



STATE OF CALIFORNIA
DEPARTMENT OF FISH AND GAME
NONGAME BIRD AND MAMMAL SECTION



CALIFORNIA SPOTTED OWL
(*Strix occidentalis occidentalis*)
INVENTORY AND DEMOGRAPHIC STUDY,
SEQUOIA AND KINGS CANYON NATIONAL PARKS:
FINAL 1988-89

by

Cindy K. Roberts

March 1993

TECHNICAL REPORT 1993 - 4
NONGAME BIRD AND MAMMAL SECTION REPORT

State of California
THE RESOURCES AGENCY
Department of Fish and Game

CALIFORNIA SPOTTED OWL
(*Strix occidentalis occidentalis*)
INVENTORY AND DEMOGRAPHIC STUDY,
SEQUOIA AND KINGS CANYON NATIONAL PARKS:

FINAL, 1988-1989¹

by

Cindy K. Roberts
Department of Biological Sciences
California State University Sacramento
Sacramento, CA 95819

ABSTRACT

The density, distribution, reproductive and survival rates, territory and mate fidelity, and habitat of California Spotted Owls (*Strix occidentalis occidentalis*) were studied in the Giant Forest-Grant Grove area in Sequoia and Kings Canyon National Parks, California, from April through August, 1988 and 1989. Additional surveys were conducted outside the Giant Forest study area (GFSA) to determine the species' general distribution and abundance in the parks. At the end of the 1989 study year, twenty-two pairs of Spotted Owls and one single male were found occupying 23 territories in the 260 km² (100 mi²) GFSA. Also, 26 territories were located outside the GFSA. The total observed adult and subadult population for the GFSA was 45 owls. Crude density was estimated to be 0.17 owls per km² (0.43/mi²) and territory density was estimated to be 0.09 territories per km² (0.24/mi²). Mean productivity was estimated to be 1.50 (1988) and 1.25 (1989) young per reproductive pair, and mean fecundity was estimated to be 0.67 (1988) and 0.31 (1989) young per pair checked for reproductive status. Small sample sizes and incomplete surveys were considered as potential biases affecting estimates of demographic values. The majority (65%) of owls detected, occurred predominantly within mature white fir (*Abies concolor*) habitat often (30%) with old-growth characteristics and sequoia (*Sequoiadendron giganteum*) groves. Owls also were detected in timber stands containing primarily mixed conifer (ca. 13%) and oak (*Quercus spp.*; ca. 13%). Most owls (69.2%) were detected at elevations from 1585 m to 2115 m (5200-6900 ft) and on west (32%) and southwest (24%) facing slopes in the GFSA. Elevations between 1520 m and 2115 m (5000-6940 ft) and west and north facing slopes held the majority (58.2% and 66%, respectively) of owls for all surveyed areas.

¹ Supported by 1987 Special Legislative Spotted Owl Allocation, Nongame Bird and Mammal Section, Wildlife Management Division, Job II.A.2. Final Report (March 1993).

FINAL REPORT TO THE CALIFORNIA DEPARTMENT OF FISH AND GAME
CONTRACT DFG-7525 (FY1987-88)

Submitted January 1990

**CALIFORNIA SPOTTED OWL INVENTORY AND DEMOGRAPHIC STUDY,
SEQUOIA AND KINGS CANYON NATIONAL PARKS**

CONTRACTOR

Hornet Foundation
California State University Sacramento
Sacramento, CA 95819

PROJECT LEADER

Dr. G. R. Trapp
Department of Biological Sciences
California State University, Sacramento
Sacramento, CA 95819

PRINCIPLE INVESTIGATOR

Cindy K. Roberts
Department of Biological Sciences
California State University, Sacramento
Sacramento, CA 95819

TABLE OF CONTENTS

	Page
LIST OF FIGURES	ii
LIST OF TABLES	iii
INTRODUCTION	1
STUDY AREA	2
Vegetation	2
Climate	2
TERMINOLOGY	4
METHODS	4
Surveys	4
Data Collection	4
Capture	5
Sex and Age Determination	5
Data Analysis	5
Habitat Evaluation	6
RESULTS	6
Surveys	6
Capture	9
Territories and Occupancy	9
Density and Distribution	17
Breeding Rates	18
Habitat	19
DISCUSSION	22
Surveys	22
Territories and Occupancy	23
Capture	23
Density and Distribution	24
Breeding Rates	25
Habitat	26
ACKNOWLEDGEMENTS	27
LITERATURE CITED	28
APPENDIX 1	31
APPENDIX 2	36

LIST OF FIGURES

Figure 1.	Location of the Giant Forest study area in the Sequoia and Kings Canyon National Parks, California	3
Figure 2.	Cumulative number of individual adult or subadult Spotted Owls detected over time (hours of survey effort) within the Giant Forest study area during 1988/89 Sequoia and Kings Canyon National Parks, California	7
Figure 3a.	Locations of the 18 Spotted Owl territories (core area) within the Giant Forest study area during 1988/89 Sequoia and Kings National Parks, California	10
Figure 3b.	Locations of eight Spotted Owl territories (core area) within the Giant Forest study area during 1988/89, Sequoia and Kings Canyon National Parks, California	11
Figure 4.	Location of eight Spotted Owl territories in the surveyed portion of Mineral King during 1988/89, Sequoia and Kings Canyon National Parks, California	12
Figure 5.	Location of six Spotted Owl territories in the surveyed portion of Garfield Grove during 1988/89, Sequoia and Kings Canyon National Parks, California	13
Figure 6.	Location of five Spotted Owl territories in the surveyed portion of Cedar Grove during 1988/89, Sequoia and Kings Canyon National Parks, California	14
Figure 7.	Location of five Spotted Owl territories in the surveyed portion of the Middle Fork Kaweah River during 1989, Sequoia and Kings Canyon National Parks, California	15
Figure 8.	Location of 15 historical Spotted Owl sightings in the Giant Forest study area, Sequoia and Kings Canyon National Parks, California	16
Figure 9.	Percent frequency of Spotted Owls detected within each Timber Stand Classification in the Giant Forest study area during 1988/1989, Sequoia and Kings Canyon National Parks, California . . .	19
Figure 10.	Percent frequency of Spotted Owls detected in 500 ft elevation intervals in the Giant Forest study area and other surveyed portions of the park during 1988/89, Sequoia and Kings Canyon National Parks, California	20
Figure 11.	Elevation distribution of sites checked for Spotted Owls in the Giant Forest study area during 1988/89, Sequoia and Kings Canyon National Parks, California	20
Figure 12.	Percent frequency of slope aspects where Spotted Owls were found in the Giant Forest study area and other surveyed portions of the park during 1988/89, Sequoia and Kings Canyon National Parks, California	21

LIST OF TABLES

Table 1.	Location and occupancy status of 39 areas inventoried for Spotted Owls within the Giant Forest study area during 1988/89, Sequoia and Kings Canyon National Parks, California	8
Table 2.	Location and status of 26 Spotted Owls territories within the surveyed portions of Sequoia and Kings Canyon National Parks, California	17
Table 3.	Social status of California Spotted Owls located in the Giant Forest study area during 1988/89, Sequoia and Kings Canyon National Parks, California	18
Table 4.	Tree species used for nesting by Spotted Owls within the Giant Forest study area during 1988/89, Sequoia and Kings Canyon National Parks, California	21
Table 5.	Nest types used by Spotted owls within the Giant Forest study area during 1988/89, Sequoia and Kings Canyon National Parks, California	22
Table 6.	A comparison of the proportion of paired birds in Spotted Owl populations in California	23
Table 7.	A comparison of crude densities of Spotted Owl populations in California	24
Table 8.	A comparison of mean fecundity and mean productivity of Spotted Owls in California	25

INTRODUCTION

The Spotted Owl (*Strix occidentalis*) is classified by the California Department of Fish and Game (DFG) as a species of special concern (Remsen 1978). This classification describes a species whose population is declining severely or is otherwise so low that extinction is a possibility if current trends continue. This possibility is an important concern to wildlife biologists, forest managers, and environmentalists because of the Spotted Owl's close association with old-growth forests (Gutiérrez and Carey 1985). Logging old-growth forests is considered a major factor in the decline of Spotted Owl populations (Gould 1977, 1985a; U.S. Fish and Wildlife Service 1982, 1987; Forsman et al. 1984). This decline is precipitating a growing controversy over the amount of old-growth forests necessary for the continued viability of Spotted Owl populations (Forsman et al. 1984).

Currently the United States Forest Service (USFS) is determining how they intend to manage Spotted Owls on commercial forest lands. This planning process is dependent on not only lands that they administer but on adjacent lands which provide suitable Spotted Owl habitat. National Park Service (NPS) lands constitute the majority of these suitable adjacent lands and as yet are, at best, partially surveyed (Gould 1985a, 1985b, U.S. Forest Service 1986).

The DFG initiated and funded this study to obtain a better understanding of the distribution, abundance and demography of Spotted Owls in Sequoia and Kings Canyon National Parks (SKCNP). Past and current research and management of the owls is almost all occurring on managed forests (Gould 1985a). There has been little opportunity to compare the demographic parameters of Spotted Owls on lands relatively undisturbed by human activity with similar parameters from studies of Spotted Owls on managed lands. Such a comparison is needed to determine if current management regimes on commercial forest lands support populations of owls similar to those on park lands, which most likely represent what is necessary to maintain a viable population. Additionally, this study should provide management agencies with a more accurate estimation of the quantity and distribution of Spotted Owls on NPS lands for use in determining the management necessary on commercial forest lands which will protect Spotted Owl viability and still provide adequate amounts of merchantable timber.

The objectives of this study were to:

- 1) Determine the distribution and abundance of Spotted Owls in SKCNP.
- 2) Calculate basic demographic parameters (occupancy status, reproductive rate, survival rate, and territory turn-over rate) on a specific population of Spotted Owls inhabiting historically undisturbed forest habitat.
- 3) Determine if the conditions created by the USFS management plan are adequate to maintain viable populations of Spotted Owls.

In this paper I present the results of a two year study, gathered from April through August 1988 and 1989.

STUDY AREA

Distribution and abundance were determined by a general survey for Spotted Owls in the western portion of SKCNP, and area of ca. 1370 km² (530 mi²), as time allowed (Figure 1). However, the main focus of this study was in the Giant Forest-Grant Grove area (Figure 1) at elevations ranging from 1,070-2,440 m (3,500-8,000 ft). The 260 km² (100 mi²) Giant Forest study area (GFSA) occupies the western portion of Sequoia National Park from the Middle Fork of the Kaweah River to the North Fork, straddling the Generals Highway, and the southwestern arm of the Kings Canyon National Park.

The GFSA was selected for intensive study because: 1) the original park survey (Gould 1974) showed that a number of Spotted Owl sites were present; 2) the shape of the area provides an east-west breadth with only a minimal amount bordering USFS lands (versus Yosemite National Park, an alternate study area choice), thus providing greater insulation from the affects of management on adjacent commercial forest lands; and 3) the access by roads and trails is adequate for the study while still maintaining the characteristics of undisturbed habitat.

Vegetation

The major vegetation type of the GFSA is Mixed Conifer Forest (MCF) community, (White and Pusateri 1979). Vegetation at elevations between 1,370-2,290 m (4,500-7,500 ft) in the parks is dominated on mesic sites by white fir (*Abies concolor*), incense cedar (*Calocedrus decurrens*) and sugar pine (*Pinus lambertiana*), and by ponderosa pine (*Pinus ponderosa*) and jeffrey pine (*Pinus jeffreyi*) on more xeric sites. Giant sequoias (*Sequoiadendron giganteum*) do not exist in extensive, pure stands but are aggregated in smaller stands and are associated with the trees comprising the MCF community. Their growing range is between 1,520-2,290 m (5,000-7,500 ft), with most stands at ca. 1,860 m (6,200 ft).

Dominant tree species at elevations between 1,070-1,370 m (3,500-4,500 ft) are canyon live oak (*Quercus crysolepis*) and interior live oak (*Quercus wislizenii*) in the shadier ravines and blue oak (*Quercus douglasii*) in the dryer areas.

At elevations above 2,290 m (7,500 ft) the dominant tree species is red fir (*Abies magnifica*) (White and Pusateri 1949, and Kuchler 1977).

Climate

The Sierra Nevada is the dominant factor influencing the climate of the GFSA. Climate within the parks is characterized by cool, wet winters, and hot, dry summers. During winter, the area receives strong flows of marine air that result in heavy precipitation, especially at intermediate elevations. Precipitation during the summer months is limited to a few, scattered thunderstorms. In the study area the 102-127 cm (40-50 in) of precipitation received annually falls during the storms of winter (Tweed 1981).

Average annual temperatures in the area range from approximately 18°C (65°F) at low elevations in the southwestern portion of the GFSA to 16°C (60°F) at higher elevations towards the northeast. Average minimum temperatures in winter range from approximately 2°C (36°F) at low elevations to -1°C (30°F) at

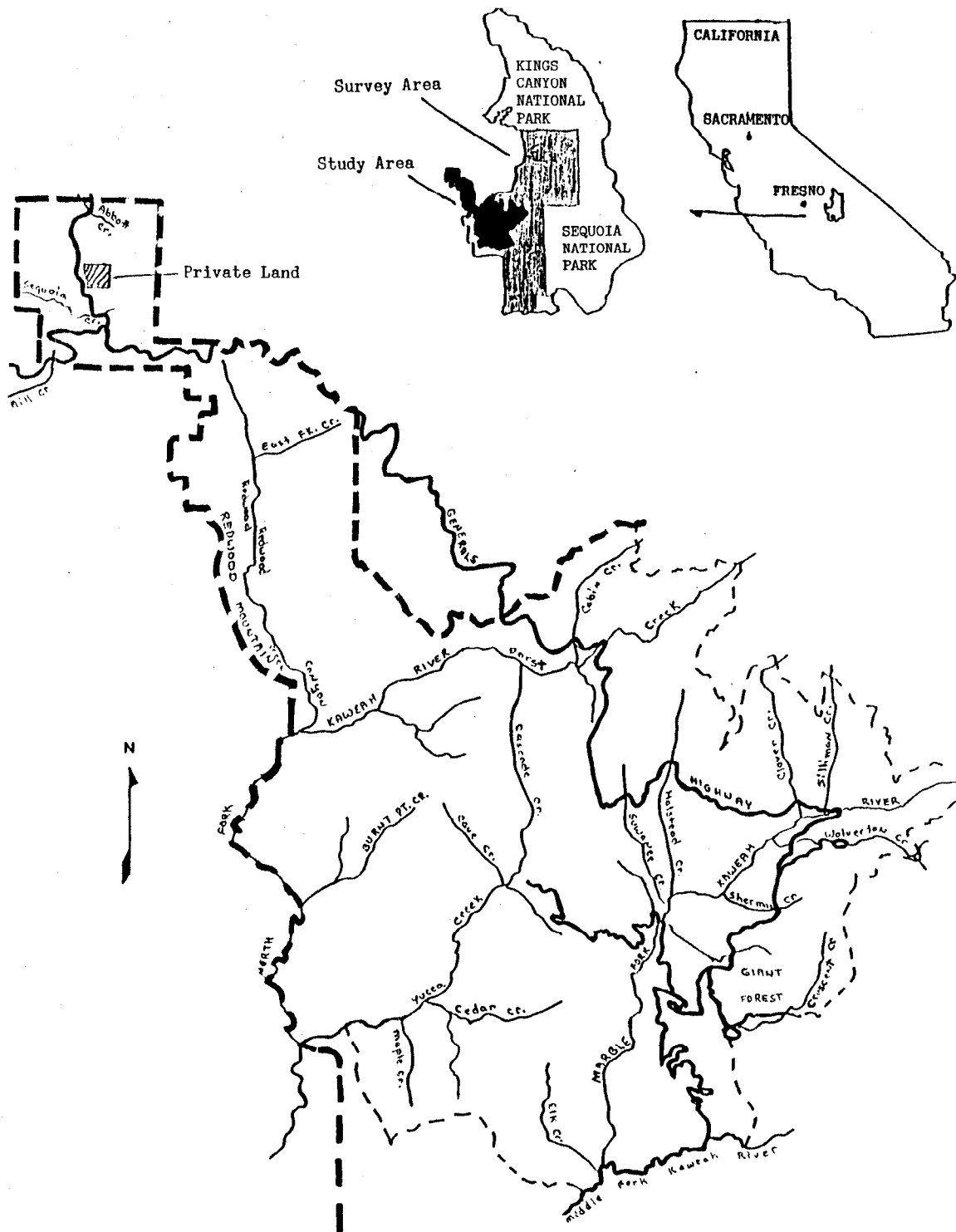


Figure 1

Location of the Giant Forest Study Area in the Sequoia and Kings Canyon National Parks, California (scale 1 in to 2 mi).

higher elevations. Average maximum temperatures in summer range from approximately 35°C (95°F) at low elevations to 27°C (80°F) at higher elevations (Tweed 1981).

TERMINOLOGY

For this paper, the terms used were defined by Forsman (1983), Franklin et al. (1986) and USFS (1988).

METHODS

We attempted to locate, identify, capture and band all individual Spotted Owls in the GFSA. As time permitted we located and identified Spotted Owls outside the GFSA but within the parks (Figure 1). Field methods used for this study were adapted from Forsman (1983), Franklin et al. (1986) and USFS (1988). Demographic parameters calculated for this report follow the survey effort methods used by Franklin et al. (1986) and USFS (1988).

Surveys

Spotted Owls were located by both night and day calling surveys. Vocal imitations of Spotted Owl calls were used to elicit responses from the owls. Surveys at night were conducted between dusk and 2400 hours PST, and consisted of leap frog (Forsman 1983), cruise, and point surveys (Franklin et al. 1986). Surveys during the day were used to locate roosting and/or nesting Spotted Owls and consisted of point, cruise, and walk-in surveys (Franklin et al. 1986). An inventory of an owl site was considered complete when the defined area, with predetermined boundaries, was surveyed and a pair was confirmed, or a single owl or no owls were detected after six surveys in that area.

All areas of the GFSA were surveyed at least once regardless of habitat type and land use. Surveys outside the GFSA, within the SKCNP, were conducted as time permitted. Most areas of suitable habitat, outside the GFSA, were surveyed by the end of the second study year.

After an adult or subadult Spotted Owl was first located (presence determined) it was "moused" (Forsman 1983) to determine the presence of its mate (occupancy of a pair). Once occupancy was verified, the owls were "moused" on up to a total of four additional visits. If either of a pair did not accept or take any mice (*Peromyscus spp.*) to their young on any of these four visits, the pair was considered not to have produced any young (Franklin et al. 1986).

Data Collection

Field data were recorded using field maps, "Grinnell System" field notes (Herman 1980) and data forms specific to survey and capture activities (Appendix 1).

Locations of Spotted Owls detected during surveys were plotted on topographic maps using at least one compass bearing, roost and/or nest site elevations determined from an altimeter, and an estimated distance from observer, or by visually locating owls. Legal descriptions (township, range, and section numbers) of all owl locations were recorded (Franklin et al. 1986).

Field notes contained route descriptions, quantity of field research time, environmental conditions, and Spotted Owl behavior.

Capture

Owls were captured and banded after reproductive status was determined. Owls were captured using a dip net. A noose pole (Forsman 1983) and mist net (Franklin et al. 1986) were also available for captures. Handling time for each owl captured was less than 22 min.

All captured adult or subadult owls were banded with a U.S. Fish and Wildlife Service (USFWS) locking aluminum and plastic, colored leg bands. An aluminum band was placed on the left tarsometatarsus of each female with the colored band on the right leg, and vice-versa for the males. Color bands provided a unique mark to each captured owl which could be used for future identification (Franklin et al. 1986). Only the USFWS aluminum band was placed on juvenile owls.

Sex and Age Determination

The sex of adult and subadult Spotted Owls was determined by the pitch of calls, the choice of calls given, and the owl's general behavior (Forsman et al. 1984). Male Spotted Owls give a lower pitched call than do female Spotted Owls. Tail barring was noted on the owls but was not used in determining sex (Barrows et al. 1982). Juvenile owls could not be sexed accurately.

The age of captured Spotted Owls was determined from plumage characteristics (Forsman 1981). Owls were identified to three age categories: juvenile, subadult, and adult.

Data Analysis

Descriptive and inferential statistics follow Zar (1974) and were generated using "Personal" and "Statistics With Finesse" statistical computer programs. Unless otherwise stated, statistical inferences were based on a preassigned significance level of $P \leq 0.05$.

Crude, observed densities were calculated for individual owls and territories by dividing the total observed number of adult and subadult owls or territories by the total area of the GFSA (Franklin et al. 1986). Estimated, expected densities were not calculated since the GFSA was surveyed as two separate areas. Ecological densities were not calculated because the total quantity of suitable Spotted Owl habitat in the GFSA is unknown.

A Poisson distribution test was used to determine randomness, that each portion of space had the same probability of containing an owl and that the occurrence of an owl in any territory in no way influences the occurrence of any other owls in any other territory. The goodness-of-fit of the Poisson distribution to a set of observed data (i.e., number of owls per territory) was then determined by a chi-square test and a log-likelihood test. A coefficient of variability test was then used to measure the dispersion, if other than random.

Two methods were used to estimate reproductive rate, mean fecundity (Caughley 1977), and mean productivity (Franklin et al. 1986). Mean fecundity was

defined as the number of offspring fledged per nesting female per year. Mean productivity was defined as the number of offspring fledged per reproductive pair per year. Only females checked for reproductive status were included in estimating the reproductive rate. A weighted mean was used since no female was younger than the lower limit (2 yrs old) of the range of ages covered by the mean and therefore, the sampled females were not aged. The Mann-Whitney U-test, a nonparametric rank sum test, was used to determine any significant differences between the mean fecundity and mean productivity.

Habitat Evaluation

General habitat types were identified for each Spotted Owl territory based on the vegetation characteristics at roost sites and in the vicinity of nest sites. The percent frequency of Spotted Owl territories that occurred within each timber stand was then graphed. Timber stands were classified by the dominant tree species and their average diameter at breast height (DBH) in the following manner. WF = white fir; M = mixed conifer; S = sequoia; O = oak; 3 = seral stage three, trees 33-61 cm (13-24 in) DBH; 4 = seral stage four, trees 63.5-101.6 cm (25-40 in) DBH; 5 = seral stage five, trees 101.6 cm (>40 in) DBH; and 6 = seral stage six, trees at least two canopy levels high.

Elevation for each roost or nest site location were recorded in field notes. Elevations were then separated by 150 m (500 ft) intervals and the percent frequency of territories within each 150 m (500 ft) elevation interval was calculated.

The slope aspect of roost or nest sites within each territory also was noted and plotted by frequency. Slope aspects were N, S, E, W, SE, SW, NE, and NW.

RESULTS

Surveys

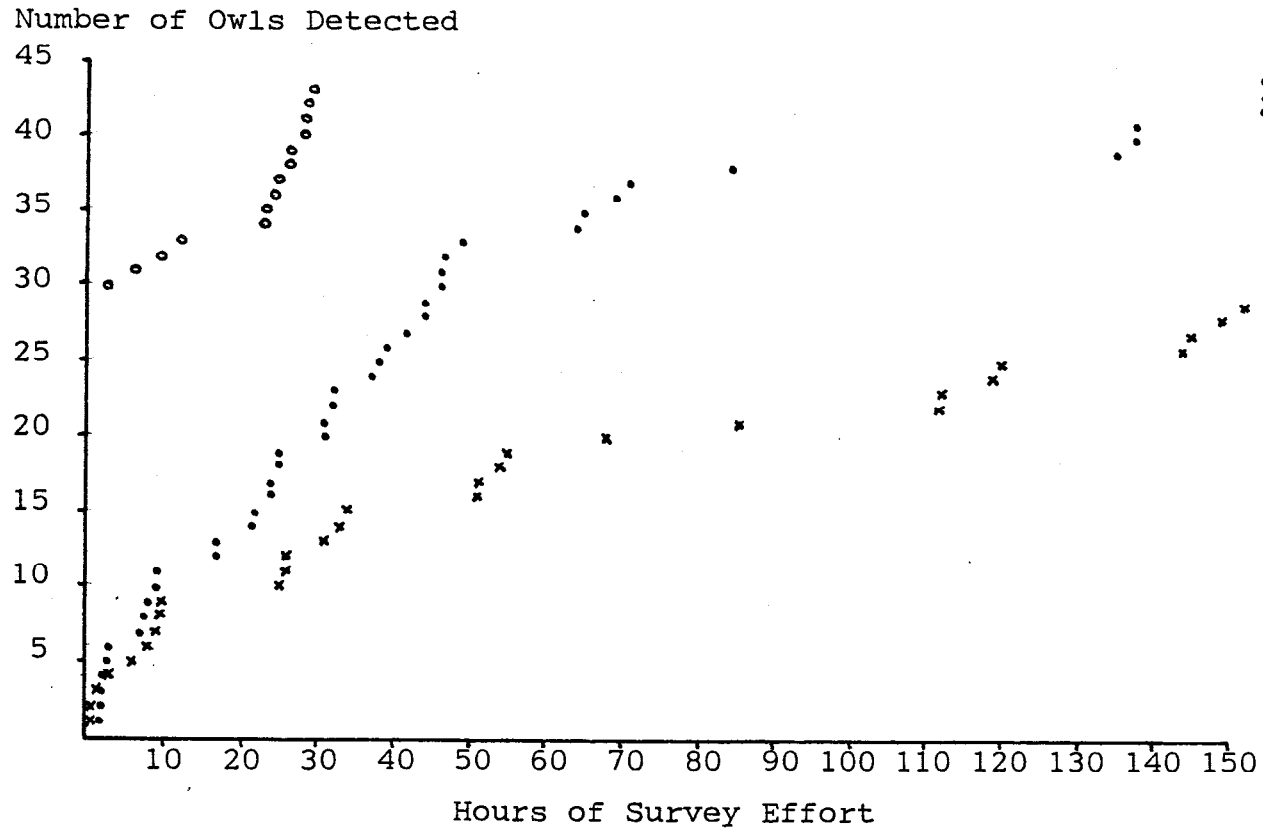
The GFSA was surveyed from April 1 through August 31 and required ca. 666 and 446 person hours in 1988 and 1989, respectively. For each respective year; 136 and 15 hrs were devoted to survey effort, 255 and 201 hrs to inventory, 142 and 141 hrs to determine reproduction, and 133 and 89 hrs to capture and band. An additional 35 and 172 hrs of survey effort, in 1988 and 1989, was spent on surveys outside of the GFSA.

To analyze survey effort within the GFSA a curve was developed by plotting the number of individual adult or subadult owls detected over time (hours of survey effort; Figure 2). Since the Giant Forest and Grant Grove portions of the GFSA were surveyed in separate stages in 1988 it was necessary to plot them separately. The results from the following year were plotted as one continuous survey. None of the curves approached an asymptotic level, which suggests that, even after the second year, the census count was probably lower than the absolute number of adult and subadult Spotted Owls in the GFSA.

The GFSA was divided into 39 areas (Table 1), based on local topography, that had a possibility of containing an owl territory. Of these 39 areas, 31 (79.%) in 1988 and 33 (84.6%) in 1989 were surveyed more than four times. Occupancy was verified, according to protocol (USFS 1988), at 17 (43.6%) sites in 1988 and 22 (56.4%) in 1989.

Figure 2

Cummulative Number of Individual Adult or Subadult Spotted Owls Detected Over Time (hours of survey effort) Within the Giant Forest Study Area During 1988/89, Sequoia and Kings Canyon National Parks, California



x = 1988 Giant Forest portion
o = 1988 Grant Grove portion
o = 1989 Giant Forest Study Area

Table 1. Location and Occupancy Status of 39 Areas Inventoried for Spotted Owls Within the Giant Forest Study Area During 1988/89, 1988/89, Sequoia and Kings Canyon National Parks, California.

Terr. ¹ No.	Territory Name	Legal Descript.			Results ²		Status ³	
		T(S)	R(E)	Sec.	88	89	88	89
<u>TU002</u>	Redwood Saddle	14	28	N15	Pr	Pr/K	O/NRC	O/NRC
<u>TU003</u>	East Fork Cr.	14	28	S23,NW24	Pr	Pr	O/RNS	O/RU
<u>TU004</u>	Lost Grove	15	29	W3,E4	Pr/K	Pr/K	O/NRC	O/NRC
<u>TU005</u>	Dorst Creek	15	29	NW11,SW2	M/F	X	P/NO	NP
<u>TU006</u>	Cascade Creek	15	29	W22	Pr	Pr/K	O/RU	O/NRC
<u>TU007</u>	Suwanee Creek	15	29	SE23	Pr/K	Pr	O/NRC	O/NRC
<u>TU008</u>	Leachfield	15	29	NW30	Pr/K	Pr/K	O/NRC	O/NRC
<u>TU009</u>	Sherman Creek	15	29	N31	Pr	Pr	O/RU	O/NRC
<u>TU010</u>	Crescent Mdw.	16	30	S5	Pr	Pr	O/RU	O/RU
<u>TU034</u>	Sugar Bowl	14	28	NW27	M	X	P/ONS	NP
<u>TU038</u>	Amphitheater	16	30	N13	Pr	Pr	O/RU	O/NRC
<u>TU041</u>	Muir Creek	15	29	SE8,SW9	Pr	Q/K	O/RU	O/RC
<u>TU042</u>	Wolverton Cr.	15	30	27,28,29	X	X	NP	NP
<u>TU051</u>	Sequoia Cr.	14	28	S6	R	R/K	O/RC	O/RC
TU065	Crystal Cv Rd.	15	29	SE34,SW35	F	Pr	P/NO	O/NRC
TU066	Lil. Deer Cr.	15	29	SE35,W36	Q/K	Q/K	O/RC	O/RC
TU067	Soldiers Tr.	16	30	S6,N7	Pr	Pr	O/RU	O/RU
TU068	S Fk Cedar Cr.	16	29	NE17	Pr	Pr	O/RU	O/NRC
TU069	Burnt Pt. Cr.	15	29	SE24,NE24	M	Pr	P/ONS	O/RU
TU070	Big Springs	15	28	NE2	R	Pr	O/RC	O/NRC
TU071	Cedar Creek	16	29	NW10	M/F	Q	P/ONS	O/RC
TU077	Mill Creek	14	28	S7,N18	Q	Pr	O/RC	O/NRC
TU080	Park Ridge	14	28	NE9	M	X	P/ONS	NP
TU079	Cave Creek	15	29	W28	M	M	P/ONS	P/ONS
<u>FR005</u>	Abbott Creek	13	28	N32,NE31	Pr	Pr	O/NRC	O/NRC
TU084	Skagway Creek	15	29	S17	X	Pr	NP	O/RU
TU085	Deep Canyon	16	29	S11,N14	X	Pr	NP	O/RU
	Silliman Cr.	15	30	9,16,21	X	Z	NP	PNS
	Congress Tr.	15	30	32	X	Z	NP	PNS
	Elk Creek	16	29	15	X	X	NP	NP
	Tokopah Falls	15	30	22,23	X	Z	NP	PNS
	Cherry Flat	15	28	11,12	Z	Z	PNS	PNS
	Clover Creek	15	29	17,20	Z	Z	PNS	PNS
	Cabin Creek	15	29	3,34,35	Z	Z	PNS	PNS
	Colony Mdw.	15	29	1,2	Z	X	PNS	NP
	Upper Halstead	15	29	12,13	Z	Z	PNS	PNS
	Maple Creek	16	29	8,17	Z	X	PNS	NP
	Chimney Cr.	15	29	6,7	Z	X	PNS	NP
	Big Baldy Gr.	14	28	25,26	Z	X	PNS	NP

¹ Terr. No. refers to the territory number assigned by the California Department of Fish and Game. Underlined territory numbers represent territories which have had historical sightings.

² M=Male; F=Female; Pr=Pair; Q=Pair + 1 young; R=Pair + 2 young;
X=complete survey with no detections; Z=Incomplete survey with no detections; K=Nest located.

³ RC=Reproduction confirmed; NRC=Nonreproduction confirmed;
P/NO=Presence/not occupied; P/ONS=Presence/occupancy not sampled;
O/RNS=Occupied/reproduction not sampled; RU=Reproduction unknown;
NP=No presence; PNS=Presence not sampled.

Capture

In the 1988 field season 15 Spotted Owls were captured and banded within the GFSA (five adult males, one subadult male, eight adult females and one juvenile). Six of the eight females were paired with the six males. During the 1989 field season five adult Spotted Owls were captured and banded. One pair and three females, but not their mates, were banded.

Territories and Occupancy

In 1988, 43 adult and subadult Spotted Owls were found at 24 sites in the 39 defined areas (Fig. 3a, 3b, and Table 1). Of the 26 (66.7%) areas completely surveyed, pair occupancy was confirmed at 17 (65.4%) sites, one (3.8%) contained a male and female (not a confirmed pair), one (3.8%) contained a single female, and no owls were located in seven (27%) areas. Of the 13 (33.3%) sites that were not surveyed completely, one (7.6%) contained a male and female (not a confirmed pair), only males were found at four (30.8%) sites, four (30.8%) sites had no owls detected and four (30.8%) areas were not surveyed. In 1989, for those same defined areas, 45 adult Spotted Owls were found at 23 sites (Figure 3a, 3b; Table 1). Of the 33 (84.6%) areas completely surveyed, pair occupancy was confirmed at 22 sites (66.7%), and a single male (3%) was found at a site which had limited access.

Surveys outside the GFSA were in the Mineral King, Garfield Grove, Cedar Grove, and Middle Fork Kaweah River areas (Figures 4, 5, 6, and 7; Table 2). These surveys usually consisted of a single visit to areas considered to be possible Spotted Owl habitat. The status of the 26 surveyed areas at the end of the 2 year study were: eight confirmed pairs, 11 males and females (occupancy not confirmed), two males, three females, and two areas with no owls detected. In 1988 Spotted Owls responded from 12 (85.7%) of 14 areas surveyed. Pairs occupied three (25%) territories, a male and female were noted at two (17%) sites, single males were detected at two (17%) sites, single females at four (33%) sites, and one (8%) site had an owl of unknown sex. The 1989 survey resulted in 16 sightings (Figure 4, 5, 6, and 7; Table 2). Of these; eight (50%) were unconfirmed pairs (one site had a female and one with a male in 1988), four (25%) were confirmed pairs, two (12.5%) had single males (one which has a female in 1988), one (9.6%) had a pair with one young, and a female was found at the one 1988 site (0.6%) that had an owl whose sex was unknown.

Prior to 1988, 15 Spotted Owl territories had been identified within the GFSA (Gould 1986, Figure 8). Protocol was finished on all 15 territories. By the end of the 1988 field season, 12 (80%) of these territories had occupancy confirmed; one (6.7%) had a single male; one (6.7%) had a male and female; and one (6.7%) had no owls detected. In 1989 no owls were detected at the two sites where presence was found and the site with no presence in 1988. See Table 1 to compare the historical sightings with the 1988/89 territory status.

Prior to 1988, six sightings had been outside the GFSA (unpubl. data since 1973, DFG, Sacramento, CA). By 1989, owls had been relocated on all six (100%) of these territories.

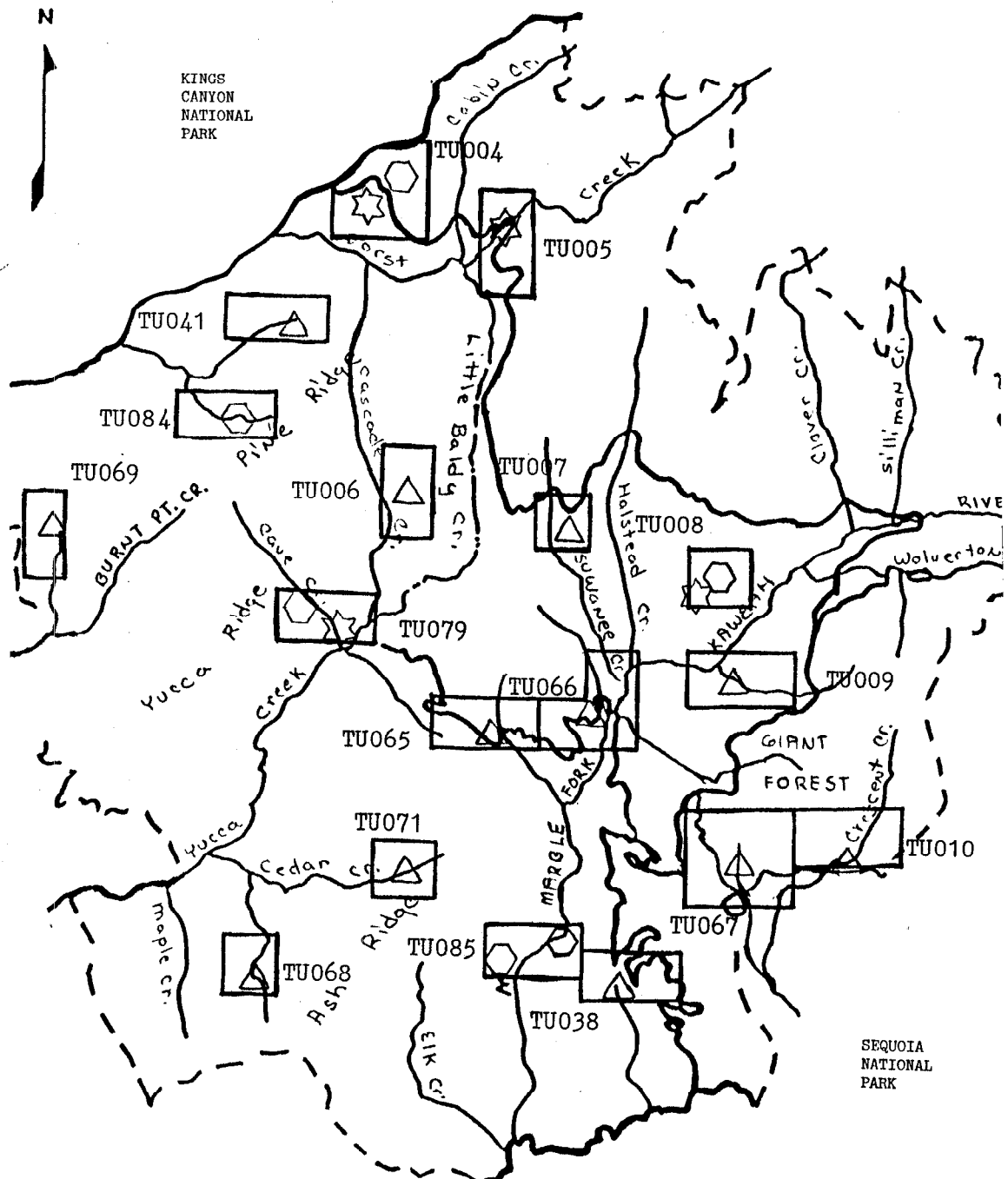


Figure 3a

Locations of the 18 Spotted Owl Territories (Core Area)
Within the Giant Forest Study Area During 1988/89,
Sequoia and Kings Canyon National Parks,
California (scale 1 in = 2.25 mi).

- ☆ = 1988 main roost site
- ⬡ = 1989 main roost site
- △ = 1988/89 main roost site

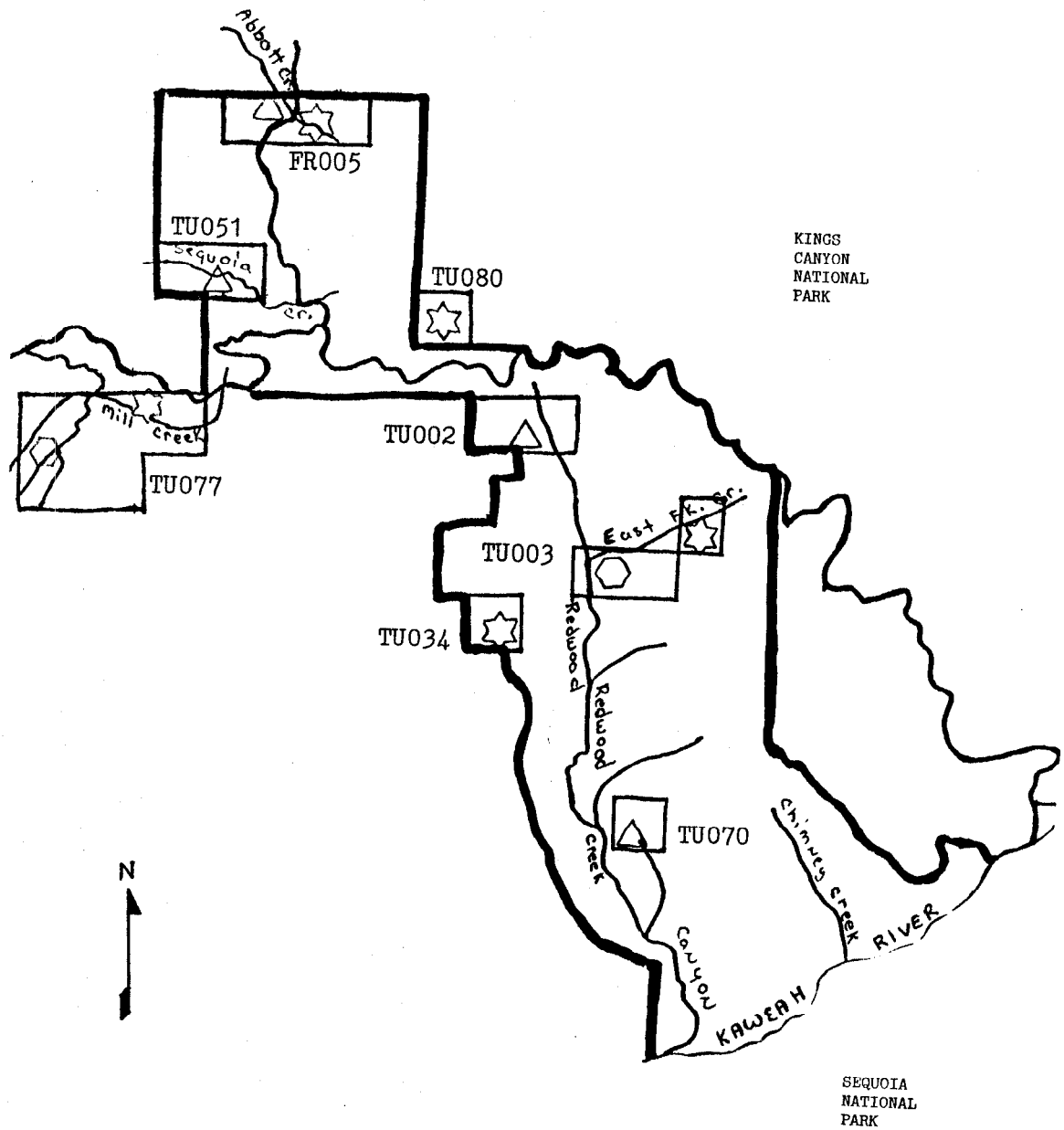


Figure 3b

Locations of Eight Spotted Owls Territories (Core Area)
Within the Giant Forest Study Area During 1988/89,
Sequoia and Kings National Parks, California
(scale 1 in = 2.25 mi).

- ☆ = 1988 main roost site
- ⬡ = 1989 main roost site
- △ = 1988/89 main roost site

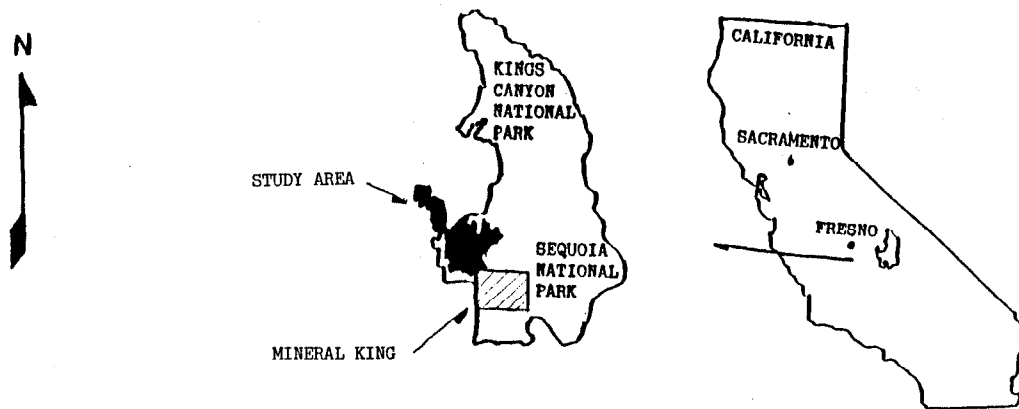
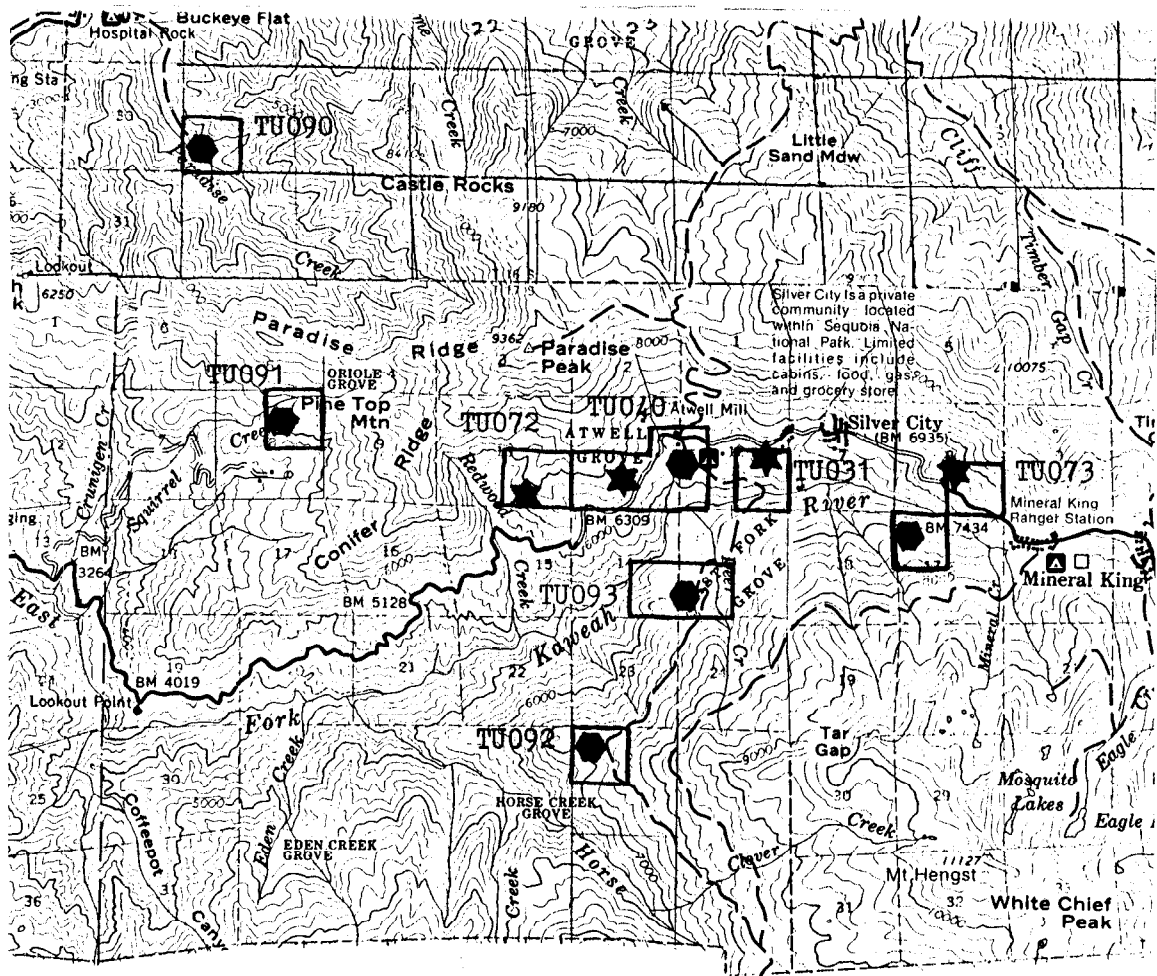


Figure 4

Location of Eight Spotted Owl Territories in the Surveyed Portion of Mineral King During 1988/89, Sequoia National Park, California (scale 1 in = 1.75 mi).

★ = 1988 sites
● = 1989 sites

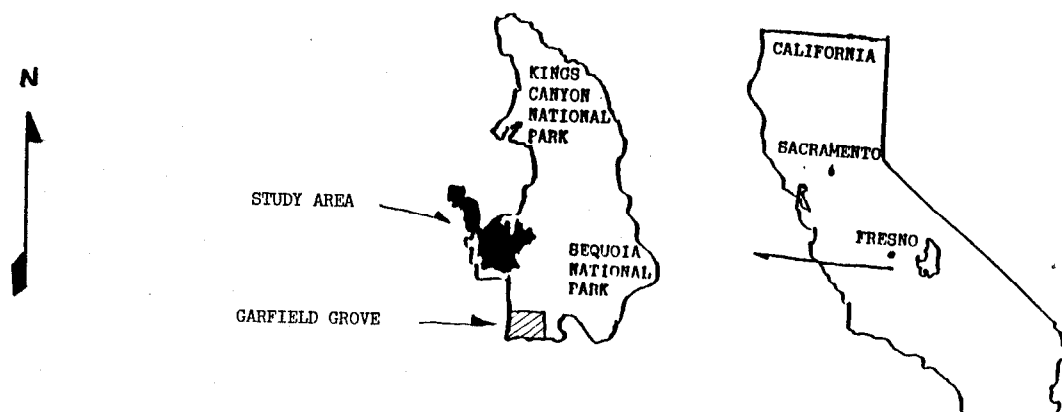
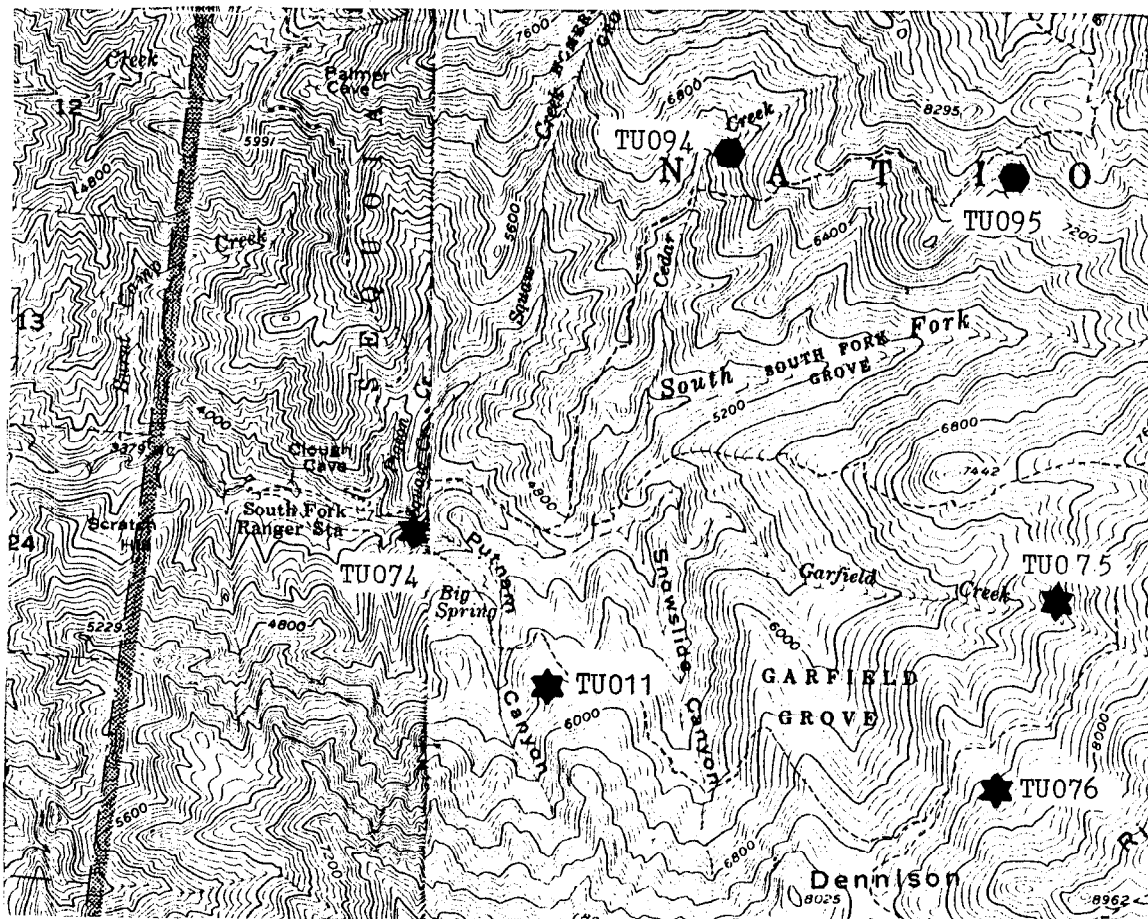


Figure 5

Location of Six Spotted Owl Territories in the Surveyed Portion of Garfield Grove During 1988/89, Sequoia National Park, California (scale 1 in = 1 mi).

★ = 1988 sites
 ● = 1989 sites

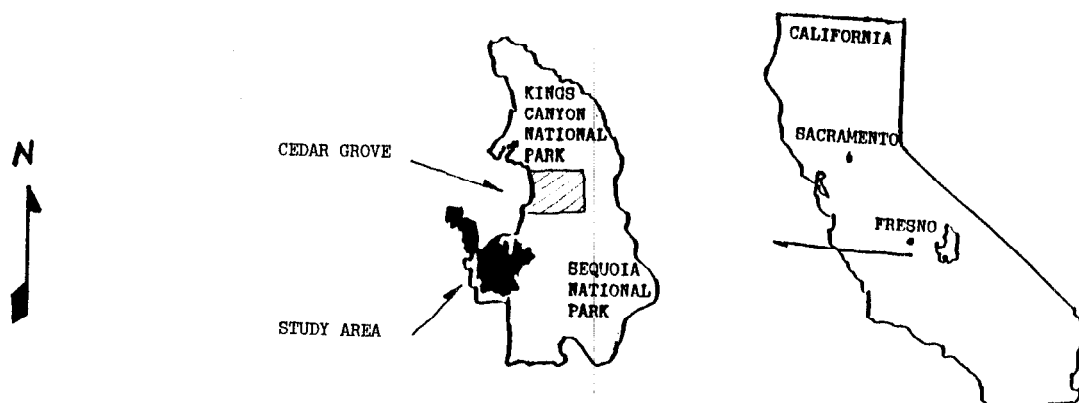
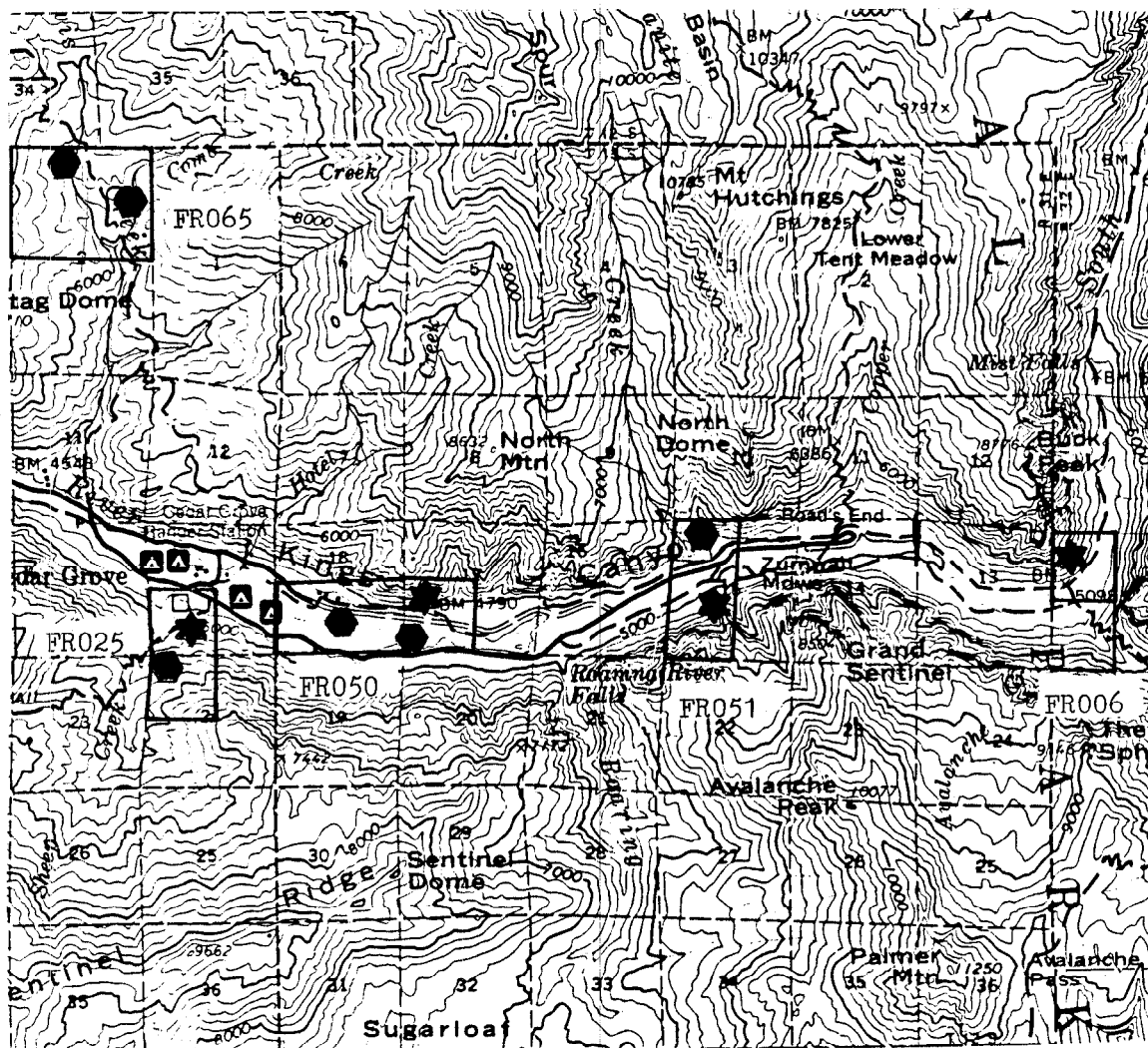


Figure 6

Location of Five Spotted Owl Territories in the Surveyed Portion of Cedar Grove During 1988/89, Kings Canyon National Park, California (scale 1 in = 1.5 mi).

- ★ = 1988 sites
- = 1989 sites

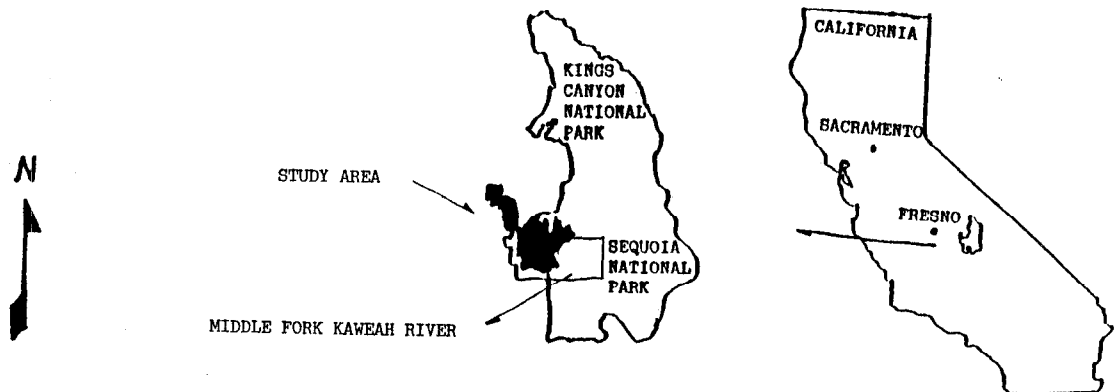
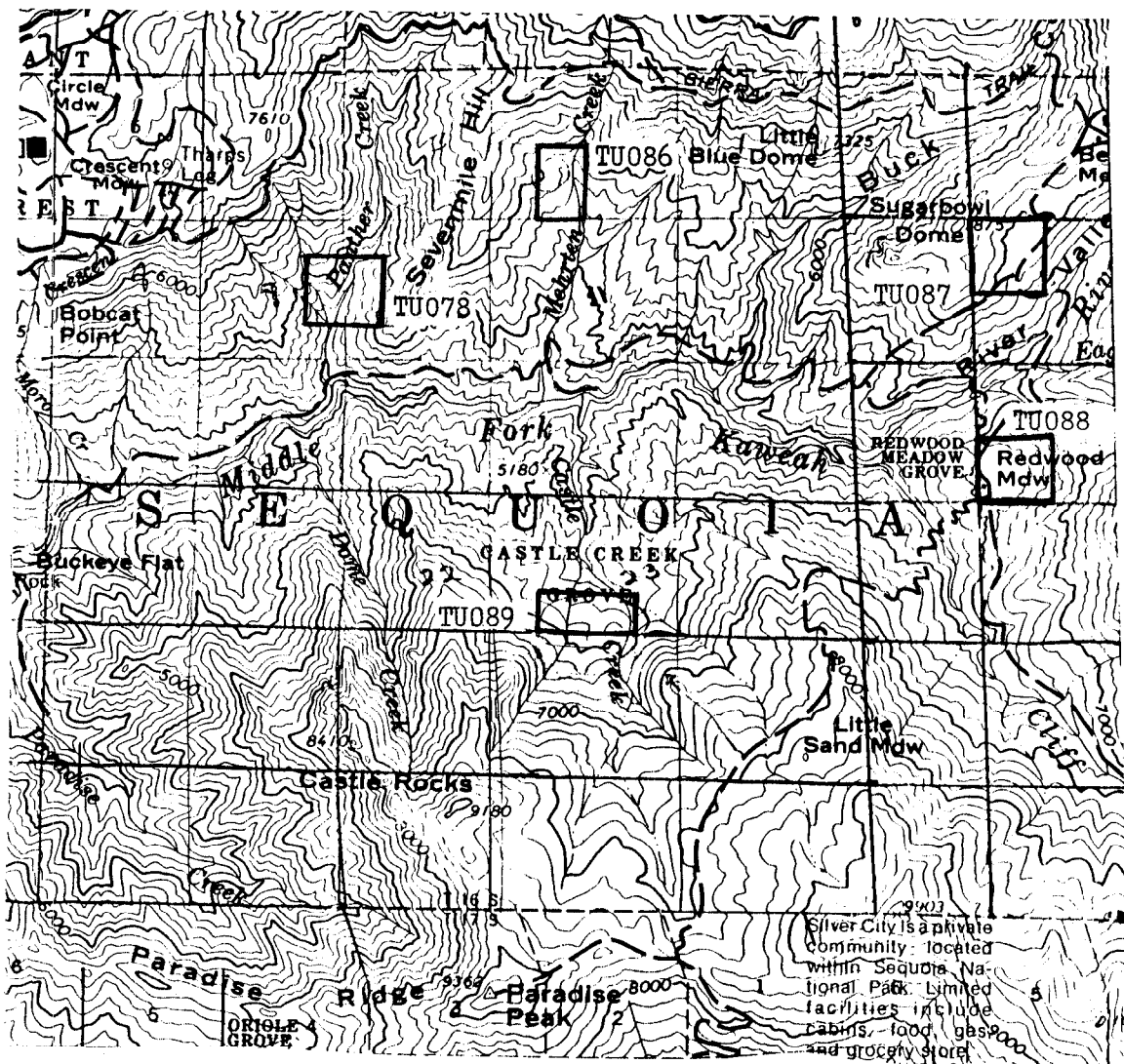


Figure 7

Location of Five Spotted Owl Territories in the Surveyed Portion of the Middle Fork Kaweah River During 1989, Sequoia National Park, California (scale 1 in = 1.25 mi).

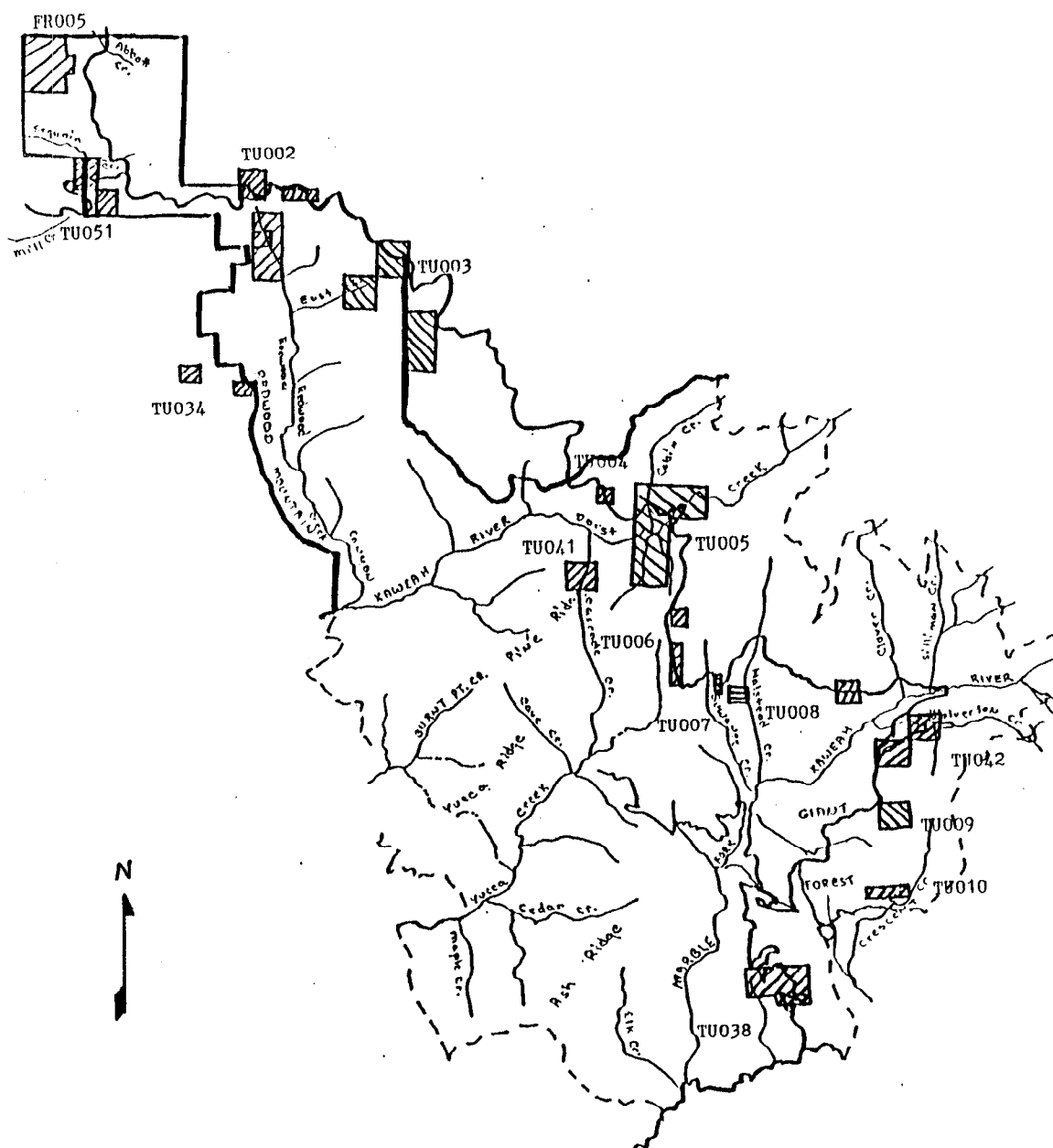


Figure 8

Location of 15 Historical Spotted Owl Sightings in the Giant Forest Study Area, Sequoia and Kings Canyon National Parks, California (scale 1 in = 1.75 mi).

Table 2. Location and Status of 26 Spotted Owl Sightings Outside the Giant Forest Study Area During 1988/89, Sequoia and Kings Canyon National Parks, California.

Terr. ¹ No.	Territory Name	Legal Descript T(S) R(E) Sec.			Results ²		Status ³	
					88	89	88	89
TU001	Whitaker Fst.	14	28	16,21	X	X	NP	PNS
TU011	Putam Canyon	18	30	N29	Q		O/RC	
TU030	Chimney Rock	14	29	5,6,7	X	Z	NP	NP
TU031	Silver City	17	30	SE12	M/F		P/ONS	
TU040	Atwell Grove	17	30	S11,SW12	F	M/F	P/ONS	P/ONS
TU072	Redwood Creek	17	30	SE10	M/F		P/ONS	
TU073	Cold Springs	17	31	SE8,NW17	F	M	P/ONS	P/ONS
TU074	Squaw Creek	18	30	NW20	F		P/ONS	
TU075	Garfield Grove	18	30	SE22	M		P/ONS	
TU076	Dennison Ridge	18	30	SE27	F		P/ONS	
TU078	Panther Creek	16	30	W9,C-9/10	U	F	P/ONS	P/ONS
FR028	Sheep Creek	13	30	SW13,NW24	Pr	M	O/NRC	P/ONS
FR050	Kings River	13	31	SW17,S18	M	M/F	P/ONS	P/ONS
FR051	Granite Creek	13	31	W15	Q	F	O/RC	P/ONS
TU086	W Fk Mehrten Cr	16	30	ESW2		M/F		P/ONS
TU087	Lil Bearpaw Mdw	16	31	NW8		Pr		O/RNS
TU088	Redwood Meadow	16	31	SW17		Pr		O/RNS
TU089	Castle Creek	16	30	C-S23		M/F		P/ONS
TV090	Paradise Creek	16	30	SW29		Pr		O/RNS
TU091	Squirrel Creek	17	30	NE8		M		P/ONS
TU092	Horse Creek	17	30	NW26		M/F		P/ONS
TU093	Deer Creek	17	30	SW13,SE14		Pr		O/RNS
TU094	Cedar Creek	18	30	C-9		M/F		P/ONS
TU095	S. Fork Grove	18	30	SE10		M/F		P/ONS
FR006	Lower Bubbs Cr	13	32	NW18		Q		O/RC
FR065	Lewis Creek	13	30	N2		M/F		P/ONS

¹, ², ³ See Table 1, page 8 for explanation of footnotes.

Density and Distribution

Crude densities for individual owls and territories were calculated by dividing the observed number of adult or subadult owls ($N = 43$ in 1988, 45 in 1989) or territories ($N = 24$ in 1988, 23 in 1989), by the total area of the GFSA (260 km^2). This produced values of 0.17 owls per km^2 ($0.43/\text{mi}^2$) and 0.09 territories per km^2 ($0.24/\text{mi}^2$).

The chi-square and log-likelihood test for goodness-of-fit of the Poisson distribution to the set of observed data, showed that there was a significant deviation from randomness in the distribution of the owl population within the GFSA (see Appendix 2 for computations). In addition, the coefficient of variability measured the relative dispersion to be uniform (Appendix 2).

Breeding Rates

Reproductive status in the GFSA was determined for nine (52.9%) of the 17 pairs during 1988, and sixteen (72.7%) of the 22 pairs in 1989. In 1988, seven (77.8%) of the pairs checked attempted nesting and four (57.1%) of the nesting pairs fledged a total of six young (Table 1). Mean fecundity was 0.67 (SE = 0.29, $n_2 = 9$, $Y = 6$). Mean productivity was 1.50 (SE = 0.29, $n_1 = 4$, $Y = 6$). The Mann-Whitney U-test indicated that there was a significant difference between the mean fecundity and mean productivity (U calc. = 34, U critical = 32, $n_2 = 9$, $n_1 = 4$, $P \leq 0.05$).

In 1989, eight (50%) of sixteen pairs checked for reproduction, attempted nesting and four (50%) of the nesting pairs fledged a total of five young (Table 1). Mean fecundity was 0.31 (SE = 0.18, $n_2 = 16$, $Y = 5$). Mean productivity was 1.25 (SE = 0.25, $n_1 = 4$, $Y = 5$). The Mann-Whitney U-test indicated that there was a significant difference between the mean fecundity and mean productivity (U calc. = 60, U critical = 28, $n_2 = 16$, $n_1 = 4$, $P \leq 0.05$).

Of the seven pairs, in 1988, which were presumed to have attempted nesting within the GFSA, four succeeded in nesting (Table 3). The following year (1989) nine pairs attempted nesting and four of those had young (Table 3). Two of the pairs which had young in 1988 also had young in 1989.

Table 3. Social Status of California Spotted Owl Located in the Giant Forest Study Area During 1988/89, Sequoia and Kings Canyon National Parks, California.

	<u>Adults</u>		<u>Subadults</u>		<u>Fledglings</u>		<u>Total</u>	
	<u>paired</u> 88 ¹ 89	<u>single</u> 88 89	<u>paired</u> 88 89	<u>single</u> 88 89	88 89	88 89	88 89	88 89
Female	19 22	1 0	0 0	0 0	- -	- -	20	22
Male	18 22	4 1	1 0	0 0	- -	- -	23	23
Unk.	- -	- -	- -	- -	6	5	6	5
Total	37 44	5 ² 1 ³	1 -	- -	6	5	49	50

¹ Year of study: 88 = 1988; 89 = 1989.

² Adequate effort to locate the other member of a pair was not spent with four of the five singles located.

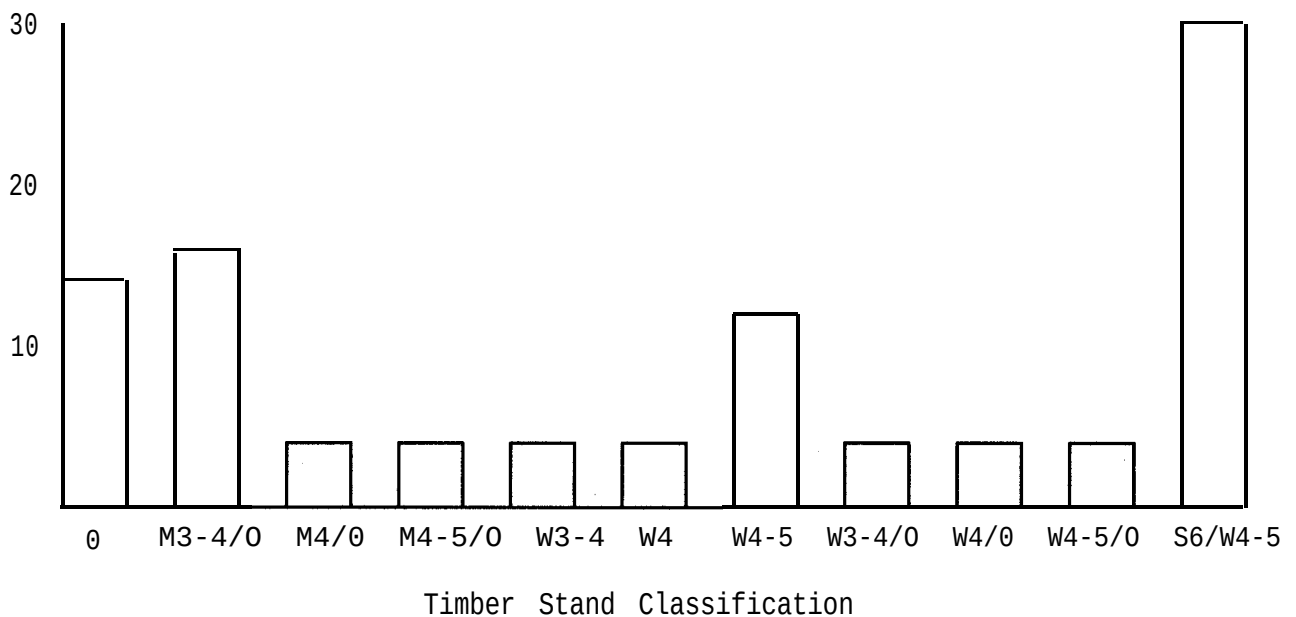
³ Access, to locate the other member of a possible pair, for complete coverage was limited by the steep terrain.

Habitat

The majority (ca. 62%) of owl territories were located in timber stands that were predominately white fir (Figure 9). Mature and old-growth white fir stands which contained sequoia groves (WF4-S(S6)) made up ca. 30 percent of the territories within which Spotted Owls were located. In addition, the second highest frequencies ($13\% \pm 2\%$) of owl detections occurred within WF4-5 (without sequoia groves), M3-4/O, or predominately oak, timber stands.

Figure 9. Percent Frequency of Spotted Owls Detected Within Each Timber Stand Classification in the Giant Forest Study Area During 1988/1989, Sequoia and Kings Canyon Parks, California.

Percent Frequency



Key:

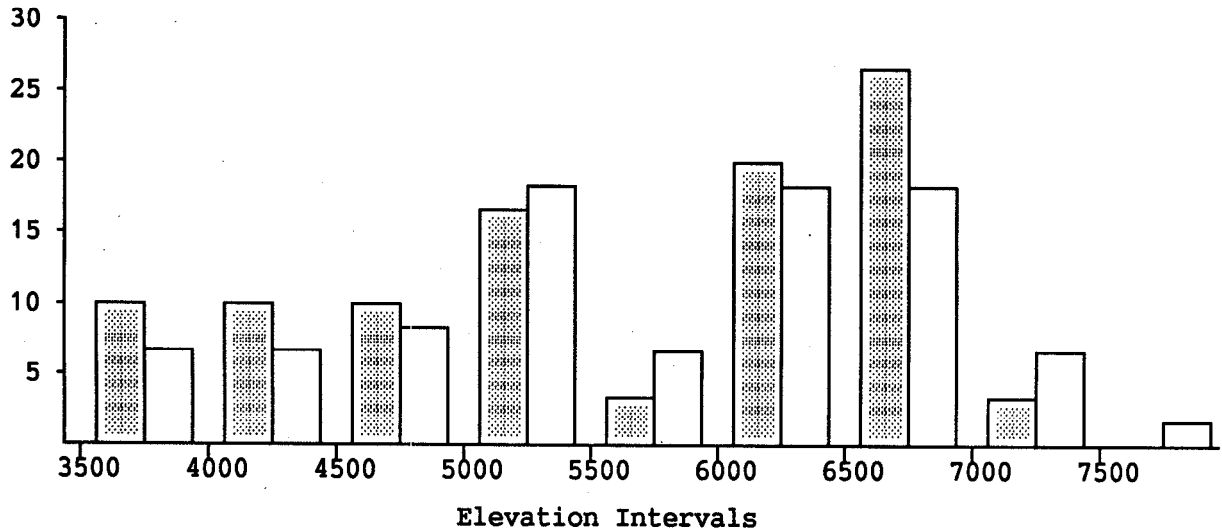
M = mixed conifer
W = white fir
S = sequoia
O = oak
3/4/5/6 = seral stages

Within the GFSA owls were detected at elevations from 1,100-2,165 m (3,600-7,100 ft), but elevations between 1,585-2,115 m (5,200-6,940 ft) contained the majority (69.2%) of owl detections (Figure 10). For the total park survey effort, most (58.2%) of the owls were located between 1,520-2,115 m (5,000-6,940 ft; Figure 10). Additionally, elevation distributions for all areas checked for presence showed selective use for certain elevations (Figure 11).

Within the GFSA, during 1989, most (32%) of the owls were detected on west-facing slopes with the next most prominent preference (24%) being for southwest-facing slopes (Figure 12). For the total survey effort the west-, southwest-, and north-facing slopes contained the majority (66%) of the owl detections.

Figure 10. Percent Frequency of Spotted Owls Detected in 500 Foot Elevation Intervals in the Giant Forest Study Area During 1988/89 and Those Elevations Combined with the Elevations Occupied Within the Surveyed Portions of the Park, Sequoia and Kings Canyon National Parks, California.

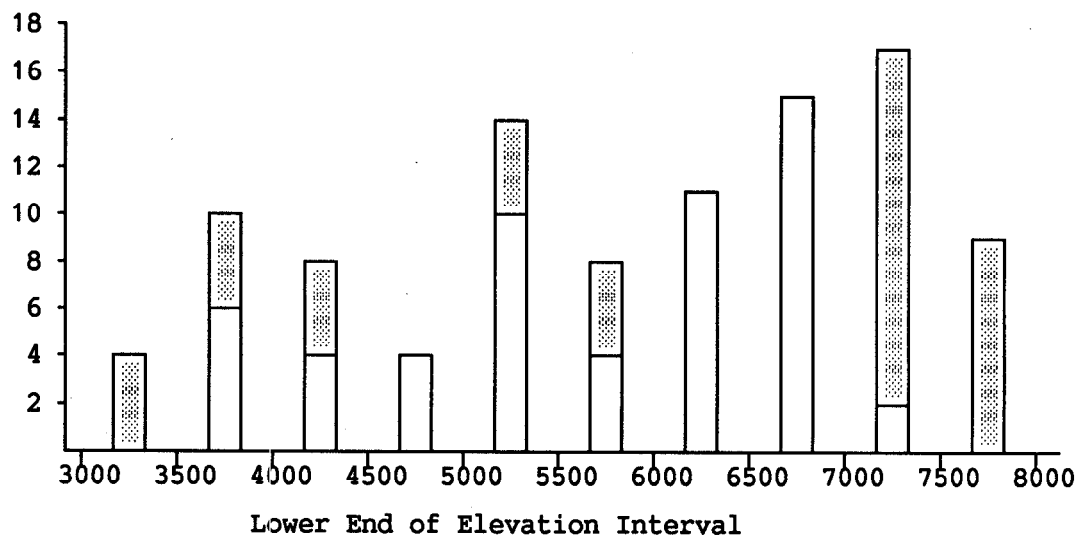
Percent Frequency



-  Elevations occupied in the GFSA during 1988/89 (n = 30)
 Elevations occupied in the parks during 1988/89 (n = 56)

Figure 11. Elevation Distribution of Areas Checked for Spotted Owls Within the Giant Forest Study Area During 1988/89, Sequoia and Kings Canyon National Parks, California.

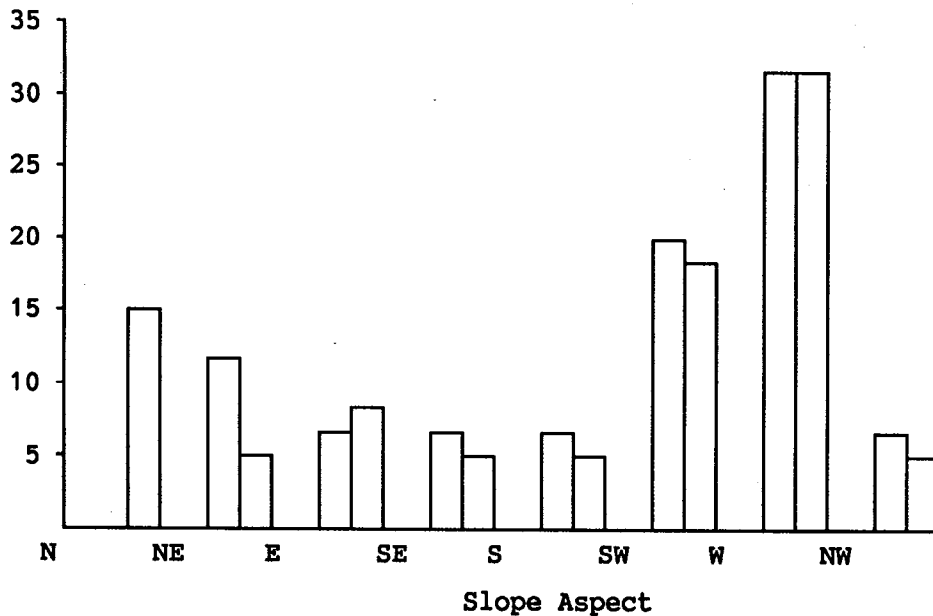
Percent Frequency



-  occupied sites
 unoccupied sites

Figure 12. Percent Frequency of Slope Aspects Where Spotted Owls Were Found in the Giant Forest Study Area and Those Elevation Combined With the Surveyed Portion of the Park During 1988/89, Sequoia and Kings Canyon National Parks, California

Percent Frequency



 Slope aspects occupied by owls within the GFSA.

 Slope aspects occupied by owls within the parks.

The tree species was identified for each nest site (Table 4). During 1988, two of the nests were in white firs, one in a jeffrey pine and one in a sequoia. Nest tree species used by the four breeding pairs in 1989 were: white fir, jeffrey pine, sequoia, and one nest in an unknown tree species (young was fledged when found).

Table 4. Tree Species Used for Nesting by Spotted Owls Within the Giant Forest Study Area During 1988/89, Sequoia and Kings Canyon National Parks, California.

Tree Spp.	<u>Frequency</u>		<u>Percent</u>	
	88	89	88	89
White Fir	2	1	50	25
Jeffrey Pine	1	1	25	25
Sequoia	1	1	25	25
Unknown	0	1	0	25

Of the three tree nest types used by Spotted Owls (Forsman 1983), the owls in the GFSA were found to use all three (Table 5). During 1988, three (75%) nests were in natural cavities and the fourth was in a broken-top (of one of two secondary tops). During 1989, one (25%) nest was in a natural cavity, one (25%) nest was in a broken-top, one (25%) was a platform nest, and the fourth nest type was unknown.

Table 5. Nest Types Used by Spotted owls Within the Giant Forest Study Area During 1988/89, Sequoia and Kings Canyon National Parks, California.

Tree Spp.	Freq .		%	
	88	89	88	89
cavity	3	1	75	25
broken-top	1	1	25	25
platform	0	1	0	25
unknown	0	1	0	25

DISCUSSION

Surveys

The final results of this study indicate that the census count of the GFSA was incomplete. First, in 1988, only 81.6% of the geographic areas with a possibility of containing owl territories had four or more survey visits. Franklin et al. (1986) showed that four survey visits were required to detect 97% of the total adult or subadult Spotted Owl population. In 1989, 29 (74.5%) of the defined geographic areas had four or more visits and two (5%) sites had less than four visits. However, some previous sites found in 1988 had limited access. Eight (20.5%) sites were not visited because they had complete surveys in 1988 with no responses and they were areas with marginal Spotted Owl habitat. Second, the curves for the survey effort (number of owls detected) over time (Figure 4) ideally should approach an asymptotic level, but did not. Contributing factors to this were possibly due to: the GFSA being surveyed as two separate areas and at different times in 1988, and it can take several years to locate all of the owls in a given area, depending on its size.

Most (69.2%) owls within the GFSA were found close to or within an hour hike. This was not surprising considering that the Generals Highway, the only main road through the park, and other available park roads run through the best possible Spotted Owl habitat.

Although the census count was incomplete at the end of the second year, 11 new territories were detected within the GFSA and 12 new territories were located within the surveyed portions of the parks. Of 26 territories where owls were found in the GFSA, single owls were detected in only three territories. In 1989, two of three singles were not located. Those two were along the park

boundaries and in areas where timber harvest was occurring on USFS lands. One single was located in 1989, but possibly due to the site's limited access, a pair was not detected. During 1988, a male and a female were located in a historical territory, however, extensive expansion of a campground within their territory may have lead to its abandonment.

Territories and Occupancy

Using data (Table 6) for territories where the occupancy status was determined, the percent of territories with paired owls within the GFSA was substantially higher than for Bias and Gutiérrez (1987, 1988), and Lutz and Gutiérrez (1989), and slightly higher than for Franklin et al. (1986 - 1989). This comparison indicates that the unmanaged forests of the GFSA probably support a higher proportion of pairs than do managed forests in the central Sierra Nevada (Central Sierra Nevada study area) or in northern California (Willow Creek study area). The GFSA percentage was the result of only a two year study while the two previously mentioned studies were the result of a three and four year study. The significance of this comparison should be taken into consideration for future management of Spotted Owl populations.

Table 6. A Comparison of the Proportion (%) of Paired Birds in Spotted Owl Populations in California. GFSA = Giant Forest Study Area (1988-89), WCSA = Willow Creek Study Area (Franklin et al. 1986-89) and CSNSA = Central Sierra Nevada Study Area (Bias, Gutiérrez, and Lutz 1987-89).									
	GFSA		WCSA				CSNSA		
	1988	1989	1985	1986	1987	1988	1986	1987	1988
Pr	18	22	28	30	31	35	18	19	23
S	1(5) ¹	0(1) ²	7	3	5	2	12	6	7
%	95	100	80	91	86	95	60	76	77
¹ Adequate effort to locate the other member of a pair was not spent with four of the five singles located. ² Access, to locate the other member of a possible pair, for complete coverage was limited by the steep terrain.									

Capture

All owls captured were caught with a dip net and not with a noose pole or mist nest as used by most other Spotted Owl field researchers. It is not known if this will adversely effect (i.e., they might be leery) future capture or mousing attempts. It is believed that my capture rate (15 in 1988 and 5 in 1989) was lower than that which was expected because the owls would either initially be out of reach of the noose pole and ignore attempts to get them lower, or would ignore mousing attempts to get them down for dip net capture. On many occasions owls were perched 1-10 ft beyond the range where capture could be attempted with a noose pole. Franklin (pers. comm. Humboldt State

Univ. Arcata, CA, 1988) stated that he found the same situation with the owls within his study area in northern California. However, he climbed the trees to capture those owls that stayed just out of noose pole reach which could account for his substantially higher capture rate (58 in 1985). Capture rates (22 in 196, 11 in 1987 and 16 in 1988) by Bias and Gutiérrez, and Lutz and Gutiérrez in the central Sierra Nevada were slightly higher than those for the GFSA.

Density and Distribution

The crude (observed) density (Table 7) of individual adult and subadult Spotted Owls and territories for the GFSA were comparable although slightly lower than those found by Franklin et al. (1986-1989) and slightly higher than those found by Bias and Gutiérrez (1987, 1988) and Lutz and Gutiérrez (1989). The crude densities on the GFSA could even be higher relative to the other areas studies by Franklin et al., Bias, Lutz and Gutiérrez. Not all of the GFSA was completely surveyed as this was only a two year study. This contrasts with the other studies where the distribution and occupancy pattern has been studied for at least 3-4 yrs. Taking this into consideration, the likely scenario is that after more years of study in the GFSA the crude densities would increase. If so, that would suggest that there are more individual owls and territories per unit area on unmanaged park land in the GFSA than on managed forests in the Sierra Nevada. However, as stated, additional time needs to be spent within the GFSA to determine the exact number of owls and territories per unit area.

Table 7. A Comparison of Crude Densities, Using Observed Numbers, of Spotted Owl Populations in California. GFSA = Giant Forest Study Area (1988-89), WCSA = Willow Creek Study Area (Franklin et al. 1986-89) and CSNSA = Central Sierra Nevada Study Area (Bias, Gutiérrez, and Lutz 1987-89).

	GFSA		WCSA				CSNSA		
	1988	1989	1985	1986	1987	1988	1986	1987	1988
Owls	43	45	63	63	67	72	48	44	53
Terr.	24	23	35	33	36	37	30	25	30
Km ²	260	260	292	292	292	292	356	355	355
Owls/Km ²	0.17	0.17	0.22	0.22	0.23	0.24	0.14	0.12	0.15
Terr./Km ²	0.09	0.09	0.12	0.11	0.12	0.13	0.09	0.07	0.08

It has been well documented that Spotted Owls are territorial and that they inhabit old-growth forests or at least forests with old-growth characteristics. Their territorial behavior explains the rejection of randomness and the measure of a uniform dispersion. In viewing a map of Spotted Owl territories within the GFSA (Figure 21, there is a noticeable clumping of their territories, which is most likely due to their requirement

of old-growth forests and the limited area and range of these forests. I believe it can be safely assumed, from analysis of these results, that the Spotted Owl territories are uniformly distributed within the suitable habitat which is clumped.

Breeding Rates

There was no significant difference in the GFSA mean productivity (Table 8) as compared to Spotted Owl populations studied by Franklin et al. (1986-1989) or by Bias and Gutiérrez (1987, 1988) or by Lutz and Gutiérrez (1989). The GFSA mean fecundity fell below the ranges seen by the previous researchers. However, potential biases exist for the mean values from the GFSA. First, the reproductive status was determined for only 37.5% of the 24 territories in 1988 and 78.3% of the 23 territories in 1989. This was partly due to the fact that the owls stayed high in the trees and were difficult to mouse for reproductive status. Second, several pairs, especially in 1988, were not located until late in the nesting season and may have experienced nest failure or were non-nesting by the time they were located. Third, the fecundity rate, which appears to fluctuate from year to year, could have been lower for the 1988 and 1989 seasons due to a low prey base cycle, because of the severe drought conditions, or it just may be lower. Finally, nine (1988) and 16 (1989) pairs each constitute a relatively small sample size to detect significant sample differences. Normally the Mann-Whitney U-test is an appropriate and useful test in determining the significance of the relationship between nonparametric samples such as mean fecundity and mean productivity. However, because of the small sample size the results would not have statistical significance.

Table 8. A Comparison of Mean Fecundity and Mean Productivity of Spotted Owls in California. GFSA = Giant Forest Study Area (1988-89), WCSA = Willow Creek Study Area (Franklin et al. 1986-89) and CSNSA = Central Sierra Nevada Study Area (Bias, Gutiérrez, and Lutz 1987-89).

	GFSA		WCSA				CSNSA		
	*1988	1989	1985	1986	1987	1988	1986	1987	1988
Fecundity	0.67	0.31	0.56	0.56	1.13	1.18	1.25	0.23	1.07
Productivity	1.50	1.25	1.67	1.53	1.70	1.3	1.67	1.50	1.88

With only two years of study completed and the low banding rate, my information on site and mate fidelity will be of limited value. However, all of the individuals banded (seven pairs) were detected with the same mates in the second year. Five banded females were repeatedly found with the same mate based on the males morphological characteristics, and their behavior and vocalizations. Also, there was no mortality noted during the two field seasons, of young or adults. Results of research from future studies will be needed to resolve many of the unanswered demographic questions about the Spotted Owl in SKCNP.

Habitat

Preliminary results of habitat analysis showed that the majority of owl detections, roost sites and nest sites occurred within mature white fir stands (WF4-5). The WF4-5 timber stands were mature forests with some old-growth structural characteristics (i.e., broken-top snags, uneven-aged and multilayered overstory). None of the owls were detected in solely old-growth timber stands, contrary to what Solis (1983) and Forsman et al. (1984) found with some of the owls in their studies in Oregon. However, they were detected in stands older than what was noted by Bias and Gutiérrez (1987, 1988), and Lutz and Gutiérrez (1989) in their central Sierra Nevada study and similar to those found by Franklin et al. (1986-1989) in their northern California study. No effort was made during this study to determine any habitat or physical characteristic preferences by comparing use with availability.

Elevations inhabited by the majority of Spotted Owls were as expected. Habitat at higher (>7,000 ft) and lower (<3,500 ft) elevations were also surveyed for owls and had few or no owls detected (Figure 8). The occupied elevations correlated with the timber stand choice.

The sample size of owl territories checked for reproductive status was too small to calculate any nest tree or nest type preferences by the owls.

Looking back on the data compiled during the study, while using the *Spotted Owl Inventory and Monitoring Handbook* (USFS 1988) as a guide, some of the results of a particular visit might have been recorded differently than they were. A few of the areas with both occupancy and reproduction unknown, if they were based on behavior and not the number of visits (i.e., protocol), would have been recorded as nonreproduction confirmed, thereby decreasing the mean fecundity count. On the other hand, if protocol was followed exactly when determining presence and then confirming occupancy it would have taken much longer. For example, we did not stop the search for a mate after presence was detected if less than six hours remained of day-light. However, in the final analysis of the data obtained the results would not have been significantly different so protocol versus nonprotocol results were combined and not written up separately.

ACKNOWLEDGEMENTS

The biggest thanks of all goes to Debbie Hom, my field assistant, for all her help. Her knowledge of Spotted Owl behavior and survey techniques were a great asset. Also, she donated many hours of overtime in and out of the field. Assistance by Kevin Roberts, Mike Escallier and Gordon Gould helped to make my load lighter. Without their hours in the field, much that did get accomplished never would have.

I would particularly like to thank Kent Smith and Gordon Gould of the California Department of Fish and Game for their planning, support, dedication and comments on this manuscript. Without them this project would not have been possible.

I want to extend my thanks to Alan Franklin, Pat Ward, Mike Bias, Bill LaHaye and Dr. R. Gutiérrez for providing me with not only information on field techniques, but also for their studies which I was able to use as a guide for my analysis.

I am especially indebted to Dave Graber for being our contact within SKCNP, taking care of all the administrative red tape and providing us with valuable, general park information. All of the many fine employees of the park that helped provide me with information on road conditions, vegetation type within an areas, available trails and their conditions, weather, etc. deserve a big thanks.

Thank you Judy Hilliard, Janet Jones and the staff of the CSUS-Hornet Foundation for handling the paperwork and money.

Thanks to all of you.

LITERATURE CITED

- Bias M. A., and R. J. Gutiérrez. 1987. Population ecology of the California Spotted Owl in the central Sierra Nevada: preliminary results, 1986. Unpubl. Tech. Rep., Calif. Dept. of Fish and Game, Sacramento, CA. 27 pp.
- _____. 1988. Population ecology of the California Spotted Owl in the central Sierra Nevada: preliminary results, 1986. Unpubl. Tech. Rep., Calif. Dept. of Fish and Game, Sacramento, CA. 22 pp. and appends.
- Barrows, C. W., P. H. Bloom and C. T. Collins. 1982. Sexual differences in the barring of Spotted Owls. North American Bird Bander 7(4): 138-139.
- Caughley, G. 1977. Analysis of vertebrate populations. J. Wiley and Sons, London. 234 pp.
- Franklin, A., J. P. Ward and R. J. Gutiérrez. 1986. Population ecology of the Northern Spotted Owl (*Strix occidentalis caurina*) in northwest California: preliminary results, 1985. Unpubl. Tech. Rep., Calif. Dept. of Fish and Game, Sacramento, CA. 42 pp.
- _____. 1987. Population ecology of the Northern Spotted Owl (*Strix occidentalis caurina*) in northwest California: preliminary results, 1986. Unpubl. Tech. Rep., Calif. Dept. of Fish and Game, Sacramento, CA. 28 pp.
- _____. 1988. Population ecology of the Northern Spotted Owl (*Strix occidentalis caurina*) in northwest California: preliminary results, 1987. Unpubl. Tech. Rep., Calif. Dept. of Fish and Game, Sacramento, CA. 27 pp.
- Franklin, A., J. Blakesley and R. J. Gutiérrez. 1989. Population ecology of the Northern Spotted Owl (*Strix occidentalis caurina*) in northwest California: preliminary results, 1988. Unpubl. Tech. Rep., Calif. Dept. of Fish and Game, Sacramento, CA. 31 pp.
- Forsman, E. D. 1981. Molt of the Spotted Owl. Auk 98: 735-742.
- _____. 1983. Methods and materials for locating and studying Spotted Owls. USDA - Forest Service, Pacific NW Forest and Range Exper. Sta. Gen. Tech. Rep. PNW-12. 8 pp.
- Forsman, E. D., E. C. Meslow and H. M. Wight. 1984. Distribution and biology of the Spotted Owl in Oregon. Wildl. Monogr. 87. 64 pp.
- Gould, G. I., Jr. 1974. The status of the Spotted Owl in California: National Park Service Supplement. Unpubl. Tech. Rep., Calif. Dept. of Fish and Game, Sacramento, CA. 7 pp.
- _____. 1977. Distribution of the Spotted Owl in California. Western Birds 8(4): 131-146.

- _____. 1985a. Management of Spotted Owls by the California Department of Fish and Game. In: Gutiérrez, R. J. and A. B. Carey (eds.). Ecology and management of the Spotted Owl. USDA - Forest Serv., Pacific NW Forest and Range Exper. Sta. Gen. Tech. Rep. PNW-185. 119 pp.
- _____. 1985b. The Spotted Owl in California. Testimony given to the Audubon Spotted Owl advisory panel, Sacramento, CA. Calif. Dept. of Fish and Game. 15 pp.
- _____. 1986. Spotted owl territory information Summary. Supplement to: Owl nest territory monitoring program. California Dept. of Fish and Game, Nongame Wildlife Invest., Job Progress Report, Project W-65-R-3 (554), Job 11-3. 33 pp.
- Gutiérrez, R. J. and A. B. Carey. 1985. Introduction In: Gutiérrez, R. J. and A. B. Carey (eds.) ecology and management of the Spotted Owl. USDA-Forest Serv., Pacific NW Forest and Range Exper. Sta. Gen. Tech. Rep. PNW-185. 119 pp.
- Herman, S. G. 1980. The naturalists' field journal. Unpubl. manuscript, Evergreen State College, Olympia, WA. 200 pp.
- Küchler, A. W. 1977. The map of the natural vegetation of California. In: Barbour, M. G. and J. S. Major (eds.). Terrestrial vegetation of California. J. Wiley and Sons, New York. 1002 pp.
- Lutz, D. W. and R. J. Gutiérrez. DRAFT-1989. Population ecology of the Spotted Owl in the central Sierra Nevada: preliminary results, 1988. Unpubl. Tech. Rep., Calif. Dept. of Fish and Game, Sacramento, CA. 13 pp.
- Remsen, J. V., Jr. 1978. Bird Species of Special Concern in California. California Dept. of Fish and Game. Wildl. Mgmt. Branch Admin. Rep. 78-1. 54 pp.
- Solis, D. M. 1983. Summer habitat ecology of Spotted Owls in northwestern California. M. S. Thesis, Humboldt State University, Arcata, CA. 169 pp.
- Tweed, W. C. 1981. Sequoia - Kings Canyon: the story behind the scenery. K C Publications, Las Vegas, NV. 64 pp.
- United States Forest Service - USDA. 1986. Draft supplement environmental impact statement. USDA - Forest Service, Pacific Northwest Regions. Portland, OR. 300 pp.
- _____. 1988. Spotted Owl Inventory and Monitoring Handbook. USDA - Forest Service, Pacific Northwest Region. Portland, OR. 13 pp.
- U.S. Fish and Wildlife Service. 1982. The northern Spotted Owl: a status review. Unpubl. Tech. Rep., U.S. Dept. of the Interior, Portland, OR. 29 pp.

- _____. 1987. The northern Spotted Owl: a status review. Unpubl. Tech. Rep., U.S. Dept. of the Interior, Portland, OR. 47 pp. and appends.
- White, J. R. and S. J. Pusateri. 1949. Sequoia and Kings Canyon National Park. Stanford University Press, Stanford, CA. 104 pp.
- Zar, J. H. 1974. Biostatistical analysis. Prentice-Hall, Englewood, NJ. 620 pp.