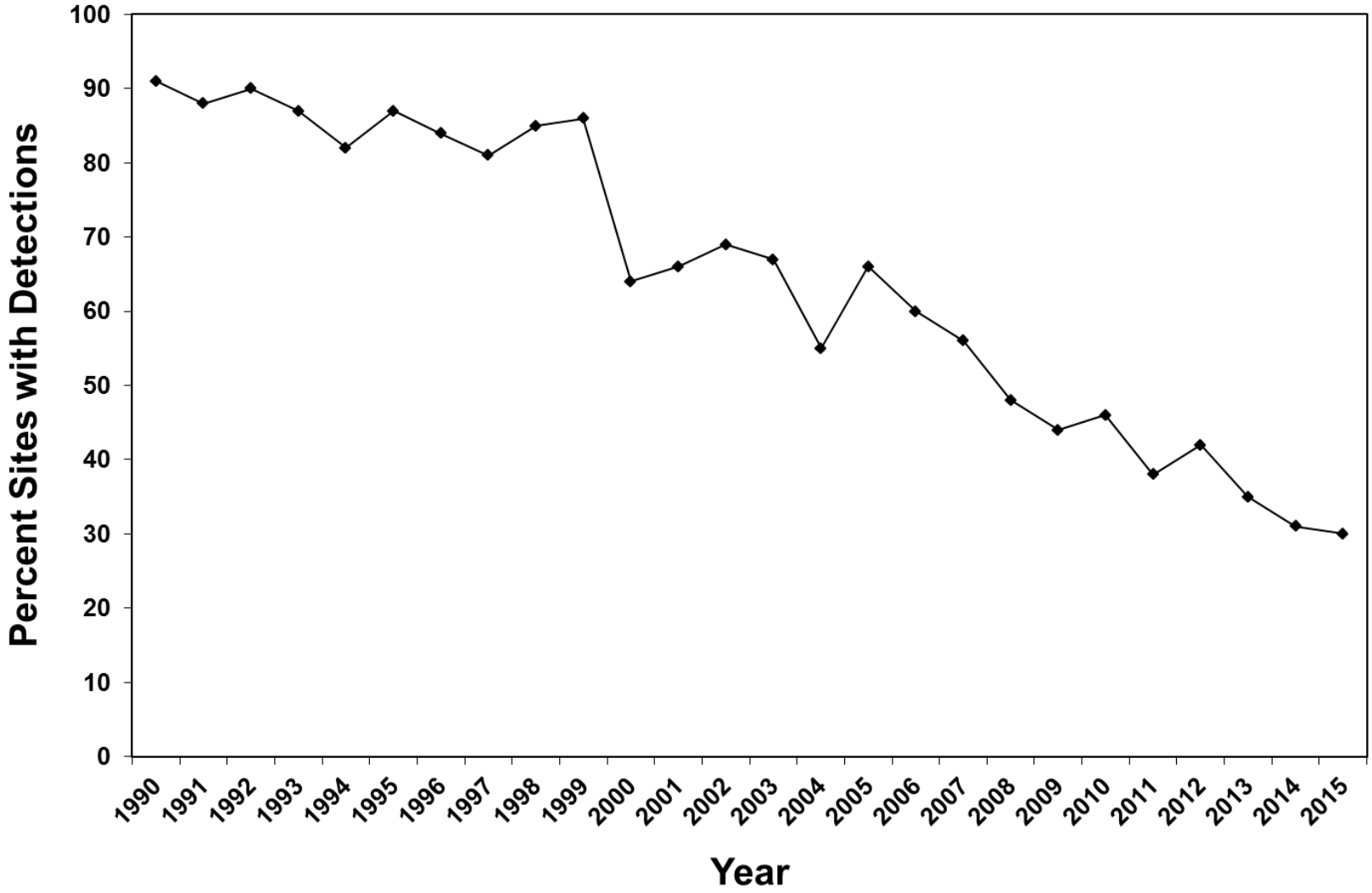

Figure 4. Percentage of all sites surveyed annually with ≥ 1 spotted owl detected on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2015.

Breeding Propensity

Twenty-six owl pairs were surveyed to protocol to determine nesting status (i.e., proportion of pairs that attempted to nest each year; Forsman 1995), and 22 of these pairs exhibited nesting behavior (85%) which was the same rate as in 2014 and among the highest nesting rates recorded for this study. On average, 55% (SE = 4.97) of pairs detected each year attempted to nest, although breeding propensity rates are generally highly variable (min. = 3%; max = 88%; n = 26 years). Five owl pairs confirmed to be nesting (by June 1st for sites < 1371m. and June 15th for sites ≥ 1371m. in elevation) in 2015 (19%) appeared to fail to fledge young. The mean rate of nest failure for pairs determined to be nesting in all years (1990-2015; n = 26) was 15% (SE = 1.54; min. = 0.0, max. = 33.3).

By the end of the field season, 36 pairs were confirmed at sites where owls were detected, and 21 of these, including pairs not surveyed to protocol for nesting status determination (i.e., located for the first time after June 1 or June 15, 2015), successfully reproduced ($\bar{x}$ = 24.0, SE = 2.92, n = 26 years; min. = 1; max. = 56). The average number of young fledged per confirmed breeding pair in 2015 (0.97) was greater than the mean for all years ($\bar{x}$ = 0.70, SE = 0.081, n = 26 years; Figure 5). The number of young produced per successful pair (1.47) in 2015 was similar to the average during the study ($\bar{x}$ = 1.60, SE = 0.041, n = 26 years; Appendix 3).

In 2015, the average number of fledglings per pair in the LSRs was 0.94, 1.11 in the Matrix and 0.80 in the Wilderness. Between 1997 and 2015 the average number of young produced per pair in Matrix ($\bar{x}$ = 0.68, SE = 0.087, n = 19 years; min. = 0.00, max. = 1.46) and LSRs ($\bar{x}$ = 0.69, SE = 0.105, n = 19 years; min. = 0.04, max. = 1.58) have been similar and slightly better than in Wilderness areas ($\bar{x}$ = 0.48, SE = 0.126, n = 19 years; min. = 0.0, max. = 1.67; Appendix 4).

We calculated productivity as the mean number of young fledged per female monitored for reproductive success (NYF). The mean NYF for females located in 2015 (age classes combined) on territories in the LSR was 0.94 ($\bar{x}$ = 0.691, SE = 0.105, n = 19 years, min. = 0.04, max. = 1.50), 0.90 ($\bar{x}$ = 0.664, SE = 0.085, n = 19 years, min. = 0.00, max. = 1.32) for territories in the Matrix, and 0.80 for territories in the Wilderness ($\bar{x}$ = 0.477, SE = 0.126, n = 19 years, min. = 0.00, max. = 1.71; Appendix 4). Over the course of the study, annual mean NYF for female spotted owls located at territories in the LSR and Matrix tended to be greater than for Wilderness sites. Overall, average NYF was 0.97 (SE = 0.145, n = 32) for all females (ages combined) in 2015 ($\bar{x}$ = 0.69, SE = 0.081, n = 26 years; min. = 0.02, max. = 1.49; Figure 6).

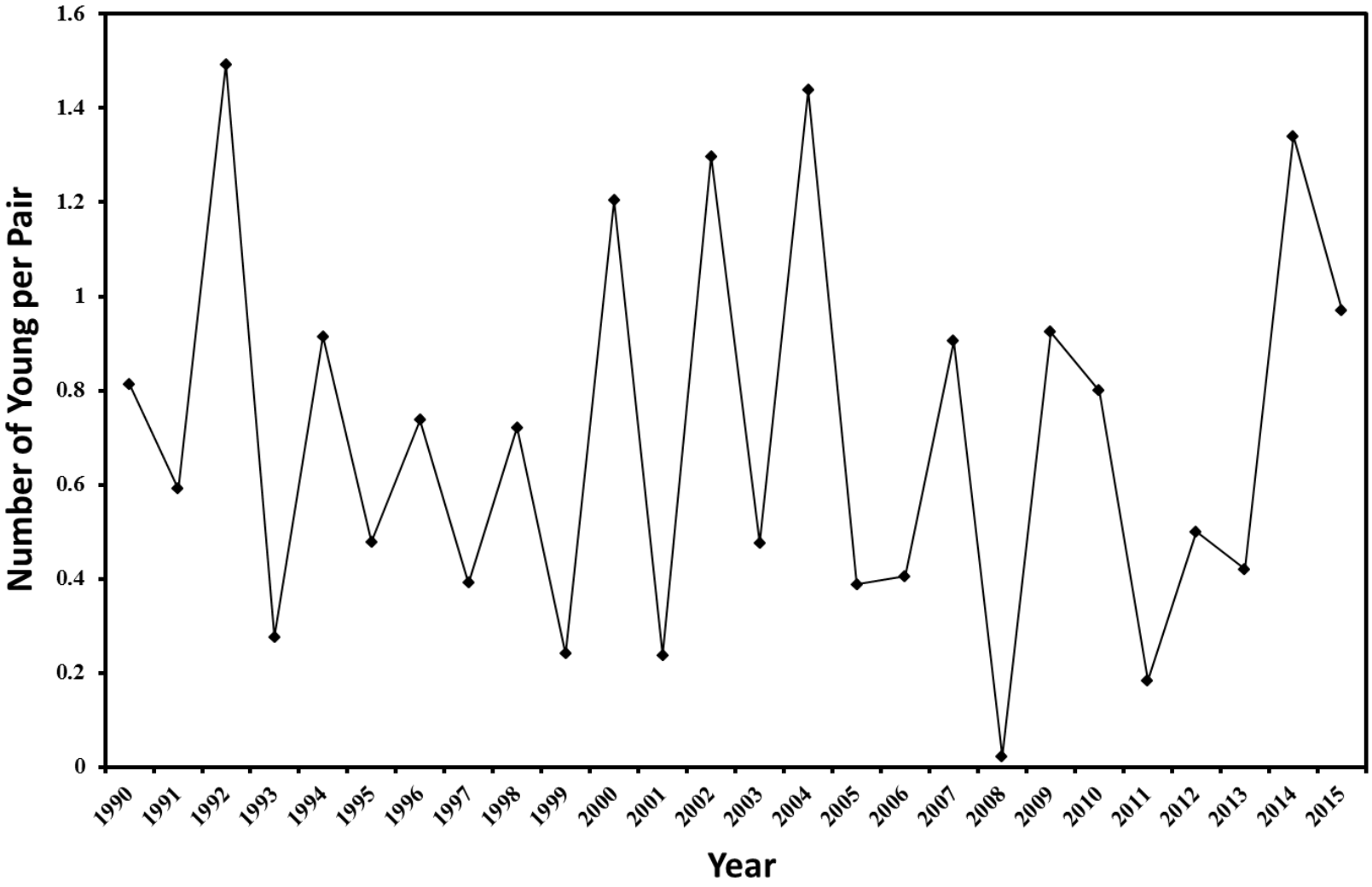

Figure 5. The number of young produced per total number of sites where spotted owl pairs were detected when surveyed to protocol for reproduction on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2015.

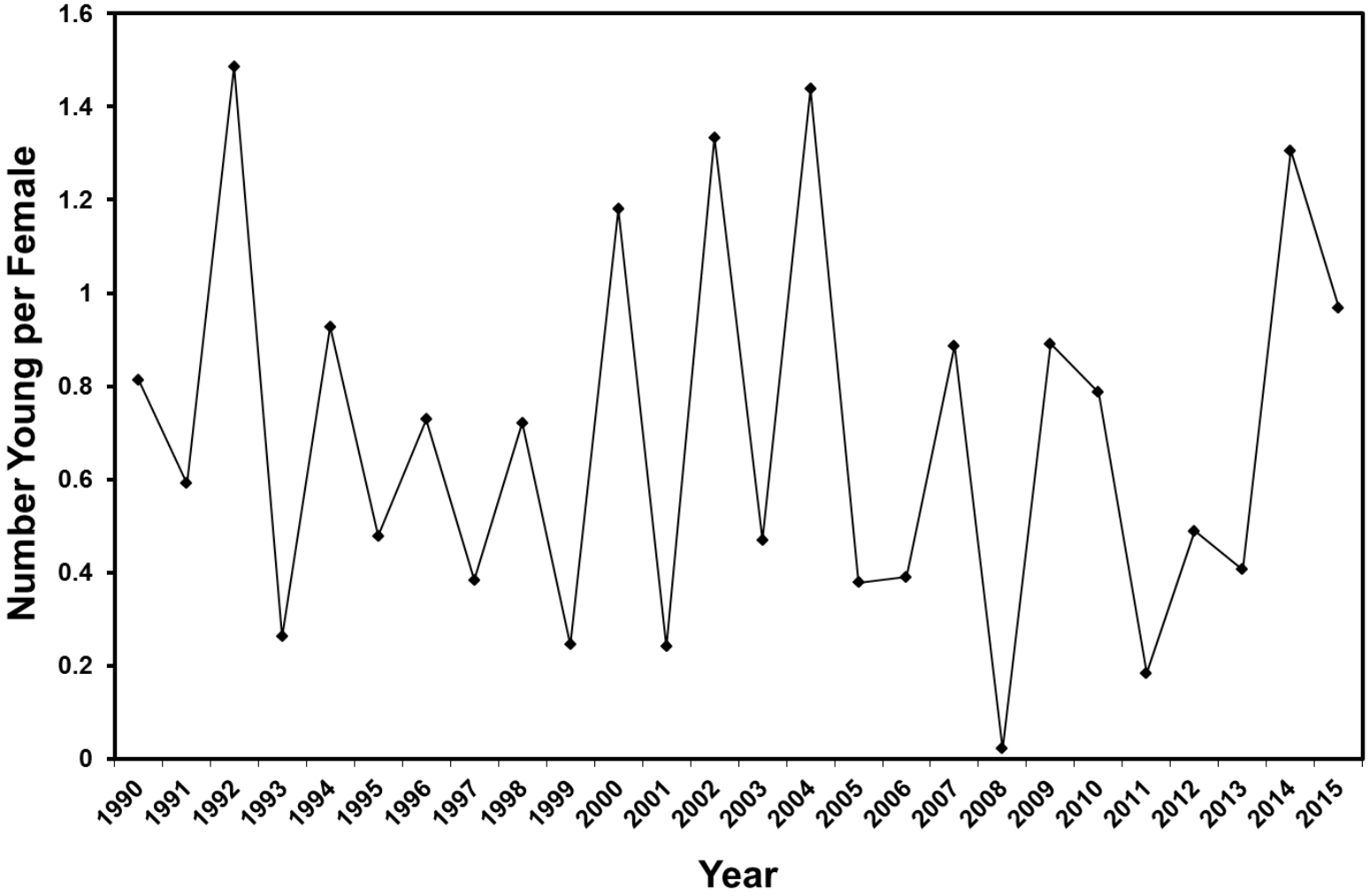

Figure 6. The mean annual number of young fledged (NYF) per female spotted owl surveyed to protocol for reproduction on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2015.

Age and Sex Composition

In 2015 there were 88 non-juvenile owls detected ($\bar{x}$ = 158.2, SE = 7.59, n = 26 years), with 47 males, and 41 females, the lowest number of owls detected during the entire study (Appendix 5). On average 46% of the owls detected each year on the study area are females, and the percentage of females in 2015 equaled the average (Appendix 5). Similar to other study areas (Dugger et al. 2016), the sex-ratio for territorial owls is male-biased, with the ratio of females relative to males varying from 0.72 to 0.96 depending on year (Figure 7).

There were 70 owls which we could assign to an age class in 2015 with 91.4% as adults (≥ 3 years old) and 8.6% as subadults, and there were slightly more subadults than in 2014 (7.5%; Appendix 5). There were 6 subadults located (1 female and 5 males), which is less than the average for all years ($\bar{x}$ = 8.4, SE = 0.87; min. = 2, max. = 19, n = 26 years). We could not ascertain the age of 20% of the study population (18 owls) which is more than the average for all years ($\bar{x}$ = 18.5%, SE = 2.39, n = 26 years). The majority of unknown aged owls represented auditory detections usually during nighttime surveys without visual observation; possibly reflecting non-territorial individuals.

Banding and Resighting

In 2015, we banded 27 owls: 20 fledglings (young of year), 2 subadults (1st year or 2nd year birds) and 5 adults (≥3 years old) on the study area. A total of 60 banded non-juvenile owls (subadults and adults) of known identity (including newly banded owls) were seen at least once during the season; an increase of 9% from 2014 (Appendix 6). Territorial females of known age (i.e., initially captured as juveniles, 1st year or 2nd year subadults) averaged 9.5 years (SE = 1.25, n = 13; min. = 2, max. = 18) and known-age territorial males averaged 9.1 years (SE = 1.25, n = 13; min. = 1, max. = 17). The oldest owls we observed were a female and a male ≥18 years of age, as both were banded as adults, so a minimum of 3 years old in 2000.

There were 7 documented inter-territory movements of banded owls in 2015 on the demographic study area. Two owls banded as juveniles (2004 and 2013) were located at non-natal sites within the study area, and 5 owls previously banded as adults were relocated on new territories within the study area.

A total of 207 movements have been recorded on the study area from 1990-2015 and the mean movement distance was 16.1 km for females (SE = 1.81, n = 90; min. = 0.4, max. = 88.0) and 8.7 km (SE = 0.80, n = 117; min. = 0.8, max. = 44.2) for males.

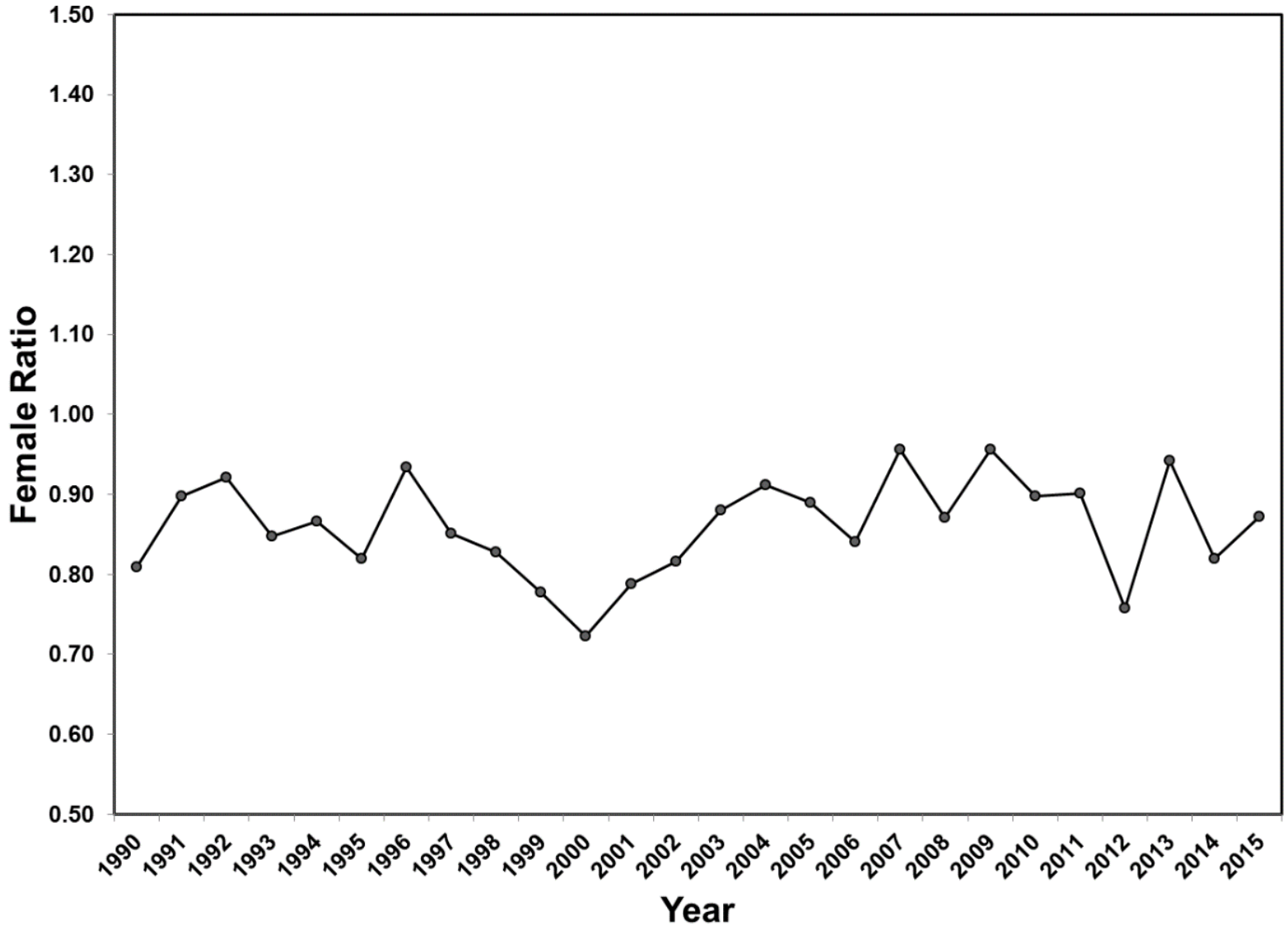

Figure 7. Ratio of female to male spotted owls on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2015.

Barred Owls

The range of the barred owl (*Strix varia*) has expanded during the last century and now overlaps that of the northern spotted owl (Livezey 2009, Wiens et al. 2014). Barred owls were first detected within the boundaries of the CAS 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 171 spotted owl territories on the study has increased from a low of 4.1% to a high of 38% in 2014 and 2015 (Figure 8). Cumulatively, barred owls have been detected at 80% of the spotted owl territories during at least one breeding season over the course of this study. The annual proportion of surveyed areas with spotted owl detections exhibits a strong negative association with the cumulative proportion of surveyed areas with barred owl detections ($r = -0.95$, $p \leq 0.001$). This proportion is likely still an underestimate of the number of spotted owl territories being influenced by barred owls, as some barred owls are probably not detected during spotted-owl specific surveys conducted on the area each year. However, detection rates are high enough to estimate detection rates and co-occurrence occupancy dynamics of both barred and spotted owls using a two-state, two-species, and multi-season occupancy model (Dugger et al. 2016). Using occupancy models that incorporate detection rates (e.g., MacKenzie et al. 2003, Richmond et al. 2010), 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, Dugger et al. 2016).

Spotted Owl Diets

A total of 6,501 prey specimens from 118 owl sites in regurgitated pellets were collected and identified during 2000-2013, with pellets collected in 2014 and 2015 as yet unprocessed. 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 9).

Pocket gophers (*Thomonys mazama and T. talpoides*), red-backed voles (*Myodes californicus*) and moles (*Scapanus orarius* and *S. latimus*) in pellets were low in biomass but higher in absolute numbers (Figure 10).

We are currently investigating the relationship of prey remains in spotted owl pellets to spatial and temporal covariates at spotted owl territories using a multi-state occupancy approach.

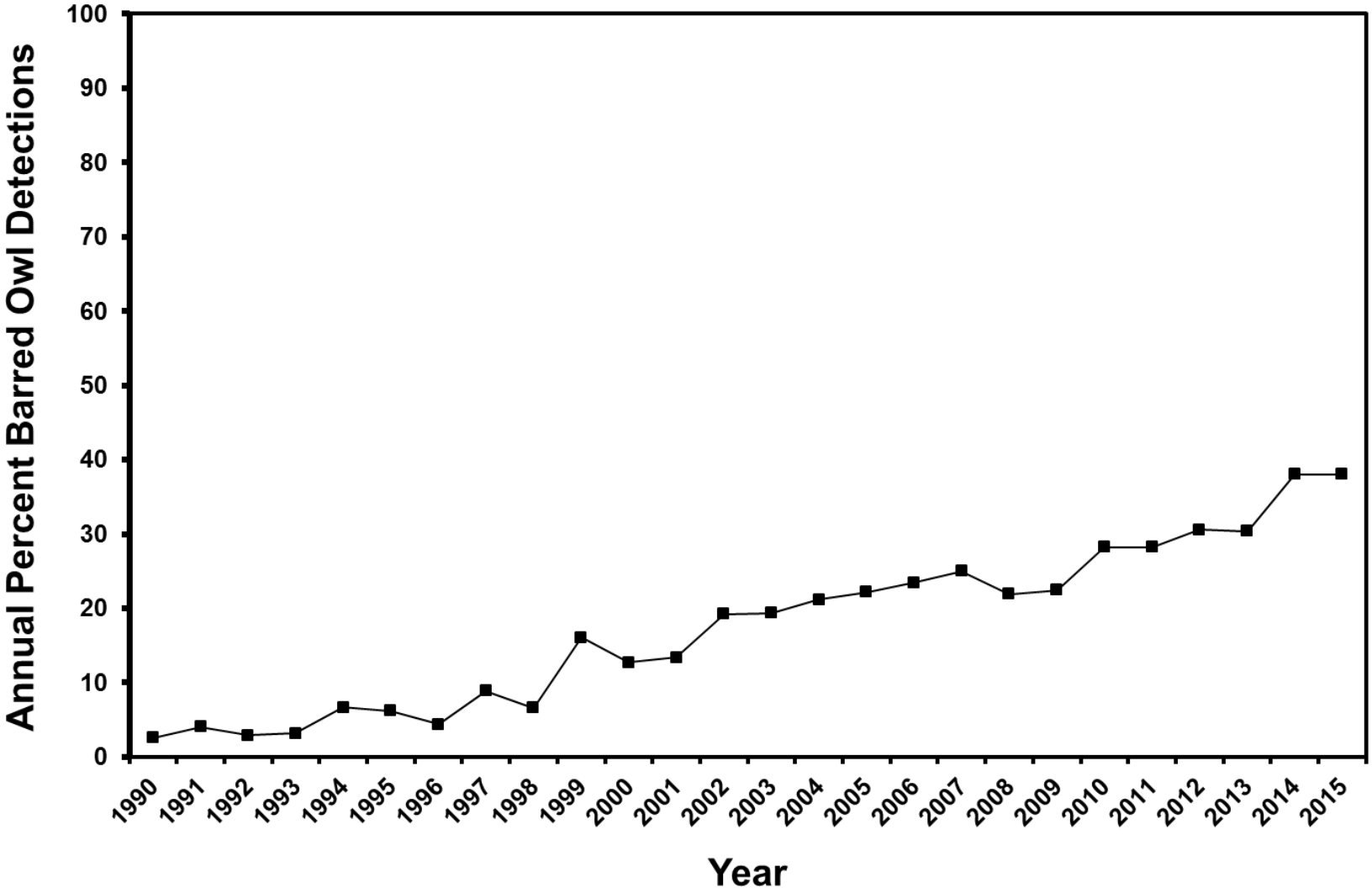

Figure 8. The annual percentages of historic spotted owl territories surveyed where barred owls were detected on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2015.

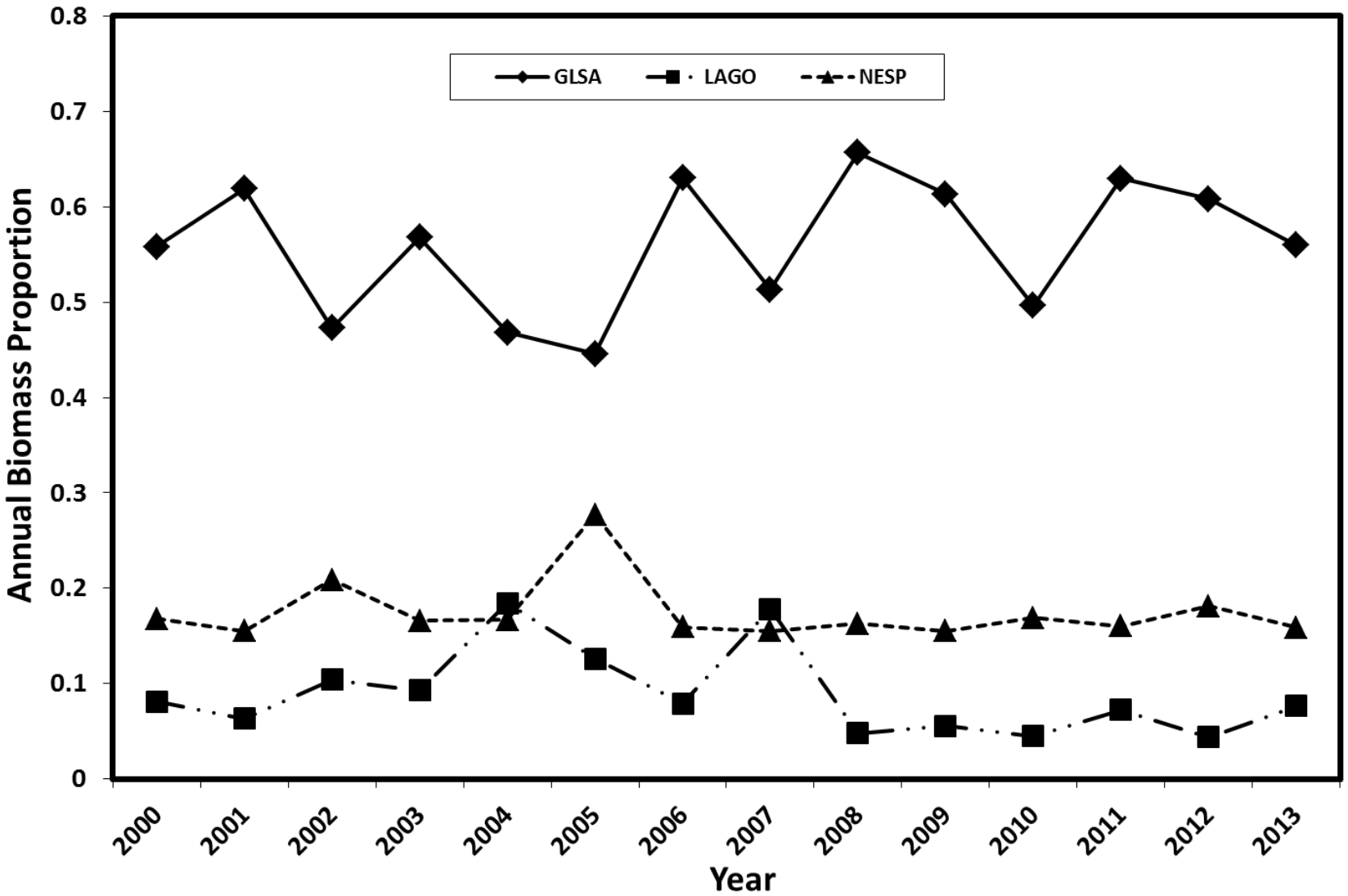

Figure 9. The annual biomass proportion of flying squirrels (GLSA = *Glaucomys sabrinus*), woodrats (NESP = *Neotoma* species) and Lagomorphs (LAGO) in regurgitated spotted owl pellets on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 2000-2013.

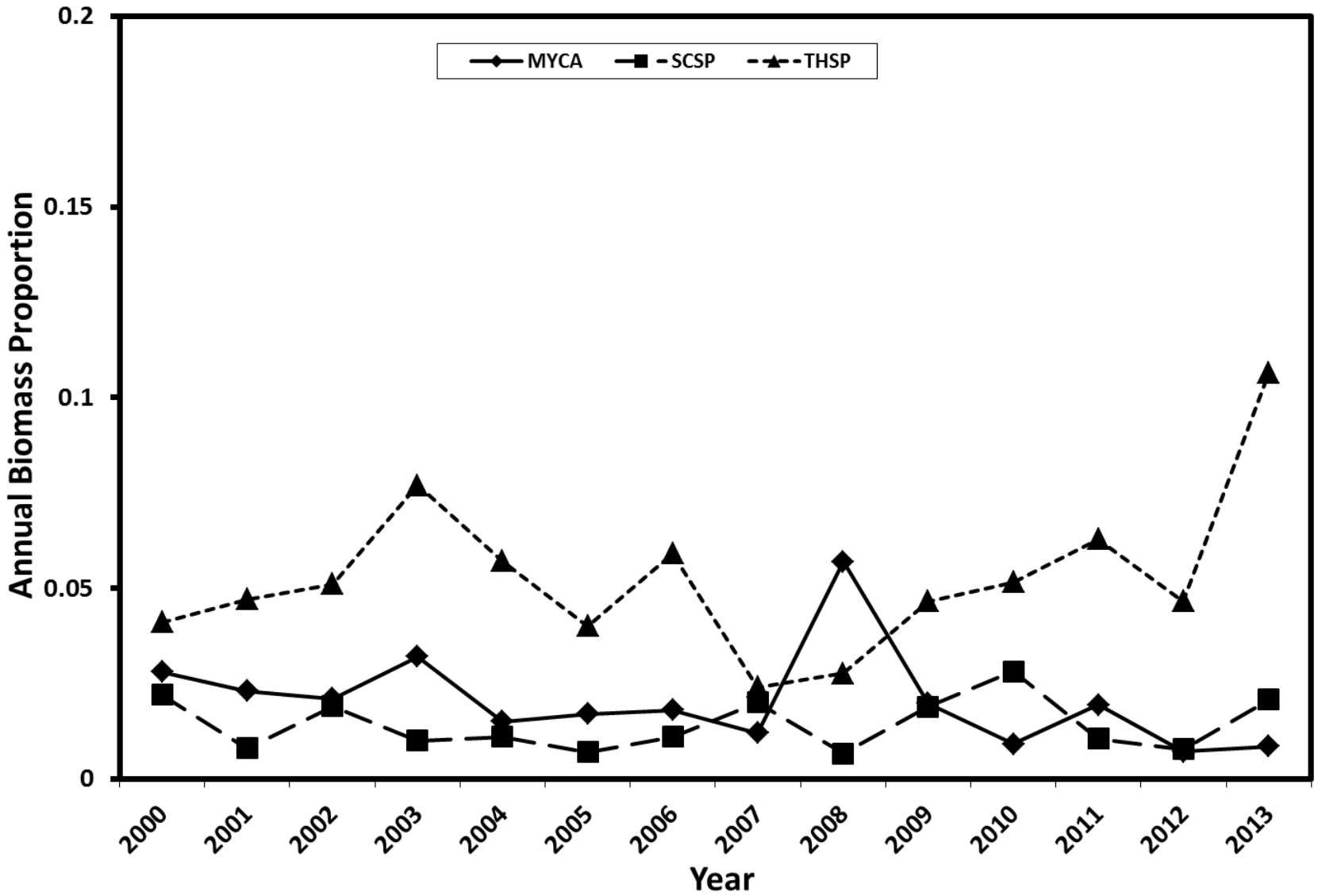

Figure 10. The annual biomass proportion of western red-backed voles (MYCA = *Myodes californicus*), moles (SCSP = *Scapanus* species) and pocket gophers (THSP = *Thomomys* species) in regurgitated spotted owl pellets on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 2000-2013.

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. Day searches will often immediately precede night surveys in case spotted owls present at a site are hesitant to vocalize in the vicinity of barred owls at night. If no detections are noted these day visits are tallied as a part of the night visit effort. The majority of the visits required to determine whether an owl was present on a site are conducted as nighttime surveys. From 1994 to 2015, 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 11). Across all visits, the proportion of nighttime surveys has varied annually while increasing (min. = 24%; max. = 66%; Figure 11).

Apparent Survival, Fecundity, Population Trend and Occupancy

A workshop was conducted to analyze northern spotted owl range-wide demographic data in January 2014 (Dugger et al. 2016). The workshop was held as a requirement of the *Northern Spotted Owl Effectiveness Monitoring Program for the Northwest Forest Plan* (Lint et al. 1999). It was the sixth in a series of demographic workshops that were convened initially in 1991 (Anderson and Burnham 1992), again in 1993 (Burnham et al. 1994, 1996), and then every five years since 1993 (1998: Franklin et al. 1999; 2004: Anthony et al. 2006; 2009: Forsman et al. 2011; 2014: Dugger et al. 2016).

The 2014 workshop built upon the findings of previous investigations of fecundity, apparent survival, and rates of population change using both a meta-analysis approach for a sample of spotted owls distributed through the species range as well as separate analyses of 11 individual demographic study areas, including the southern Oregon Cascades study area (Dugger et al. 2016). For the 2014 workshop maps were developed that incorporated habitat metrics and delimited northern spotted owl territories over the entire analysis area. This refined mapping permitted a multi-scale exploration of spatial covariates which facilitated a more thorough investigation of the interaction of habitat and meteorological covariates across the range of the spotted owl compared to previous efforts (e.g., Forsman et al. 2011). Additionally, this workshop expanded its scope relative to past meta-analyses by incorporating a two-state, two-species, multi-season occupancy analysis to better assess the species interactions of barred owl and spotted owls (Dugger et al. 2016).

To incorporate data into the workshop analyses from color-marked spotted owls across the entire range of habitat types available on the southern Oregon Cascades (including spotted owls on the eastern slope), we incorporated data from a sample of spotted owls territories not reported on elsewhere in this report that are contiguous with the CAS area and monitored by cooperators at Crater Lake National Park and the Klamath Falls Resource Area, Lakeview District-BLM. Estimates of fecundity, survival, annual rates of population change, and occupancy dynamics from the meta-analysis workshop for the southern Oregon Cascades data are reported in Dugger et al. (2016).

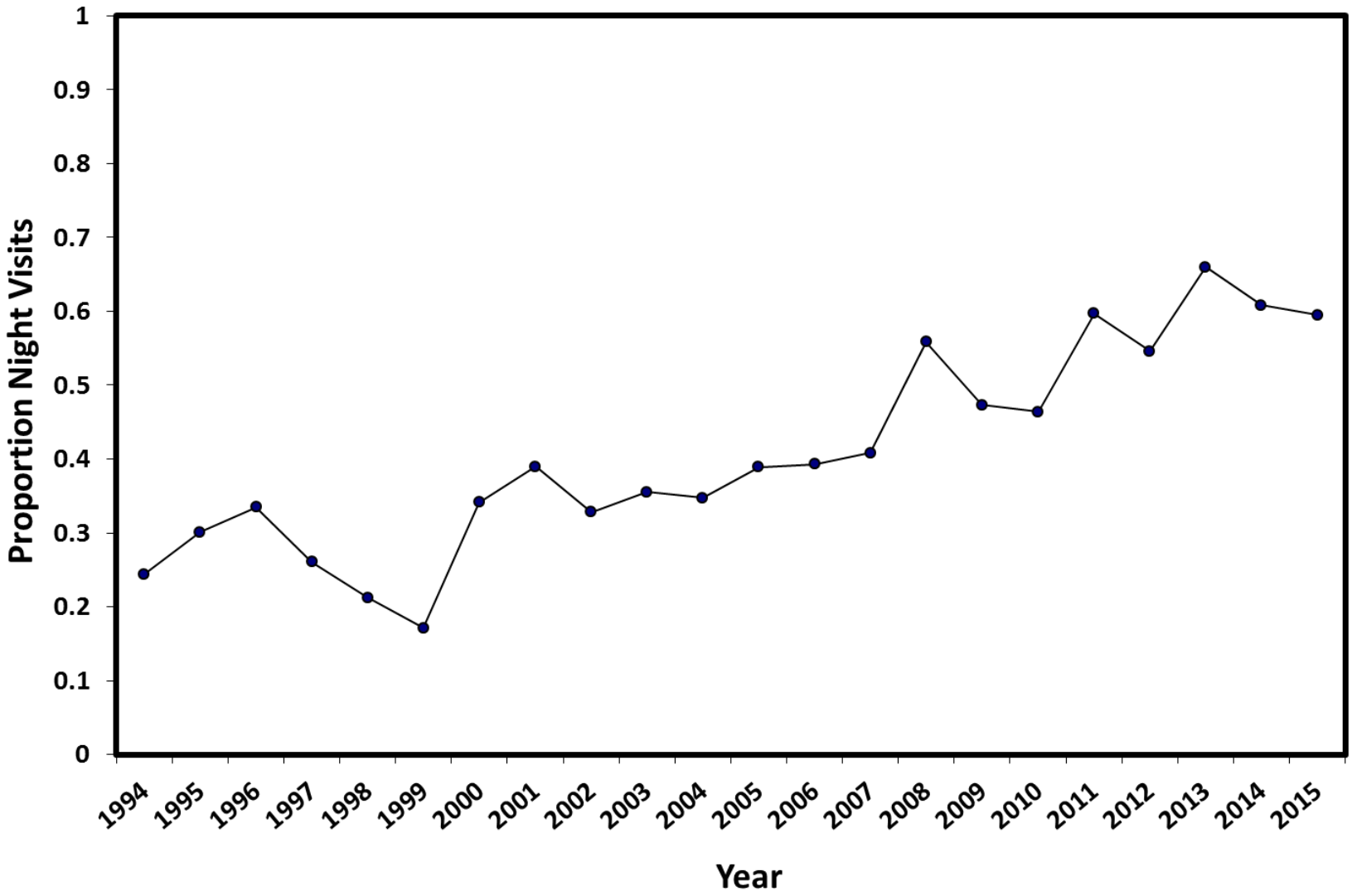

Figure 11. The annual proportion of total visits conducted as nighttime surveys of historic spotted owl territories on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1994-2015.

Discussion

In 2015 field work was aided by a low snow pack largely due to warmer than average winter temperatures which improved our access to most sites in the study area. However, during the winter season there had been several high wind events and in February a localized warm air cell brought destructive rainfall down onto already frozen ground. Several road networks sustained severe water damage. Damage to the road system cut off vehicular access to 10 historic owl territories. Owing to our inability to gain safe access for night work to 4 of these areas, surveys were only conducted as day visits. There were also large amounts of windfall timber on access roads which resulted in approximately 4 workdays lost to survey work for one crew member who spent that time removing ~100 downed trees. Elsewhere on the study the lack of snow pack permitted us easy access which allowed us to begin a schedule of swing shifts with night work at the onset of the field season.

In late July a number of lightning caused ignitions grew into the 8452 ha. National Fire Complex. The wildfire directly impacted 4 historic spotted owl territories on the Rogue River-Siskiyou National Forest. Due to the hazard posed to the public, the area adjacent to the fire was placed under an access closure. We were unable to revisit 10 spotted owl sites, primarily to attempt bird banding. At one site the final occupancy visit was conducted after the closure was lifted in early September.

In 2015 productivity decreased relative to 2014 but was still greater than in most years. Warmer temperatures in the early nesting season has been consistently associated with increased productivity and there is also evidence that increased precipitation during winter is associated with lower productivity in the southern Oregon Cascades (Dugger et al. 2005, Forsman et al. 2011, Dugger et al. 2016). The better than average productivity observed in 2015 was consistent with past years where early nesting season temperatures were higher than average while precipitation during the winter was slightly below the 30 year average (PRISM Climate Group, http://prism.oregonstate.edu). 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 higher reproduction in both 2009-2010. The annual total number of young produced on the study area generally declined or increased slightly in the previous six years so 2015 was consistent with the recent pattern where the even-odd year cycle seen early in the study has diminished.

The total number of spotted owls detected and the number of previously banded owls identified each year has generally declined during the course of the study. The number of spotted owls detected in 2015 continued this apparent decline and were the lowest recorded for the study; however, the number of banded owls we observed increased (including newly banded owls). There were 2 re-observations in 2015 of spotted owls originally banded as juveniles and given that the winter was warmer than average with moderate precipitation this observation was consistent with the results of the λ meta-analysis where higher recruitment of territorial owls was noted after warmer, dryer winters (Dugger et al. 2016). The individual study area survival analysis for the southern Cascades as well as in the meta-analysis of survival indicated that higher winter temperatures and lower early nesting season precipitation were associated with increased survival so we might have expected more resightings of previously banded non-juvenile owls than was noted in 2015 (Dugger et al. 2016). The number of sites on the CAS study area where barred owls were detected in 2015 was unchanged from 2014 but the cumulative proportion of sites with

at least one barred owl detection increased to 80%. Spotted owl detection probabilities in the southern Oregon Cascades appear to decline on territories where barred owls are also detected at least once during a survey season (Dugger et al. 2011, Dugger et al. 2016).

There were fewer historic territories where we detected spotted owls than in previous years similar to the decline we have observed for individual spotted owl detections. In the southern Oregon Cascades the most significant factors affecting extinction and colonization rates for spotted owl sites is area of suitable habitat and the presence of barred owls (Dugger et al. 2011, Dugger et al. 2016). Wildfires (affecting 18 spotted owl core areas since 2008) and timber harvest have reduced the area of suitable habitat on the CAS study in recent years and may be a factor in the decline in site occupancy. Given the strong association between barred owl detections and increased site extinction and decreased site colonization probabilities (Dugger et al. 2016), it is likely that displacement of spotted owls from historic territories contributed to the decline in proportion of sites where spotted owls were detected in 2015. Barred owl presence on a territory also reduces spotted owl detection rates so the apparent decline in site occupancy for a single season could be attributable to a decrease in spotted owl responses (Dugger et al. 2011, Dugger et al. 2016).

We also observed geographic differences in the distribution of sites occupied by spotted owls within the study area. The central portion of the study area on both the west and east slopes of the Cascades had lower rates of apparent occupancy (i.e., proportion of sites where spotted owls were detected) than observed at the northern and southern parts of the study area. The study encompasses a diverse range of vegetation zones, however, initial spotted owl apparent occupancy at the onset of the study was geographically more similar than in 2015. There is evidence from other species that sub-populations on the margins of the species range are vulnerable to localized extirpations owing to increased extinction probabilities and may have reduced recolonization probability related to dispersal (Doherty et al. 2003, Holt et al. 2004). It is noteworthy in this regard that the eastern boundary of the study area where many spotted owl territories appear to be unoccupied approximates the eastern extent of the species range boundary in southern Oregon so spotted owl occupancy at these sites may be inherently more exposed to the risk of localized extirpations.

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9. Research Plans for FY 2016:

a) Continue data collection on occupancy, survival, and reproductive success of northern spotted owls on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area.
b) Continue the collection of pellets and analysis of spotted owl diets.
c) Continue preparation of manuscripts relating to spotted owl nesting sites and diets.

10. Manuscripts in FY 2015

a) Dugger, K.M., E.D. Forsman, A.B. Franklin, R.J. Davis, G.C. White, C.J. Schwartz, K.P. Burnham, J. Nichols, J.E. Hines, C. Yackulic, P. Doherty, Jr., L. Bailey, D.A. Clark, S.H. Ackers, L.S. Andrews, B. Augustine, B.L. Biswell, J. Blakesley, P.C. Carlson, M. Clement, L.V. Diller, E.M. Glenn, A. Green, S.A. Gremel, D.A. Herter, M. Higley, J. Hobson, R.B. Horn, K. Huyvaert, C. McCafferty, T. McDonald,. K. McDonnell, G.S. Olson, J.A. Reid, J. Rockweit, V. Ruiz, J. Saenz, and S.G. Sovern. 2016. The effects of habitat, climate and Barred Owls on long-term demography of spotted owls. The Condor: Ornithological Applications. 118:57-116.
b) Davis, R.J., and L.S. Andrews. 2015. Current and Potential Distribution of red tree voles based on habitat models. *In* Distribution, Habitat, Diet, and Management of the Red Tree Vole and Sonoma Tree Vole, E. Forsman *edit*. PNW Gen. Tech. Rep. XXX. 147pp. *In* Review.

11. Technology Transfer Completed in FY 2015:

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

12. Presentations:

a) K. Dugger participated in the Public Forum for "Sharing Key Findings of the Northwest Forest Plan 20-Year Monitoring Reports" and made a presentation. The forum was sponsored by the Interagency Regional Monitoring Program, and included stakeholders from a variety of state and federal agencies, NGO's, the media, and the general public, Vancouver, WA, (June, 2015).
b) K. Dugger gave an invited lecture for FW507, OSU Department of Fisheries and Wildlife Seminar series entitled *The effects of habitat, climate and barred owls on long-term demographics of northern spotted owls*. Corvallis, OR, October 21, 2015.

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 Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2015[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
2013	171	36	4	20	60	111	35
2014	171	36	5	12	53	118	31
2015	171	36	8	8	52	119	30

[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 detection 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 Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1997-2015[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
	2013	54	13	1	6	20	34	37
	2014	54	12	1	1	14	40	26
	2015	54	10	2	0	12	42	22
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
	2013	99	19	3	12	34	65	34
	2014	99	19	4	11	34	65	34
	2015	99	21	6	4	31	68	31

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
	2013	18	4	0	2	6	12	33
	2014	18	5	0	0	5	13	28
	2015	18	5	0	3	8	10	44

[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 Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2015[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
2013	31	8	13	26	1.63	0.42
2014	35	28	47	80	1.68	1.34
2015	32	20	31	63	1.55	0.97

[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 Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1997-2015[a].

Land-Use Allocation[b]	Year	# Pairs Checked	# Pairs Fledging Young	# Young Fledged	% Pairs Percent Producing Young	Average # of Young/ Successful Pair	Average # of Young/Pair	Average # of Young/All Females
Matrix								
	1997	17	6	9	35	1.50	0.53	0.529 (17)
	1998	16	10	13	63	1.30	0.81	0.750 (16)
	1999	15	6	10	40	1.67	0.67	0.667 (15)
	2000	14	7	11	50	1.57	0.79	0.786 (14)
	2001	20	4	6	20	1.50	0.30	0.286 (21)
	2002	22	12	24	55	2.00	1.09	1.091 (22)
	2003	23	6	11	26	1.83	0.48	0.458 (24)
	2004	22	18	32	82	1.78	1.46	1.318 (22)
	2005	28	8	10	29	1.25	0.36	0.333 (30)
	2006	22	6	10	27	1.67	0.46	0.435 (23)
	2007	20	11	19	55	1.72	0.95	0.905 (21)
	2008	14	0	0	0	NA	0.00	0.000 (17)
	2009	17	11	20	65	1.82	1.18	1.111 (18)
	2010	15	7	12	47	1.71	0.80	0.750 (16)
	2011	15	3	4	20	1.33	0.26	0.267 (15)
	2012	14	5	7	37	1.40	0.50	0.538 (13)
	2013	12	2	3	17	1.50	0.25	0.250 (12)
	2014	12	9	15	75	1.67	1.25	1.250 (12)
	2015	9	6	10	67	1.67	1.11	1.111 (9)
LSR								
	1997	27	6	9	22	1.50	0.33	0.333 (27)
	1998	37	21	30	57	1.43	0.81	0.811 (37)
	1999	32	1	2	3	2.00	0.06	0.065 (32)
	2000	29	23	40	79	1.74	1.38	1.333 (30)
	2001	47	7	12	15	1.71	0.26	0.255 (47)
	2002	45	33	60	73	1.82	1.33	1.333 (45)
	2003	48	15	25	31	1.67	0.52	0.520 (48)
	2004	42	30	58	71	1.93	1.38	1.381 (42)
	2005	45	12	18	27	1.50	0.40	0.400 (45)
	2006	44	12	18	27	1.50	0.41	0.382 (47)
	2007	46	28	45	61	1.61	0.98	0.900 (50)
	2008	23	1	1	4	1.00	0.04	0.040 (25)
	2009	32	14	26	44	1.86	0.81	0.788 (33)
	2010	40	21	32	53	1.52	0.80	0.850 (40)
	2011	30	3	5	10	1.67	0.17	0.167 (30)
	2012	26	9	13	35	1.44	0.50	0.500 (26)
	2013	15	6	10	40	1.67	0.67	0.625 (16)
	2014	19	18	30	95	1.67	1.58	1.500 (20)
	2015	18	12	17	67	1.42	0.94	0.944 (18)

Cont.

Land-Use Allocation	Year	# Pairs Checked	# Pairs Fledging Young	# Young Fledged	% Pairs Producing Young	Average # of Young/ Successful Pair	Average # of Young/Pair	Average # of Young/Female
Wilderness								
	1997	3	0	0	0	NA	0.00	0.000 (3)
	1998	8	2	2	25	1.00	0.25	0.250 (8)
	1999	3	0	0	0	NA	0.00	0.000 (3)
	2000	6	4	8	67	2.00	1.33	1.333 (6)
	2001	8	0	0	0	NA	0.00	0.000 (8)
	2002	7	6	12	86	2.00	1.71	1.714 (7)
	2003	11	2	3	18	1.50	0.27	0.250 (12)
	2004	9	9	15	100	1.67	1.66	1.667 (9)
	2005	7	3	3	43	1.00	0.43	0.375 (8)
	2006	8	1	2	13	2.00	0.25	0.250 (8)
	2007	8	2	3	25	1.50	0.38	0.375 (8)
	2008	6	0	0	0	NA	0.00	0.000 (7)
	2009	4	2	3	50	1.50	0.75	0.750 (4)
	2010	5	1	2	20	2.00	0.40	0.400 (5)
	2011	4	0	0	0	NA	0.00	0.000 (4)
	2012	4	1	2	25	2.00	0.50	0.400 (5)
	2013	4	0	0	0	NA	0.00	0.000 (4)
	2014	4	1	2	25	2.00	0.50	0.500 (4)
	2015	5	3	4	60	1.33	0.80	0.800 (5)

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

Appendix 5. Age and sex of northern spotted owls detected on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2014[a].

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)	14 (6,8)	27 (17,10)	198 (109,89)	98	8	55
2003	168 (90,78)	14 (3,11)	21 (15,6)	203 (108,95)	39	8	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)	148 (78,70)	48	8	53
2011	97 (50,47)	4 (3,1)	15 (8,7)	116 (61,55)	10	4	53
2012	98 (55,43)	3 (3,0)	22 (12,10)	123 (70,53)	22	3	54
2013	68 (35,33)	6 (3,3)	27 (14,13)	101 (53,48)	13	8	53

Cont.

Year	Adults (M,F)	Subadults (M,F)	Age Unknown (M,F)	Age Combined (M,F)	All Juveniles	Subadults (%)	Males (%)
2014	74 (39,35)	6 (4,2)	11 (7,4)	91 (50,41)	47	8	55
2015	64 (33,31)	6 (5,1)	18 (9,9)	88 (47,41)	31	9	54

[a] Not included are both age and sex unknown owls.

Appendix 6. Number of spotted owls newly banded, re-sighted, and recaptured on the Southern Oregon Cascades Northern Spotted Owl Demography Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 2015.

	Owls newly banded			Owls re-sighted			Owls recaptured		
Age class	Males	Females	Unk.	Males	Females	Unk.	Males	Females	Unk.
Adults	2	3	0	26	25	0	1	0	0
Subadults	1	1	0	0	0	0	1	0	0
Juveniles	-	-	21	-	-	-	-	-	-