

SUMMARY REPORT

Demographic Parameters of the California Spotted Owl on the Lassen National Forest; Preliminary Results (1990-1998)

February 1999

Project Supervisor: **Jennifer A. Blakesley¹**
Principal Investigator: **Dr. Barry R. Noon¹**

U.S. Forest Service
Pacific Southwest Research Station
Redwood Sciences Laboratory
1700 Bayview Drive
Arcata, CA 95521

¹Current address: Department of Fishery and Wildlife Biology, Colorado State University, Ft. Collins, CO 80523

Blakesley
(Demographic)

LASSEN VOLCANIC NATIONAL PARK
Research Library

ABSTRACT

From spring 1990 through fall 1998 we studied a population of California spotted owls (*Strix occidentalis occidentalis*) in northeastern California. The primary goal of the study was to estimate demographic parameters (birth and death rates) in order to compute the trend of the owl population. Based on the capture histories of 191 subadult and adult owls and contemporary capture/recapture models, we were able to precisely estimate age-specific survival rates and sex-and-age-specific recapture rates. From 374 breeding records of female owls, we were also able to estimate age-specific fecundity rates. All reproductive parameters showed year-to-year variation. Fecundity ranged from 0.06 to 1.04 female offspring per female. Mean fecundity for all years combined was 0.052 for subadult females and 0.368 for adult females. Productivity ranged from 0.74 to 1.15 female offspring per productive female. All reproductive parameters measured (nesting rates, nest success rates, fecundity, productivity) were higher in 1992 than other years and all except productivity were lowest in 1997. The magnitude of the 1992 breeding pulse was reflected in unusually high proportions of recruits into the subadult age class in 1993 and 1994. Forty owls banded as juveniles were reobserved in subsequent years, up to 76 km from their natal site. Based on the combined capture histories of all owls, our estimates of apparent survival were 0.354 for juveniles and 0.817 for non-juvenile owls. Given a three-stage Leslie projection matrix, with separate estimates of survival for juvenile and non-juvenile stages, and separate fecundity estimates for adult and subadult females, we computed an annual rate of population change (λ) = 0.923 (95% CI: 0.888-0.958). This rate of change suggests that the population of territorial spotted owls in our Lassen study area decreased at approximately 7.7% per year from 1990-1998. Our results suggest that, in the southern Cascade/northern Sierra Nevada region, additional efforts need to be expended to preserve and restore spotted owl habitat.

INTRODUCTION

The population status of the California subspecies of the spotted owl (*Strix occidentalis occidentalis*) was reviewed in the early 1990s (Verner et al. 1992a). At the time of completion of the review (1991), among four ongoing demographic studies of the California spotted owl (including this study) only the San Bernardino Mountains study area had sufficient data to reliably estimate the finite rate of population change (λ) over the period of study. This population of owls declined at an average rate of approximately 17 percent per year in the period 1987-1991 (Noon et al. 1992). Estimates of λ were computed for studies in the Eldorado National Forest (NF) and Sequoia/Kings Canyon National Park. These estimates were imprecise, and λ was not significantly different from a $\lambda = 1.0$, characteristic of a stationary population (Noon et al. 1992). Given the low power of the test of $H_0: \lambda \geq 1.0$, however, Verner et al. (1992a) concluded that the true trend of spotted owls in these populations was uncertain.

The USDA Forest Service is currently managing the California spotted owl in the Sierra province under interim guidelines (Verner et al. 1992a; USDA 1993a, 1993b) while a long-term management strategy to maintain viability of the subspecies is developed (USDA 1995). Particularly relevant to the development of a long-term management plan is the new information, since publication of the status review (Verner et al. 1992a), on the trend in the owl population in different parts of its range. In this document we summarize demographic data from a nine year mark-recapture study of California spotted owls in the Lassen National Forest. These data allow a reliable estimate of the rate and trend of population change for the period 1990-1998.

Our study of spotted owl demography was initiated in 1990 and has continued through 1998. The study is planned to continue at least through 1999.

Study Objectives

The objectives of this study were to:

1. Estimate the following demographic parameters for spotted owls:
 - a. age-and sex-specific survival rates;
 - b. nesting rate, nest success rate, productivity and fecundity;

- c. the annual, finite rate of population change over the study interval.
 - d. Describe the sex and age class structure of the spotted owl population.
2. Estimate the degree of site and mate fidelity for spotted owls.
 3. Describe dispersal movements of juvenile spotted owls.
 4. Assess the current status of the spotted owl in Lassen National Forest.
 5. Establish the relationship between demographic variation and variation in habitat structure and composition around spotted owl nest sites at a variety of spatial scales.

In this document, we provide an updated report and an interim interpretation relative to our progress on objectives 1-4.

Study Area

The Lassen study area encompassed approximately 500 square miles of National Forest land in northeastern California (Fig. 1). The majority of the study area occurred on the Almanor and Eagle Lake Districts of the Lassen National Forest (LNF), with two owl sites on the Hat Creek District of the LNF and four sites on the Plumas NF. In addition, some owls were found on land immediately adjacent to the LNF which was owned or administered by private timber companies (seven sites), the National Park Service (one site), the Bureau of Land Management (one site), or private individuals (one site; Appendix A).

The study area lies at the southern end of the Cascade Geographic Province. However, it is included in the Sierra Nevada Province for spotted owl management purposes (e.g., USDA 1993a, 1993b, Verner et al. 1992a, USDA 1995), as it lies at the northern limit of the distribution of the California spotted owl. The majority of forested stands on the study area were classified as white fir-mixed conifer ("mixed conifer") or red fir; both are typical of the Sierra Nevada (Rundel et al. 1977). Mixed conifer stands included white fir (Abies concolor), sugar pine (Pinus lambertiana), ponderosa pine (Pinus ponderosa), incense cedar (Calocedrus decurrens) and Douglas fir (Pseudotsuga menziesii). Red fir (Abies magnifica) stands were monocultures or

contained occasional white firs. Elevations on the study area ranged from 4000 to 7000 feet.

METHODS

Field Methods

In 1990 we began searching for owls at historic nest, roost, and nighttime detection locations, and added sites by surveying new areas or as LNF personnel found owls while surveying timber sale areas. Owl sites were delimited on the basis of the owls' behavior, movement patterns, and reproductive histories. Sites roughly approximated owl territories -- territory boundaries, however, were not determined. This process of associating owls with specific sites (i.e., spatial referencing) was most accurate when owls were individually identifiable (by unique color bands) or when owls occupied discrete nest groves. Owl site locations often fluctuated between years: owls were known to move between sites, and some owl detections were not easily assigned to specific sites. Therefore, the assignment of an owl detection to a specific site may sometimes have been imprecise.

For purposes of estimating demographic parameters, however, the unit of observation and analysis is the owl and its capture history, not the site. The site designation is largely a "bookkeeping" device to facilitate field surveys. It is important to note that our methods of survey contrast sharply with the spotted owl survey approach required for timber sale inventories and Spotted Owl Habitat Area (SOHA) monitoring, in which the unit of observation is an area of land. Our study was not designed to thoroughly survey large areas or to completely enumerate all owls within a specified area (i.e., to estimate spotted owl density).

The methods we used to locate, identify and capture spotted owls are similar to other spotted owl demographic studies (Forsman 1983, Franklin et al. 1996a). To summarize briefly: Owls were initially located at night by vocally imitating their calls. All habitat types were surveyed in proportion to their representation along survey routes. When owls responded by calling back, field crew personnel estimated each owl's location on a topographical map using one or more compass bearings taken from

the observer to the calling owl. The following day, a field crew attempted to visually locate the owl by hiking to and surveying (imitated calls) the area where the owl was detected the previous night.

When owls were found, their reproductive status was determined by following a standardized protocol (Miller 1990; Franklin et al. 1996a) based on the owl's response to the presentation of live mice. In general, an owl belonging to a nesting pair will take mice to the nest; if fledged young are present, a parent will take mice to the young; if an owl is not nesting and no fledglings are present, the owl will eat and/or cache the mice. Field crews followed a strict protocol during the "mousing" procedure (Miller 1990, Appendix B) to eliminate observer bias in drawing conclusions about owl reproductive status.

Social status of non-juvenile owls (age ≥ 1 year old) was determined on each visit; an overall determination of occupancy and, if occupied, social status was made for each site each year (Miller 1990, Appendix B). In establishing pair status a male and female owl had to be detected together on two or more occasions, with at least one pair detection occurring in the daytime.

During daytime visits, owls were captured and banded with unique color bands, or, if already banded, identified by observation of the color bands. Whenever possible, the age class of each owl (juvenile [young of the year], first year subadult, second year subadult, adult) was determined based on plumage characteristics (Forsman 1981, Moen et al. 1991). Juvenile owls were banded with a cohort (year-specific color) band that identified them as juveniles fledged in a specific year. When an owl wearing a juvenile band was subsequently relocated as a subadult or adult, a concerted effort was made to recapture it and band it with a unique color band. Each year, field crews attempted to locate and identify all subadult and adult owls which had color bands during at least one of the previous two years. Any owl not located was searched for systematically for up to two subsequent field seasons, following a standardized protocol (Miller 1990, Appendix B). The search entailed a complete nighttime survey of a 1.5 mile radius area centered around the last or most representative nest or primary roost location of the owl in question (e.g., centered around the previous year's nest tree). If

an owl was replaced at a site by another owl of the same sex, two complete searches were conducted each year. If the owl had not been replaced, six visits to the site including four complete searches were conducted each year (Miller 1990).

Estimating Demographic Parameters

Estimates of age-specific fecundity were computed according to standardized methods (Franklin et al. 1996a). Fecundity was defined as the mean number of female young produced per female at least one year old. We assumed that one half of the juveniles produced were female. The assumption of a 1:1 sex ratio at birth has been shown to be valid for northern spotted owls in northwestern California (Franklin et al. 1996b). Productivity was defined as the mean number of female young fledged per female that successfully produced fledglings.

We estimated survival rates with contemporary mark/recapture methods using model nomenclature, selection and testing procedures outlined in Franklin et al. (1996a). We used program MARK (White and Burnham 1999) which allows for modeling the effects of time, sex, age class and interactions between these factors on recapture probability and survival rate. We used Akaike's Information Criterion (AIC) to select the best model supported by our data (Lebreton et al. 1992; Burnham and Anderson 1998).

We used a 3-stage projection matrix model to estimate λ , the annual finite rate of population change. Assumptions and details of the estimation procedures are discussed in Noon and Biles (1990) and Noon et al. (1992). For spotted owls, stages were associated with age including juvenile ($0 < \text{age} < 1$ year), subadult ($1 < \text{age} < 2$, and $2 < \text{age} < 3$), and adult birds ($\text{age} \geq 3$). The size of the matrix (number of stages) was determined by the number of distinct stage (age)-class categories resulting from parameter estimation procedures for fecundity and survival.

Analysis/Statistical Tests

Chi-square tests were used to determine whether there were significant between-year differences in the proportion of subadult owls in the population and in

nesting and fledging rates. When significant differences were found ($P < 0.05$), we recalculated chi-square values based on subsets of years to determine which years contributed most to the overall differences. In cases of two by two contingency tables with sparse data, we used Fisher's exact test (Zar 1984).

Kruskal-Wallis tests were used to compare annual estimates of fecundity and productivity. Nonparametric multiple comparisons were calculated using a formula for comparing mean ranks with unequal sample sizes (Zar 1984). A Mann-Whitney Test was used to compare fecundity estimates of subadult and adult female owls.

Our primary hypothesis of interest was whether the population was declining during our study period. Therefore, we tested $H_0: \lambda \geq 1.0$ versus the alternative, $H_a: \lambda < 1.0$. A standard one-tailed Z-statistic was used to test the null hypothesis (Zar 1984). The parameter λ was estimated as the dominant eigenvalue of the stage projection matrix (Caswell 1989). The variance of λ was estimated by a first order Taylor series approximation -- a function based on the sensitivities of λ to variation in the vital rates and the estimated variances of the rates (Caswell 1989:185).

RESULTS

Lassen National Forest personnel began surveying for spotted owls in 1981. Between 1981 and 1989, owls were detected at approximately 50 sites within our current study area. We subsequently detected owls at 117 sites from 1990 through 1998 (Table 1A). Owl pairs occurred at 82 distinct sites in at least one year of our study (Tables 1A and 1B). It is possible that many of the remaining sites ($n=35$) were also occupied by owl pairs, but we did not have sufficient information to verify pair status at these sites. Changes in the number of sites where owls were found each year should not be interpreted as changes in owl density over time (Table 1B); nor should the addition of new owl sites in our study each year be interpreted as an increase in the owl population (Table 1A). Some owl sites which were occupied by owls in earlier years of the study were unoccupied in subsequent years, based on thorough surveys (e.g., Caribou Peak, Coppervale /101, Gurnsey Creek, Longville). Many sites where owls were found in earlier years were not surveyed in subsequent years because no

owls were banded at those sites. These sites were often at the periphery of the area encompassing banded owls (e.g., Ashurst Mountain, Bear Flat, Black's Mountain, Colby Creek, Heart Lake SOHA, Homer Lake, Humboldt Summit, Keddie Ridge, Light's Creek, Moonlight Pass, Reese Flat SOHA, Soda Ridge SOHA, Squirrel Creek, Wheeler Sheep Camp, Willard Creek SOHA). Table 1A distinguishes between sites which were not surveyed and sites which were thoroughly surveyed each year.

From 1990-98, 210 juvenile owls and 191 adult and subadult owls were captured and banded at 90 distinct sites. Thirty-five non-juvenile (subadult and adult) territorial owls were observed to move between sites (18 females and 17 males; Table 2). Distances moved ranged from 1.2 to 32.7 km. At least seven of the females and at least four of the males were subadults (≤ 2 years of age) when occupying their initial sites.

Forty owls banded as juveniles were reobserved in subsequent years (21 females and 19 males; Table 3). Twenty-seven of these owls were recaptured and given unique color bands. Straight line distances moved from natal sites to points of recapture ranged from 9.3 to 76.4 km.

Subadults accounted for 2.2 (1998) to 23.5 percent (1993) of the non-juvenile owls observed each year (Table 4). The null hypothesis that there was no yearly difference in the proportion of subadult owls in the population was rejected ($\chi^2 = 44.51$, $df = 8$, $P = 0.001$). Further tests showed that the proportion of subadults was not significantly different among 1991, 1992, 1995, 1996, 1997 & 1998, nor among 1990, 1993 and 1994 ($P > 0.05$), but was significantly different between these two groups of years.

Reproduction

The proportion of females nesting ranged from 0.14 in 1997 to 0.97 in 1992 (Table 5). The null hypothesis of no annual differences in the proportion of female owls nesting was rejected ($\chi^2 = 80.33$, $df = 8$, $P < 0.001$). Subsequent tests based on subsamples of the data showed that nesting rate was significantly higher in 1992 than all other years, and in 1998 was higher than in all remaining years except 1990 and

1993 ($P < 0.05$).

The proportion of nesting females which successfully fledged young ranged from 0.40 in 1997 to 0.89 in 1992 (Table 6). The statistical significance of the observed differences among years could not be reliably tested because 39% of cells in the contingency table had expected values less than five.

The proportion of all females which successfully fledged young ranged from 0.07 in 1997 to 0.91 in 1992 (Table 7). The proportion successful was significantly different among years ($\chi^2 = 108.69$, $df = 8$, $P < 0.001$). The proportion of females fledging young in 1991, 1994, 1995, 1996 and 1997 was lower than other years ($P < 0.05$). The proportion fledging young in 1992 was significantly higher than in all other years ($P < 0.05$). 1990, 1993 and 1998 had intermediate fledging rates which were not significantly different from each other.

Fecundity of spotted owls ranged from 0.06 in 1997 to 1.04 in 1992 (Table 8; Fig. 2). The annual differences in fecundity were significant ($\chi^2 = 129.75$, $df = 8$, $P < 0.001$). Multiple comparison tests showed that fecundity in 1992 was significantly greater than in all other years and also higher in 1998 than in 1995 and 1997 ($P < 0.05$). Fecundity of adult female owls was significantly greater than that of subadult females for all years combined ($\chi^2 = 11.44$, $P < 0.001$). Mean fecundity rates over all years were 0.052 (95% CI = 0.00 to 0.11) for subadult females and 0.368 (95% CI = 0.32 to 0.42) for adult females (Table 10). Separate fecundity rate estimates were used for subadult ($1 \geq \text{age} < 3$ years) and adult owls.

Data are also available from owl pairs observed during the daytime in 1987 ($n = 11$), 1988 ($n = 22$) and 1989 ($n = 36$) (Lassen National Forest, unpublished data). Five, 21, and 29 juveniles were found at those sites in 1987, 1988 and 1989, respectively. The number of sites where a protocol was followed to determine that owls were not nesting is unknown. Using these data, we estimated minimum fecundity rates equal to 0.23, 0.48 and 0.40 female young per non-juvenile female in 1987, 1988 and 1989, respectively. These estimates suggest that fecundity was higher in 1988 and possibly 1989 than any year of our study excluding 1992 and 1998 (Table 8). A breeding pulse in 1988 is consistent with the high proportion of subadults we observed in the

population in 1990 (compare with proportion of subadults two years following the breeding pulse of 1992, Table 4).

Productivity of spotted owls ranged from 0.74 in 1990 to 1.15 in 1992 (Table 9). The between year differences were significant ($X^2 = 30.14$, $df = 8$, $P < 0.001$). Multiple comparisons showed only that productivity was significantly greater in 1992 than in 1990 and 1998 ($P < 0.05$). Failure to detect a difference between 1992 and 1995 was likely due to the small sample size of productive females in 1995 ($n = 8$).

Survival

Open population capture-recapture models provide estimates of apparent survival rather than true survival. That is, survival rate estimates includes data from animals that died between sample periods, as well as those that emigrated from the study area, survived ≥ 1 year, and were never reobserved. Based on AIC values (Lebreton et al. 1992), our most parsimonious model from program MARK resulted in estimates of apparent survival rates of 0.354 for juvenile owls (95% CI = 0.257 to 0.464) and 0.817 for non-juvenile owls (95% CI = 0.786 to 0.844). This model estimated separate recapture probabilities for subadults and adults of each sex as well as an increasing trend over time in the recapture probability of owls first captured as juveniles.

Population Trend

The estimate of the annual rate of change is based on the mean values of the demographic rates. The "best" model supported by the data using program MARK (White and Burnham 1999) provided a separate survival estimate for juvenile owls (s_0), and a common survival rate estimate for subadult and adult birds (the non-juvenile survival rate(s)). These estimates, coupled with separate fecundity estimates for subadult (b_1) and adult (b) owls, resulted in a projection matrix (L) with the following structure:

$$L = \begin{bmatrix} s_0 b_1 & s b_1 & s b \\ s_0 & 0 & 0 \\ 0 & s & s \end{bmatrix}$$

The estimate of λ (mean annual rate of population change) from 1990-98 for our study population was 0.923 (95% CI = 0.888 - 0.958). This estimate was significantly different from a stationary population (1-tailed $Z = 4.327$, $p < 0.001$), and suggests the territorial population experienced a 7.7% annual rate of decline from 1990-1998 (Table 10).

Values for the partial derivatives of each parameter estimate with respect to λ indicate that λ is most sensitive to variation in the survival rates of females $\geq$ one year old (Noon and Biles 1990; Noon et al. 1992). Thus, we expect that observed rates of decline may have been most influenced by low rates of subadult and adult female survival from 1990-98.

DISCUSSION

Our estimates of demographic rates, and rates of population change, are not based on a random sample of owls from the Lassen National Forest. Therefore, if our sample is not representative of the complete owl population in this region, then inference is limited to the population of owls sampled within our study area. Nevertheless, we believe our sample to be representative of the regional population, and that reliable inference can be made to the dynamics of the resident, territorial population of owls occupying public lands within the southern Cascades/northern Sierra Province for the period 1990-98.

Reproduction

All measures of reproductive success showed extensive annual variation. The proportion of female owls nesting, the proportion of young fledged, and fecundity were all significantly greater in 1992 than any other year. However, there was no evidence

for a declining time trend in reproduction. Over half of the broods observed in 1992 were composed of triplets; only one set of triplets was observed in all other years. As a result, the point estimate for fecundity in 1992 was 2-8 times greater than in any other year. The exceptional reproductive output in 1992 was reflected in increased recruitment the subsequent year – a greater proportion of subadults were observed in 1993 (Table 4). Annual variation in reproductive output of California spotted owls, with a strong peak in 1992, has also been reported from demographic studies on the Sierra National Forest, Sequoia and Kings Canyon National Parks (Steger et al. 1993), and the Eldorado NF (Moen and Gutierrez, draft report, Feb. 1996). Apparently, conditions favorable to reproduction were synchronous through the Sierra Nevada Mountains in 1992.

Survival

Because many juveniles owls may move beyond the bounds of the study area before their fates can be determined, estimates of first-year survival rate are particularly difficult to obtain. A negative bias in the estimate of s_0 will arise if juvenile emigrants survive for ≥ 1 year and are never recaptured. The magnitude of bias in our estimate is unknown, but several lines of argument suggest it may be small. For example, the estimate of juvenile survival rate in this study, $s_0 = 0.354$ (95% CI: 0.249-0.459), is generally higher than that obtained from long-term studies of the northern spotted owl (Burnham et al. 1993). Further, for our population to have shown a stable population from 1990-98 ($\lambda = 1.0$), would require an extremely high first-year survival rate of $s_0 = 0.697$. This rate of survival would require a permanent annual emigration rate of 0.49.

Estimates of survival rate from other age classes are also subject to a negative bias if birds emigrate, survive > 1 year, and are never recaptured. However, the likelihood of owls showing permanent emigration once they have been territorial in the study area is probably very low (Burnham et al. 1996). The apparent survival rate of non-juvenile (owls > 1 year old) from our study is similar to those reported for other studies in the Sierra Nevada (Noon et al. 1992). For example, a recent estimate of

female, non-juvenile survival rate for the Eldorado study area, 1986-1995, was 0.79 (Moen and Gutierrez, draft report, Feb. 1996). The estimate for non-juvenile, female survival rate is particularly important because this demographic rate most influences rates of population change (Noon and Biles 1990). There was, however, no evidence of a temporal trend in non-juvenile survivorship over the period 1990-98.

In a mathematical context, the finite rate of population change (λ) is most affected by the mean and variance of the survival rate of owls ≥ 1 year old (Noon and Biles 1990). If the remaining demographic parameters were to remain constant, the survival rate of female owls ≥ 1 year old would have to increase to ≥ 0.87 to have a stationary population. Such an increase would require a reduction in adult female mortality. To the extent that survival rates are affected by habitat loss and fragmentation, changes in management practices may lead to increases in survival.

Population Trend

Our estimates of the demographic rates (Table 10) provide a λ estimate = 0.923, which is significantly less than 1.0. Given unbiased parameter estimates, the true λ lies between 0.888 and 0.958 with a 95% probability. This λ value suggests that the territorial population of owls in the Lassen study area declined at an average of 7.7% per year from 1990-1998. In comparison, λ for the northern spotted owl throughout its range was estimated to be 0.955 (95% CI = 0.916 - 0.993) from 1985-93 (Burnham et al. 1996).

Valid estimates of λ from the analysis of projection matrices are subject to a number of strict assumptions. Among these are a stable age (or stage) distribution and unbiased parameter estimates. The significance of these assumptions, relative to spotted owls population dynamics, are discussed in detail in Noon et al. (1992). For the purposes of trend estimates, the most relevant potential problem is the underestimation of juvenile survival rate, leading to a negative bias in the estimate of λ .

If the true rate of change were as low as 4% per year ($\lambda = 0.96$, Table 10), and the demographic rates remained at their current mean values, the population would be forecast to decline by one-half within approximately 25 years. This inference is valid

only if the conditions operative during our study were to remain constant. Given our uncertainty of the underlying causes for the observed means and variances of the birth and survival rates, projecting population trends beyond the period of study must be done with great caution. Our results, however, suggest that until we better understand cause-effect relationships, management practices should retain or restore those attributes of the habitat demonstrated to be related to the distribution of spotted owls (Gutierrez et al. 1992; Verner et al. 1992b).

Annual Variation

Our estimates of fecundity and non-juvenile survival rate show extensive annual variation (Fig 2). The observed year-to-year variation in our estimates represents some unknown combination of sampling error and true process variation (i.e., actual year-to-year changes in the mean value of the rates). If the process component of variance is substantial, this factor could contribute significantly to population fluctuations and eventual declines. This arises because the actual growth rate of any population with stochastic vital rates is always less than or equal to the the growth rate estimated from the mean value of the vital rates (Cohen et al. 1983).

Management Implications

Verner et al. (1992a:24) listed eight major factors of concern in habitats occupied by California spotted owls in the Sierra Nevada, and recommended actions to ameliorate the effect of those factors. Of the eight factors identified, six would be alleviated by a strategy that retains the largest trees in the stand and removes some significant proportion of the smaller ones. Towards this goal, Verner et al. (1992a) proposed specific silvicultural guidelines to stabilize the amount and distribution of owl habitat in the short-term. In general, these guidelines entailed minimum levels of basal area retention in large tree size classes after a unit was harvested. These guidelines were developed prior to the existence of conclusive evidence indicating a decline in any spotted owl population in the Sierra Nevada Province.

The results of our demographic study, coupled with strong evidence that

California spotted owls select stands dominated by trees > 24 inches dbh and with at least 40% canopy closure (Verner et al. 1992b, Gutierrez et al. 1992, Zabel et al. 1992) suggest that interim measures to retain spotted owl habitat should be no less than those proposed by Verner et al. (1992a). Given the evidence for decline of the owl population in the Lassen National Forest, efforts to accelerate restoration and to increase retention of the large-tree components (old trees, snags, and downed logs) in harvest units should be encouraged.

Harvest guidelines address factors of owl habitat quality at the local scale. However, rates of population change are affected by processes operative at both local and landscape scales. Therefore, it is important that harvest activities be evaluated collectively in order to assess their cumulative effects on habitat quality. Future management activities, for example should not increase the mean nearest-neighbor distance among suitable owl pair sites. Management activities which reduce population density by lowering habitat quality or increasing fragmentation will increase the uncertainties associated with successful dispersal and mate-finding.

The rate of population change (λ) shows its greatest sensitivity to variation in non-juvenile (i.e., adult) survival rates (Noon and Biles 1990), suggesting strong natural selection to maintain high adult survival rates. Further, the low and variable fecundity rate suggests that recruitment may be highly uncertain. Thus, high adult survival may allow the spotted owl to persist through long periods of low reproductive success. The tradeoff between these two demographic rates has important management implications. Population size should not be allowed to become too small, because low fecundity precludes rapid recovery from population declines. Also, any management actions which further reduce the survival rates of subadult/adult owls will have disproportionate negative effects on population size. The most positive step that can be taken is to identify, and implement, those actions that will lead to increases in adult survival rates. Owl studies to date suggest that this will occur with increased retention and recruitment of large trees to the Sierra Nevada landscape.

Should the California Spotted Owl Receive Additional Protection?

Both the northern and Mexican subspecies of spotted owls are currently listed as threatened subspecies under the federal Endangered Species Act. Both these subspecies were listed on evidence of population declines that was less extensive and less reliable than that for the California subspecies. Given the results of our study, as well as those of other researchers within the range of the California spotted owl (e.g., Gutierrez and Seamans 1998), we believe it is timely to conduct a range-wide review of the status of this subspecies.

Public forest lands encompassing our study area will receive intensive management under a special agreement with the U.S. Congress. The special privilege granted the "Quincy Library Group" to direct management practices on the Lassen, Plumas, and the Sierraville Ranger District of the Tahoe National Forests by the 105th Congress will have unknown impacts on the current and future status of the California spotted owl within this part of its range. Of particular concern relative to the fate of the California spotted owl is the magnitude of proposed timber harvest activities: 40,000 to 60,000 acres per year in fuel-break construction, and > 9000 acres per year in group selection cuts. Large diameter trees will be obvious targets during these harvests, in direct conflict with the recommendations of Verner et al. (1992) for large tree retention.

The ESA provides additional protection for species (and subspecies), on both public and private lands, by attempting to mitigate against the adverse impact of otherwise legal activities on these lands. Because levels of timber harvest are likely to increase in the near-term, we believe the U.S. Fish and Wildlife Service should thoroughly evaluate the status and trend of the California spotted owl to determine if it warrants listing as a threatened species under the ESA.

ACKNOWLEDGMENT

Special thanks to Alan Franklin for technical and collegial assistance during many phases of this study. This study was primarily funded by the Pacific Southwest Region (Region 5) of the Forest Service and the Lassen National Forest. We would like to thank everyone who provided financial and logistical support on the Lassen National Forest and at Region 5. We are grateful for the cooperation of Roseburg Resources Company, Sierra Pacific Industries, and W.M. Beaty and Associates, Inc.,

for sharing information and permitting us access to their properties. We heartily thank each field crew member, all of whom worked horrendous hours while maintaining a sense of humor: Daniel Shaw, Toby Alexander, Tammi Lesh, David Olson, Kim Revo, Keith Benson, Charisse Davidson, Andrew Eller, Helen Fitting, Leigh Rouse, Jeff Seay, Cathy Schmall, Michael Stephens, Greg Walsh, Kendal Young, Steve Anderson, Jason Bennett, Wendi Bonds, Amy Grochowski, Tammy Hamer, Karen Randall, Missy Sparrow and Theresa Wicktor. Finally, we thank everyone at Redwood Sciences Laboratory who supported our work.

Table 1A. Social status^a of California spotted owls at 117 sites in northeastern California, 1990 through 1998.

Site Name	1990	1991	1992	1993	1994	1995	1996	1997	1998
Alder Campground	NS	NS	NS	NS	NS	NS	MRFP	PAIR	PAIR
Alder Creek SOHA	NS	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Ashurst Mountain	MRS	NS	NS	NS	NS	MR	NS	NS	NS
Bathtub Lake	NS	PAIR	NS	NS	NS	NS	MRFP	PAIR	MP
Bathtub Lake West	NS	NS	NS	NS	NS	NS	NS	PAIR	PAIR
Battle Creek	NS	NS	NS	NS	NS	NS	PAIR	MRFP	PAIR
Baxter Creek SOHA	PAIR	PAIR	PAIR	PAIR	PAIR	MP	NS	NS	NS
Bear Flat	NS	MRFP	0	FP	0	0	NS	NS	NS
Benner Creek SOHA	PAIR	PAIR	PAIR	PAIR	PAIR	MRFR	FP	PAIR	MP
Benner Springs	0	0	0	FR	0	0	MR	0	MR
Bennett Knoll	TX	TX	MP	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Big Bend SOHA	MPFP	MPFP	NS	NS	NS	NS	NS	PAIR	MRFR
Black's Mountain	NS	NS	NS	NS	MPFP	NS	NS	NS	NS
Blue Lead Gulch	NS	NS	NS	MRFR	NS	MRFR	PAIR	MRS	MRFP
Bogard Buttes SOHA	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	MRS	PAIR
Butt Creek	PAIR	MRFR	PAIR	PAIR	MRFR	PAIR	PAIR	MRFP	PAIR
Butt Mountain North	PAIR	PAIR	PAIR	PAIR	PAIR	MRFR	PAIR	PAIR	PAIR
Butt Mountain West	PAIR	PAIR	PAIR	PAIR	MRFP	PAIR	PAIR	PAIR	PAIR
Cairn Butte SOHA	PAIR	PAIR	PAIR	PAIR	MRFP	0	MRFP	0	0
Campbell Mountain	NS	NS	NS	NS	NS	NS	MR	NS	NS
Caribou Peak	PAIR	PAIR	PAIR	0	0	NS	0	0	NS

Site Name	1990	1991	1992	1993	1994	1995	1996	1997	1998
Carter Creek	NS	NS	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Christie Hill	FRS	MRFR	PAIR	MR	MP	MR	MP	PAIR	NS
Colby Creek	NS	NS	NS	NS	NS	FP	NS	NS	NS
Cold Creek	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Cone Lake	NS	MR	NS	0	0	MR	0	0	NS
Coppervale / 101	PAIR	PAIR	PAIR	PAIR	0	MPFP	0	0	NS
Crater Mountain	NS	NS	NS	NS	PAIR	PAIR	PAIR	PAIR	PAIR
Crazy Harry Gulch	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Cub Creek SOHA	MRS	PAIR	MPFP	MRFP	MRFP	MRFR	FP	NS	NS
Cummings SOHA	TX	TX	TX	MP	NS	NS	PAIR	PAIR	PAIR
Doe Mountain	NS	NS	NS	NS	NS	NS	PAIR	MPFR	NS
Domingo Springs	NS	NS	NS	NS	NS	MRFP	NS	NS	NS
Dyer Mountain	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	FRS	PAIR
Eagle Rocks	NS	MRFP	PAIR	NS	NS	NS	NS	NS	NS
Elam Creek East	NS	NS	PAIR	PAIR	MRFR	MRFR	0	0	0
Elam Creek SOHA	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Elam Creek West	NS	NS	NS	NS	NS	MR	0	0	0
Fanani Meadow	MRFP	PAIR	MRS	PAIR	MPFP	0	NS	NS	0
Fanani South	NS	NS	NS	PAIR	MPFR	PAIR	MPFR	PAIR	PAIR
Feather R. Homesite	NS	NS	NS	MP	NS	NS	NS	NS	NS
Fleischmann Lake	PAIR	MR	PAIR	MRFP	PAIR	PAIR	PAIR	MRS	0
Gold Run Creek	PAIR	PAIR	PAIR	PAIR	0	MP	MP	0	NS

Site Name	1990	1991	1992	1993	1994	1995	1996	1997	1998
Gold Run East	NS	FP	0	0	0	0	0	0	NS
Gray's Flat	NS	NS	NS	NS	NS	MR	NS	NS	MR
Grizzly Creek SOHA	PAIR	PAIR	PAIR	MPFP	NS	NS	NS	MPFP	NS
Gurnsey Creek	NS	MRFP	PAIR	PAIR	PAIR	0	0	0	NS
Hamilton Mt. SOHA	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Hampton Butte	MPFP	MP	NS	NS	NS	NS	NS	MP	NS
Hazen Flat	NS	NS	NS	NS	NS	NS	MP	NS	NS
Heart Lake SOHA	PAIR	PAIR	MR	MRFP	NS	NS	NS	NS	NS
Hole in Grnd. SOHA	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Homer Lake	MP	NS	NS	NS	NS	NS	NS	NS	NS
Humboldt Summit	MRFP	FP	NS	MPFP	NS	NS	NS	NS	NS
Jennie Creek	NS	NS	NS	NS	NS	NS	NS	PAIR	PAIR
Jennie Mt. SOHA	TX	TX	PAIR	MRFR	MRFP	MPFP	PAIR	PAIR	PAIR
Jones Valley	NS	NS	NS	NS	NS	MP	NS	NS	NS
Kay	PAIR	PAIR	PAIR	PAIR	MPFR	PAIR	PAIR	PAIR	PAIR
Keddie Ridge SOHA	NS	MPFP	NS	NS	NS	NS	NS	NS	MPFP
Keddie Ridge South	PAIR	PAIR	NS	NS	NS	NS	NS	NS	NS
Last Chance Campg.	NS	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Last Chance Creek	NS	MR	PAIR	TX	MRFR	MRFR	PAIR	PAIR	0
Last Chance Cr West	NS	NS	NS	NS	NS	MPFP	PAIR	PAIR	PAIR
Last Chance Springs	NS	NS	NS	NS	NS	NS	NS	NS	PAIR
Lights Creek	NS	NS	NS	NS	MRFR	MP	NS	NS	NS

Site Name	1990	1991	1992	1993	1994	1995	1996	1997	1998
Little Grizzly Campg.	NS	PAIR	PAIR	PAIR	PAIR	PAIR	MRS	MRS	MRS
Locherman SOHA	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Logan Mountain	MRFR	NS	NS	NS	NS	NS	NS	PAIR	PAIR
Longville	NS	PAIR	PAIR	PAIR	PAIR	MRFP	0	0	0
Lost Tom	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	MRS	MRS	0
Martin Creek SOHA	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Martin Springs	NS	NS	NS	NS	NS	NS	NS	MR	MR
Mill Creek	NS	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Miller Ravine	MP	MP	MR	MRFR	PAIR	MRS	0	0	MRFP
Moonlight Pass	PAIR	PAIR	NS	0	NS	NS	NS	NS	NS
Moonlight Peak	NS	NS	NS	NS	NS	MP	NS	NS	FP
Morgan Mt. SOHA	MRFP	PAIR	PAIR	PAIR	MR	PAIR	PAIR	PAIR	PAIR
Mosquito Springs	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Mud Creek SOHA	PAIR	TX	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Mud Creek South	NS	NS	NS	FR	0	0	NS	NS	NS
Pacific Crest Trail	MPFP	MPFR	PAIR	MRFR	PAIR	FP	FP	0	0
Peacock Point North	MRFR	MRFR	NS	NS	MR	NS	MR	0	0
Peacock Point SOHA	PAIR	MRFP	PAIR	MPFR	MRFR	MR	MR	MR	0
Pegleg Mt. SOHA	PAIR	MRFP	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Philbrook SOHA	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Pine Creek	NS	NS	NS	MRFR	MRS	0	0	MRFP	MRFP
Reese Flat SOHA	MPFP	MRFP	MP	NS	NS	NS	NS	NS	NS

Site Name	1990	1991	1992	1993	1994	1995	1996	1997	1998
Rice Creek	MP	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Rock Creek	TX	TX	PAIR	PAIR	MPFR	PAIR	FP	NS	FP
Rocky Point SOHA	PAIR	PAIR	PAIR	PAIR	MRFP	PAIR	MRFP	PAIR	PAIR
Roop Mountain	NS	NS	PAIR	MRFP	PAIR	PAIR	PAIR	MRFP	0
Ruffa Ranch	NS	MRFP	0	NS	NS	NS	NS	PAIR	PAIR
Scenic Loop	PAIR	PAIR	PAIR	MRFR	PAIR	PAIR	PAIR	PAIR	PAIR
Shanghai Creek	MRFP	MRFR	0	0	NS	0	MP	NS	0
Shanghai North	NS	NS	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Soda Ravine	NS	NS	NS	NS	NS	NS	MRFP	MR	MR
Soda Ridge SOHA	MR	MRFP	NS	NS	NS	NS	NS	NS	NS
Soldier Meadow	NS	NS	NS	NS	NS	MRFP	MP	MP	NS
Spencer Mdw. Trail	NS	NS	NS	NS	NS	0	PAIR	PAIR	PAIR
Squirrel Creek	NS	MP	NS	FP	NS	NS	NS	NS	NS
Star Butte SOHA	TX	TX	TX	TX	TX	TX	NS	NS	NS
Susan River SOHA	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Swain Meadow	NS	NS	NS	NS	NS	NS	PAIR	PAIR	MPFP
Turner Mountain	MR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR
Twin	PAIR	MRFR	PAIR	MPFR	PAIR	PAIR	PAIR	PAIR	MRS
Upper Deer Creek	NS	NS	NS	NS	NS	MRFR	FP	NS	NS
Upper Steph. Mdw.	PAIR	TX	NS	PAIR	MRS	PAIR	MRS	0	NS
Upper Yellow Creek	PAIR	PAIR	PAIR	PAIR	MRS	PAIR	PAIR	PAIR	PAIR
Warner Ranger Stn.	NS	NS	NS	NS	NS	FP	NS	NS	NS

Site Name	1990	1991	1992	1993	1994	1995	1996	1997	1998
Warner Creek SOHA	MRFR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	0
Warner Valley	NS	NS	NS	NS	PAIR	0	0	NS	NS
Wheeler Sheep Cmp.	NS	NS	PAIR	0	0	0	NS	NS	NS
Wild Cattle Mt. SOHA	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	0	0	NS
Willard Creek SOHA	MPFP	MPFP	NS	NS	NS	NS	NS	NS	NS
Willow Lake SOHA	PAIR	PAIR	PAIR	PAIR	PAIR	MPFR	PAIR	PAIR	PAIR
Willow Lake South	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	PAIR	0	PAIR
Wilson Meadow	MPFR	0	0	MRFR	PAIR	PAIR	PAIR	PAIR	PAIR

^a Key: M = Male; F = Female

R = Owl Resident (detected at least 2 times, separated by one week)

P = Owl Present

PAIR = Male and Female Resident, found together at least twice

S = Resident owl is confirmed to be single (no owl of the opposite sex detected after 6 visits)

TX = One or more owls carrying a radio transmitter; not used for demographics

NS = Not Surveyed completely

0 = Surveyed completely and no owls detected

Table 1B. Summary of social status of California spotted owls in northeastern California, 1990 through 1998.

Social Status	1990	1991	1992	1993	1994	1995	1996	1997	1998
Pair	39	44	56	47	42	41	46	50	46
Single Male	2	0	1	0	3	1	3	5	2
Single Female	1	0	2	0	0	0	0	1	0
Male & Female Resident/Present	13	17	1	15	16	15	6	6	6
Male Resident/Present	5	6	4	3	3	12	9	5	6
Female Resident/Present	0	2	0	4	0	3	5	0	2
Total Sites with Owls Detected	60	69	64	69	64	72	69	67	62

Table 2. Inter-site movements of non-juvenile California spotted owls in northeastern California, 1990 through 1998.

Sex	Initial Age	Initial Site	Initial Year	Reobservation Site	Reobs. Year	Km Moved
F	2=	Christie Hill	1990	Morgan Mountain SOHA	1991	3.2
F	3+	Jennie Mountain SOHA ^a	1990	Last Chance Creek	1993	10.3
F	2=	Scenic Loop	1990	Roop Mountain	1993	17.5
F	5+	Butt Mountain North	1991	Carter Creek	1992	1.2
F	5+	Caribou Peak	1992	Crater Mountain	1994	18.5
F	1=	Carter Creek	1993	Longville	1995	18.3
F	1=	Elam Creek East	1993	Butt Mountain West	1994	3.3
F	1=	Fanani Meadow	1993	Shanghai North	1995	4.1
				Last Chance Springs	1998	21.7
F	5+	Morgan Mountain SOHA	1993	Hole in the Ground SOHA	1994	5.4
F	1=	Pine Creek	1993	Bathtub Lake	1996	15.9
				Pine Creek	1997	15.9
				Bogard Buttes SOHA	1998	12.1
F	3=	Rock Creek	1993	Mud Creek SOHA	1997	5.1
F	1=	Black's Mountain	1994	Upper Stephens Meadow	1995	22.4
F	6+	Gurnsey Creek	1994	Locherman SOHA	1998	10.8
F	3+	Mosquito Springs ^b	1995	Shanghai North	1996	18.1
F	1=	Benner Creek SOHA ^d	1996	Bathtub Lake West	1998	22.3
F	5=	Dyer Mountain	1996	Cairn Butte SOHA ^e	1997	18.1
F	2+	Fleischmann Lake	1996	Benner Creek SOHA	1997	3.2
				Willow Lake South	1998	6.6
F	7=	Swain Meadow	1997	Pegleg Mountain SOHA	1998	11.3
M	5+	Butt Mountain North	1991	Carter Creek	1992	1.2
M	2=	Fanani Meadow	1991	Shanghai North	1992	1.8
M	4=	Fleischmann Lake	1992	Warner Creek	1993	2.4
M	2=	Cub Creek SOHA	1993	Alder Campground	1996	2.7
M	1=	Fanani Meadow ^c	1993	Soda Ravine	1996	11.0
M	6+	Rocky Point SOHA	1993	Locherman SOHA	1995	19.9
M	3=	Miller Ravine	1994	Blue Lead Gulch	1995	4.1
M	5+	Pacific Crest Trail	1994	Butt Mountain West	1995	3.5

Sex	Initial Age	Initial Site	Initial Year	Reobservation Site	Reobs. Year	Km Moved
M	2+	Pine Creek	1994	Benner Creek SOHA	1995	19.5
M	2+	Warner Valley	1994	Elam Creek East	1995	20.8
M	1=	Ashurst Mountain	1995	Logan Mountain	1996	9.6
M	3=	Fleischmann Lake	1995	Peacock Point North	1996	32.7
M	2+	Miller Ravine	1995	Lost Tom	1996	2.7
M	2+	Upper Stephens Mdw	1995	Bennett Knoll	1996	6.9
M	3=	Willow Lake South	1996	Last Chance West	1997	8.9
M	3+	Doe Mountain	1996	Spencer Meadow Trail	1998	2.0
M	4=	Bathtub Lake	1997	Logan Mountain	1998	30.1

^a This owl was equipped with a radio transmitter in 1990 and was not included in the demography study until she was recaptured at Last Chance Creek. ^b This owl was believed to be a non-territorial "floater" in 1995; she was present in the vicinity of the Mosquito Springs owl pair. ^c This owl was believed to be a non-territorial "floater" in 1993; he was observed only once in the vicinity of the Fanani Meadow owl pair. ^d This owl was believed to be a non-territorial "floater" in 1996; she was present in the vicinity of the Benner Creek SOHA owl pair. ^e This owl returned to Dyer Mountain in 1998.

Table 3. Reobservations of California Spotted Owls first banded as juveniles in northeastern California, 1990 through 1998.

Sex	Natal Site	Natal Year	Reobservation Site	Reobs. Year	Km Moved
F	Elam Creek SOHA	1990	Star Butte SOHA	1991	35.3
F	Caim Butte SOHA	1990	Beardsley Mine (PNF ^a)	1992	23.1
F	Moonlight Pass	1990	Swain Meadow	1996	25.0
F	Unknown	1991	Wheeler Sheep Camp (PNF ^a)	1992	
F	Fleischmann Lake	1992	Pine Creek	1993	21.9
F	Kay	1992	Carter Creek	1993	19.5
F	Butt Creek	1992	Longville	1993	12.6
F	Caribou Peak	1992	Mosquito Springs	1994	22.6
F	Unknown	1992	Elam Creek East	1994	
F	Baxter Creek SOHA	1992	Morgan Mountain SOHA	1995	76.4
F	Gold Run Creek	1992	Big Bend SOHA	1997	72.2
F	Rocky Point SOHA	1992	Poplar Creek (PNF ^a)	1997	52.2
F	Fleischmann Lake	1992	Ruffa Ranch	1997	25.0
F	Unknown	1992	Logan Mountain ^b	1997	
F	Unknown	1992	Butt Creek	1998	
F	Susan River SOHA	1993	Black's Mountain	1994	41.6
F	Butt Mountain West	1993	Battle Creek	1998	23.8
F	Turner Mountain	1994	Upper Yellow Creek	1996	31.4
F	Crater Mountain	1995	Benner Creek SOHA	1996	32.2
F	Unknown	1996	Roop Mountain	1997	
F	Pegleg Mountain SOHA	1996	Mud Creek SOHA	1998	22.2
M	Unknown	1991	Missouri Gulch (PNF ^a)	1992	
M	Longville	1991	Peacock Point SOHA	1993	9.3
M	Rice Creek	1991	Elam Creek East	1994	12.3
M	Unknown	1992	Upper Stephens Meadow	1993 1997	
M	Unknown	1992	Bogard Buttes SOHA ^b	1994	
M	Mosquito Springs	1992	Mud Creek SOHA	1994	11.5
M	Unknown	1992	Butt Mountain North ^b	1995	

Sex	Natal Site	Natal Year	Reobservation Site	Reobs. Year	Km Moved
M	Crazy Harry Gulch	1992	Crater Mountain	1995	31.3
M	Unknown	1992	Locherman SOHA ^b	1995	
M	Martin Creek SOHA	1992	Bathtub Lake	1996	34.4
M	Benner Creek SOHA	1992	Jennie Creek	1997	18.2
M	Unknown	1992	Ashpan Butte ^b	1997	
M	Last Chance Campgr.	1992	Bathtub Lake West	1998	28.9
M	Unknown	1993	Upper Stephens Meadow	1994	
M	Warner Creek	1993	Bathtub Lake	1997	22.6
M	Crater Mountain	1994	Ashurst Mountain	1995	11.0
M	Unknown	1994	Jones Valley	1995	
M	Bennett Knoll	1994	Campbell Mountainn	1996	10.2
M	Willow Lake SOHA	1994	Hamilton Mountain SOHA	1998	46.4

^aPNF = Plumas National Forest.

^b These owls were still present in 1998; most other reobserved but unrecaptured owls were present in only one year and often were observed on only one occasion.

Table 4. Age class distribution of California spotted owls identified to age class in northeastern California, 1990 through 1998.

Year	Age class	Male		Female		Both Sexes	
		n	%	n	%	n	%
1990	Adult	38	86.4	32	82.1	70	84.3
	Subadult	6	13.6	7	17.9	13	15.7
1991	Adult	55	93.2	48	92.3	103	92.8
	Subadult	4	6.8	4	7.7	8	7.2
1992	Adult	52	88.1	52	92.9	104	90.4
	Subadult	7	11.9	4	7.1	11	9.6
1993	Adult	46	78.0	42	75.0	88	76.5
	Subadult	13	22.0	14	25.0	27	23.5
1994	Adult	42	79.2	42	85.7	84	82.4
	Subadult	11	20.8	7	14.3	18	17.6
1995	Adult	51	87.9	51	96.2	102	91.9
	Subadult	7	12.1	2	3.8	9	8.1
1996	Adult	49	90.7	43	95.6	92	92.9
	Subadult	5	9.3	2	4.4	7	7.1
1997	Adult	53	98.1	44	95.7	97	97.0
	Subadult	1	1.9	2	4.3	3	3.0
1998	Adult	48	100	43	95.6	91	97.8
	Subadult	0	0	2	4.4	2	2.2

Table 5. Proportion of female California spotted owls nesting in northeastern California, 1990 through 1998.

Year	Age class	n	P	95% CI
1990	Adult	21	0.76	0.53 - 0.90
	Subadult	4	0.00	
	Total	25	0.64	0.43 - 0.81
1991	Adult	28	0.39	0.21 - 0.59
	Subadult	1	0.00	
	Total ^a	30	0.37	0.20 - 0.56
1992	Adult	37	0.97	0.86 - 1.00
	Subadult	1	1.00	
	Total	38	0.97	0.86 - 1.00
1993	Adult	29	0.66	0.46 - 0.81
	Subadult	6	0.17	0.00 - 0.61
	Total	35	0.57	0.39 - 0.73
1994	Adult	28	0.36	0.19 - 0.55
	Subadult	5	0.00	
	Total ^a	35	0.29	0.15 - 0.46
1995	Adult	36	0.33	0.19 - 0.51
	Subadult	0	0.00	
	Total	36	0.33	0.19 - 0.51
1996	Adult	32	0.38	0.21 - 0.56
	Subadult	1	0.00	
	Total	33	0.36	0.20 - 0.55

Year	Age class	n	P	95% CI
1997	Adult	30	0.17	0.06 - 0.35
	Subadult	2	0.00	
	Total ^a	36	0.14	
1998	Adult	22	0.86	0.65 - 0.96
	Subadult	2	0.00	
	Total ^a	26	0.81	

^a Totals are the sum of adults, subadults and owls of undetermined age class.

Table 6. Proportion of nesting female California spotted owls which fledged young in northeastern California, 1990 through 1998.

Year	Age class	n	P	95% CI
1990	Adult	16	0.69	0.45 - 0.92
	Subadult	0		
	Total	16	0.69	0.45 - 0.92
1991	Adult	11	0.55	0.24 - 0.85
	Subadult	0		
	Total	11	0.55	0.24 - 0.85
1992	Adult	36	0.92	0.78 - 0.97
	Subadult	1	0.00	
	Total	37	0.89	0.79 - 0.99
1993	Adult	19	0.68	0.43 - 0.86
	Subadult	1	1.00	
	Total	20	0.70	0.49 - 0.91
1994	Adult	10	0.80	0.54 - 1.00
	Subadult	0		
	Total	10	0.80	0.54 - 1.00
1995	Adult	12	0.58	0.29 - 0.87
	Subadult	0		
	Total	12	0.58	0.29 - 0.87
1996	Adult	12	0.58	0.29 - 0.87
	Subadult	0		
	Total	12	0.58	0.29 - 0.87

Year	Age class	n	P	95% CI
1997	Adult	5	0.40	0.00 - 0.88
	Subadult	0		
	Total	5	0.40	0.00 - 0.88
1998	Adult	19	0.58	0.34 - 0.78
	Subadult	0		
	Total ^a	20	0.55	0.32 - 0.76

^a Totals are the sum of adults, subadults and owls of undetermined age class.

Table 7. Proportion of female California spotted owls which fledged young in northeastern California, 1990 through 1998.

Year	Age class	n	P	95% CI
1990	Adult	30	0.50	0.31 - 0.68
	Subadult	4	0.00	
	Total ^a	38	0.45	0.29 - 0.62
1991	Adult	35	0.23	0.10 - 0.40
	Subadult	2	0.00	
	Total ^a	38	0.21	0.10 - 0.37
1992	Adult	49	0.92	0.80 - 0.97
	Subadult	3	0.67	0.09 - 0.95
	Total ^a	53	0.91	0.79 - 0.96
1993	Adult	33	0.49	0.30 - 0.66
	Subadult	9	0.11	0.00 - 0.47
	Total ^a	43	0.40	0.25 - 0.56
1994	Adult	36	0.33	0.19 - 0.51
	Subadult	5	0.00	
	Total ^a	45	0.27	0.15 - 0.42
1995	Adult	46	0.17	0.08 - 0.31
	Subadult	1	0.00	
	Total	47	0.17	0.08 - 0.31
1996	Adult	40	0.23	0.11 - 0.38
	Subadult	1	0.00	
	Total ^a	46	0.24	0.13 - 0.39

Year	Age class	n	P	95% CI
1997	Adult	37	0.08	0.02 - 0.22
	Subadult	2	0.00	
	Total	45	0.07	0.01 - 0.18
1998	Adult	39	0.62	0.44 - 0.76
	Subadult	2	0	
	Total ^a	42	0.57	0.41 - 0.72

^a Totals are the sum of adults, subadults and owls of undetermined age class.

Table 8. Fecundity of California spotted owls checked for reproduction in northeastern California, 1990 through 1998. Fecundity is defined as the mean number of female young fledged per female^a.

Year	Age class	n	x	95% CI
1990	Adult	30	0.35	0.21 - 0.49
	Subadult	4	0.00	
	Total ^b	38	0.33	0.20 - 0.46
1991	Adult	35	0.19	0.06 - 0.31
	Subadult	2	0.00	
	Total ^b	38	0.17	0.06 - 0.28
1992	Adult	49	1.09	0.95 - 1.23
	Subadult	3	0.33	0.01 - 0.66
	Total ^b	53	1.04	0.90 - 1.18
1993	Adult	33	0.38	0.23 - 0.53
	Subadult	9	0.06	0.00 - 0.16
	Total ^b	43	0.30	0.18 - 0.42
1994	Adult	36	0.28	0.14 - 0.42
	Subadult	5	0.00	
	Total ^b	45	0.22	0.11 - 0.34
1995	Adult	46	0.13	0.04 - 0.22
	Subadult	1	0.00	
	Total	47	0.13	0.04 - 0.21
1996	Adult	40	0.19	0.07 - 0.30
	Subadult	1	0.00	
	Total ^b	46	0.20	0.09 - 0.30

Year	Age class	n	x	95% CI
1997	Adult	37	0.07	0.00 - 0.15
	Subadult	2	0.00	
	Total ^b	45	0.06	0.00 - 0.12
1998	Adult	39	0.46	0.32 - 0.60
	Subadult	2	0	
	Total ^b	42	0.43	0.29 - 0.56

^a We assumed that one half of the juveniles fledged were female.

^b Totals are the sum of adults, subadults and owls of undetermined age class.

Table 9. Productivity of California spotted owls checked for reproduction in northeastern California, 1990 through 1998. Productivity is defined as the mean number of female young fledged per female that fledged young^a.

Year	Age class	n	x	95% CI
1990	Adult	15	0.70	0.57 - 0.83
	Subadult	0	0.00	
	Total ^b	17	0.74	0.61 - 0.86
1991	Adult	8	0.81	0.63 - 0.99
	Subadult	0	0.00	
	Total	8	0.81	0.63 - 0.99
1992	Adult	45	1.19	1.08 - 1.30
	Subadult	2	0.50	
	Total ^b	48	1.15	1.03 - 1.26
1993	Adult	16	0.78	0.66 - 0.91
	Subadult	1	0.50	
	Total	17	0.76	0.64 - 0.89
1994	Adult	12	0.83	0.69 - 0.97
	Subadult	0	0.00	
	Total	12	0.83	0.69 - 0.97
1995	Adult	8	0.75	0.56 - 0.94
	Subadult	0	0.00	
	Total	8	0.75	0.56 - 0.94
1996	Adult	9	0.83	0.67 - 1.00
	Subadult	0	0.00	
	Total ^b	11	0.82	0.67 - 0.97

Year	Age class	n	x	95% CI
1997	Adult	3	0.83	0.51 - 1.16
	Subadult	0		
	Total	3	0.83	0.51 - 1.16
1998	Adult	24	0.75	0.63 - 0.87
	Subadult	0		
	Total	24	0.75	0.63 - 0.87

^a We assumed that one half of the juveniles fledged were female.

^b Totals are the sum of adults, subadults, and owls of undetermined age class.

Table 10. Estimates of apparent survival rate and annual rate of population change (Λ) for California spotted owls in northeastern California, 1990 through 1998.

Parameter	Estimate	Sample size	95% Confidence Interval
Juvenile survival	0.354	210	0.257 - 0.464
Nonjuvenile survival	0.817	191	0.786 - 0.844
Subadult fecundity	0.052	29	0.000 - 0.111
Adult fecundity	0.368	345	0.315 - 0.421
Population change	0.923		0.888 - 0.958

Appendix A. Land ownership of spotted owl sites of the Lassen Study Area.

Owls at Gold Run Creek (and an extra owl at Gold Run Creek East) were found on BLM land in 1990 and 1991. The owls at Dyer Mountain have been found each year within an 80 acre parcel of land which was traded from the Forest Service to Roseburg Resources Company (Roseburg) between the 1990 and 1991 field seasons. The Last Chance Campground spotted owls were also on Roseburg land in 1992 through 1998. The Last Chance Creek West owls were on land managed by Sierra Pacific Industries. The Roop Mountain owls were on land managed by W.M. Beaty and Associates, Inc. (Beaty). The Miller Ravine and the Blue Lead Gulch owls have been found on both Beaty-managed and Forest Service land. The Jennie Creek and Soldier Meadow owls were on private timber company lands (ownership unknown). The Baxter Creek owls were on non-commercial private land in 1992 through 1995. Wheeler Sheep Camp, Lights Creek, Soda Ravine and Moonlight Peak were on the Greenville Ranger District of the Plumas National Forest. The Willow Lake SOHA owls were found within Lassen Volcanic National Park each year. All other sites occurred within the Almanor and Eagle Lake Ranger Districts of the Lassen National Forest, with the exception of the Heart Lake SOHA and Bathtub Lake West, which are on the Hat Creek District.

Appendix B. Departures from Demography Protocol (Miller 1990).

We followed the protocol outlined by Miller (1990) for spotted owl demography studies, with the following exceptions, all of which made our protocol more rigorous:

1. In establishing pair status, 2 nighttime responses from a pair were insufficient. We required that at least one of the pair responses must have occurred during the daytime.
2. We did not use the presence of a brood patch on a female owl (observed in-hand) to conclude that nesting occurred.
3. To determine that a roosting female was not nesting during April, we required that she be observed continuously for at least 60 rather than 30 minutes.
4. To conclude that a pair of owls was not reproductive, a minimum of 4 mice must have been offered to one member of the pair, rather than split between both members of a pair.
5. A mouse must have been available to an owl for at least 30 minutes before it was considered to be "refused" by an owl (no time limit was given in Miller 1990).

LITERATURE CITED

- Burnham, K.P., and D.R. Anderson. 1998. Model Selection and Inference: A Practical Information-Theoretic Approach. Springer-Verlag, New York, 353pp.
- Burnham, K.P., D.R. Anderson and G.C. White. 1996. Meta-analysis of vital rates of the northern spotted owl. *Studies in Avian Biology* 17:92-101.
- Caswell, H. 1989. Matrix population models. Sinauer Associates, Massachusetts.
- Cohen, J.E., S.W. Christensen, and C.P. Goodyear. 1983. A stochastic age-structured population model of the striped bass (*Morone saxatilis*) in the Potomac River. *Canadian J. Fisheries and Aquatic Science* 40:2170-2183.
- Forsman, E.D. 1981. Molt of the Spotted Owl. *Auk* 98: 735-742.
- Forsman, E.D. 1983. Methods and Materials for Locating and Studying Spotted Owls. USDA Forest Service Gen. Tech. Rep. PNW-162. 8 p.
- Franklin, A.B., D.R. Anderson, E.D. Forsman, K.P. Burnham, and F.F. Wagner. 1996a. Methods for collecting and analyzing demographic data on the northern spotted owl. *Studies in Avian Biology*:12-20.
- Franklin, A.B., R.J. Gutierrez, B.R. Noon, and J.P. Ward, Jr. 1996b. Demographic characteristics and trends of northern spotted owl populations in northwestern California. *Studies in Avian Biology* 17:83-91.
- Gutierrez, R.J., J. Verner, K.S. McKelvey, B.R. Noon, G.N. Steger, D.R. Call, W.S. LaHaye, B.B. Bingham, and J.S. Senser. 1992. Habitat Relations of the California Spotted Owl. Chapter 5 in J. Verner, K.S. McKelvey, B.R. Noon, R.J. Gutierrez, G.I. Gould, Jr., and T.W. Beck. *The California Spotted Owl: A Technical Assessment of Its Current Status*. USDA Forest Service Gen. Tech. Rep. PSW-GTR-133.
- Gutierrez, R.J., and M.E. Seamans. 1998. Population ecology in the California Spotted Owl in the Central Sierra Nevada: Annual Results 1997. Annual progress report (contract #53-91S8-4-FW20) to Region 5 of the U.S. Forest Service.
- LaHaye, W.S., Research Associate, Wildlife Department, Humboldt State Univ., Arcata, CA. [Personal communication]. November 1995.
- Lebreton, J.D., K.P. Burnham, J. Clobert, and D.R. Anderson. 1992. Modeling Survival and Testing Biological Hypotheses using Marked Animals: A Unified Approach with Case Studies. *Ecol. Monogr.* 62:67-118.

- Miller, G. 1990. Standards and Guidelines for Establishment and Implementation of Demographic and Density Study Areas for Spotted Owls. Unpubl. Manuscript. Oregon Cooperative Wildlife Research Unit, Corvallis, OR. 8 p.
- Moen, C.A., A.B. Franklin, and R.J. Gutierrez. 1991. Age Determination in Northern Spotted Owls. *Wildlife Soc. Bulletin* 19:489-493.
- Moen, C.A., and R.J. Gutierrez. 1996. Population ecology of the California spotted owl in the central Sierra Nevada: Annual results 1995. Draft report. 27 p.
- Noon, B.R., and C.M. Biles. 1990. Mathematical demography of spotted owls in the Pacific northwest. *Journal of Wildlife Management* 54:18-27.
- Noon, B.R., K.S. McKelvey, D.W. Lutz, W.S. LaHaye, R.J. Gutierrez, and C.A. Moen. 1992. Estimates of Demographic Parameters and Rates of Population Change. Chapter 8 in J. Verner, K.S. McKelvey, B.R. Noon, R.J. Gutierrez, G.I. Gould, Jr., and T.W. Beck. *The California Spotted Owl: A Technical Assessment of Its Current Status*. USDA Forest Service Gen. Tech. Rep. PSW-GTR-133.
- Pradel, R., and J.D. Lebreton. 1991. User's Manual for Program SURGE. Centre d'Ecologie Fonctionnelle et Evolutive C.N.R.S. Montpellier-Cedex, France. 31 p.
- Rundel, P.W., D.J. Parsons, and D.T. Gordon. 1977. Montane and Subalpine Vegetation of the Sierra Nevada and Cascade Ranges. In: Barbour, M.G., and J. Major, eds. *Terrestrial Vegetation of California*. John Wiley & Sons, New York. 1002 p.
- Steger, G.N., T.E. Munton, and G. P. Eberlein. 1993. A Study of Spotted Owl Demographics in the Sierra National Forest and Sequoia and Kings Canyon National Parks. Unpublished report. Pacific Southwest Forest and Range Experiment Station, Fresno, CA. 15 p.
- USDA. 1993a. Decision Notice and Finding of No Significant Impact for California Spotted Owl Sierran Province Interim Guidelines. Forest Service, Pacific Southwest Region. 15 p.
- USDA. 1993b. California Spotted Owl Sierran Province Interim Guidelines Environmental Assessment. Forest Service, Pacific Southwest Region. 279 p.
- USDA. 1995. Draft Environmental Impact Statement, Managing California Spotted Owl Habitat in the Sierra Nevada National Forests of California, An Ecosystem Approach. 501 p.
- Verner, J., K.S. McKelvey, B.R. Noon, R.J. Gutierrez, G.I. Gould, Jr., and T.W. Beck. 1992a. *The California Spotted Owl: A Technical Assessment of Its Current Status*. USDA Forest Service Gen. Tech. Rep. PSW-GTR-133. 285 p.

- Verner, J., R.J. Gutierrez, and G.I. Gould, Jr. 1992b. The California Spotted Owl: General Biology and Ecological Relations. Chapter 4 in J. Verner, K.S. McKelvey, B.R. Noon, R.J. Gutierrez, G.I. Gould, Jr., and T.W. Beck. The California Spotted Owl: A Technical Assessment of Its Current Status. USDA Forest Service Gen. Tech. Rep. PSW-GTR-133.
- White, G.C., and K.P. Burnham. 1999. Program MARK: Survival estimates from populations of marked animals. *Bird Study*. In Press.
- Zabel, C.J., G.N. Steger, K.S. McKelvey, G.P. Eberlein, B.R. Noon, and J. Verner. 1992. Home-Range Size and Habitat-Use Patterns of California Spotted Owls in the Sierra Nevada. Chapter 6 in J. Verner, K.S. McKelvey, B.R. Noon, R.J. Gutierrez, G.I. Gould, Jr., and T.W. Beck. The California Spotted Owl: A Technical Assessment of Its Current Status. USDA Forest Service Gen. Tech. Rep. PSW-GTR-133.
- Zar, J.H. 1984. *Biostatistical Analysis*, second edition. Prentice-Hall, Inc., Englewood Cliffs, NJ. 718 p.

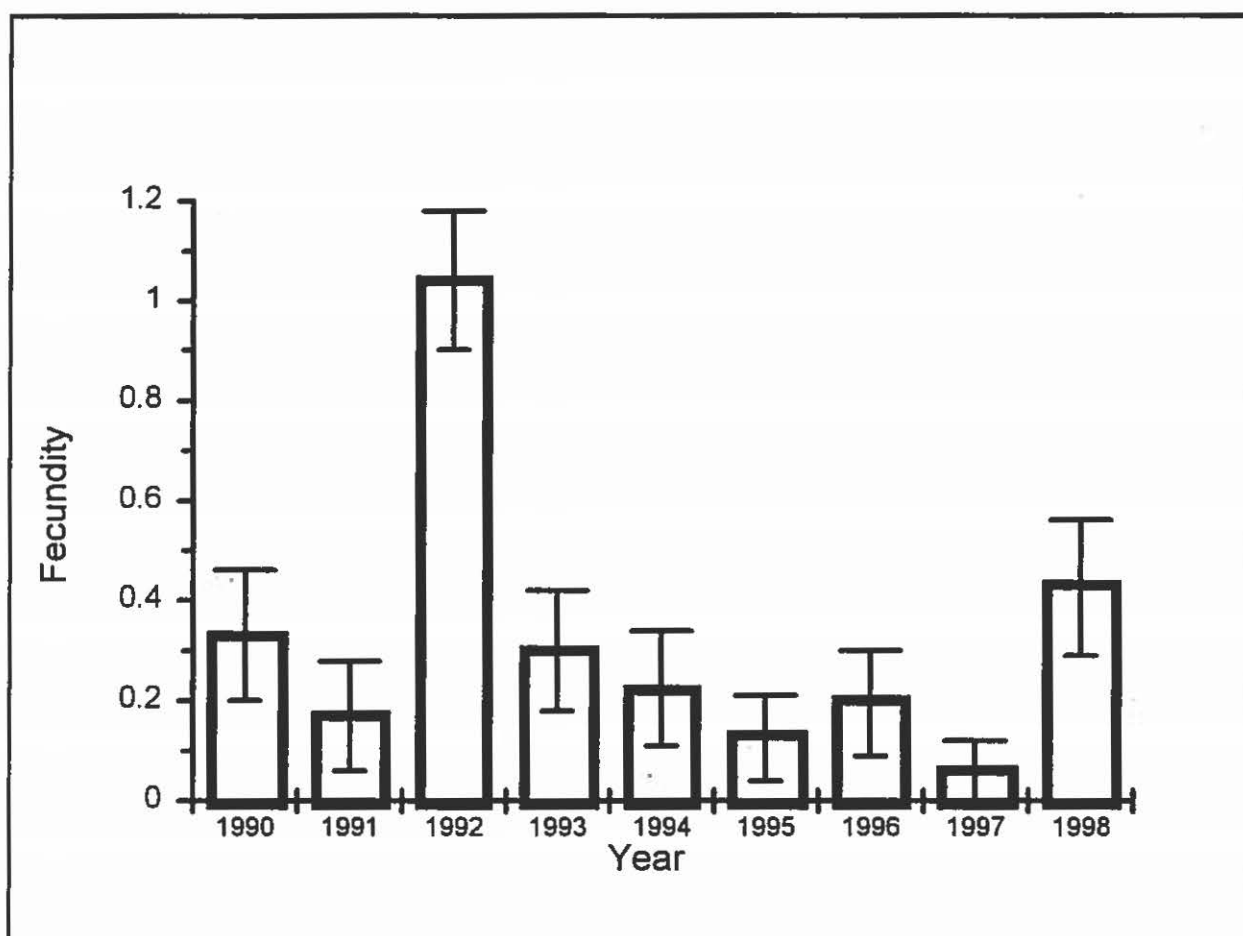


Figure 2. Fecundity (female offspring fledged per female) of California spotted owls (*Strix occidentalis occidentalis*) in northeastern California, 1990 through 1998. Error bars indicate 95% confidence intervals.

USDA Forest Service
PSW Research Station
Forestry Sciences Lab
2081 E. Sierra Ave
Fresno, CA 93710-4639

Russel Lesko
Mary McCutcheon
Lassen Volcanic National Park
Division of Resource Management
38050 Hwy 36E
PO Box 100
Mineral, CA 96063-0100

Russel and Mary:

I have enclosed an application for a collecting permit, a summary of our findings through the 1998 field season, and a draft agreement between Colorado State University and the U.S. Forest Service, Pacific Southwest Research Station, Forestry Science Lab.

The draft agreement details the change over to Colorado State University, the proposed length of the project, and the respective principal investigator and project leaders. The summary report includes preliminary results from information collected since 1990. The sites on table 1a which are in or near the LVNP include Willow Lake SOHA, Bathtub Lake and Bathtub Lake West.

Concerning the collecting permit, I have been working on this project and banding owls since 1995. I have a B.S. in Wildlife Management from Humboldt State University and an M.S. in Biology from California State University, Chico.

If you have questions concerning any of the material included, I would be more than happy to provide necessary additional materials and information.

Sincerely,

A handwritten signature in black ink, appearing to read "Daniel W. H. Shaw", with a long horizontal flourish extending to the right.

Daniel W. H. Shaw

Draft to Roxanne
~2/12/99

**RESEARCH PROPOSAL FOR EXTRAMURAL RESEARCH COOPERATIVE
AGREEMENT/GRANT**

Name and address of
cooperating institution:
Colorado State University
Fort Collins, Colorado, 80523

Contact person for agreement negotiation
(name and telephone number):
Betty Eckert, Sponsored Programs
970-491-1554

Title of research: Demography and Habitat Relationships of the California Spotted Owl on
the Lassen National Forest.

Principal Investigator (name, department, and telephone number): Dr. David Anderson,
970-491-5396

Type of research: x Basic Type of research agreement:
Applied Entire x Open-end Grant
Open-end renewal

Proposed duration of study: 3 years Proposed start date: 1 Mar 1999

Authorized Departmental Officer's
Delegated Representative (ADODR): William F. Laudenslayer, Jr.

Research Work Unit No. PSW-4202

Proposed funding: Forest Service share	<u>\$107,122</u>
Cooperator share	<u>\$ 21,424</u>
est. TOTAL	<u>\$128,546</u>

Coop Aid
Contingency
Budget: x Yes
 No

RWU Operating MC: 649804

We certify that we have reviewed the attached proposal and have determined
that the research meets the criteria shown on the reverse for a cooperative agreement.

Proposal submitted
and approved by:

Concurrence:

William F. Laudenslayer, Jr. 2/12/99
(Project Leader) (date)

(Assistant Station (date)
Director/Program Mgr.)

COMPETITION DETERMINATION

- A. The proposed cooperative agreement/grant may be excepted from
competition for reason(s) # 6 shown on the reverse of this form.
- B. The proposed cooperative agreement/grant is excepted from competition
because it is impracticable to secure competition (reason #6).
Documentation to support this determination is attached to this sheet.

Station Director (date)

REVERSE OF FACE SHEET

Cooperative Agreement

1. The primary purpose is to provide assistance rather than acquisition by purchase, or lease, or property or services for the direct benefit of the Forest Service.
2. The Forest Service and recipient have a mutual interest and shared responsibility in planning and conducting the research.
3. The Forest Service will be substantially involved during performance of the research. Substantial involvement includes:
 - a. The Forest Service will collaborate in the preparation of study/work plans.
 - b. The Forest Service will review and approve one stage before work begins on the next stage during the period of activity covered by the agreement.
 - c. The Forest Service will review and approve proposed sub-contracts or contracts except for supplies and services which are both necessary for and merely incidental to the performance of the work.
 - d. The Forest Service may be involved in the selection of key recipient personnel. (This does not include provisions for a named principal investigator for research activities.)
 - e. The Forest Service and recipient will collaborate or jointly participate in the research activity.
 - f. The Forest Service may limit the recipient's discretion on scope of service, organizational structure, staffing, mode of operation or other management processes.

Grant

1. The primary purpose is to provide assistance rather than acquisition by purchase, or lease, or property or services for the direct benefit of the Forest Service.
2. The Forest Service will not be substantially involved during performance of the research. No substantial involvement is indicated when:
 - a. The recipient can expect to run the research within the terms of the grant.
 - b. The Forest Service approval of recipient plans is made prior to award.
 - c. The Forest Service performs normal stewardship, i.e., site visits, technical and financial reports, audit.
 - d. The Forest Service will be involved when correction is needed for unanticipated deficiencies of research activity and financial aspects from the terms of the grant.
 - e. The Forest Service will provide technical assistance if (1) it is requested by the recipient, (2) the recipient is not required to follow it, or (3) the recipient is required to follow it but it is provided by the agency in advance of the award.

REVERSE OF FACE SHEET, continued

FSM 1580.71 Competition. Stations must seek competition in the award of grants and cooperative agreements for research projects. Exceptions may be made, however, when the awarding official determines that competition is not appropriate for one or more of the following reasons:

1. Statutorily mandated awards or those based upon a statutory formula.
2. Property or service awards (non-monetary).
3. Awards of less than \$75,000.
4. Awards to fund work that was started under a previous award.
5. Awards that cannot be delayed due to an emergency or substantial danger to health or safety.
6. Awards where it is impracticable to secure competition. (When this item seems to apply, see FSH 1509.11, Section 22.2.1, for required documentation.)

FSH 1509.11 22.2 - Project Solicitation

1. When a Station determines that competition for a proposed agreement is not practical, this position must be supported by documentation. Typically, a Project Leader should write the Station Director requesting approval for the proposed grant or cooperative agreement. This letter should include the following:

- a. A brief statement of the research to be conducted.
- b. The cooperator involved.
- c. Why this cooperator is the best qualified.
- d. A list of the cooperator's resources.
- e. A description of any emergency or substantial danger to health or safety.
- f. Cost savings or improved effectiveness, if any.
- g. A critical need for timeliness.
- h. Other specific criteria met by the selected cooperator that might demonstrate the award is in the best interest of the Federal government and necessary to accomplish the research.

Justification Statement:

Dr. David Anderson, is an experienced biologist with an excellent analytical background; he will serve as Principal Investigator for the term of the agreement. Dr. Barry Noon will also provide expertise to the project. Dr. Noon has a great deal of experience working with both the Northern and California subspecies of Spotted Owls. His experience will greatly facilitate the completion of the work. Jennifer Blakesley will serve as project leader. Ms Blakesley also has a great deal of experience working with California Spotted Owls and will ensure successful completion of the study.

Background/Problem Statement:

We propose to continue a long-term study of a population of California spotted owls (*Strix occidentalis occidentalis*) in northeastern California, begun in 1990. The study has two primary goals, (1) to estimate demographic parameters (birth and death rates) in order to compute the trend of the owl population; and (2) to explore the relationships between forest structure/composition and population dynamics. The second objective is covered under a current, separate contract. Preliminary results suggest that the population of territorial spotted owls in the Lassen study area decreased at approximately 7.7% per year from 1990-1998 (annual rate of population change = 0.923; Blakesley et al. 1999).

Objectives:

The objectives of this study are to:

1. Estimate the following demographic parameters for spotted owls:
 - a. age and sex-specific survival rates;
 - b. nesting rate, nest success rate, productivity and fecundity;
 - c. the annual, finite rate of population change over the study interval.
 - d. describe the sex and age class structure of the spotted owl population.
2. Estimate the degree of site and mate fidelity for spotted owls.
3. Describe dispersal movements of juvenile spotted owls.
4. Assess the current status of the spotted owl in Lassen National Forest.
5. Provide guidance to Lassen National Forest managers so that they can more effectively manage for California spotted owls and fulfill their legal obligations under the National Forest Management Act.

Methods and Geographical Location where work will be performed:

Field Methods

The methods we will use to locate, identify and capture spotted owls are similar to other spotted owl demographic studies (Forsman 1983, Franklin et al. 1996). To summarize briefly: Owls will be initially located at night by vocally imitating their calls. All habitat types along calling routes will be surveyed. When owls respond by calling back, field crew personnel will estimate each owl's location on a topographical map using one or more compass bearings taken from the observer to the calling owl. The following day, a field crew will attempt to visually locate the owl by hiking to the area where the owl was detected the previous night.

When owls are found, their reproductive status will be determined by following a standardized protocol (Miller 1990; Franklin et al. 1996) based on the owl's response to live mice. In general, an owl which is nesting or whose mate is nesting will take mice to the nest; if fledged young are present, a parent will take mice to the young; if an owl is not nesting and no fledglings are present, the owl will eat and/or cache the mice. Field crews will follow a strict protocol during the "mousing" procedure (Miller 1990) to eliminate observer bias in drawing conclusions about owl reproductive status.

Social status of non-juvenile owls will be determined on each visit; an overall determination of occupancy and, if occupied, social status will be made for each site (Miller

1990). In establishing pair status a male and female owl must be detected together on two or more occasions, with at least one pair detection occurring in the daytime.

During daytime visits, owls will be captured and banded with unique color bands, or, if already banded, identified by observation of the color bands. Whenever possible, the age class of each owl (juvenile [young of the year], first year subadult, second year subadult, adult) will be determined based on plumage characteristics (Forsman 1981, Moen et al. 1991). Juvenile owls will be banded with a cohort (year-specific color) band that identified them as juveniles fledged in a specific year. When an owl wearing a juvenile band is subsequently relocated as a subadult or adult, a concerted effort will be made to recapture it and band it with a unique color band. Field crews will attempt to locate and identify all subadult and adult owls which had color bands during at least one of the previous two years. Any owl not located will be searched for systematically for up to two subsequent field seasons, following a standardized protocol (Miller 1990). The search will entail a complete nighttime survey of a 1.5 mile radius area centered around the last or most representative roost location of the owl in question (e.g., centered around the previous year's nest tree). If an owl is replaced at a site by another owl of the same sex, two complete searches will be conducted. If the owl has not been replaced, six visits to the site including four complete searches will be conducted each year (Miller 1990).

Estimating Demographic Parameters

Estimates of age-specific fecundity will be computed according to standardized methods (Franklin et al. 1996, Blakesley et al. 1999). We will estimate survival rates using model nomenclature, selection and testing procedures outlined in Franklin et al. (1996). We will use program MARK which allows for modeling the effects of time, sex, age class and interactions between these factors on recapture probability and survival rate. We will use Akaike's Information Criterion (AIC) to select the simplest model that fits our data (Lebreton et al. 1992).

We will use a 3-stage Lefkovich matrix model to estimate the annual finite rate of population change (Noon and Biles 1990; Noon et al. 1992). Stages are generally associated with age and for spotted owls included juvenile ($0 < \text{age} < 1$ year), subadult ($1 < \text{age} < 2$, and $2 < \text{age} < 3$), and adult birds ($\text{age} > 3$). The size of the matrix (number of stages) is determined by the number of distinct stage (age)-class categories resulting from parameter estimation procedures for fecundity and survival.

Study Area

The Lassen study area encompasses approximately 500 square miles of National Forest land in northeastern California. The majority of the study area occurs on the Almanor and Eagle Lake Districts of the Lassen National Forest (LNF), with two owl sites on the Hat Creek District of the LNF and four sites on the Plumas NF.

The study area lies at the southern end of the Cascade Geographic Province. However, it is included in the Sierra Nevada Province for spotted owl management purposes (e.g., USDA 1993a, 1993b, Verner et al. 1992, USDA 1995), as it lies at the northern limit of the distribution of the California spotted owl. The majority of forested stands on the study area were classified as white fir-mixed conifer ("mixed conifer") or red fir; both are typical of the Sierra Nevada (Rundel et al. 1977). Mixed conifer stands included white fir (*Abies concolor*), sugar pine (*Pinus lambertiana*), ponderosa pine (*Pinus ponderosa*), incense cedar (*Calocedrus decurrens*) and Douglas fir (*Pseudotsuga menziesii*). Red fir (*Abies magnifica*) stands were monocultures or contained occasional white firs. Elevations on the study area ranged from 4000 to 7000 feet.

Staging Intervals:

Preparation for field work will begin on 1 February 1999. Field work will be conducted from April through September 1999. Yearly interim report will be submitted to the U.S. Forest Service by 31 December of 1999, 2000, and 2001. A final report consisting of chapters of a PhD Dissertation will be completed by 1 October 2002.

LITERATURE CITED

- Blakesley, J.A., B.R. Noon and C.J. Zabel. 1999. Demographic Parameters of the California Spotted Owl on the Lassen National Forest; Preliminary Results (1990-1998). Unpubl. Report.
- Forsman, E.D. 1981. Molt of the Spotted Owl. *Auk* 98: 735-742.
- Forsman, E.D. 1983. Methods and Materials for Locating and Studying Spotted Owls. USDA Forest Service Gen. Tech. Rep. PNW-162. 8 p.
- Franklin, A.B., D.R. Anderson, E.D. Forsman, K.P. Burnham, and F.F. Wagner. 1996. Methods for collecting and analyzing demographic data on the northern spotted owl. *Studies in Avian Biology*:12-20.
- Lebreton, J.D., K.P. Burnham, J. Clobert, and D.R. Anderson. 1992. Modeling Survival and Testing Biological Hypotheses using Marked Animals: A Unified Approach with Case Studies. *Ecol. Monogr.* 62:67-118.
- Miller, G. 1990. Standards and Guidelines for Establishment and Implementation of Demographic and Density Study Areas for Spotted Owls. Unpubl. Manuscript. Oregon Cooperative Wildlife Research Unit, Corvallis, OR. 8 p.
- Moen, C.A., A.B. Franklin, and R.J. Gutierrez. 1991. Age Determination in Northern Spotted Owls. *Wildlife Soc. Bulletin* 19:489-493.
- Noon, B.R., and C.M. Biles. 1990. Mathematical demography of spotted owls in the Pacific northwest. *Journal of Wildlife Management* 54:18-27.
- Noon, B.R., K.S. McKelvey, D.W. Lutz, W.S. LaHaye, R.J. Gutierrez, and C.A. Moen. 1992. Estimates of Demographic Parameters and Rates of Population Change. Chapter 8 in J. Verner, K.S. McKelvey, B.R. Noon, R.J. Gutierrez, G.I. Gould, Jr., and T.W. Beck. *The California Spotted Owl: A Technical Assessment of Its Current Status*. USDA Forest Service Gen. Tech. Rep. PSW-GTR-133.
- Rundel, P.W., D.J. Parsons, and D.T. Gordon. 1977. Montane and Subalpine Vegetation of the Sierra Nevada and Cascade Ranges. In: Barbour, M.G., and J. Major, eds. *Terrestrial Vegetation of California*. John Wiley & Sons, New York. 1002 p.
- USDA. 1993a. Decision Notice and Finding of No Significant Impact for California Spotted Owl Sierran Province Interim Guidelines. Forest Service, Pacific Southwest Region. 15 p.
- USDA. 1993b. California Spotted Owl Sierran Province Interim Guidelines Environmental Assessment. Forest Service, Pacific Southwest Region. 279 p.
- USDA. 1995. Draft Environmental Impact Statement, Managing California Spotted Owl Habitat in the Sierra Nevada National Forests of California, An Ecosystem Approach. 501 p.
- Verner, J., K.S. McKelvey, B.R. Noon, R.J. Gutierrez, G.I. Gould, Jr., and T.W. Beck. 1992. *The California Spotted Owl: A Technical Assessment of Its Current Status*. USDA Forest Service Gen. Tech. Rep. PSW-GTR-133. 285 p.