

Demographic Parameters of the California Spotted Owl  
on the Lassen National Forest;  
Preliminary Results (1990-1995)

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(Demographic)

# ABSTRACT

From 1990 through 1995 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 >170 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 253 breeding records of female owls, we were also able to estimate age-specific fecundity rates. All demographic parameters showed year-to-year variation, being most pronounced for the reproductive parameters. Fecundity ranged from 0.13 to 1.04 female offspring per female. Productivity ranged from 0.74 to 1.15 female offspring per productive female. All reproductive parameters measured (nesting rate, nest success, fecundity, productivity) were higher in 1992 than other years. The magnitude of the 1992 breeding pulse was reflected in unusually high proportions of non-juvenile owls in the subadult age class in 1993 and 1994. Based on the combined capture histories of all owls > 1 year old, our estimate of non-juvenile survival was 0.802. Twenty-two owls banded as juveniles were reobserved in subsequent years, up to 76 km from their natal site. However, this sample was too small for a reliable estimate of juvenile survival. Instead, we used estimates of juvenile survival from northern spotted owls (S. o. caurina) and from California spotted owls in southern California. We believe these estimates probably bracket the true juvenile survival rate for owls on our study area. Based on a two-stage Leslie projection matrix, with separate estimates of survival for juvenile and nonjuvenile stages, and separate fecundity estimates for adult and subadult females, we computed an annual rate of population change ( $\Lambda$ ) = 0.934. This rate of change suggests that the population of territorial spotted owls in our Lassen study area decreased at approximately 6.6% per year from 1990-1995. 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 status of the California subspecies of the spotted owl (Strix occidentalis occidentalis) has been recently reviewed (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 ( $\Lambda$ ) 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  $\Lambda$  were computed for studies in the Eldorado National Forest (NF) and Sequoia/Kings Canyon National Park. These estimates were imprecise, and  $\Lambda$  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  $H_0: \Lambda \geq 1.0$ , 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 Sierran 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. For the Lassen study area, demographic data from six years of mark-recapture study allow a reliable estimate of the rate and trend of population change from 1990-95.

### 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.
2. Describe the sex and age class structure of the spotted owl population.
3. Estimate the degree of site and mate fidelity for spotted owls.
4. Describe dispersal movements of juvenile spotted owls.

### 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 1 owl site on the Hat Creek Ranger District of the LNF and 2 sites on the Plumas National Forest. In addition, some owls were found on land immediately adjacent to the LNF which was owned or administered by private timber companies (4 sites), the National Park Service (1 site), the Bureau of Land Management (1 site), or private individuals (1 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 may be pure or contain white fir. Elevations on the study area ranged from 4000 to 7000 feet.

### METHODS

#### Field Methods

Our study of spotted owl demography was initiated in 1990 and has continued through 1995. The study is planned to continue at least through 1996.

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. 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. 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 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 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, owls will take mice to the young; if the 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 was determined on each visit; an overall determination of 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 2 years. Any owl not initially located was searched for systematically for up to two subsequent breeding seasons, following a standardized protocol (Miller 1990, Appendix B). The search entailed a complete night-time 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 was replaced at a site by another owl of the same sex, 2 complete searches were conducted each year. If the owl had not been replaced, 6 visits to the site including 4 complete searches were conducted each year (Miller 1990).

Owl sites were delimited on the basis of the owls' behavior, movement patterns, and reproductive histories. Sites roughly approximated owl territories without defining territory boundaries. This process was most accurate when owls were individually recognizable (by unique color band combinations) 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 site may sometimes have been arbitrary. For purposes of estimating demographic parameters, however, the unit of observation and analysis is the owl and its capture history. The site designation is simply 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 nor to estimate spotted owl density.

### 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  $\geq 1$  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 (*S. o. caurina*) 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 using model nomenclature, selection and testing procedures outlined in Franklin et al. (1996a). These methods use Program SURGE (Pradel and Lebreton 1991), 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 simplest model that fit our data (Lebreton et al. 1992).

We used a 2-stage Lefkovich matrix model to estimate  $\lambda$ , the annual finite rate of population change (Noon and Biles 1990; Noon et al. 1992). The size of the matrix was determined by the number of 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 (Zar 1984). In cases of  $2 \times 2$  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  $H_0: \lambda \geq 1$  versus the alternative,  $H_1: \lambda < 1.0$ . A standard one-tailed Z statistic was used to test the null hypothesis.

### 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 105 sites from 1990 through 1995. Owl pairs occurred at 69 distinct sites in at least one year of our study (Tables 1A and 1B). It is possible that many of the remaining sites ( $n=36$ ) were also occupied by owl pairs, but we did not have sufficient information to verify pair status at these sites. Between 1990-95, 158 juvenile owls and 160 adult and subadult owls were banded at 74 distinct sites.

Seventeen non-juvenile (subadult and adult) owls were observed to move between sites (9 females and 8 males; Table 2). Distances moved ranged from 1.2 to 22.4 km. Six of the females and at least one of the males were subadults when occupying their initial sites.

Twenty-two owls banded as juveniles were reobserved in subsequent years (10 females and 12 males; Table 3). Fifty percent of these owls were recaptured and given a unique color band combination. Straightline distances moved from natal sites to points of recapture ranged from 9.3 to 76.4 km.

Subadults accounted for 7.2 (1991) to 23.5 percent (1993) of the non-juvenile owls observed each year (Table 4). The null hypothesis that there were no yearly differences in the proportion of subadult owls in the population was rejected ( $X^2 = 19.69$ ,  $df = 5$ ,  $P = 0.001$ ). Further tests showed that the proportion of subadults was not significantly different among 1990, 1991, 1992, 1994 and 1995, nor among 1990, 1993 and 1994 ( $P > 0.05$ ).

### Reproduction

The proportion of females nesting ranged from 0.29 in 1994 to 0.97 in 1992 (Table 5). The null hypothesis of no annual differences in the proportion of all female owls nesting was rejected ( $X^2 = 48.70$ ,  $df = 5$ ,  $P < 0.001$ ). Subsequent tests based on subsamples of the data showed that nesting rates were lower in 1991, 1993, 1994 and 1995 than other years ( $P < 0.05$ ) and higher in 1992 than all other years ( $P < 0.001$ ). The proportion of adult female owls nesting ranged from 0.33 in 1995 to 0.97 in 1992 (Table 5). The between year difference in proportions was significant ( $X^2 = 45.74$ ,  $df = 5$ ,  $P < 0.001$ ). The proportion of adults nesting in 1991, 1994 and 1995 was significantly lower than all other years and the proportion nesting in 1992 was significantly higher than other years ( $P < 0.05$ ).

The proportion of nesting females which successfully fledged young ranged from 0.55 in 1991 to 0.89 in 1992 (Table 6). The statistical significance of the observed annual variation could not be tested because 33% of cells in the contingency table had expected values less than 5.

The proportion of all females which successfully fledged young ranged from 0.17 in 1995 to 0.91 in 1992 (Table 7). Annual variation was significant ( $X^2 = 74.92$ ,  $df = 5$ ,  $P < 0.001$ ). The proportion of females fledging young in 1991, 1993, 1994 and 1995 was lower than other years ( $P < 0.05$ ). The proportion fledging young in 1992 was significantly higher than in all other years ( $P < 0.001$ ).

Fecundity of spotted owls ranged from 0.13 in 1995 to 1.04 in 1992 (Table 8). The annual differences in fecundity were significant ( $X^2 = 95.93$ ,  $df = 5$ ,  $P < 0.001$ ). Multiple comparison tests showed that fecundity in 1992 was significantly greater than in all other years ( $P < 0.05$ ). Fecundity of adult female owls was significantly greater than that of subadult females ( $Z = 3.306$ ,  $P < 0.001$ ).

Data are also available from owl pairs observed during the daytime in 1987 ( $n=11$ ), 1988 ( $n=22$ ), and 1989 ( $n=36$ ) (Lassen NF, 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 breeding age female during 1987, 1988 and 1989, respectively (Fig. 2). These estimates suggest that fecundity was higher in 1988 and possibly 1989 than any year of our study excluding 1992 (Table 8; Fig. 2). 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 2 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 ( $X^2 = 24.54$ ,  $df = 5$ ,

$P < 0.001$ ). Multiple comparisons showed significant differences only between 1990 and 1992 ( $P < 0.05$ ). Failure to detect a difference between 1992 and 1995 was apparently due to the small sample size of productive females in 1995 ( $n = 8$ ).

### Survival

Based on AIC values (Lebreton et al. 1992), the best model provided separate survival rate estimates for juvenile (age  $< 1$  year) and non-juvenile (age  $\geq 1$  year) owls and separate estimates of recapture rate for each age class (juveniles, subadults [ $1 \leq \text{age} \leq 2$  yrs] and adults). The overall estimate for mean, annual non-juvenile survival rate was 0.802 (95% CI = 0.759 - 0.839; Table 10). Although modeling time and sex effects of non-juvenile owls did not produce the most parsimonious model, results of this model are presented (Fig. 3) to illustrate the lack of evidence for time trends in the survival data.

Our juvenile survival rate estimate, 0.200, was probably biased low (Burnham et al. 1996). Juveniles which dispersed outside the study area, survived at least one year, and were never recaptured were treated as mortalities. Therefore, we used the estimates of annual juvenile survival rate from the San Bernardino Mountain (SBM) study area (0.349; W.S. LaHaye, personal communication) and from the northern spotted owl (0.258; Burnham et al. 1996) in calculating Lambda. The SBM study area comprised a geographically isolated mountain range; there were no records of juvenile spotted owls which dispersed from that study area and survived (W.S. LaHaye, personal communication). The northern spotted owl juvenile survival estimates were adjusted to account for emigration.

### Population Trend

The estimate of the annual rate of change is based on the mean values of the demographic rates (Table 10). Using the SBM juvenile survival rate, the estimate of Lambda (mean annual rate of population change) for our study population was 0.934 (95% CI = 0.909 - 0.960), which was significantly different from a stationary population (1-tailed  $Z = 2.52$ ,  $P = 0.006$ ). This estimates a 6.6% annual rate of population decline from 1990-95. Based on the juvenile survival rate for northern spotted owls, the estimate of Lambda was 0.895 (95% CI = 0.845 - 0.945,  $Z = 4.04$ ,  $P < 0.0001$ ), suggesting a 10.5% annual rate of decline (Table 10). Values for the partial derivatives of each parameter estimate with respect to Lambda indicate that Lambda is most sensitive to variation in the survival rates of females  $\geq 1$  year old.

### DISCUSSION

Inferences drawn from our study can, at most, be extended to the resident, territorial population of owls occupying public lands within the southern Cascades/northern Sierra Province for the period 1990-95. The most limited scope of inference is the population of owls sampled within our study area. Limits to inference must recognize that owl sites within our study area were not selected at random.

### Reproduction

All measures of reproductive success showed extensive annual variation. The proportion of female owls nesting, the proportion fledging young, and

fecundity were all significantly greater in 1992 than any other year. However, there was no evidence of a declining time trend (Fig. 2). Over half of the broods observed in 1992 were composed of triplets; no triplets were observed in any other years. As a result, the point estimate for fecundity in 1992 was 3-8 times greater than in any other year. The exceptional reproductive output in 1992 was reflected in a greater proportion of subadults observed in 1993. Annual variation in reproductive parameters of California spotted owls, with a peak in 1992, has also been reported from demographic studies on the Sierra National Forest and Sequoia and Kings Canyon National Parks (Steger et al. 1993) and the Eldorado NF (Moen and Gutierrez, draft report, Feb. 1996).

### Survival

The non-juvenile (owls > 1 yr old) survival rate estimate for our study was 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 survivorship (Fig. 3). The observed year-to-year variation in our estimates probably represents some combination of sampling error and true process variation.

The finite rate of population change ( $\Lambda$ ) is most affected by the mean and variance of the survival rate of owls  $\geq 1$  year old (Noon and Biles 1990). If the remaining demographic parameters were to remain constant, the survival rate of female owls  $\geq 1$  year old would have to increase to  $\geq 0.87$  to have a stationary population.

### Population Trend

Our estimates of the demographic rates (Table 10) provide a  $\Lambda$  estimate = 0.934, which is significantly less than 1.0. Given unbiased parameter estimates, the true  $\Lambda$  lies between 0.909 and 0.960 with a 95% probability. This  $\Lambda$  value suggests that the territorial population of owls in the Lassen study area declined at an average of 6.6% per year from 1990-95. In comparison,  $\Lambda$  for the northern spotted owl throughout its range was estimated to be 0.955 (95% CI = 0.916 - 0.993) from 1985-1993 (Burnham et al. 1996).

Valid estimates of  $\Lambda$  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. These assumptions, relative to spotted owls, are discussed in detail in Noon et al. (1992). For the purposes of trend estimates, the most severe potential problem is the underestimation of juvenile survival rate, leading to a negative bias in the estimate of  $\Lambda$ . We attempted to address this possible bias by basing our  $\Lambda$  estimate on the highest juvenile survival rate known for California spotted owls.

If the true rate of change were as low as 4% per year ( $\Lambda = 0.960$ , Table 10), and the demographic rates remained at their current mean values, the population would be forecast to decline by one-half within approximately 17 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).

#### Management Implications

Verner et al. (1992a:24) listed eight major factors of concern in habitats of 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 at least be maintained, and possibly expanded to retain more large-tree components (old trees, snags, and downed logs) in harvest units.

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 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.

Lambda shows its greatest sensitivity to variation in subadult/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.

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Table 1A. Social status of California spotted owls at 105 sites on the Lassen National Forest, 1990 through 1995.

| SITE NAME              | SOCIAL STATUS <sup>a</sup> |      |      |      |      |      |
|------------------------|----------------------------|------|------|------|------|------|
|                        | 1990                       | 1991 | 1992 | 1993 | 1994 | 1995 |
| ALDER CREEK SOHA       | N.S.                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| ASHURST MOUNTAIN       | MRS                        | N.S. | N.S. | N.S. | N.S. | MR   |
| BATHTUB LAKE           | N.S.                       | PAIR | N.S. | N.S. | N.S. | N.S. |
| BAXTER CREEK SOHA      | PAIR                       | PAIR | PAIR | PAIR | PAIR | MP   |
| BEAR FLAT              | N.S.                       | MRFP | 0    | FP   | 0    | 0    |
| BENNER CREEK SOHA      | PAIR                       | PAIR | PAIR | PAIR | PAIR | MRFR |
| BENNER SPRINGS         | 0                          | 0    | 0    | FR   | 0    | 0    |
| BENNETT KNOLL          | TX                         | TX   | MP   | PAIR | PAIR | PAIR |
| BIG BEND SOHA          | MPFP                       | MPFP | N.S. | N.S. | N.S. | N.S. |
| BLACK'S MOUNTAIN       | N.S.                       | N.S. | N.S. | N.S. | MPFP | N.S. |
| BLUE LEAD GULCH        | N.S.                       | N.S. | N.S. | MRFR | N.S. | MRFR |
| BOGARD BUTTES SOHA     | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| BUTT CREEK             | PAIR                       | MRFR | PAIR | PAIR | MRFR | PAIR |
| BUTT MOUNTAIN NORTH    | PAIR                       | PAIR | PAIR | PAIR | PAIR | MRFR |
| BUTT MOUNTAIN WEST     | PAIR                       | PAIR | PAIR | PAIR | MRFP | PAIR |
| CAIRN BUTTE SOHA       | PAIR                       | PAIR | PAIR | PAIR | MRFP | 0    |
| CARIBOU PEAK           | PAIR                       | PAIR | PAIR | 0    | 0    | N.S. |
| CARTER CREEK           | N.S.                       | N.S. | PAIR | PAIR | PAIR | PAIR |
| CHRISTIE HILL          | FRS                        | MRFR | PAIR | MR   | MP   | MR   |
| COLBY CREEK            | N.S.                       | N.S. | N.S. | N.S. | N.S. | FP   |
| COLD CREEK             | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| CONE LAKE              | N.S.                       | MR   | N.S. | 0    | 0    | MR   |
| COPPERVALE/101         | PAIR                       | PAIR | PAIR | PAIR | 0    | MPFP |
| CRATER MOUNTAIN        | N.S.                       | N.S. | N.S. | N.S. | PAIR | PAIR |
| CRAZY HARRY GULCH      | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| CUB CREEK SOHA         | MRS                        | PAIR | MPFP | MRFP | MRFP | MRFR |
| CUMMINGS SOHA          | TX                         | TX   | TX   | MP   | N.S. | N.S. |
| DOMINGO SPRINGS        | N.S.                       | N.S. | N.S. | N.S. | N.S. | MRFP |
| DYER MOUNTAIN          | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| EAGLE ROCKS            | N.S.                       | MRFP | PAIR | N.S. | N.S. | N.S. |
| ELAM CREEK EAST        | N.S.                       | N.S. | PAIR | PAIR | MRFR | MRFR |
| ELAM CREEK SOHA        | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| ELAM CREEK WEST        | N.S.                       | N.S. | N.S. | N.S. | N.S. | MR   |
| FANANI MEADOW          | MRFP                       | PAIR | MRS  | PAIR | MPFP | 0    |
| FANANI SOUTH           | N.S.                       | N.S. | N.S. | PAIR | MPFR | PAIR |
| FEATHER RIVER HOMESITE | N.S.                       | N.S. | N.S. | MP   | N.S. | N.S. |
| FLEISCHMANN LAKE       | PAIR                       | MR   | PAIR | MRFP | PAIR | PAIR |
| GOLD RUN CREEK         | PAIR                       | PAIR | PAIR | PAIR | 0    | MP   |
| GOLD RUN EAST          | N.S.                       | FP   | 0    | 0    | 0    | 0    |
| GRAY'S FLAT            | N.S.                       | N.S. | N.S. | N.S. | N.S. | MR   |
| GRIZZLY CREEK SOHA     | PAIR                       | PAIR | PAIR | MPFP | N.S. | N.S. |
| GURNSEY CREEK          | N.S.                       | MRFP | PAIR | PAIR | PAIR | 0    |
| HAMILTON MT. SOHA      | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| HAMPTON BUTTE          | MPFP                       | MP   | N.S. | N.S. | N.S. | N.S. |
| HEART LAKE SOHA        | PAIR                       | PAIR | MR   | MRFP | N.S. | N.S. |
| HOLE IN GROUND SOHA    | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |

(continued)

Table 1A (cont.)

| SITE NAME               | SOCIAL STATUS <sup>a</sup> |      |      |      |      |      |
|-------------------------|----------------------------|------|------|------|------|------|
|                         | 1990                       | 1991 | 1992 | 1993 | 1994 | 1995 |
| HOMER LAKE              | MP                         | N.S. | N.S. | N.S. | N.S. | N.S. |
| HUMBOLDT SUMMIT         | MRFP                       | FP   | N.S. | MPFP | N.S. | N.S. |
| JENNIE MT SOHA          | TX                         | TX   | PAIR | MRFR | MRFP | MPFP |
| JONES VALLEY            | N.S.                       | N.S. | N.S. | N.S. | N.S. | MP   |
| KAY TIMBER SALE         | PAIR                       | PAIR | PAIR | PAIR | MPFR | PAIR |
| KEDDIE RIDGE SOHA       | N.S.                       | MPFP | N.S. | N.S. | N.S. | N.S. |
| KEDDIE RIDGE T. SALE    | PAIR                       | PAIR | N.S. | N.S. | N.S. | N.S. |
| LAST CHANCE CAMPGROUND  | N.S.                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| LAST CHANCE CREEK       | N.S.                       | MR   | PAIR | TX   | MRFR | MRFR |
| LAST CHANCE CR. WEST    | N.S.                       | N.S. | N.S. | N.S. | N.S. | MPFP |
| LIGHTS CREEK            | N.S.                       | N.S. | N.S. | N.S. | MRFR | MP   |
| LITTLE GRIZZLY CAMPGRND | N.S.                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| LOCHERMAN SOHA          | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| LOGAN MOUNTAIN          | MRFR                       | N.S. | N.S. | N.S. | N.S. | N.S. |
| LONGVILLE               | N.S.                       | PAIR | PAIR | PAIR | PAIR | MRFP |
| LOST TOM TIMBER SALE    | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| MARTIN CREEK SOHA       | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| MILL CREEK              | N.S.                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| MILLER RAVINE           | MP                         | MP   | MR   | MRFR | PAIR | MRS  |
| MOONLIGHT PASS          | PAIR                       | PAIR | N.S. | 0    | N.S. | N.S. |
| MOONLIGHT PEAK          | N.S.                       | N.S. | N.S. | N.S. | N.S. | MP   |
| MORGAN MT. SOHA         | MRFP                       | PAIR | PAIR | PAIR | MR   | PAIR |
| MOSQUITO SPRINGS        | PAIR                       | PAIR | PAIR | PAIR | PAIR | MRFP |
| MUD CREEK SOHA          | PAIR                       | TX   | PAIR | PAIR | PAIR | PAIR |
| MUD CREEK SOUTH         | N.S.                       | N.S. | N.S. | FR   | 0    | 0    |
| PACIFIC CREST TRAIL     | MPFP                       | MPFR | PAIR | MRFR | PAIR | FP   |
| PEACOCK POINT NORTH     | MRFR                       | MRFR | N.S. | N.S. | MR   | N.S. |
| PEACOCK POINT SOHA      | PAIR                       | MRFP | PAIR | MPFR | MRFR | MR   |
| PEGLEG MT. SOHA         | PAIR                       | MRFP | PAIR | PAIR | PAIR | PAIR |
| PHILBROOK SOHA          | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| PINE CREEK              | N.S.                       | N.S. | N.S. | MRFR | MRS  | 0    |
| REESE FLAT SOHA         | MPFP                       | MRFP | MP   | N.S. | N.S. | N.S. |
| RICE CREEK              | MP                         | PAIR | PAIR | PAIR | PAIR | PAIR |
| ROCK CREEK              | TX                         | TX   | PAIR | PAIR | MPFR | PAIR |
| ROCKY POINT SOHA        | PAIR                       | PAIR | PAIR | PAIR | MRFP | PAIR |
| ROOP MOUNTAIN           | N.S.                       | N.S. | PAIR | MRFP | PAIR | PAIR |
| RUFFA RANCH             | N.S.                       | MRFP | 0    | N.S. | N.S. | N.S. |
| SCENIC LOOP             | PAIR                       | PAIR | PAIR | MRFR | PAIR | PAIR |
| SHANGHAI CREEK          | MRFP                       | MRFR | 0    | 0    | N.S. | 0    |
| SHANGHAI NORTH          | N.S.                       | N.S. | PAIR | PAIR | PAIR | PAIR |
| SODA RIDGE SOHA         | MR                         | MRFP | N.S. | N.S. | N.S. | N.S. |
| SOLDIER MEADOW          | N.S.                       | N.S. | N.S. | N.S. | N.S. | MRFP |
| SQUIRREL CREEK          | N.S.                       | MP   | N.S. | FP   | N.S. | N.S. |
| STAR BUTTE SOHA         | TX                         | TX   | TX   | TX   | MRFP | MR   |
| SUSAN RIVER SOHA        | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| TURNER MOUNTAIN         | MR                         | PAIR | PAIR | PAIR | PAIR | PAIR |
| TWIN TIMBER SALE        | PAIR                       | MRFR | PAIR | MPFR | PAIR | PAIR |

(continued)

Table 1A (cont.)

| SITE NAME             | SOCIAL STATUS <sup>a</sup> |      |      |      |      |      |
|-----------------------|----------------------------|------|------|------|------|------|
|                       | 1990                       | 1991 | 1992 | 1993 | 1994 | 1995 |
| UPPER DEER CREEK      | N.S.                       | N.S. | N.S. | N.S. | N.S. | MRFR |
| UPPER STEPHENS MDW    | PAIR                       | TX   | N.S. | PAIR | MRS  | PAIR |
| UPPER YELLOW CREEK    | PAIR                       | PAIR | PAIR | PAIR | MRS  | PAIR |
| WARNER RANGER STATION | N.S.                       | N.S. | N.S. | N.S. | N.S. | FP   |
| WARNER TIMBER SALE    | MRFR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| WARNER VALLEY         | N.S.                       | N.S. | N.S. | N.S. | PAIR | 0    |
| WHEELER SHEEP CAMP    | N.S.                       | N.S. | PAIR | 0    | 0    | 0    |
| WILD CATTLE MT. SOHA  | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| WILLARD CREEK SOHA    | MPFP                       | MPFP | N.S. | N.S. | N.S. | N.S. |
| WILLOW LAKE SOHA      | PAIR                       | PAIR | PAIR | PAIR | PAIR | MPFR |
| WILLOW LAKE SOUTH     | PAIR                       | PAIR | PAIR | PAIR | PAIR | PAIR |
| WILSON MEADOW         | MPFR                       | 0    | 0    | MRFR | PAIR | PAIR |

<sup>a</sup> KEY: MR - MALE RESIDENT (detected at least 2 times, separated by a week)  
 MP - MALE PRESENT  
 FR - FEMALE RESIDENT (detected at least 2 times, separated by a week)  
 FP - FEMALE 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 - TELEMETRY SITE; NOT USED FOR DEMOGRAPHICS  
 N.S. - NOT SURVEYED  
 0 - SURVEYED AND NO OWLS DETECTED

California spotted owl demographics, Lassen NF: Preliminary results, 1995 14

Table 1B. Summary of social status of California spotted owls on the Lassen National Forest, 1990 through 1995.

| SOCIAL STATUS                  | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|--------------------------------|------|------|------|------|------|------|
| PAIR                           | 39   | 44   | 56   | 47   | 42   | 41   |
| SINGLE MALE                    | 2    | 0    | 1    | 0    | 3    | 1    |
| SINGLE FEMALE                  | 1    | 0    | 2    | 0    | 0    | 0    |
| MALE & FEMALE RESIDENT/PRESENT | 13   | 17   | 1    | 15   | 16   | 15   |
| MALE RESIDENT/PRESENT          | 5    | 6    | 4    | 3    | 3    | 12   |
| FEMALE RESIDENT/PRESENT        | 0    | 2    | 0    | 4    | 0    | 3    |
| TOTAL SITES WITH OWLS DETECTED | 60   | 69   | 64   | 69   | 64   | 72   |

Table 2. Inter-site movements of non-juvenile California spotted owls on the Lassen National Forest, 1990 through 1995.

| Age           | Site & Year       | Site & Year |                   |      |          |          |
|---------------|-------------------|-------------|-------------------|------|----------|----------|
| Sex Last Seen | Last Seen         | Relocated   |                   |      | Km Moved | Mi Moved |
| F 2-          | CHRISTIE HILL     | 1990        | MORGAN MT. SOHA   | 1991 | 3.2      | 2.0      |
| F 2-          | SCENIC LOOP       | 1990        | ROOP MOUNTAIN     | 1993 | 17.5     | 10.9     |
| F 5+          | BUTT MT. NORTH    | 1991        | CARTER CREEK      | 1992 | 1.2      | 0.8      |
| F 5+          | CARIBOU PEAK      | 1992        | CRATER MOUNTAIN   | 1994 | 18.5     | 11.6     |
| F 1-          | ELAM CREEK EAST   | 1993        | BUTT MT. WEST     | 1994 | 3.3      | 2.1      |
| F 5+          | MORGAN MT. SOHA   | 1993        | HOLE IN GROUND    | 1994 | 5.4      | 3.4      |
| F 1-          | CARTER CREEK      | 1993        | LONGVILLE         | 1995 | 18.3     | 11.4     |
| F 1-          | FANANI MEADOW     | 1993        | SHANGHAI NORTH    | 1995 | 4.1      | 2.6      |
| F 1-          | BLACK'S MOUNTAIN  | 1994        | UPPPER STEPH. MDW | 1995 | 22.4     | 14.0     |
| M 2-          | FANANI MEADOW     | 1991        | SHANGHAI NORTH    | 1992 | 1.8      | 1.1      |
| M 5+          | BUTT MT. NORTH    | 1991        | CARTER CREEK      | 1992 | 1.2      | 0.8      |
| M 4-          | FLEISCHMANN LAKE  | 1992        | WARNER T.S.       | 1993 | 2.4      | 1.5      |
| M 6+          | ROCKY POINT SOHA  | 1993        | LOCHERMAN SOHA    | 1995 | 19.9     | 12.4     |
| M 3-          | MILLER RAVINE     | 1994        | BLUE LEAD GULCH   | 1995 | 4.1      | 2.6      |
| M 5+          | PACIFIC CREST TR. | 1994        | BUTT MT. WEST     | 1995 | 3.5      | 2.2      |
| M 2+          | PINE CREEK        | 1994        | BENNER CREEK SOHA | 1995 | 19.5     | 12.2     |
| M 2+          | WARNER VALLEY     | 1994        | ELAM CREEK EAST   | 1995 | 20.8     | 13.0     |

Table 3. Reobservations of California spotted owls first banded as juveniles on the Lassen National Forest, 1990 through 1995.

| Sex | Natal Yr | Natal Site          | Reob.Yr | Reobservation Site         | Km Moved | Mi Moved |
|-----|----------|---------------------|---------|----------------------------|----------|----------|
| F   | 1990     | ELAM CREEK SOHA     | 1991    | STAR BUTTE SOHA            | 35.3     | 22.1     |
| F   | 1990     | CAIRN BUTTE SOHA N. | 1992    | BEARDSLEY (PLUMAS NF)      | 23.1     | 14.4     |
| F   | 1991     | UNKNOWN             | 1992    | WHEELER CAMP (PLUMAS NF)   |          |          |
| F   | 1992     | FLEISCHMANN LAKE    | 1993    | PINE CREEK                 | 21.9     | 13.7     |
| F   | 1992     | KAY TIMBER SALE     | 1993    | CARTER CREEK               | 19.5     | 12.2     |
| F   | 1992     | BUTT CREEK          | 1993    | LONGVILLE                  | 12.6     | 7.9      |
| F   | 1992     | CARIBOU PEAK        | 1994    | MOSQUITO SPRINGS           | 22.6     | 14.1     |
| F   | 1992     | UNKNOWN             | 1994    | ELAM CREEK EAST            |          |          |
| F   | 1992     | BAXTER CREEK SOHA   | 1995    | MORGAN MOUNTAIN SOHA       | 76.4     | 47.8     |
| F   | 1993     | SUSAN RIVER SOHA N. | 1994    | BLACK'S MOUNTAIN           | 41.6     | 26.0     |
| M   | 1991     | UNKNOWN             | 1992    | MISSOURI GULCH (PLUMAS NF) |          |          |
| M   | 1991     | LONGVILLE           | 1993    | PEACOCK POINT SOHA         | 9.3      | 5.8      |
| M   | 1991     | RICE CREEK          | 1994    | ELAM CREEK EAST            | 12.3     | 7.7      |
| M   | 1992     | UNKNOWN             | 1993    | UPPER STEPHENS MEADOW      |          |          |
| M   | 1992     | UNKNOWN             | 1994    | BOGARD BUTTES SOHA         |          |          |
| M   | 1992     | UNKNOWN             | 1994    | MUD CREEK SOHA             |          |          |
| M   | 1992     | UNKNOWN             | 1995    | BUTT MOUNTAIN NORTH        |          |          |
| M   | 1992     | UNKNOWN             | 1995    | CRATER MOUNTAIN            |          |          |
| M   | 1992     | UNKNOWN             | 1995    | LOCHERMAN SOHA             |          |          |
| M   | 1993     | UNKNOWN             | 1994    | UPPER STEPHENS MEADOW      |          |          |
| M   | 1994     | CRATER MOUNTAIN     | 1995    | ASHURST MOUNTAIN           | 11.0     | 6.8      |
| M   | 1994     | UNKNOWN             | 1995    | JONES VALLEY               |          |          |

Table 4. Age class distribution of California spotted owls identified to age class on the Lassen National Forest, 1990 through 1995.

| 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  |
|      | Combined  | 44   | 100.0 | 39     | 100.0 | 83         | 100.0 |
| 1991 | Adult     | 55   | 93.2  | 48     | 92.3  | 103        | 92.8  |
|      | Subadult  | 4    | 6.8   | 4      | 7.7   | 8          | 7.2   |
|      | Combined  | 59   | 100.0 | 52     | 100.0 | 111        | 100.0 |
| 1992 | Adult     | 52   | 88.1  | 52     | 92.9  | 104        | 90.4  |
|      | Subadult  | 7    | 11.9  | 4      | 7.1   | 11         | 9.6   |
|      | Combined  | 59   | 100.0 | 56     | 100.0 | 115        | 100.0 |
| 1993 | Adult     | 46   | 78.0  | 42     | 75.0  | 88         | 76.5  |
|      | Subadult  | 13   | 22.0  | 14     | 25.0  | 27         | 23.5  |
|      | Combined  | 59   | 100.0 | 56     | 100.0 | 115        | 100.0 |
| 1994 | Adult     | 42   | 79.2  | 42     | 85.7  | 84         | 82.4  |
|      | Subadult  | 11   | 20.8  | 7      | 14.3  | 18         | 17.6  |
|      | Combined  | 53   | 100.0 | 49     | 100.0 | 102        | 100.0 |
| 1995 | Adult     | 51   | 87.9  | 51     | 96.2  | 102        | 91.9  |
|      | Subadult  | 7    | 12.1  | 2      | 3.8   | 9          | 8.1   |
|      | Combined  | 58   | 100.0 | 53     | 100.0 | 111        | 100.0 |

Table 5. Proportion of female California spotted owls nesting on the Lassen National Forest, 1990 through 1995.

| YEAR | Age Class          | n  | Females checked for nesting |               |
|------|--------------------|----|-----------------------------|---------------|
|      |                    |    | Proportion Nesting          |               |
|      |                    |    | p                           | (95% CI)      |
| 1990 | Adult              | 21 | 0.76                        | (0.58 - 0.95) |
|      | Subadult           | 4  | 0.00                        |               |
|      | Total              | 25 | 0.64                        | (0.45 - 0.83) |
| 1991 | Adult              | 28 | 0.39                        | (0.21 - 0.58) |
|      | Subadult           | 1  | 0.00                        |               |
|      | Total <sup>a</sup> | 30 | 0.37                        | (0.19 - 0.54) |
| 1992 | Adult              | 37 | 0.97                        | (0.92 - 1.00) |
|      | Subadult           | 1  | 1.00                        |               |
|      | Total              | 38 | 0.97                        | (0.92 - 1.00) |
| 1993 | Adult              | 29 | 0.66                        | (0.48 - 0.83) |
|      | Subadult           | 6  | 0.17                        | (0.00 - 0.49) |
|      | Total              | 35 | 0.57                        | (0.41 - 0.74) |
| 1994 | Adult              | 28 | 0.36                        | (0.18 - 0.54) |
|      | Subadult           | 5  | 0.00                        |               |
|      | Total <sup>a</sup> | 35 | 0.29                        | (0.13 - 0.44) |
| 1995 | Adult              | 36 | 0.33                        | (0.18 - 0.49) |
|      | Subadult           | 0  | 0.00                        |               |
|      | Total              | 36 | 0.33                        | (0.18 - 0.49) |

<sup>a</sup>Totals are the sum of adults, subadults, and owls of unknown age class.

Table 6. Proportion of nesting female California spotted owls which fledged young on the Lassen National Forest, 1990 through 1995.

| YEAR | Age Class | Number<br>Nesting (n) | Proportion of Nesting Females<br>Which Fledged Young |               |
|------|-----------|-----------------------|------------------------------------------------------|---------------|
|      |           |                       | 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                                                 | (0.83 - 1.00) |
|      | Subadult  | 1                     | 0.00                                                 |               |
|      | Total     | 37                    | 0.89                                                 | (0.79 - 0.99) |
| 1993 | Adult     | 19                    | 0.68                                                 | (0.47 - 0.90) |
|      | 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) |

Table 7. Proportion of female California spotted owls which fledged young on the Lassen National Forest, 1990 through 1995.

| YEAR | Age Class          | Number<br>Checked (n) | Proportion of All Females Checked<br>Which Fledged Young |               |
|------|--------------------|-----------------------|----------------------------------------------------------|---------------|
|      |                    |                       | p                                                        | (95% CI)      |
| 1990 | Adult              | 30                    | 0.50                                                     | (0.32 - 0.68) |
|      | Subadult           | 4                     | 0.00                                                     |               |
|      | Total <sup>a</sup> | 38                    | 0.45                                                     | (0.29 - 0.61) |
| 1991 | Adult              | 35                    | 0.23                                                     | (0.09 - 0.37) |
|      | Subadult           | 2                     | 0.00                                                     |               |
|      | Total <sup>a</sup> | 38                    | 0.21                                                     | (0.08 - 0.34) |
| 1992 | Adult              | 49                    | 0.92                                                     | (0.84 - 1.00) |
|      | Subadult           | 3                     | 0.67                                                     | (0.01 - 1.00) |
|      | Total <sup>a</sup> | 53                    | 0.91                                                     | (0.83 - 0.99) |
| 1993 | Adult              | 33                    | 0.48                                                     | (0.31 - 0.66) |
|      | Subadult           | 9                     | 0.11                                                     | (0.00 - 0.33) |
|      | Total <sup>a</sup> | 43                    | 0.40                                                     | (0.25 - 0.54) |
| 1994 | Adult              | 36                    | 0.33                                                     | (0.18 - 0.49) |
|      | Subadult           | 5                     | 0.00                                                     |               |
|      | Total <sup>a</sup> | 45                    | 0.27                                                     | (0.14 - 0.40) |
| 1995 | Adult              | 46                    | 0.17                                                     | (0.06 - 0.28) |
|      | Subadult           | 1                     | 0.00                                                     |               |
|      | Total              | 47                    | 0.17                                                     | (0.06 - 0.28) |

<sup>a</sup>Totals are the sum of adults, subadults, and owls of unknown age class.

Table 8. Fecundity of California spotted owls checked for reproduction on the Lassen National Forest, 1990 through 1995. Fecundity is defined as the mean number of female young fledged per female<sup>a</sup>.

| YEAR | Age Class          | Number<br>Checked (n) | Mean Number of Female Young / Female |               |
|------|--------------------|-----------------------|--------------------------------------|---------------|
|      |                    |                       | $\bar{x}$                            | (95% CI)      |
| 1990 | Adult              | 30                    | 0.35                                 | (0.21 - 0.49) |
|      | Subadult           | 4                     | 0                                    |               |
|      | Total <sup>b</sup> | 38                    | 0.33                                 | (0.20 - 0.46) |
| 1991 | Adult              | 35                    | 0.19                                 | (0.06 - 0.31) |
|      | Subadult           | 2                     | 0                                    |               |
|      | Total <sup>b</sup> | 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 <sup>b</sup> | 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 <sup>b</sup> | 43                    | 0.30                                 | (0.18 - 0.42) |
| 1994 | Adult              | 36                    | 0.28                                 | (0.14 - 0.42) |
|      | Subadult           | 5                     | 0                                    |               |
|      | Total <sup>b</sup> | 45                    | 0.22                                 | (0.11 - 0.34) |
| 1995 | Adult              | 46                    | 0.13                                 | (0.04 - 0.22) |
|      | Subadult           | 1                     | 0                                    |               |
|      | Total <sup>b</sup> | 47                    | 0.13                                 | (0.04 - 0.21) |

<sup>a</sup>We assumed that half of the juveniles fledged were female.

<sup>b</sup>Totals are the sum of adults, subadults, and owls of unknown age class.

Table 9. Productivity of California spotted owls checked for reproduction on the Lassen National Forest, 1990 through 1995. Productivity is defined as the mean number of female young fledged per female that fledged young<sup>a</sup>.

| YEAR | Age Class          | No. Females<br>Successful | Mean Number of Female Young / Female |               |
|------|--------------------|---------------------------|--------------------------------------|---------------|
|      |                    |                           | $\bar{x}$                            | (95% CI)      |
| 1990 | Adult              | 15                        | 0.70                                 | (0.57 - 0.83) |
|      | Subadult           | 0                         | 0                                    |               |
|      | Total <sup>b</sup> | 17                        | 0.74                                 | (0.61 - 0.86) |
| 1991 | Adult              | 8                         | 0.81                                 | (0.63 - 0.99) |
|      | Subadult           | 0                         | 0                                    |               |
|      | Total              | 8                         | 0.81                                 | (0.63 - 0.99) |
| 1992 | Adult              | 45                        | 1.19                                 | (1.08 - 1.30) |
|      | Subadult           | 2                         | 0.50                                 |               |
|      | Total <sup>b</sup> | 48                        | 1.15                                 | (1.06 - 1.29) |
| 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                         |                                      |               |
|      | Total              | 12                        | 0.83                                 | (0.69 - 0.97) |
| 1995 | Adult              | 8                         | 0.75                                 | (0.56 - 0.94) |
|      | Subadult           | 0                         |                                      |               |
|      | Total              | 8                         | 0.75                                 | (0.56 - 0.94) |

<sup>a</sup>We assumed that half of the juveniles fledged were female.

<sup>b</sup>Totals are the sum of adults, subadults, and owls of unknown age class.

Table 10. Estimates of survival rate and annual rate of population change ( $\lambda$ ) for California spotted owls on the Lassen National Forest, 1990 through 1995.

| Parameter                      | Estimate | Sample size | 95% Confidence Interval |
|--------------------------------|----------|-------------|-------------------------|
| Juvenile survival <sup>a</sup> | 0.349    | 275         | 0.281 - 0.425           |
| Juvenile survival <sup>b</sup> | 0.258    | 2443        | 0.187 - 0.329           |
| Nonjuvenile survival           | 0.802    | 171         | 0.759 - 0.839           |
| Subadult fecundity             | 0.063    | 24          | 0.000 - 0.130           |
| Adult fecundity                | 0.432    | 229         | 0.363 - 0.502           |
| Population change <sup>a</sup> | 0.934    |             | 0.909 - 0.960           |
| Population change <sup>b</sup> | 0.895    |             | 0.845 - 0.945           |

<sup>a</sup> Juvenile survival data is from the San Bernardino Mountains study area, 1987-1994 (LaHaye, pers. comm.).

<sup>b</sup> Juvenile survival data is from the northern spotted owl, throughout its range, 1985 - 1993 (Burnham et al. 1996).

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

Owls at Gold Run Creek and 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 to a private timber company (Roseburg) between the 1990 and 1991 field seasons. The Last Chance campground spotted owls were also on Roseburg land in 1992 through 1995. The Last Chance Creek West owls were found on private timber land. The Roop Mountain owls were on land managed by Beatty and Associates. The Baxter Creek owls were on non-commercial private land in 1992 through 1995. Wheeler Sheep Camp and Lights Creek are on the Greenville Ranger District of the Plumas National Forest. The Willow Lake SOHA overlaps Lassen Volcanic National Park and the Lassen National Forest; the owls have been found within the Park each year. All other sites occur within the Almanor and Eagle Lake Ranger Districts of the Lassen National Forest, with the exception of the Heart Lake SOHA, which is in 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 are not sufficient. We required that at least one of the pair responses must occur 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 is not reproductive, a minimum of 4 mice must be offered to one member of the pair, rather than split between both members of a pair.
5. A mouse must be available to an owl for at least 30 minutes before it is considered to be "refused" by an owl (no time limit given in Miller 1990).

Appendix C. History of juvenile owls banded on the Lassen study area.

22 Juveniles were banded in 1990.

13 Juveniles were banded in 1991; 2 were dead before the end of the field season.

72 Juveniles were banded in 1992. One juvenile was found in the field with a broken leg and was taken to UC Davis for rehabilitation. It died in captivity. In addition, 5 juveniles were captured and taken to UC Davis by Peter Hodum for a study of spotted owl energetics. Four of these owls were released in July 1993. The fifth died in captivity.

23 Juveniles were banded in 1993. In addition, one juvenile was found dead in the field. A necropsy was unable to reveal cause of death.

16 Juveniles were banded in 1994. One juvenile was found in the field with a broken leg and wing and was taken to UC Davis for rehabilitation. It died in captivity.

12 Juveniles were banded in 1995.

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#### FIGURE LEGENDS

Figure 1. Location of the Lassen Spotted Owl Demography Study Area.

Figure 2. Annual Fecundity Rate Estimates for the California Spotted Owl on the Lassen National Forest, 1987 through 1995. Circles indicate point estimates and bars indicate 95% confidence intervals.

Figure 3. Annual Survival Rate Estimates for Female and Male California Spotted Owls on the Lassen National Forest, 1990 through 1995. Circles indicate point estimates and bars indicate 95% confidence intervals.

# LASSEN SPOTTED OWL DEMOGRAPHY STUDY AREA

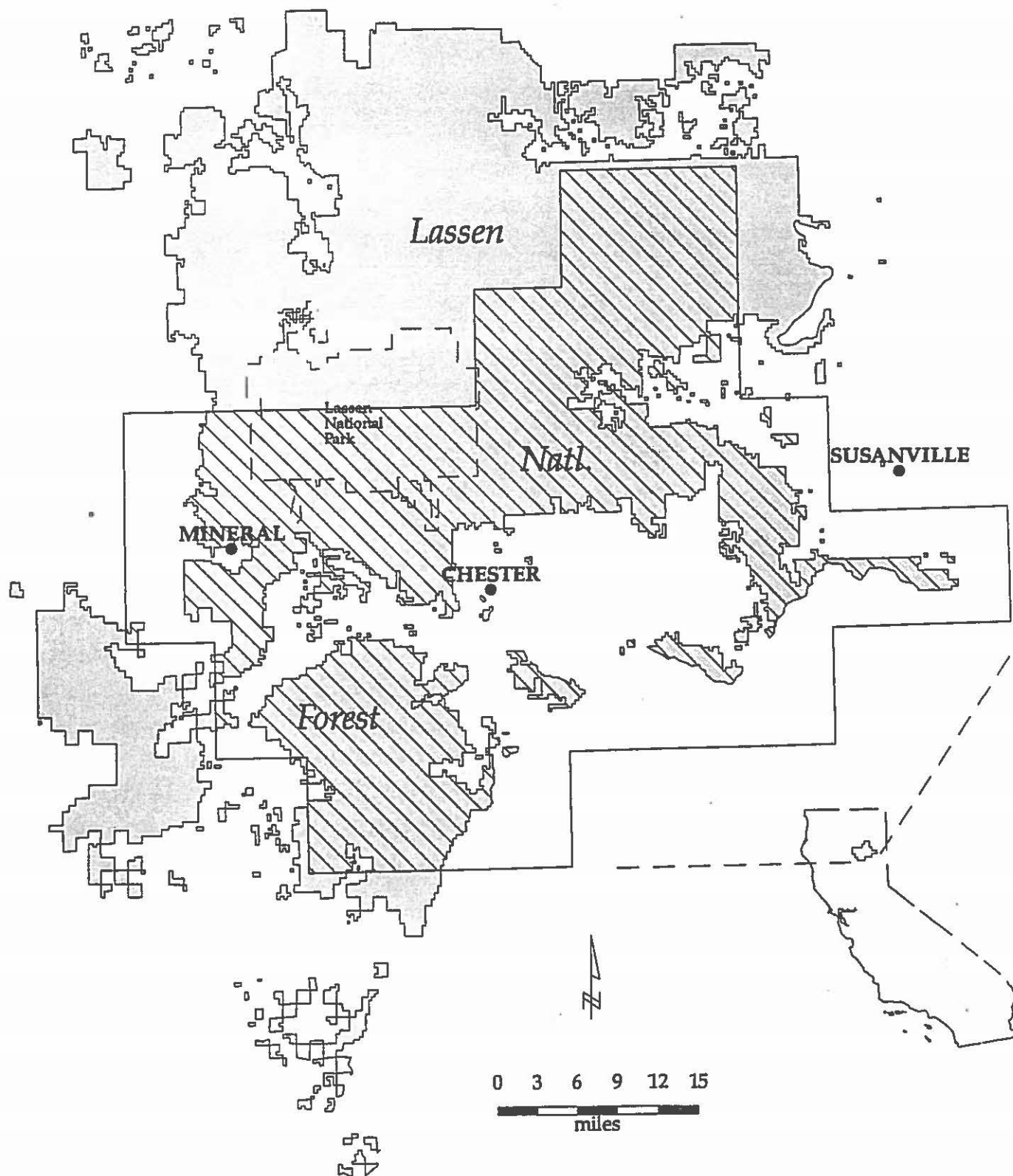


Fig. 1

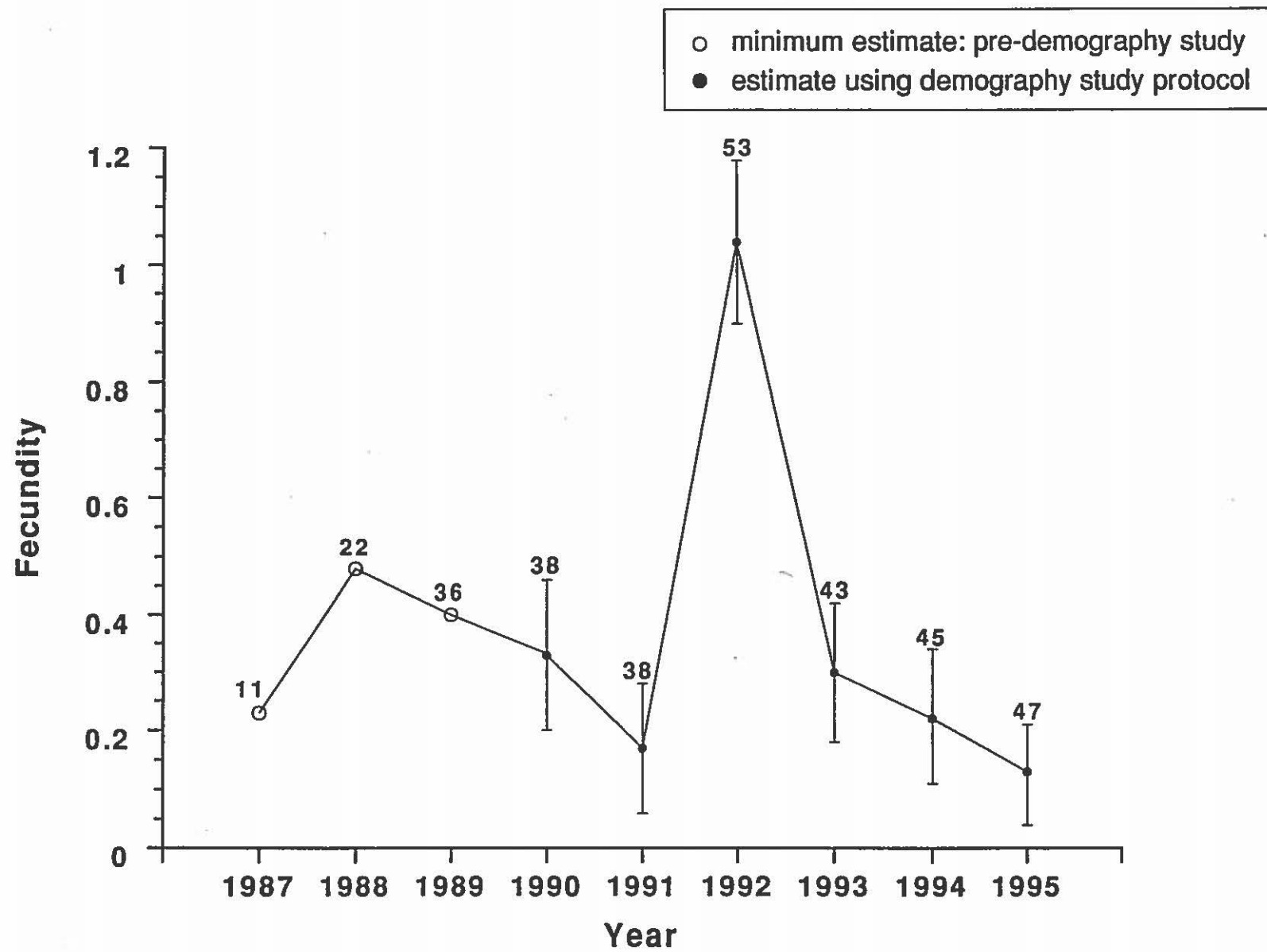


Fig. 2

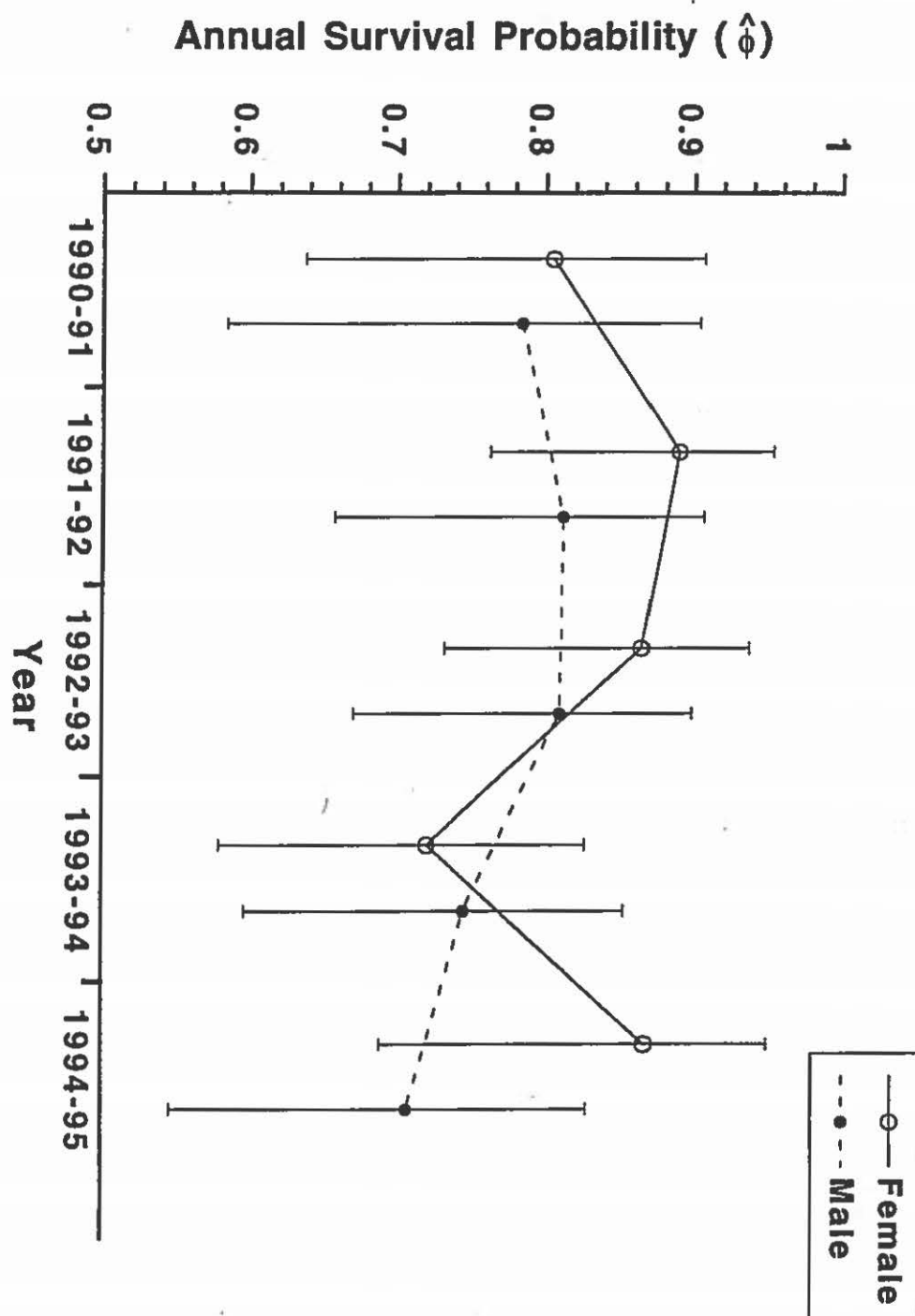


Fig. 3