

## **California Spotted Owl Module: 2008 Annual Report**

---

### ***Principal Investigator:***

John J. Keane  
Sierra Nevada Research Center  
Pacific Southwest Research Station  
U.S. Forest Service  
2121 2<sup>nd</sup> Street, Suite A-101  
Davis, CA 95616  
530-759-1704; [jkeane@fs.fed.us](mailto:jkeane@fs.fed.us)

### ***Research Team:***

Claire V. Gallagher, Ross A. Gerrard, Gretchen Jehle, Paula A. Shaklee  
Sierra Nevada Research Center  
Pacific Southwest Research Station  
U.S. Forest Service  
1731 Research Park Drive  
Davis, CA 95618  
530-759-1700

## **Introduction**

---

Knowledge regarding the effects of fuels and vegetation management on California spotted owls (*Strix occidentalis occidentalis*; CSOs) and their habitat is a primary information need for addressing conservation and management objectives in Sierra Nevada forests. The specific research objectives of the California spotted owl module as identified and described in the Plumas-Lassen Study (PLS) Plan are:

- 1) What are the associations among landscape fuels treatments and CSO density, distribution, population trends and habitat suitability at the landscape-scale?
- 2) What are the associations among landscape fuels treatments and CSO reproduction, survival, and habitat fitness potential at the core area/home range scales?
- 3) What are the associations among landscape fuels treatments and CSO habitat use and home range configuration at the core area/home range scale?
- 4) What is the population trend of CSO in the northern Sierra Nevada and which factors account for variation in population trend?

5) Are barred owls increasing in the northern Sierra Nevada, what factors are associated with their distribution and abundance, and are they associated with reduced CSO territory occupancy?

6) Does West Nile Virus affect the survival, distribution and abundance of California spotted owls in the study area?

7) What are the effects of wildfire on California spotted owls and their habitat?

Current information on the distribution and density of CSOs across the HFQLG study area is required to provide the data necessary to build predictive habitat models and provide baseline population information against which we will assess post-treatment changes in CSO populations and habitat. Continued monitoring on the Lassen Demographic Study Area is critical for estimating CSO population trends and status. Our focus in 2008 was to conduct landscape inventories of CSO distribution and abundance, and continue banding to provide the required data and baseline information to meet the objectives of Research Questions 1-4 identified above. Complete landscape inventory surveys were conducted across 9 of 11 survey areas in 2008 (Figure 1). Surveys were not conducted in 2 survey areas in 2006-2008 (SA-5, SA-7, Figure 1). Surveys were not conducted in these 2 study areas in 2006-2008 because sufficient data for determining the number and distribution of CSO sites for initial habitat modeling efforts was collected in 2004-2005. Details on survey methods are described in the study plan. Efforts were made to monitor the pair and reproductive status of each owl, and to capture, uniquely color-mark, and collect blood samples from each individual owl across the study area. Capture and color-marking is necessary to estimate survival and population trend, and to assess exposure to West Nile Virus (WNV)(Research Question #5). We also recorded all barred and hybrid barred-spotted owls encountered in the study area and synthesized all existing barred owl records for the northern Sierra Nevada to address Research Question #6. Additionally, we conducted the second year of a radio-telemetry study on CSOs within SA-4 in the Meadow Valley project area to document home range size and configuration, and to assess habitat selection relative to the recently implemented treatments. In response to a need for information on the association between CSOs and wildfire we initiated an assessment of CSO distribution, abundance and habitat associations in the Moonlight and Antelope Complex fire areas. These fires burned in 2007 and we initiated surveys in 2008 to assess the immediate post-fire response of CSOs. We have added a seventh research questions to reflect this new research direction.

## **Results**

---

### **CSO Numbers, Reproductive Success, Density and Population Trends:**

A total of 72 territorial CSO sites were documented across the core PLS study area in 2008 (Figure 2). This total consisted of 52 confirmed pairs, 9 unconfirmed pairs (i.e., one

member of pair confirmed as territorial single plus single detection of opposite sex bird), and 11 territorial single CSOs (single owl detected multiple times with no pair-mate detected). Ten pairs successfully reproduced in 2008 (16.4% of confirmed/unconfirmed pairs). Of these ten pairs, eight were located on the Lassen NF and 2 were located on the Plumas NF. One of the Plumas pairs involved a spotted owl paired with a sparrowed owl (spotted-barred hybrid) that produced one hybrid fledgling. The number of successful nests on the Plumas was the lowest reproductive year we have recorded during the study. A total of 17 fledged young were documented in 2008 (1.70 young per successful nest) (Table 1). Across the recent five years of the study, CSO reproduction has been highest in 2004 and 2007 in terms of the percent of CSO pairs that successfully reproduced, and in terms of the number of young fledged per successful nest. Approximately 50% of CSO pairs successfully reproduced in 2004 and 2007 whereas the proportion of pairs successfully reproducing ranged between 14%-18% in 2005, 2006 and 2008. The number of young produced per successful nest was more similar across years, ranging between 1.47 -1.81. CSO reproduction is known to vary with spring weather: precipitation patterns were more similar in 2004 and 2007, with total precipitation relatively low during March-April of 2004 and 2007 as compared to 2005 and 2006 (Figure 3). However, this pattern varied in 2008 as precipitation was low in March-April. Although precipitation was low during these two months in 2008, CSO reproduction was low in 2008. The low reproduction may be associated with the heavy snowpack that persisted into May-June as a result of heavy snowfall in January-February that accumulated across much of the study area. Additionally, small mammal numbers appeared to be low in 2008 (D.Kelt, pers. comm.)

The Lassen Demographic Study Area (SA-1A, SA-11, SA-12, SA-13, SA-14, SA-15) and Plumas NF Survey Areas (SA-2, SA-3, SA-4, SA-5, SA-7) were fully integrated in 2005 to define the overall Plumas-Lassen Study project area and provide consistent CSO survey effort across the project area. (Figures 1 & 2). We estimated the crude density of CSOs based on the number of territorial owls detected across 9 survey areas during 2008 surveys at the Survey Area spatial scales (Tables 2 and 3). The estimated crude density across the overall study area in 2008 was 0.067 territorial owls/km<sup>2</sup>. Overall study area crude densities are not directly comparable across years because different total areas were surveyed in each year. However, crude density estimates within individual Survey Areas indicate similar densities and number of territorial sites (pair sites plus territorial single sites) between 2004-2008 for the survey areas on the Plumas NF (SA-2, SA-3, SA-4), while numbers have declined somewhat on the Lassen survey areas (SA-1A, SA-11, SA-12, SA-13, SA-14, SA-15) between 2005-2008 (Tables 2 and 3). Due to an active wildfire (Cub Fire) and associated safety concerns we could not conduct surveys at two CSO territories within SA-13 in 2008. Thus, the crude density estimate for SA-13 in 2008 is not directly comparable to previous years.

The most recent information on CSO population trends is included in the January 2006 meta-analysis, conducted to estimate CSO population trends and to assess population status in response to a petition to list the CSO under the Endangered Species Act (Blakesley et al. 2006). These data continue to provide the best estimates of CSO population trends. Data collected between 1990-2005 from four CSO demographic

studies across the Sierra Nevada and southern Cascades, including the Lassen Demographic Study Area, were analyzed as part of the meta-analysis workshop. The Lassen Demographic Study Area is contained within the overall PLS study area and consists of survey areas SA-1A, SA-11, SA-12, SA-13, SA-14 and SA-15 in Figure 1. Full details on meta-analysis methods and results are provided in Blakesley et al. (2006). In synopsis, across the four study areas, results indicated that the Lassen Study CSO population exhibited the strongest evidence for a population decline between 1990-2005. Mean lambda for the Lassen Demographic Study was 0.973, with 95% confidence limits ranging from 0.946-1.001 (Table 4).

### **Habitat Assessment – Nest/Roost Plot Scale**

We documented a total of 103 CSO territorial sites between 2004-2006. We overlaid the primary nest/roost locations for each of the 103 CSO sites with the CWHR vegetation classes available within the VESTRA photo-interpreted vegetation map for the PLS to examine nest/roost-site habitat association patterns. Approximately 53% of the nest sites were located within CWHR 5M, 5D and 6 size classes (Table 5, Figure 4). An additional 37% of the sites were located within CWHR size class 4M and 4D polygons. CWHR size class 4 is defined as stands with average tree sizes of 12-24 inch diameter-at-breast-height (dbh) trees. Of the 38 sites located in size class 4 polygons, 25 (66%) were in size class 4 polygons with a large tree component (i.e., presence of >24 inch dbh trees). Overall, about 90% of the sites were located within CWHR 4M, 4D, 5M, 5D, and 6 size classes. The remaining 10 sites were located in more open, smaller-tree size polygons, with nests or roosts located within remnant, scattered larger trees (Table 5, Figure 4).

While the distribution of nest site locations relative to broad vegetation classes provides insight into patterns of nest-site habitat, we also conducted vegetation sampling at nest or primary roost sites to describe vegetation structure and composition. Vegetation plot sampling was conducted at 80 CSO territories across 2005-2007. Vegetation plots were centered on CSO nest trees, or on a primary roost tree for sites where no nest has been documented, and were measured using the national Forest and Inventory Assessment (FIA) protocol. The FIA protocol is used nationally by the USDA Forest Service for inventorying and monitoring vegetation. FIA sampling consists of measuring vegetation structural and compositional variables within a 1-ha plot centered on a CSO nest or roost tree. Only one plot was collected from each CSO territory, with the most frequently used nest tree serving as the plot center location, or the most recent nest tree used at sites where no nest tree was used more frequently than another. CSO nest sites were characterized by mean total basal areas of 260.8 ft<sup>2</sup>/acre, 7.4 snags (>15 inch dbh)/acre, and 10.7 trees (>30 inch dbh)/acre (Table 6). Under the FIA protocol, canopy cover is modeled based on the tree inventory list. The modeled canopy cover for these plots averaged 64.1%. Shrub cover averaged 7.7%. Fuel loads averaged 0.75 tons/acre for 1-hr fuels, 4.0 tons/acre for 10-hr fuels and 4.44 tons/acre for 100-hr fuels (Table 6). Use of the FIA sampling protocol will facilitate monitoring of vegetation and development of CSO habitat models that can be used as adaptive management planning tools. Habitat

models are currently being evaluated that can be used to assess projected changes in CSO nesting habitat suitability under varying fuels and vegetation treatment scenarios.

### **Habitat Assessment – Core Area/Home Range Scale**

Core area habitat associations around 102 CSO nest/roost sites was assessed by using a Geographic Information System (GIS) and the VESTRA photo-interpreted vegetation map to determine the vegetation patterns within a 500 acre (201 ha) circle centered on each of the CSO territory sites. To compare the CSO sites with the general availability of habitat across the study area we also assessed the same vegetation patterns around 130 points determined by placing a systematic grid across the study area. For this summary we assessed vegetation using the USDA Forest Service Region 5 classification system. Overall, CSO core areas averaged 75.7% suitable habitat (classes 3N, 3G, 4N, 4G) whereas the grid points averaged 61.9% (Table 7, Figure 5). Approximately 32% of CSO core areas was composed of large tree polygons (>24inch dbh, >=40% canopy cover) compared to 19.6% of the grid points (Table 7, Figure 6).

### **Radio-Telemetry – Meadow Valley Project Area**

Eight adult territorial CSOs were radio-tagged during April-June of 2007 within SA-4 in the Meadow Valley Project Area. The sample included 3 males and 5 females. CSOs were fitted with 12g backpack-mounted transmitters from Holohil Systems with projected radio life expectancy of 1.5 years. We attempted to locate each radio-tagged CSO 5 times over each 2-week sample period between April and September 2007. CSOs were tracked from the ground using vehicles and hand-held H-antennas. Approximately 30 locations were recorded for each individual between April and September. The eight birds tagged in 2007 were followed at reduced effort during the 2007-2008 nonbreeding period to determine wintering locations and post-breeding movements. Two mortalities were recorded during the nonbreeding period. One male and one female died of apparent natural causes.

An additional 2 territorial CSOs (one male, one female) were radio-tagged during April-June 2008 within SA-4 in the Meadow Valley Project Area. The six birds tagged in 2007 plus the 2 new birds tagged in 2008 were followed between April-September 2008 using the same sampling protocol and frequency described above for the 2007 breeding period. These data will be used to investigate CSO home ranges sizes and configurations, as well as habitat selection within home ranges relative to available vegetation and fuels treatments. These efforts to assess CSO use of the post-treated landscape in SA-4 (Meadow Valley) are severely hampered by the lack of post-treatment vegetation data (see discussion below under Meadow Valley Project Area Case Study for further details).

The radio-telemetry data will also be used to look at the plot-scale vegetation structure and composition at CSO activity locations determined via telemetry. Eighty-seven

vegetation plots were measured to the standard FIA protocol between August-November 2008 at a sub-sample of CSO activity locations.

### **Meadow Valley Project Area Case Study:**

The Meadow Valley Project Area (MVPA) is the first area within the PLS where the full implementation of HFQLG treatments has occurred. Treatments were implemented on the ground within this project area during 2001-2008, with primarily light-thinning and underburning occurring in 2001-2005, and Defensible Fuel Profile Zones and Group Selections implemented during 2005-2008. The MVPA corresponds closely with the boundaries of SA-4 of the PLS.

We began monitoring CSOs SA-4 in 2003 and have annually monitored the distribution, abundance and reproduction of CSOs within SA-4. Additionally, we have color-banded all individuals within this area, with the exception of one male who could not be captured. Full survey methods are described in detail in our study plan (available from field project leaders) and are consistent with USDA Forest Service R5 survey methods. Briefly, we conduct 3 nocturnal broadcast surveys during the breeding period (April-August) across a network of survey points to detect CSOs. When a CSO is detected we then conduct dusk status surveys to pinpoint roost and nest locations for each bird. Status surveys are used to determine the social status of each bird (pair or single), nesting and reproductive status (breeding, non-breeding, unknown), and to identify color-banded individual birds.

In general, in years of higher CSO reproduction, such as occurred in 2004 and 2007, it is easier to establish pair and reproductive status and to identify individual birds as they are more vocal and exhibit stronger ties to their core areas. In years of lower reproduction, such as occurred in 2005, 2006, and 2008, it is more difficult to determine the status of birds as they tend to range more widely and are not as vocal and territorial, particularly the females. Based on our cumulative survey results, we then use accepted, standardized methods for estimating the overall number of territorial sites (confirmed pairs, unconfirmed pairs and territorial singles) for each year. Confirmed pairs consist of a reproductive pair of CSOs or, at non-reproductive sites, the detection of a male and female on more than one occasion within 1/2-mile of each other across the breeding period. Unconfirmed pairs consist of two sightings of one sex and one detection of the opposite sex within 1/2-mile of each other across the breeding period. Territorial singles are considered to be individuals that are detected on at least 2 occasions within a 1/2-mile distance across the breeding period without a detection of the opposite sex. Birds detected on only a single occasion across the breeding period are not considered to be territorial.

Figure 7 illustrates the proposed treatment locations and the cumulative number and distribution of CSO territorial sites across the six years between 2003-2008. The number of territorial sites across SA-4 varied annually between 6-9 (Table 8, Fig. 8). Overall, the

numbers of territorial sites was fairly similar with 7 sites documented between 2004-2006, an increase to 9 territorial sites during the high reproductive year that occurred in 2007, and then decreasing to 6 territorial sites in 2008.

Of note, one of the territorial sites occupied from 2004-2007 was not occupied in 2008, thus reducing the number of territorial sites to 6 as compared to the base of 7 documented between 2004-2006. The territory in question was located at Maple Flat in the extreme Northwest corner of SA-4. This site was located at high elevation (approx. 1700m, 5600 ft.) relative to the other sites in the SA. Treatments occurred in this site during Fall 2007. Both the male and female from this pair were out-fitted with radio-transmitters in Spring 2007. Both birds remained on their territory through the 2007 breeding period. In November 2007 the male traveled approximately 29 km (18 mi.) to Coyote Gap, dropping to about 1400m (4600 ft) elevation. He remained in this area through February 2008, when he was found dead. He had been scavenged and a cause of death could not be determined. The female left the Maple Flat site in September 2007, moved north to near Seneca where she remained until early November. She then was detected in Maple Flat on 7 November 2007, after which she then migrated down west slope of the Sierra Nevada, ultimately settling for the winter near Lake Oroville at approximately 480m (1600 ft.) elevation. This winter location was a straight-line distance of 56 km (35 miles) from the Maple Flat breeding site. The female remained at this winter location through early-March 2008. She moved back upslope and was detected within 3.2 km (2 miles) of the Maple Flat breeding site in mid-March 2008. She then began to wander and moved 24 km (15 miles) north to Wolf Creek near Greenville, eventually settling 14.5 km (9 miles) from Maple Flat near Seneca in early June 2008. She remained in this area through October 2008 when she was recaptured and the radio-transmitter was removed. No new CSOs were detected or colonized the Maple Flat site in 2008.

Whether the treatments may have caused the Maple Flat site to be unoccupied in 2008 can not be determined with certainty. CSOs are known to exhibit breeding dispersal from a territory following the death of a mate. The radio-tagged female returned to the Maple Flat area in Spring 2008, apparently may not have found a male present and then dispersed until eventually settling 14.5 km away in SA-2 for the summer. Whether or not the Maple Flat site, or an alternate site in the near vicinity, will be re-colonized will require additional years of monitoring. Of importance, 2008 was the lowest reproductive year recorded on the Plumas NF, with only 2 nests documented across all of the Plumas NF sites. Thus, the conditions leading to the low reproductive activity in 2008 may have resulted in a low probability of recruitment for a new male colonizing the site in 2008. For example, a higher number of territorial sites (9) were documented within SA-4 in the higher breeding year of 2007 as compared to the 7 territorial sites documented in the low reproductive years of 2005-2006. Also, higher CSO reproduction in 2007 may result in increased number of recruits available to colonize sites in 2009-2010.

To date, we have not observed apparent nor dramatic changes in the numbers of territorial CSO sites within SA-4 as an immediate acute response to treatments. These initial findings should be tempered by the need to assess possible chronic, or longer-term, responses by CSOs. Specifically, we recommend that monitoring be continued to assess:

(1) long-term occupancy, abundance and distribution of CSOs across the project area to document longer-term responses to address concerns that site fidelity in such a long-lived species may obscure possible negative effects of habitat change over the short term; and (2) to continue to monitor color-banded birds to assess longer-term associations between CSO survival, reproduction, and recruitment related to changes in habitat. Each of the pieces of above information is necessary to fully assess the potential acute and chronic responses of CSOs to landscape treatments.

One significant impediment to fully assessing the associations between CSO response and treatments in the MVPA is the lack of accurate spatial mapping of: (1) the specific locations where treatments were actually implemented on the ground; (2) the specific site-specific treatments that were implemented on a piece of ground; (3) when the treatments were implemented on the ground (which year at minimum); and (4) the resulting post-treatment vegetation structure and composition. Understanding the what, where, when, and effects of treatments is the foundation on which subsequent adaptive management assessments will be constructed. Generalized project-planning polygon mapping showing where treatments may occur, and what specific treatments might be implemented, are not specific and accurate enough for post-treatment adaptive management assessment of treatment effects on CSOs and their habitat.

Accurate post-treatment vegetation maps are needed at resolutions appropriate for differing management and research objectives. In the case of the CSO, we have not observed dramatic short-term changes in CSO numbers across the broader MVPA in response to treatments. However, we have documented some changes in the distribution and occupancy of CSO territories where treatments have occurred within SA-4 that may be related to treatments. We require accurate post-treatment vegetation information if we are to fully explore the response of CSOs and their habitat to treatment effects within an adaptive management framework. This is a critical information issue that requires immediate attention.

### **Moonlight and Antelope Complex Fire Area Case Study**

A primary source of uncertainty regarding the effects of fuels treatments is an assessment of risk to CSOs and their habitat from treatments versus the risk from wildfire that occurs across untreated landscapes. Our PLS work to date has focused on assessing CSO distribution, abundance and habitat associations across the untreated overall project area landscape and being in position to monitor effects as treatments are implemented within specific project areas, as illustrated by the MVPA case study described above. In 2008 we were fortunate to have the opportunity and funding support from the Plumas National Forest to inventory CSO distribution, abundance, and status across the Moonlight and Antelope Complex Fire Area (MACFA) that burned in 2007. These two fires burned adjacent to each other in 2007 and both were primarily high severity fires. The MACFA covers approximately 88,000 acres. We conducted CSO surveys across this entire landscape and within a 1.6 km (1 mile) unburned buffer surrounding the MACFA during the 2008 breeding period. We used our standardized survey protocol and conducted 3



nocturnal surveys across the landscape with follow-up visits to attempt to located nest/roost locations for birds detected on nocturnal surveys. These methods are described in the section above and fully in protocol described in the study plan. We also contracted to obtain pre- and post-fire vegetation maps to be able to assess changes to the vegetation and CSO habitat.

The high-severity fires that burned in the MACFA resulted in significant changes to the vegetation (Figures 9,10,11). The amount of suitable CSO habitat (CWHR classes 4M, 4D, 5M, 5D) within the 88,000 acre MACFA decreased from 70.1% of the landscape to 5.8% of the landscape following the fires. The largest increase in the post-fire landscape occurred in the CWHR classes  $\leq$  2D which increased from 8.2% to 64.9%. The remaining forested areas across the post-fire landscape were predominantly classified as either 4P (18.5%) or 4S (7.9%) (Fig 9 & 10).

We are still in the process of synthesizing all of the pre-fire CSO survey information for the MACFA as there is not a solid baseline of consistently collected survey information prior to the fire such as exists for our core PLS project area. Nevertheless, this synthesis may provide us with a reasonable estimate of the pre-fire distribution and abundance of CSO sites across the MACFA. All or parts of at least 23 PACs were located within the pre-fire MACFA. Given the lack of continuous annual CSO survey effort we are uncertain what proportion of those PACs were occupied in 2007 prior to the fires.

During our 2008 surveys we documented a single confirmed pair of CSOs (non-breeding) within the MACFA, with the female from this pair being the only female we detected within the fire area (Fig 11). We had 10 single detections of male CSOs across the burned area. In each of these ten cases we were not able to locate the birds at nests or roosts on follow-up status surveys. Each of these ten locations occurred primarily in the middle of the night when birds are out foraging and none of the detections occurred within 1/2-mile of each other as required to classify these individuals as territorial birds under currently accepted protocols. Within the unburned 1-mile buffer area surrounding the burned area we documented 5 confirmed pairs, 1 unconfirmed pair, 1 territorial male single, and 6 single detections (4 males, 2 sex unknown). Thus, in the immediate unburned buffer area we observed territorial sites whereas we only were able to document the single confirmed territorial pair within the burned area.

In this first year of survey work in the MACFA we were able to document significant changes to the vegetation and amounts and distribution of CSO habitat as a result of the high-severity wildfires. Our initial year of CSO survey work suggests that the immediate post-fire landscape may not support territorial CSO sites as evidenced by the single confirmed pair of owls that we documented in 2008. The lack of additional confirmed pairs, lack of female detections, timing of male detections, and our inability to pin down nest/roost locations for any of the males detected within the burned area supports this hypothesis. Alternatively, perhaps CSOs within the burned area were behaving differently and were not as responsive to surveys in the burned landscape as compared to unburned buffer and broader PLS project area. Additionally, 2008 was a very low reproductive year on the Plumas and perhaps female CSOs were less vocal and less likely

to be detected within the fire area as compared to the buffer and PLS project area. However, both of these explanations do not seem probable as we do not suspect that there would be significant differences in response rates between CSOs in the burned area compared to the buffer area. Our 2009 surveys will shed light on these issues as we will be able to re-survey the burned and unburned areas to document if CSOs are able to persist on territories within the MACFA.

It is important to determine both the acute and chronic responses of CSOs and their habitat to wildfire as it is unknown if CSOs can persist over both the short-term and long-term in these areas. Whether a landscape that has experienced wildfire can support CSOs likely depends on the pre-fire habitat suitability and variable fire severity patterns both within individual fires and across different fires. Largely low-mid severity fires may have positive or neutral effects on CSOs and their habitat while high severity fires may result in greater negative effects.

### **Banding, Blood Sampling, West Nile Virus Monitoring**

Forty-seven owls were captured and banded in 2008. Blood samples were collected from 21 individuals that will be screened at the University of California, Davis for West Nile Virus (WNV) antibodies. None of the 158 individual blood samples collected from 2004-2007 have tested positive for WNV antibodies. The 2008 samples have not been analyzed to date.

### **Barred and Spurred (Spotted x Barred hybrid) Distributional Records**

We detected the presence of 3 barred owl and 4 spurred owls during 2008 surveys within our intensive study area. Our synthesis and update of barred-spurred owl records through 2008 based on Forest Service and California Department of Fish and Game databases indicates that there are a minimum of 38 individual records across the HFQLG Project Area and a minimum total of 51 across the Sierra Nevada (Figure 7). This includes a minimum total of 18 records that have been documented within our intensively surveyed study area. The first barred owl in the region was reported in 1989. The first documented breeding in the PLS survey area was in 2007, and repeated again in 2008. The pattern of records suggests that barred/spurred owls have been increasing in the northern Sierra Nevada between 1989-2008.

### **California Spotted Owl Diet**

A single diet survey plot was established at a CSO nest or roost location at each CSO territory on the Plumas National Forest during 2003-2007. Systematic searches for pellets and prey remains were conducted in each plot during each year. A total of approximately 3398 pellets have been collected during 2003-2007 (2003 = 606; 2004 = 807; 2005 = 838; 2006 = 516; 2007 = 552). To date 2846 pellets, covering the period

2003-2006, have been sorted and all prey items identified to species, or taxonomic group when species identification could not be ascertained. Scientific names of all species recorded in pellets are listed in Appendix A. Mammals comprised the dominant taxonomic group identified in the diet. Across years the four most frequently detected species or taxa were the dusky-footed woodrat (recorded in 45% of pellets), northern flying squirrel (recorded in 35% of pellets), *Peromyscus* species (recorded in 31% of pellets) and other small mammals (recorded in 31% of pellets) (Fig. 13a, Table 9). In terms of biomass contributions across years, dusky-footed woodrats contributed 45% of the estimated biomass, followed by northern flying squirrels (20%) (Fig 13b, Table 10). There appears to be some level of annual variation in diet (Figures 14a&b, Tables 9 & 10). For example the annual estimate of biomass contribution from woodrats was estimated to range from 38-54% in any single year. The 552 pellets collected in 2007 have been sorted and identification of all prey species is near completion. Our objective was to sample over several years to assess temporal variation in diets and possible relationships to variation in CSO reproduction, and to sample widely over space in order to investigate potential variation in CSO diets associated with elevation and vegetation conditions. Once the 2007 samples are fully complete we will have enough information to meet these objectives.

## **Summary 2003-2008**

---

Our efforts from 2003-2007 have focused on collecting the initial data to address our primary research objectives and provide the baseline data for monitoring HFQLG implementation. In conjunction with the now fully integrated Lassen Demographic Study we have collected landscape-scale information on the distribution and abundance of CSOs across approximately 650,000 acres of land. Determining the accurate number and distribution of CSO sites requires multiple years of survey and marking of individual CSOs to delineate separate territories and identify individual birds that move among multiple sites within and across years. These baseline data are fundamental for developing empirically based habitat models for understanding CSO habitat associations and developing adaptive management tools and models. The near completion of the Meadow Valley area projects in 2007-2008 marked the first landscape series of HFQLG treatments to be implemented within the study area, providing the first opportunity to address treatment effects within a case study framework. Our baseline information on CSO distribution and habitat associations, coupled with our 2007-2008 radio-telemetry work, will allow us to assess associations between CSOs and vegetation changes. In 2008 we were now able to begin monitoring CSO distribution and abundance in the Meadow valley project area, providing the first empirical data from a treated landscape. Additionally we were able to expand our work to address the effects of wildfire and CSOs and their habitat through our initial survey work in the Moonlight-Antelope Complex fire area. In summary, we are working towards being able to broadly address CSO management questions across a gradient of landscape conditions ranging across untreated landscapes, landscapes treated to meet desired fuels/vegetation conditions, and

landscapes that have experienced wildfire in order to address primary management issues.

Dedicated monitoring of CSOs on the Lassen Demographic study continues to provide critically valuable demographic and population trend information for determining the status of CSOs. The declining population trend estimated through the meta-analysis of the Lassen Demographic Study data and the apparent decline in numbers of CSOs observed between 2005-2007 within the Lassen NF survey areas warrant close continued monitoring of the status of CSOs within the study area, along with continued management focus on providing high-quality CSO habitat during the planning and implementation of HFQLG treatments. We lack similar long-term demographic data for the Plumas NF study areas, but our baseline information on CSO distribution and abundance suggests that numbers of territorial CSOs and sites have been similar across 2004-2008.

Our focused diet analyses have broadened and deepened our understanding of CSO diets and sources of variation in CSO diets among pairs and across environmental gradients. Monitoring of WNV exposure coupled with demographic monitoring has provided an opportunity to assess if WNV may ultimately be a factor influencing CSO viability. To date we have not had a positive detection for WNV within CSOs. Finally, through our research into historical and current occurrence records, in conjunction with our field surveys, we have been able to document the colonization of the northern Sierra Nevada by barred owls. Our results indicate that barred owls are increasing in the northern Sierra Nevada and may become an increasing risk factor to CSOs.

### **Current Research: 2009**

---

In 2009 we will continue monitoring owl distribution, abundance, demography, and population trend across the core PLS study area. We will also conduct our second year of CSO surveys to document distribution, abundance and habitat associations within the Moonlight and Antelope Complex fire area. We will augment our existing work with two additions. First, we will conduct CSO surveys in Empire (Plumas NF) and Scotts John Creek (Lassen NF) proposed project areas. This new work, coupled with our ongoing work in the Meadow Valley (Plumas NF) and Creeks (Lassen NF) will provide the baseline data for four of the first project areas that are scheduled for implementation and position us to assess effects to CSOs and their habitat as these first projects are implemented on the ground. Together this work will provide a more comprehensive base of knowledge regarding CSO habitat associations and the effects of treatments and wildfires.

In addition to continuing field surveys in 2009 designed to address our six research questions, we have broadened our emphasis on the development of predictive habitat relationship models as described in the module study plan. We have continued to work closely with biologists on the Plumas and Lassen National Forests, and the R5 Regional

Office, to identify and define the types of analyses and tools that would best address management needs. Baseline information collected during this study forms the foundation for this phase of the research. The combination of broad-scale landscape CSO distribution data, in conjunction with detailed demographic information available from the Lassen Demographic Study, will facilitate exploration and development of predictive habitat models for use in an adaptive management framework and to directly monitor implementation of the HFQLG project.

### **Literature Cited**

---

Blakesley, J.A., M.E. Seamans, M.M. Connor, A.B. Franklin, G.C. White, R.J. Gutierrez, J.E. Hines, J.D. Nichols, T.E. Munton, D.W.H. Shaw, J.J. Keane, G.N. Steger, B.R. Noon, T.L. McDonald, S. Britting. 2006. Demography of the California Spotted Owl in the Sierra Nevada: Report to the US Fish and Wildlife Service on the January 2006 Meta-Analysis. February 2006.

Table 1. California spotted owl reproduction on the Plumas and Lassen National Forests 2004-2008.

| <b>Year</b> | <b>Percent of confirmed/unconfirmed pairs with successful nests</b> | <b>Young fledged per successful nest</b> |
|-------------|---|--|
| 2004        | 49.4%   | 1.68                                     |
| 2005        | 17.7%   | 1.47                                     |
| 2006        | 13.8%   | 1.50                                     |
| 2007        | 55.4%   | 1.81                                     |
| 2008        | 16.4%   | 1.70                                     |

Table 2. Crude density of territorial California spotted owls across survey areas on the Plumas and Lassen National Forests 2004-2008. Locations of survey areas are identified in Figure 1.

| Survey Area      | Size (km <sup>2</sup> ) | Crude Density of Territorial Owls (#/km <sup>2</sup> ) |       |        |        |            |
|------------------|-------------------------|--|-------|--------|--------|------------|
|                  |                         | 2004*  | 2005* | 2006*  | 2007*  | 2008*      |
| SA-2             | 182.4                   | 0.126  | 0.143 | 0.115  | 0.115  | 0.132      |
| SA-3             | 214.4                   | 0.075  | 0.093 | 0.089  | 0.103  | 0.098      |
| SA-4             | 238.2                   | 0.059  | 0.050 | 0.046  | 0.071  | 0.046      |
| SA-5             | 260.2                   | 0.069  | 0.069 | NS**** | NS**** | NS****     |
| SA-7             | 210.3                   | 0.071  | 0.062 | NS     | NS     | NS         |
| SA-1A            | 190.4                   | NI***  | 0.042 | 0.042  | 0.053  | 0.042      |
| SA-1B**          | 130.3                   | NI   | 0.023 | NS     | NS     | NS         |
| SA-11            | 179.4                   | NI   | 0.045 | 0.033  | 0.033  | 0.045      |
| SA-12            | 215.8                   | NI   | 0.097 | 0.070  | 0.074  | 0.070      |
| SA-13            | 152.9                   | NI   | 0.105 | 0.085  | 0.065  | 0.050***** |
| SA-14            | 318.7                   | NI   | 0.053 | 0.044  | 0.035  | 0.047      |
| SA-15            | 196.8                   | NI   | 0.086 | 0.036  | 0.056  | 0.081      |
| Total Study Area | 2489.8                  | 0.078  | 0.073 | 0.060  | 0.066  | 0.067      |

\*Total Area surveyed each year: 2004 = 1,106 km<sup>2</sup>; 2005 = 2,490 km<sup>2</sup>; 2006 = 1,889 km<sup>2</sup>; 2007 = 1,889 km<sup>2</sup>; 2008 = 1,877 km<sup>2</sup>

\*\*NI = not included. Project level area surveyed only in 2005. Included for comparative purposes.

\*\*\*Lassen Demographic Study Area – incorporated into the overall study in 2005.

\*\*\*\*Survey areas not surveyed in 2006-2008.

\*\*\*\*\*This survey area was not completely surveyed during 2008 because of wildfire activity in the area. Two CSO territories within the study area could not be surveyed.

Table 3. Number of pairs (confirmed and unconfirmed) and territorial single California spotted owls across the Plumas-Lassen Study survey areas on the Plumas and Lassen National Forests, California, 2004-2008.

| Survey Area | 2004  |     | 2005  |     | 2006  |     | 2007  |     | 2008  |     |
|-------------|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
|             | Pairs | TS* | Pairs | TS* | Pairs | TS* | Pairs | TS* | Pairs | TS* |
| SA-2        | 11    | 1   | 12    | 2   | 10    | 1   | 10    | 1   | 12    | 0   |
| SA-3        | 7     | 2   | 10    | 0   | 9     | 1   | 11    | 0   | 9     | 3   |
| SA-4        | 7     | 0   | 5     | 2   | 4     | 3   | 8     | 1   | 5     | 1   |
| SA-5        | 8     | 2   | 9     | 0   | NS**  | --  | NS**  | --  | NS**  | --  |
| SA-7        | 7     | 1   | 6     | 1   | NS    | --  | NS    | --  | NS    | --  |
| SA-1A       | NI*** | --  | 4     | 0   | 4     | 0   | 5     | 0   | 4     | 0   |
| SA-1B**     | NI    | --  | 3     | 0   | NS    | --  | NS    | --  | NS    | --  |
| SA-11       | NI    | --  | 4     | 0   | 3     | 0   | 3     | 0   | 3     | 2   |
| SA-12       | NI    | --  | 10    | 1   | 1     | 7   | 8     | 0   | 7     | 1   |
| SA-13       | NI    | --  | 8     | 0   | 6     | 1   | 5     | 0   | 3**** | 1   |
| SA-14       | NI    | --  | 8     | 1   | 7     | 0   | 5     | 1   | 7     | 1   |
| SA-15       | NI    | --  | 8     | 1   | 3     | 1   | 4     | 3   | 8     | 0   |

\*TS = Territorial Single.

\*\*NI = not included. Project level area surveyed only in 2005. Included for comparative purposes.

\*\*\*Lassen Demographic Study Area – incorporated into the overall study in 2005.

\*\*\*\*Survey areas not surveyed in 2006-2008.

\*\*\*\*\* This survey area was not completely surveyed during 2008 because of wildfire activity in the area. Two CSO territories within the study area could not be surveyed.



Table 4. Mean estimated population lambda (population change) for California spotted owls on four study areas in the southern cascades and Sierra Nevada, 1990-2005 (Blakesley et al. 2006)

| <b>Study Area</b>                 | <b>Lambda</b> | <b>Standard Error</b> | <b>95% Confidence Interval</b> |
|-----------------------------------|---------------|-----------------------|--------------------------------|
| Lassen National Forest            | 0.973         | 0.014                 | 0.946-1.001                    |
| Sierra National Forest            | 0.992         | 0.013                 | 0.966-1.018                    |
| Sequoia-King Canyon National Park | 1.006         | 0.031                 | 0.947-1.068                    |
| Eldorado National Forest          | 1.007         | 0.029                 | 0.952-1.066                    |

Table 5. Distribution of California spotted owl nest/primary roost sites (n = 103) across CWHR tree size classes within the Plumas-Lassen Study on the Plumas and Lassen National Forests, 2004-2006.

| <b>CWHR Size Class*</b> | <b>CWHR Size Class Description</b>              | <b>Number of Nests</b> | <b>Percent</b> |
|-------------------------|---|------------------------|----------------|
| Barren                  | Open, sparse tree coverage                      | 1                      | 1.0            |
| 3S                      | 6-12 inch dbh, 20% CC                           | 1                      | 1.0            |
| 3M-LT                   | 6-12 inch dbh, 40-60% CC, large trees recorded  | 1                      | 1.0            |
| 3D                      | 6-12 inch dbh, >60% CC                          | 4                      | 3.9            |
| 4P                      | 12-24 inch dbh, 20-40% CC                       | 3                      | 2.9            |
| 4M                      | 12-24 inch dbh, 40-60% CC                       | 3                      | 2.9            |
| 4M-LT                   | 12-24 inch dbh, 40-60% CC, large trees recorded | 12                     | 11.7           |
| 4D                      | 12-24 inch dbh, >60% CC                         | 10                     | 9.7            |
| 4D-LT                   | 12-24 inch dbh, >60% CC, large trees recorded   | 13                     | 12.6           |
| 5M                      | >24 inch dbh, 40-60% CC                         | 25                     | 24.3           |
| 5D                      | >24 inch dbh, >60% CC                           | 9                      | 8.7            |
| 6                       | >24 inch dbh, >60% CC, multi-layer canopy       | 21                     | 20.1           |

\*defined by average tree size (dbh = diameter at breast-height) and average percent canopy cover (CC).

Table 6. Nest-site (1 ha (2.47 acres)) habitat characteristics collected using the Forest Inventory and Analysis sampling protocol at California spotted owl nest sites (n = 80) on the Plumas and Lassen National Forests, California, 2005-2006.

| <b>Variable</b>   | <b>Mean</b> | <b>SE</b> |
|---|-------------|-----------|
| Total Basal Area (ft <sup>2</sup> /acre)                | 260.8       | 6.47      |
| # Trees >= 30 inch dbh (#/acre)                         | 10.7        | 0.58      |
| Basal Area Trees >= 30 inch dbh (ft <sup>2</sup> /acre) | 96.0        | 5.70      |
| # Trees >= 24 inch dbh (#/acre)                         | 19.9        | 0.90      |
| Basal Area Trees >= 24 inch dbh (ft <sup>2</sup> /acre) | 131.7       | 6.29      |
| # Trees <12 inch dbh (#/acre)                           | 383.5       | 26.36     |
| Basal Area Trees , <12 inch dbh (ft <sup>2</sup> /acre) | 50.1        | 2.71      |
| # Snags >=15 inch dbh (#/acre)                          | 7.4         | 0.80      |
| Mean Duff Depth (inches)                                | 3.0         | 0.16      |
| Duff (tons/acre)  | 67.4        | 3.64      |
| Mean Litter Depth (inches)                              | 2.3         | 0.18      |
| Litter (tons/acre)                                      | 23.7        | 1.81      |
| 1 Hour Fuels (tons/acre)                                | 0.75        | 0.03      |
| 10 Hour Fuels (tons/acre)                               | 4.0         | 0.21      |
| 100 Hour Fuels (tons/acre)                              | 4.4         | 0.28      |
| Shrub Cover (%)   | 7.7         | 1.16      |
| Canopy Cover (%)*                                       | 64.1        | 1.24      |

\* estimated through Forest Vegetation Simulator modeling of plot-based tree lists.

Table 7. Distribution of USDA Region 5 vegetation classes (Mean (SE)) within 500 acre (201 ha) circles centered on California spotted owl (CSO) territories (n = 102) and systematic grid (Grid) points (n = 130) within the Plumas-Lassen Study on the Plumas and Lassen National Forests, 2004-2006.

| <b>R5 Size Class*</b>  | <b>R5 Size Class Description</b>                      | <b>CSO</b>  | <b>Grid</b> |
|------------------------|---|-------------|-------------|
| Non-forest             | Sum of non-forest land types                          | 4.4 (1.0)   | 8.4 (1.2)   |
| Total Size 1           | Sum of 1G,1N, 1P, 1S: <6 inch dbh, all %CC classes    | 1.7 (0.3)   | 1.6 (0.3)   |
| 2P & 2S                | 6-12 inch dbh, 10-39% CC                              | 3.4 (0.4)   | 4.1 (0.5)   |
| 2N                     | 6-12 inch dbh, 40-69% CC                              | 3.8 (0.6)   | 4.4 (0.9)   |
| 2G                     | 6-12-24 inch dbh, >=70% CC                            | 1.6 (0.5)   | 0.5 (0.1)   |
| 3P&3S                  | 12-24 inch dbh, >10-39% CC                            | 9.2 (0.8)   | 16.1 (1.3)  |
| 3N                     | 12-24 inch dbh, 40-69% CC                             | 37.2 (2.4)  | 38.5 (1.8)  |
| 3G                     | 12-24 inch dbh, >=70% CC                              | 6.2 (1.0)   | 3.8 (0.7)   |
| 4P&4S                  | >24 inch dbh, >10-39% CC                              | 1.0 (0.3)   | 2.1 (0.4)   |
| 4N                     | >24 inch dbh, 40-69% CC                               | 25.8 (2.0)  | 17.3 (1.6)  |
| 4G                     | >24 inch dbh, >=70% CC                                | 6.5 (0.1)   | 2.4 (0.8)   |
| Total 4N & 4G          | Sum of 4N & 4G: >24 inch dbh, >=40% CC                | 32.4 (2.3)  | 19.6 (1.8)  |
| Total Suitable habitat | Sum of classes 3N, 3G, 4N, 4G = >12 inch dbh, >40% CC | 75.7 (2.19) | 61.9 (1.75) |

\*defined by average tree size (dbh = diameter at breast-height) and average percent canopy cover (CC).

Table 8. Annual number of California spotted owls documented during the breeding period (April-August) in SA-4 (Meadow Valley Project Area) between 2004-2008 on the Plumas National Forest, California..

| Year | Confirmed Pairs | Unconfirmed Pairs | Territorial Singles | Total Territorial Sites |
|------|-----------------|-------------------|---------------------|-------------------------|
| 2003 | 7               | 0                 | 1                   | 8                       |
| 2004 | 7               | 0                 | 0                   | 7                       |
| 2005 | 4               | 1                 | 2                   | 7                       |
| 2006 | 3               | 1                 | 3                   | 7                       |
| 2007 | 8               | 0                 | 1                   | 9                       |
| 2008 | 5               | 0                 | 1                   | 6                       |

Table 9. Frequency of occurrence of species or taxonomic groups in California spotted owl pellets collected on the Plumas National Forest, California, 2003-2006.

|                                 | <b>2003</b><br>(n=607) | <b>2004</b><br>(n=813) | <b>2005</b><br>(n=886) | <b>2006</b><br>(n=540) | <b>All Years</b><br>(n=2846) |
|---------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------------|
| <b>Dusky Footed Woodrat</b>     | 0.4745                 | 0.3924                 | 0.4537                 | 0.5259                 | 0.4547                       |
| <b>Northern Flying Squirrel</b> | 0.4135                 | 0.3653                 | 0.3115                 | 0.3037                 | 0.3472                       |
| <i>Peromyscus ssp.</i>          | 0.2669                 | 0.3370                 | 0.3251                 | 0.2685                 | 0.3053                       |
| <b>Other small Mammals</b>      | 0.2306                 | 0.3407                 | 0.3002                 | 0.3556                 | 0.3074                       |
| <b>Other Large Mammals</b>      | 0.0626                 | 0.1095                 | 0.0542                 | 0.0370                 | 0.0685                       |
| <b>Birds</b>                    | 0.0923                 | 0.1230                 | 0.1479                 | 0.1093                 | 0.1216                       |
| <b>Insects</b>                  | 0.1351                 | 0.1796                 | 0.2077                 | 0.1167                 | 0.1669                       |

Table 10. Percent biomass contribution of species or taxonomic groups in California spotted owl diets based on pellet analysis on the Plumas National Forest, California, 2003-2006.

|                                 | <b>2003</b><br>(n=607) | <b>2004</b><br>(n=813) | <b>2005</b><br>(n=886) | <b>2006</b><br>(n=540) | <b>All Years</b><br>(n=2846) |
|---------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------------|
| <b>Dusky Footed Woodrat</b>     | 48.03                  | 37.87                  | 42.33                  | 53.51                  | 44.75                        |
| <b>Northern Flying Squirrel</b> | 24.10                  | 21.12                  | 17.79                  | 14.34                  | 19.53                        |
| <i>Peromyscus ssp.</i>          | 5.15                   | 7.47                   | 6.19                   | 4.27                   | 6.01                         |
| <b>Other small Mammals</b>      | 6.55                   | 11.32                  | 11.64                  | 11.43                  | 9.85                         |
| <b>Other Large Mammals</b>      | 7.54                   | 11.31                  | 11.11                  | 5.36                   | 7.83                         |
| <b>Birds</b>                    | 7.87                   | 10.02                  | 15.41                  | 8.87                   | 11.07                        |
| <b>Insects</b>                  | 0.75                   | 0.89                   | 1.29                   | 1.02                   | 0.96                         |

Figure 1. (A) Location of CSO Survey Areas surveyed in 2004-2008. (B) Example of original survey plot consisting of multiple Cal-Planning watersheds. (C) Example of Primary Sampling Units for surveying for CSOs. See text and study plan for further details .

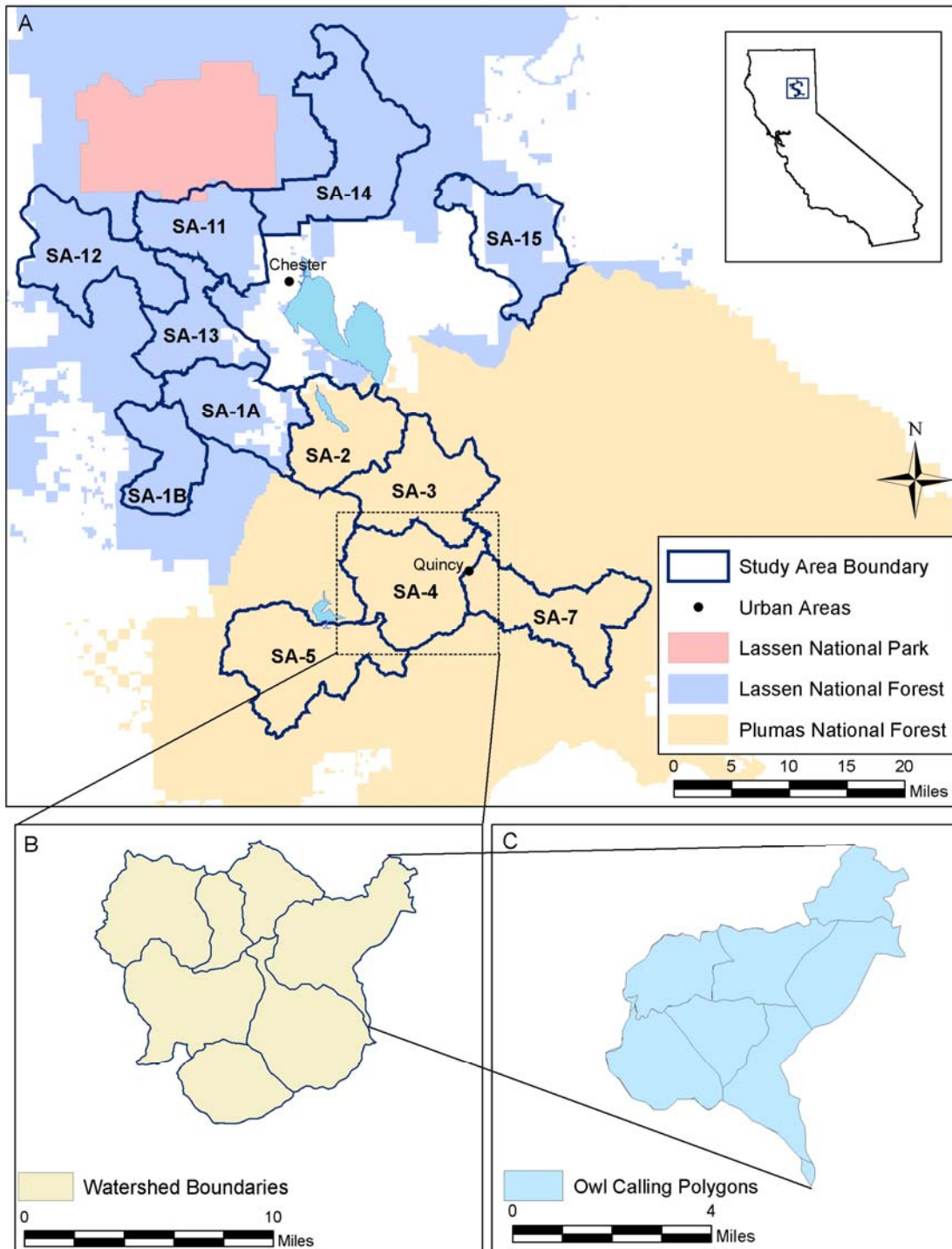


Figure 2. Distribution of California spotted owl territories within CSO survey plots across the Plumas and Lassen National Forests, 2008.

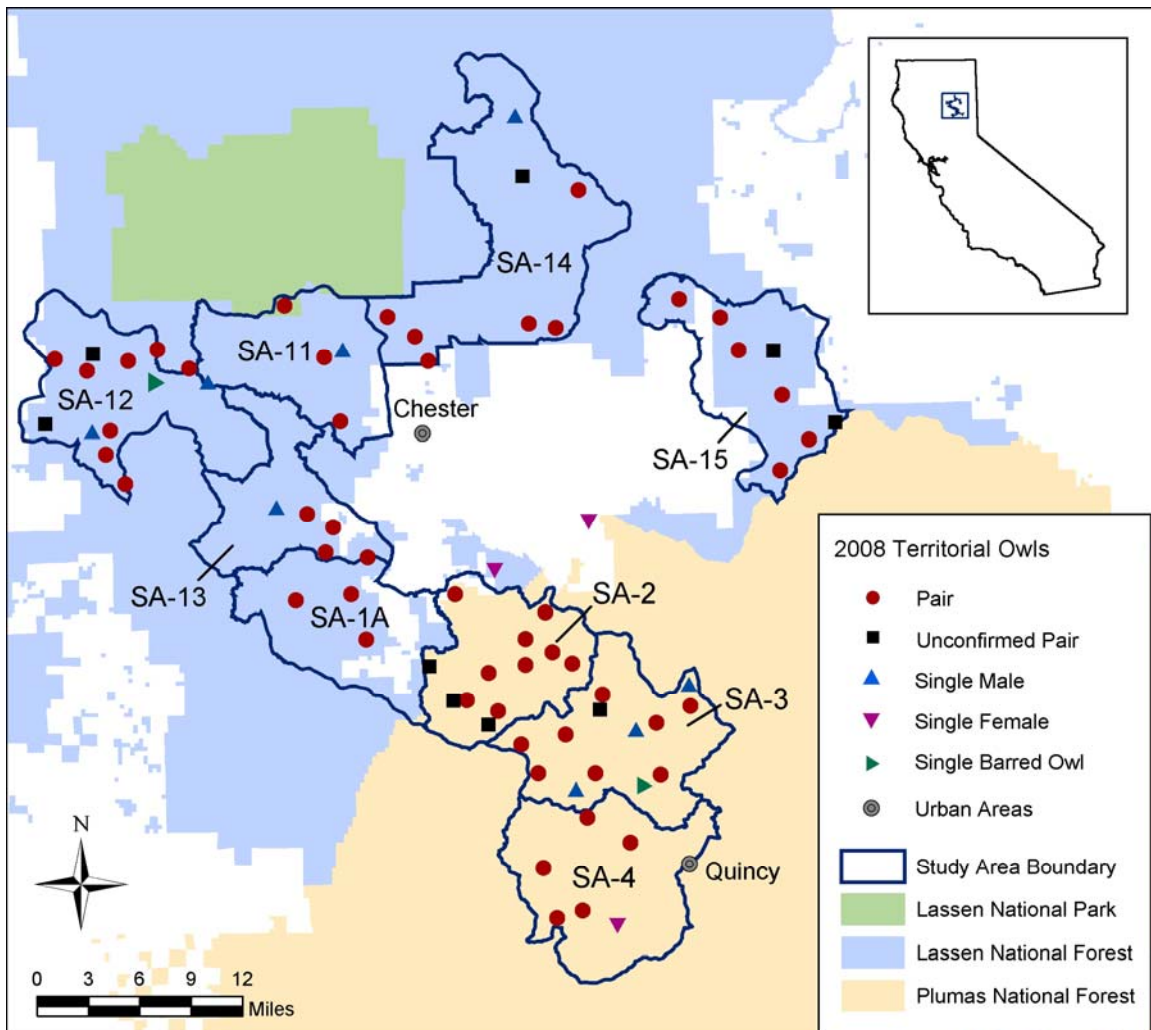




Figure 3. Monthly precipitation totals for Quincy, California, during January-May, 2004-2008 (data from Western Regional Climate Center).

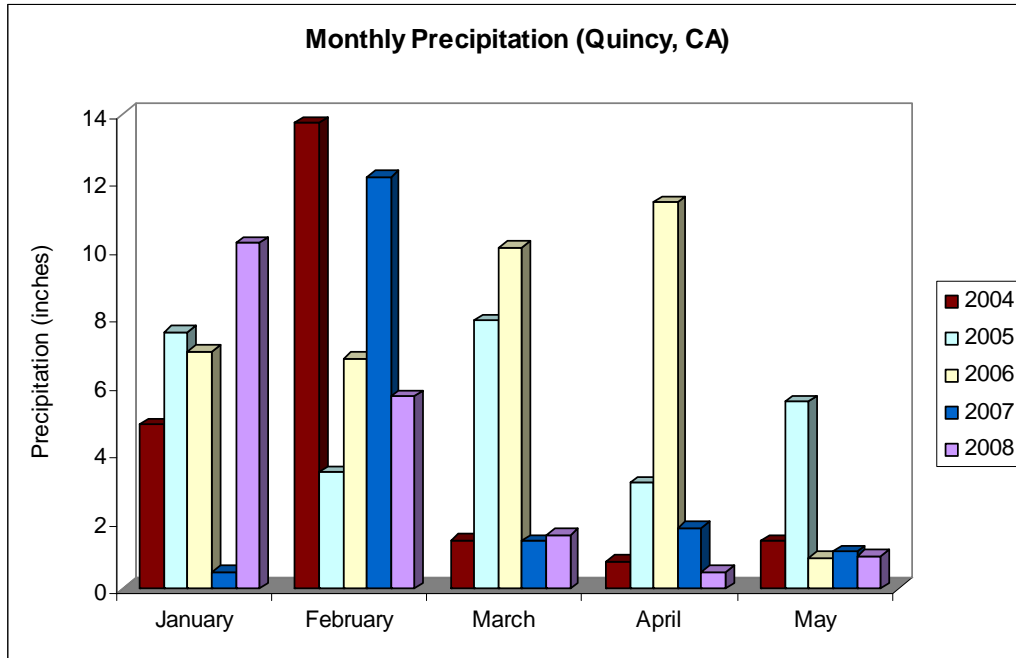


Figure 4. Distribution of California spotted owl (n = 103) nest sites by California Wildlife Habitat Relationship (CWHR) database vegetation classes on the Plumas and Lassen national Forests, California, 2004-2007. Descriptions of the CWHR classes are provided in Table 5 within the text of this document.

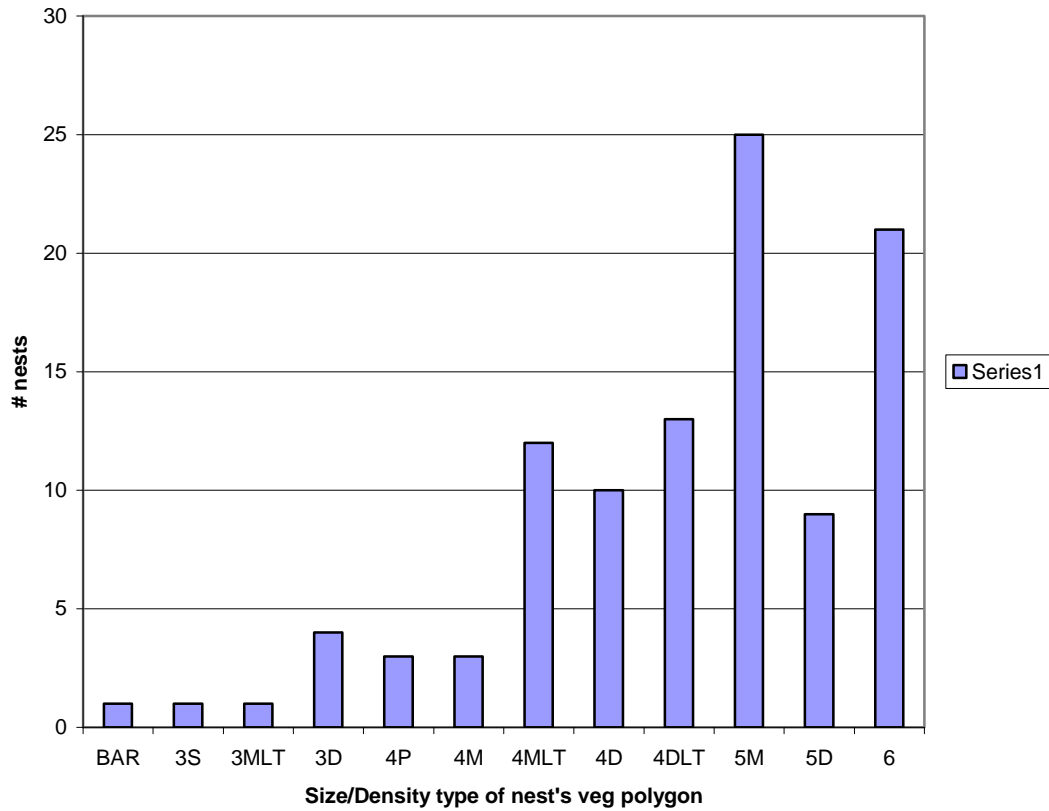


Figure 5. Percent suitable habitat ( $\geq 12$  inch dbh trees with  $\geq 40\%$  canopy cover) within 500 acre (201 ha) circles centered on California spotted owl (CSO,  $n = 102$ ) and systematic grid points (Grid,  $n = 130$ ) on the Plumas and Lassen National Forests, California, 2004-2007.

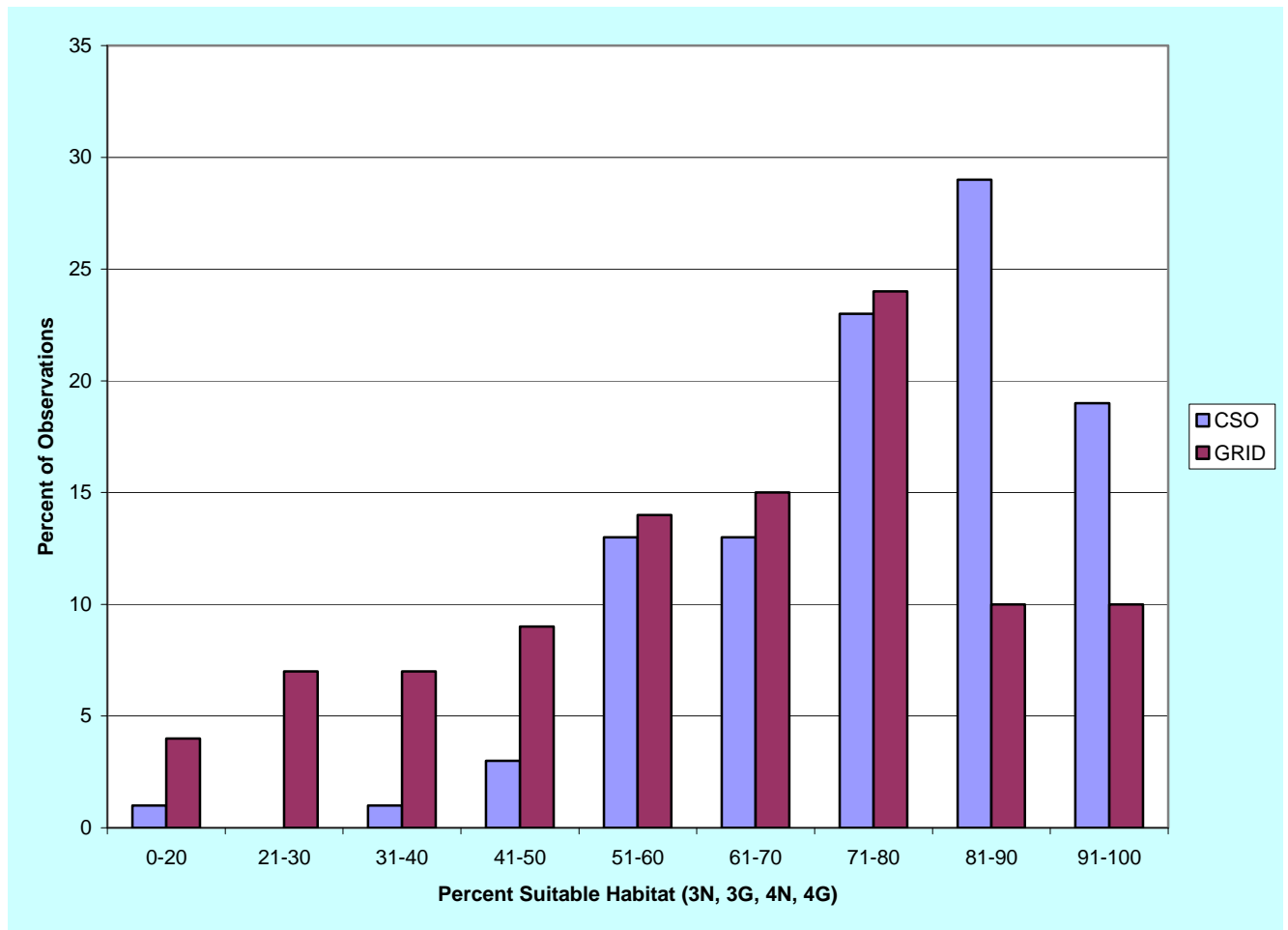


Figure 6. Percent large tree habitat (R5 classes 4N & 4G:  $\geq 24$  inch dbh trees with  $\geq 40\%$  canopy cover) within 500 acre (201 ha) circles centered on California spotted owl (CSO, n = 102) and systematic grid points (Grid, n = 130) on the Plumas and Lassen National Forests, California, 2004-2007. Descriptions of R5 classes are provided in Table 7 within the text of this document.

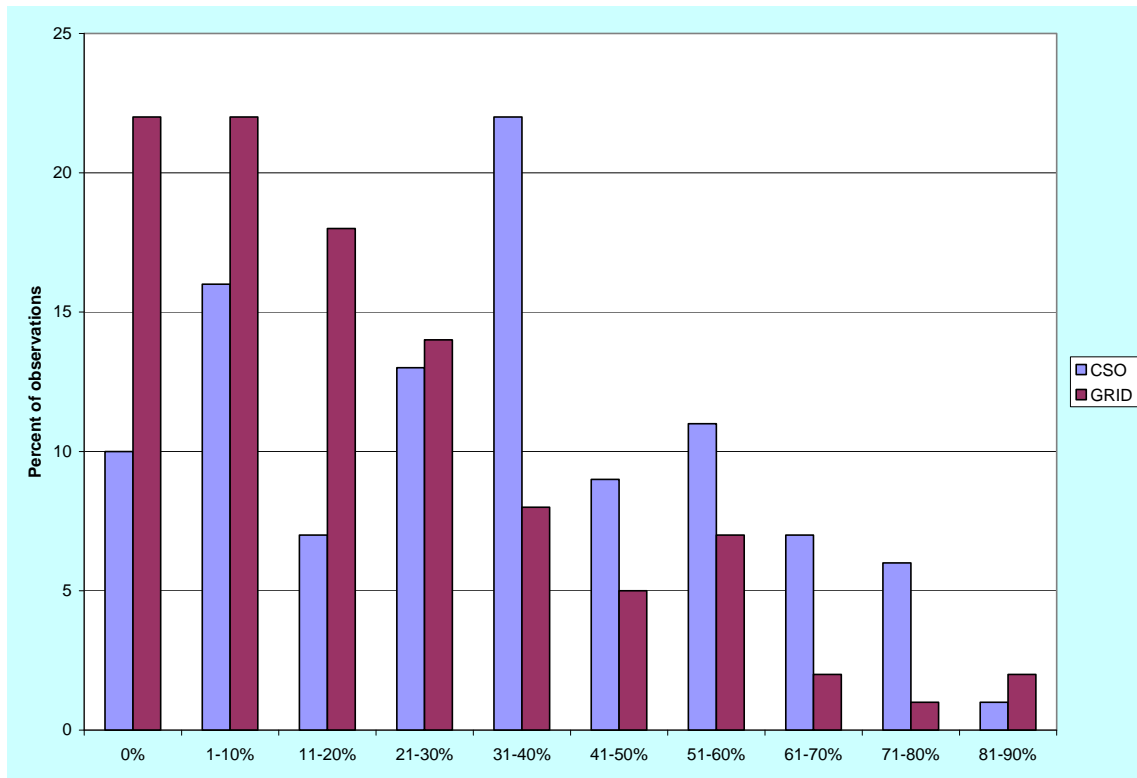


Figure 7. Distribution of proposed Meadow Valley Project Area forest management treatments and cumulative distribution of California spotted owl territorial sites between 2003-2008 in Survey Area-4 of the Plumas-Lassen Study, Plumas National Forest, California.

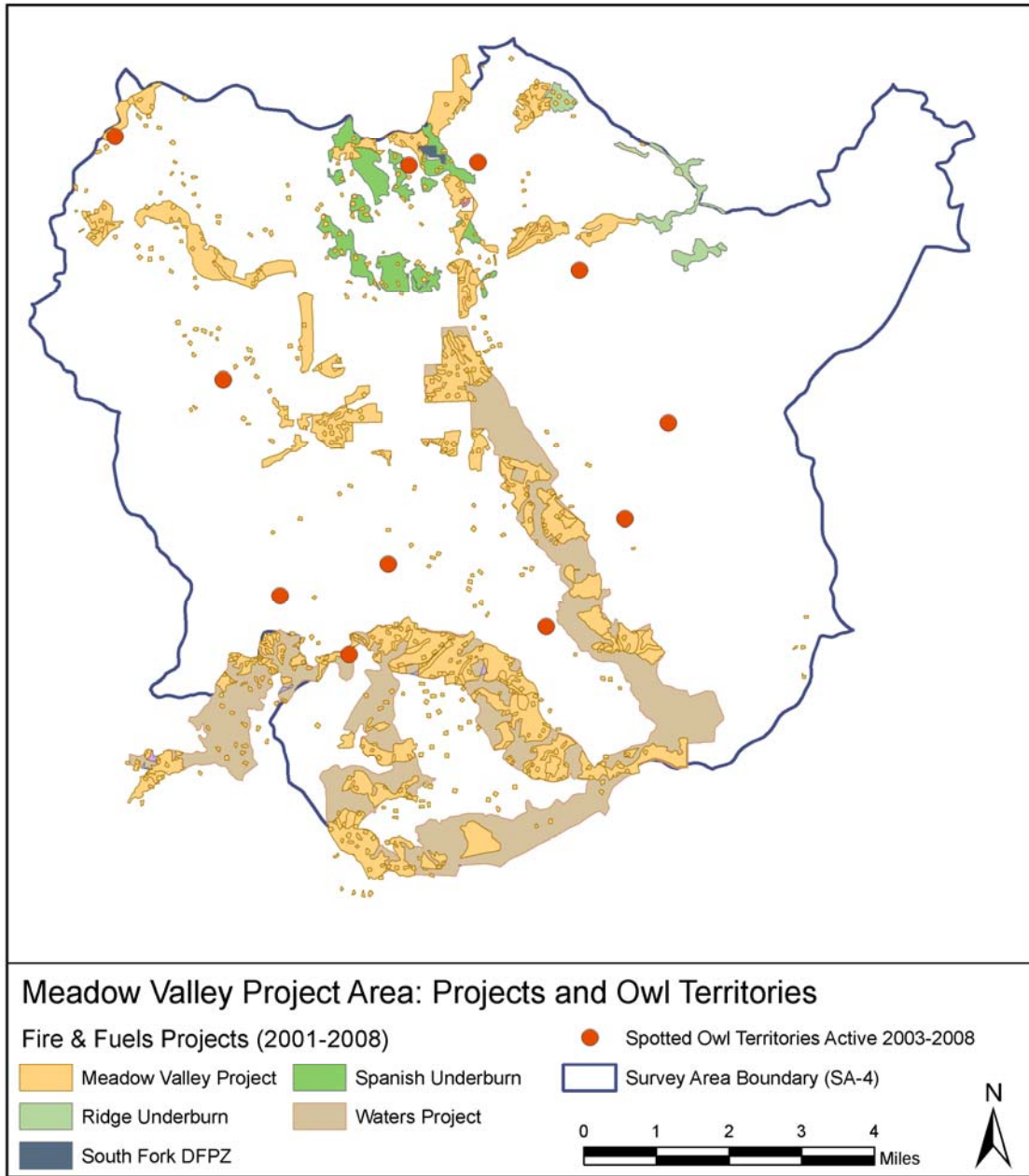


Figure 8. Annual summary distribution of California spotted owl territorial sites between 2003-2008 across Survey Area-4 (Meadow Valley Project Area) of the Plumas-Lassen Study, Plumas National Forest, California.

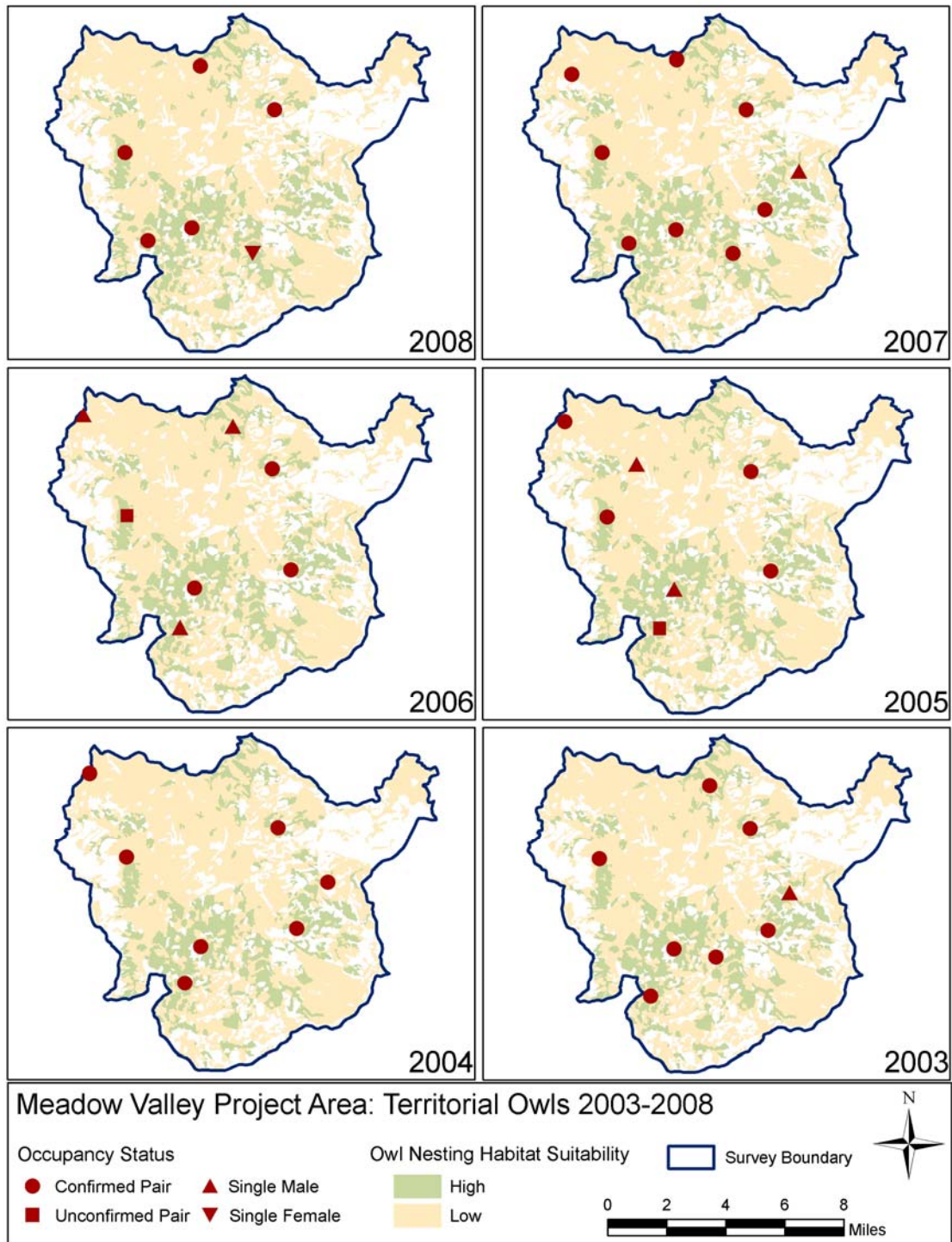


Figure 9. Distribution of pre- and post-fire California Wildlife Habitat Relationship vegetation classes within the Moonlight-Antelope Complex fire areas 2008 on the Plumas and Lassen National Forests, California.

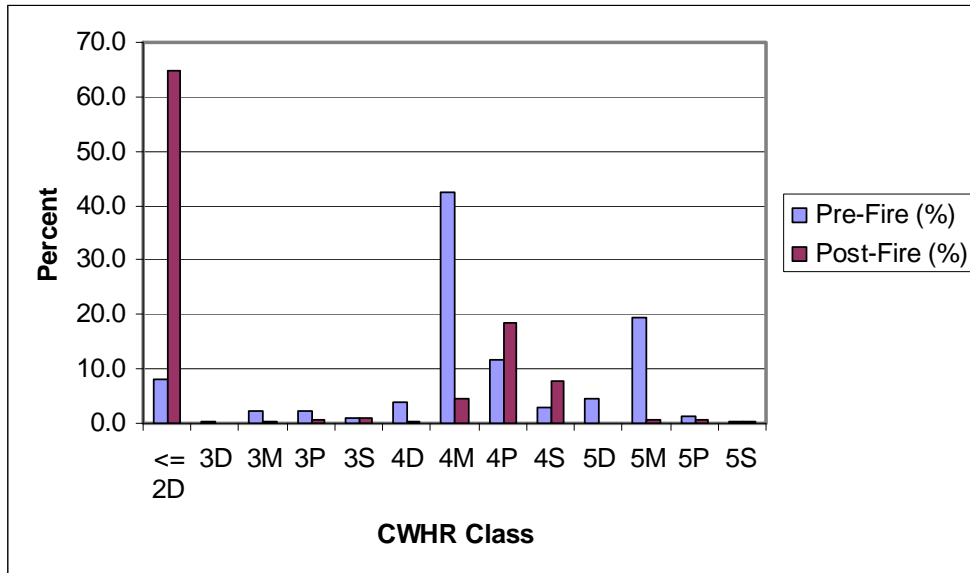
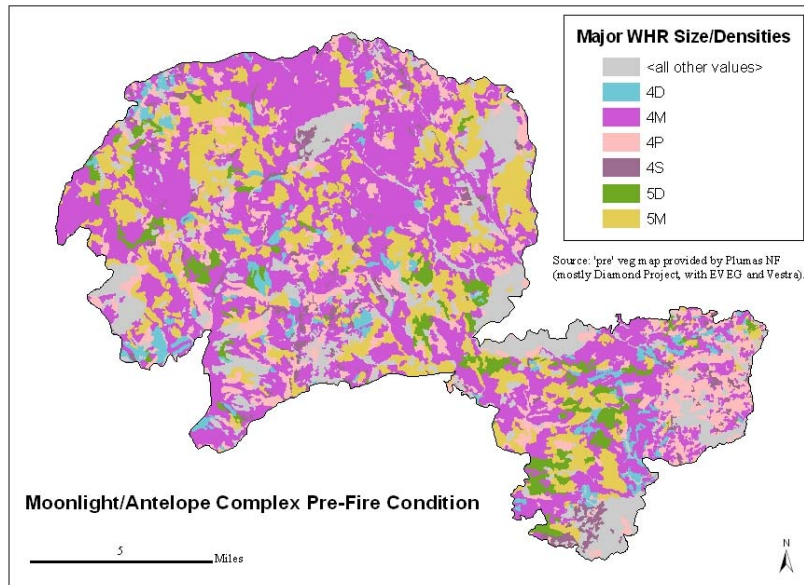


Figure 10. Maps of (a) pre-fire and (b) post-fire California Wildlife Habitat Relationship vegetation classes within the Moonlight-Antelope Complex fire areas 2008 on the Plumas and Lassen National Forests, California.

(a)



(b)

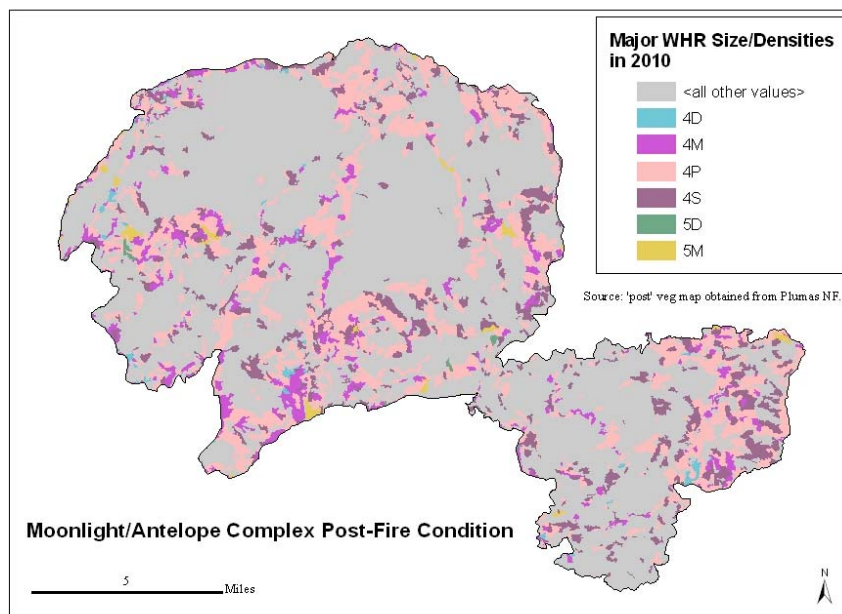




Figure 11. Distribution of California spotted owls detected in 2008 within the Moonlight-Antelope Complex Fire Area and a 1.6 km buffer and wildfire burn severity classes on the Plumas and Lassen National Forests, California.

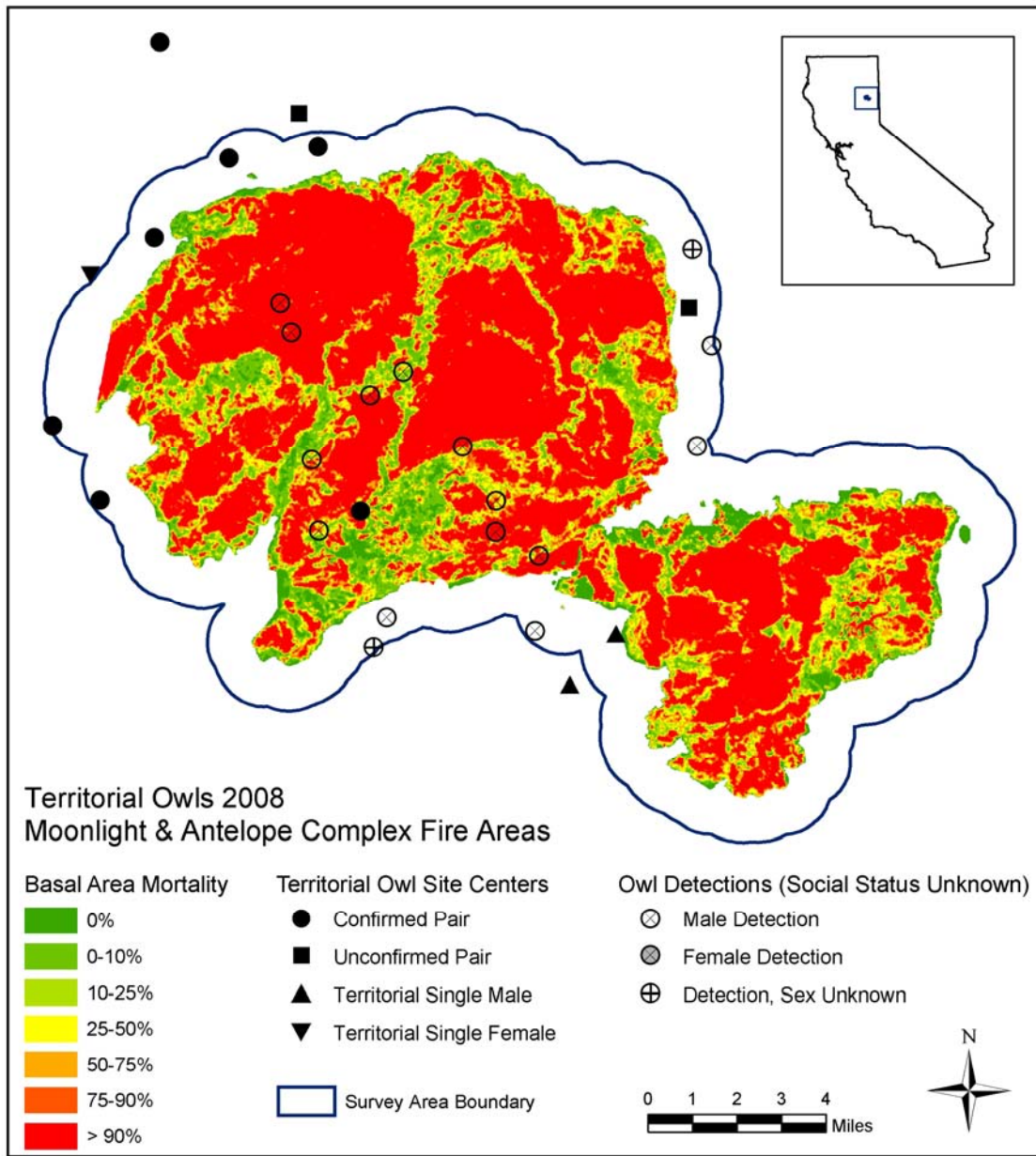


Figure 12. Distribution of Barred and Spurred (Spotted-Barred hybrids) Owls between 1989-2008 within the HFQLG Project area.

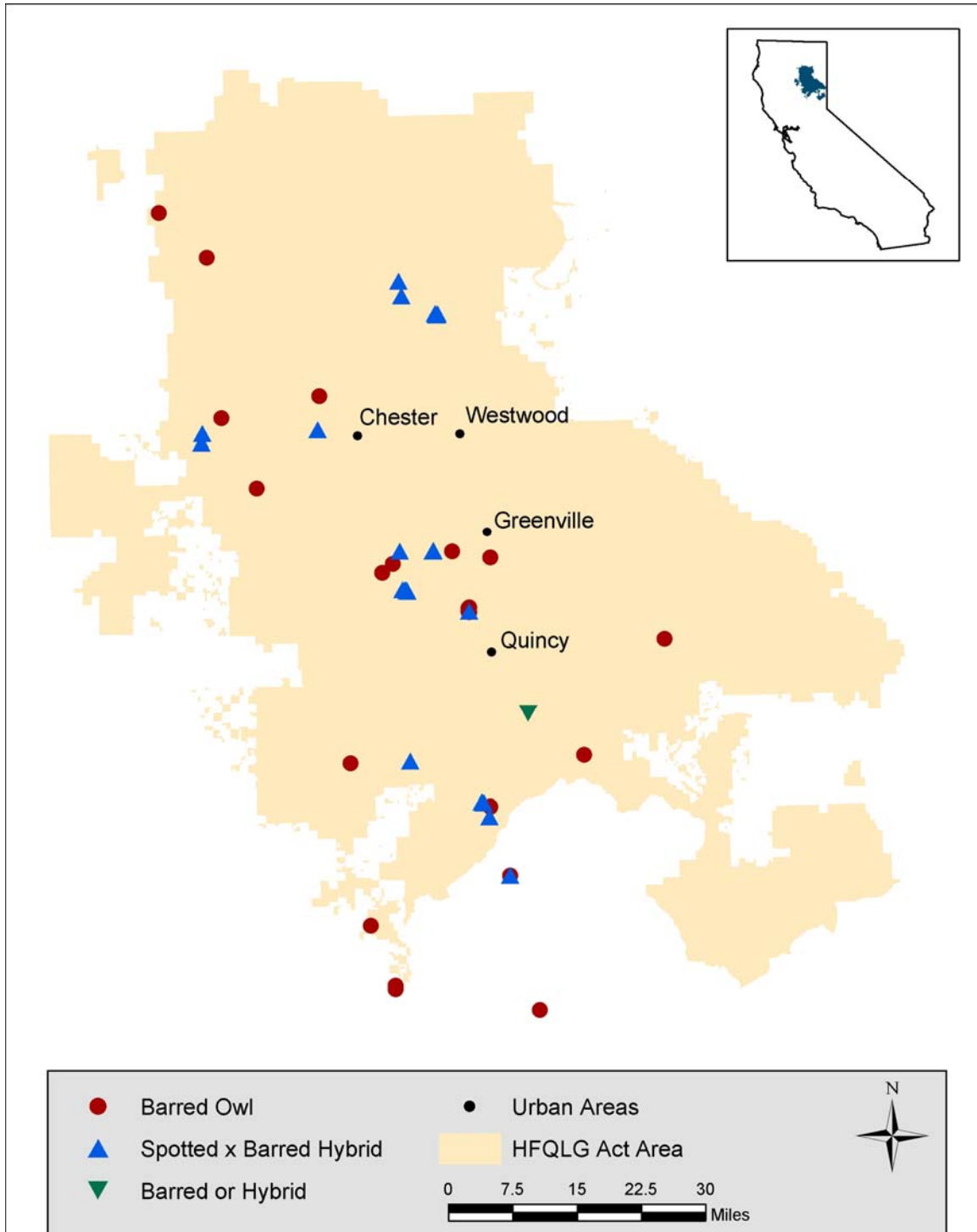
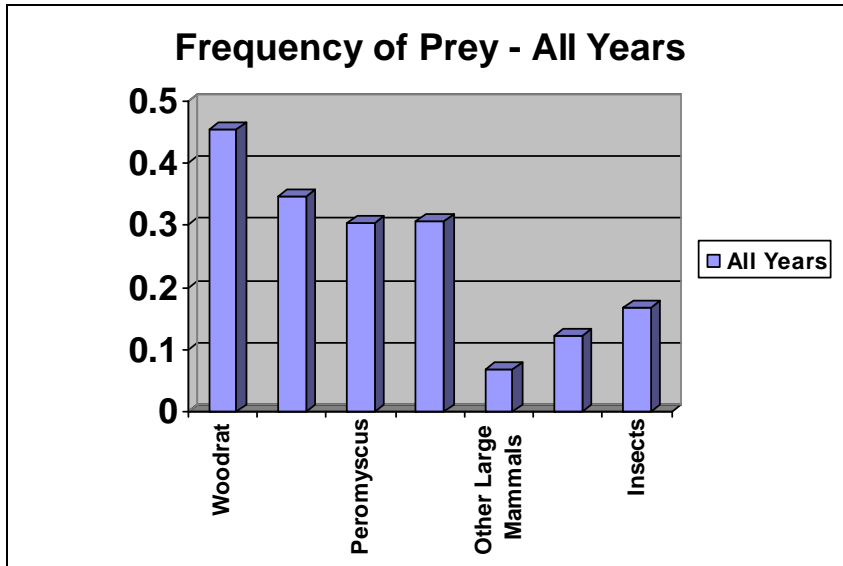


Figure 13. Cumulative (a) frequency of occurrence in pellets and (b) percent biomass contribution of species or taxonomic groups in California spotted owl diets based on pellet analysis across 2003-2006 on the Plumas National Forest, California.

(a)



(b)

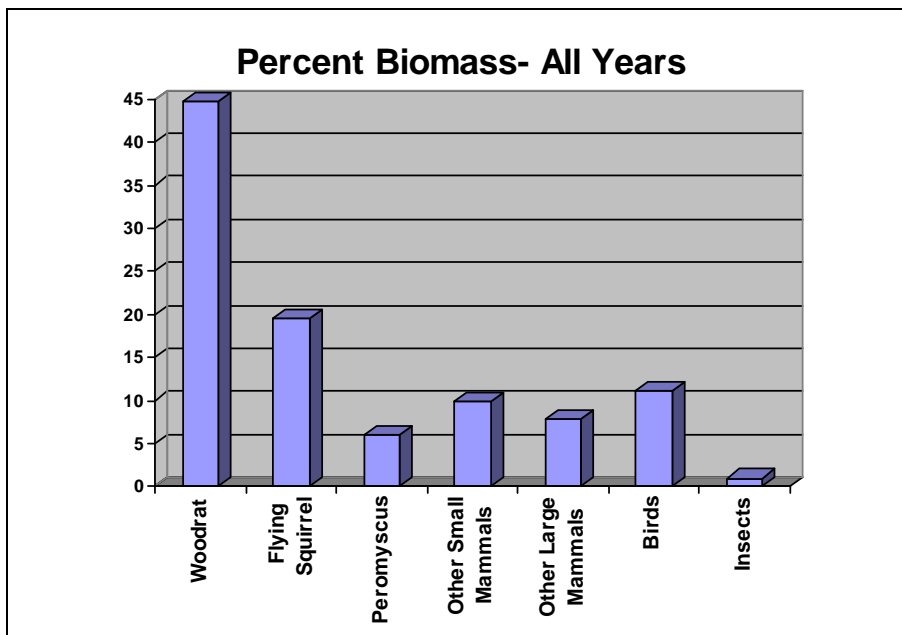
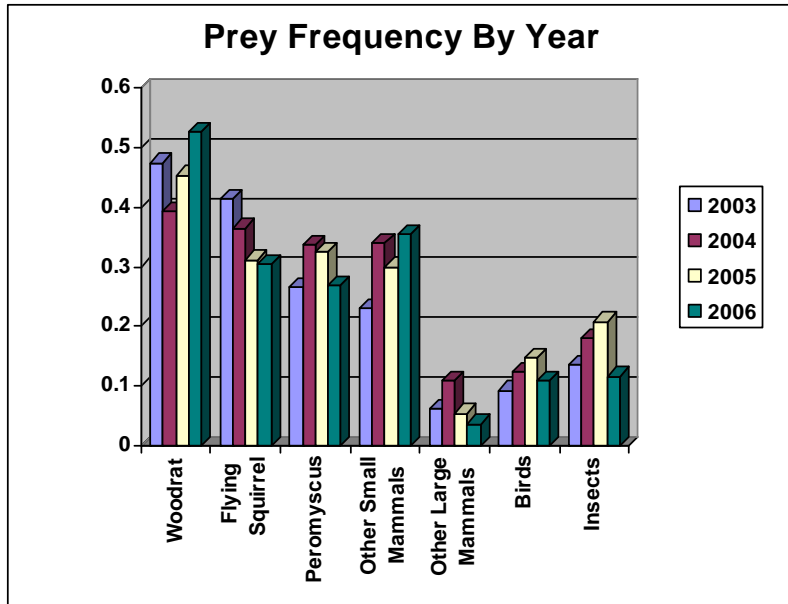


Figure 14. Annual (a) frequency of occurrence in pellets and (b) percent biomass contribution of species or taxonomic groups in California spotted owl diets based on pellet analysis across 2003-2006 on the Plumas National Forest, California.

(a)



(b)

