



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



**POPULATION ECOLOGY OF THE CALIFORNIA
SPOTTED OWL IN THE CENTRAL SIERRA
NEVADA: ANNUAL RESULTS, 1992**

by

Christine A. Moen and R. J. Gutiérrez

November 1993

State of California
THE RESOURCES AGENCY
Department of Fish and Game

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ABSTRACT

In 1992 we surveyed 39 California Spotted Owl territories on the 355 km² Eldorado study area located in the central Sierra Nevada, California. We found 63 Spotted Owls occupying 32 territories. Abundance and density of Spotted Owls have steadily increased from 1986-1992, primarily due to increased sampling. Fecundity for 1992 was 0.88. Reproductive activity was variable with a mean fecundity estimate of 0.57 over all seven years of the study. Turnover rates for males and females in 1992 were 0.26 and 0.32 respectively. Mean annual survival estimates pooled for 1986 through 1992 were 0.86 for males and 0.76 for females.

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INTRODUCTION

The Northern Spotted Owl (*Strix occidentalis caurina*) is closely associated with late successional stage forests (Forsman et al. 1984, LaHaye 1988, Solis and Gutiérrez 1990, Carey et al. 1990, Carey et al. 1992). Logging, particularly clear-cutting, is considered to be the major factor in the decline of Northern Spotted Owl populations (Thomas et al. 1990, USDI 1990). As a result, the Northern Spotted Owl is now a federally listed threatened species (USDI 1990). The California Spotted Owl (*S. o. occidentalis*) inhabits not only late successional conifer forests (Bias 1989, Lutz and Gutiérrez 1989, Call 1990), but also other forest types (Gutiérrez et al. 1992). Nevertheless, California Spotted Owl habitat is being logged in the Sierra Nevada with subsequent concern for its continued persistence (Verner et al. 1992).

In order to evaluate the status of the Spotted Owl in the central Sierra Nevada, this study was initiated in 1986 with funding from the California Department of Fish and Game (Department). The USDA Forest Service, Pacific Southwest Forest and Range Experiment Station in Fresno, California and the Department continue their support of this project. The demographic data collected in this study complements demographic research on the Northern Spotted Owl in northwest California (Franklin et al. 1990) and on an insular population of California Spotted Owls in southern California (LaHaye and Gutiérrez 1992, LaHaye et al. 1992). Thus, the objectives of this study were to estimate:

- 1) Density of Spotted Owls and occupancy status of owl territories within the study area;
- 2) owl breeding and mortality rates,
- 3) site and mate fidelity of individual owls,
- 4) turnover rates of territorial individuals,
- 5) owl distribution relative to habitat type.

Results from the first two years (1986-87) of the study were reported by Bias and Gutiérrez (1987,1988), the third (1988) and fourth (1989) year were reported by Lutz and Gutiérrez (1989) and Lutz (1992) respectively, and the fifth (1990) and sixth (1991) year were reported by Moen and Gutiérrez (1993). We herein present the results of the seventh year of study, May to August 1992.

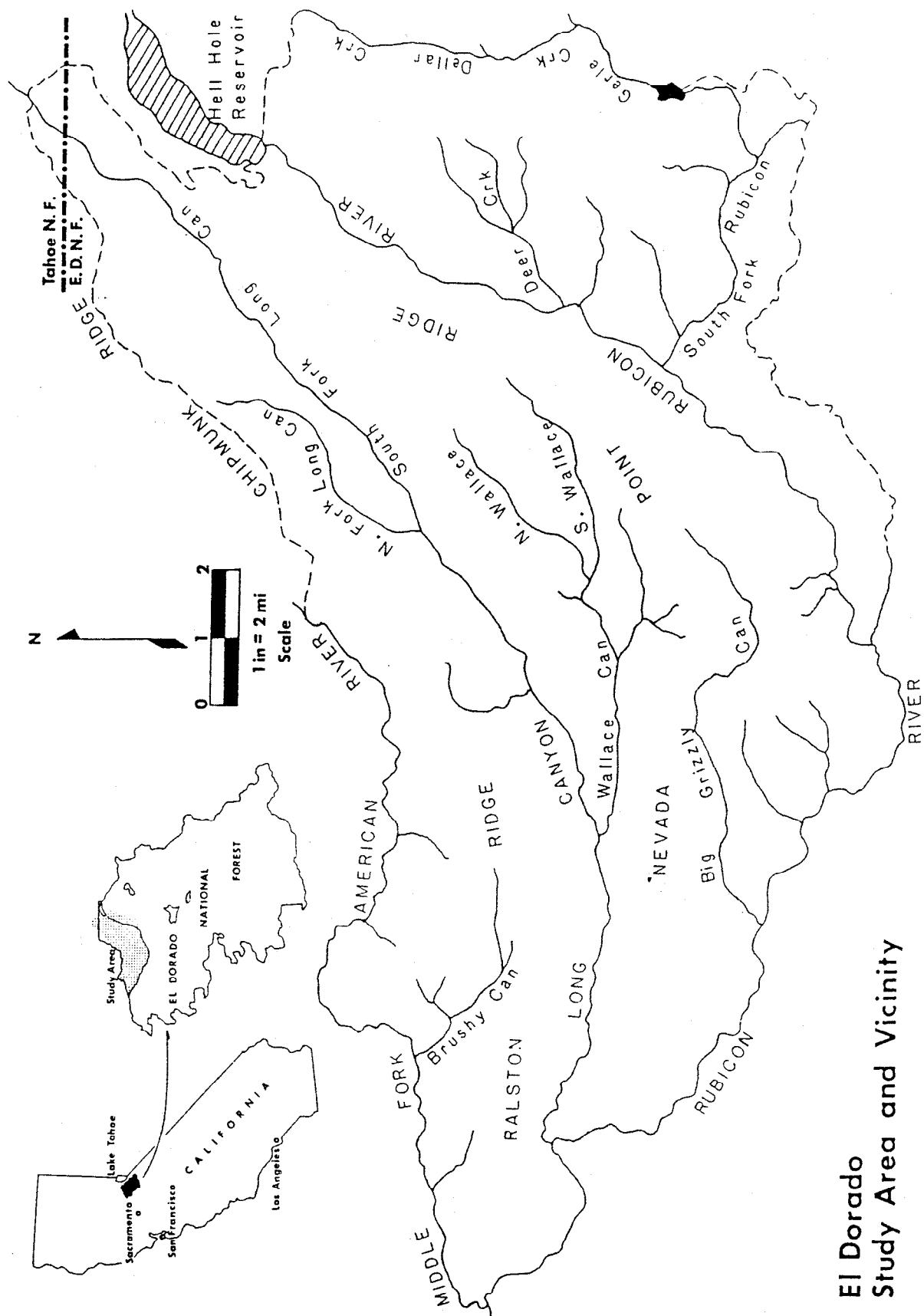
STUDY AREA

The study area is located in the central Sierra Nevada approximately 10 km (6 mi) northeast of Georgetown, El Dorado County, California. The study area is included in the Georgetown and Pacific Ranger Districts, Eldorado National Forest, with a small portion in the Foresthill Ranger District, Tahoe National Forest, in El Dorado and Placer Counties (Figure 1). The study area is approximately 355 km² (136 mi²). Elevations range from 366 m (1200 ft) to 2,257 m (7400 ft). Public (USFS) land comprises 62.7% of the study area, whereas 37.3% of the area is private land (Figure 2). The study area is ideal because of a history of Spotted Owl occupation, previous Spotted Owl research (Bias and Gutiérrez 1987, 1988, Laymon 1988, Lutz and Gutiérrez 1989, 1989b, Moen and Gutiérrez 1992), and good road access.

The study area is typical of Sierran Montane Forest (SMF) described by Küchler (1977). Dominant tree species of the SMF are white fir (*Abies concolor*) and sugar pine (*Pinus lambertiana*). At lower elevations, 600 m to 1,500 m, the SMF is dominated by ponderosa pine (*P. ponderosa*) on more xeric sites and white fir on more mesic sites. At higher elevations, above 1,500 m, there is a transition zone dominated by red fir (*A. magnifica*) (Rundel et al. 1977). Other species that occur within the study area include: Douglas-fir (*Pseudotsuga menziesii*), incense cedar (*Libocedrus decurrens*), canyon live oak (*Quercus crysolepis*), California black oak (*Q. kelloggii*), Pacific dogwood (*Cornus nuttallii*), and tan oak (*Lithocarpus densiflora*).

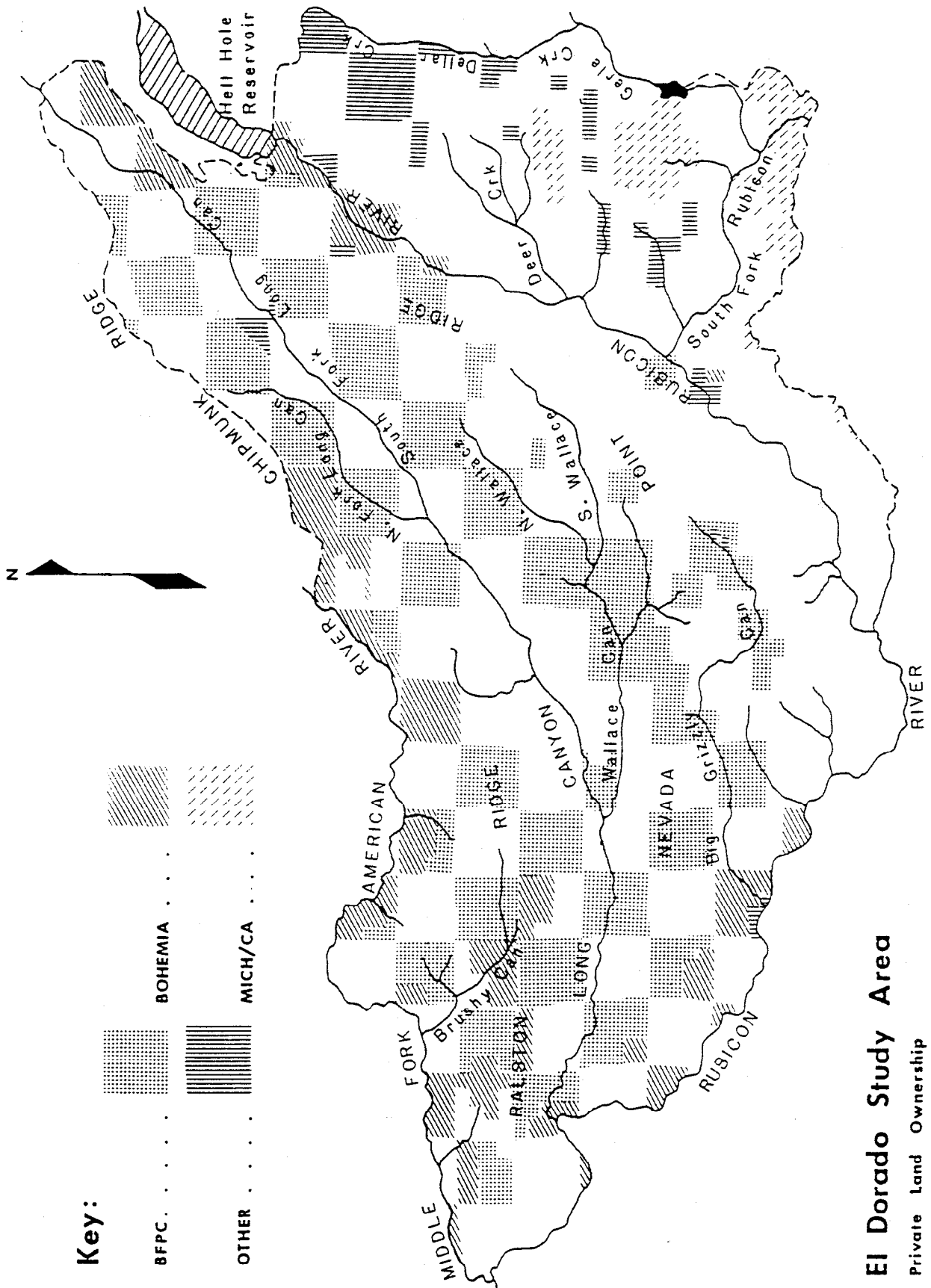
The Sierra Nevada is the dominant factor influencing the climate of the study area. It is cold and wet during the winter and hot and dry during the summer. Average annual precipitation in the study area is about 130 cm (51 in) (Elford 1974). The average annual temperatures range from about 15°C (60°F) at low elevations to 13°C (55°F) at higher elevations, ranging from -1°C (30°F) in winter to 35°C (95°F) in summer (Elford 1974).

Figure 1. Eldorado study area and its location within the Eldorado National Forest and California.



El Dorado
Study Area and Vicinity

Figure 2. Location of private and public lands within the Eldorado study area, Eldorado National Forest, California.



METHODS

Surveys

Spotted Owl surveys followed procedures described by Forsman (1983) and Franklin et al. (1990). Surveys consisted of point, walk-in, and cruise surveys and were conducted from May to August 1992. Night surveys were conducted from dusk to 2300 hrs. Walk-in surveys were conducted from dawn and throughout daylight hours. The study area was completely surveyed at least once. The majority of forested areas were surveyed several times and all previously occupied territories were surveyed at least four times. All areas were surveyed without regard to ownership or land management practice.

Once an owl was detected, its location was plotted onto a U.S. Geological Survey (USGS) 1:24,000 scale topographic map. At least one compass bearing was used and distance was estimated to an owl location during a night survey. Locations of owls during day-time walk-in surveys were estimated by topography and elevation of the roost site. Legal descriptions and Universal Transverse Mercator (UTM) of all locations were recorded.

Capture

We attempted to capture and band all Spotted Owls within the study area. Capture procedures followed Forsman (1983). An owl, when captured, was fitted with a USFWS locking band (size 7B for females and juveniles, 7A for males) on the tarso-metatarsus of one leg and a unique color band with color tab on the other leg.

Sex and Age

The sexes of adult and subadult Spotted Owls were distinguished by calls and behavior. Male Spotted Owls have a lower pitched call than do female Spotted Owls (Forsman 1983). Juvenile Spotted Owls could not be sexed accurately. Spotted Owls were aged according to plumage characteristics described by Moen et al. (1991).

Reproduction

We attempted to estimate the reproductive status of the owls once they were located at their daytime roost. To estimate reproductive success we followed the guidelines outlined by Forsman (1983) where an individual owl is fed mice and either eats or caches the mice, or delivers them to a female on a nest or to fledged young.

RESULTS

Surveys

In 1992, we spent a minimum of 347 hours surveying for Spotted Owls. We conducted 661 separate surveys; 515 (78%) points surveys, 115 (18 %) walk-in surveys, and 31 (4%) cruise surveys. The study area was completely surveyed at least once and multiple surveys were conducted at known territories.

Capture

During the 1992 field season, 38 Spotted Owls were captured and fitted with bands; 3 adult females, 1 subadult female, 6 adult males, 2 subadult males, and 26 juveniles. Fourteen males and 17 females banded in previous years were identified again in 1992. We attempted to determine the status of all previously banded birds within the study area.

Territory Occupancy

Thirty seven territories previously occupied by California Spotted Owls were surveyed at least three times in 1992. Spotted Owls were detected at 30 (81 %) territories and 7 (19%) previously occupied territories were estimated to be currently unoccupied (Appendix 1). We located owls at 2 new sites during 1992. Owl pairs were detected in 30 territories while 2 territories apparently were occupied by single males. One of the territories that had a pair of Spotted Owls also had a second female. Both females on this territory are color-banded and both have been observed roosting and allopreening with the male. On at least one occasion, the 3 birds were roosting within 16 meters of each other and numerous night surveys confirmed the presence of two females and one male, all apparently defending the one territory.

Movements Between Territories

In 1992, 3 females banded in previous years moved to different territories and mated with the males resident at the new site. The Zuver territory female in 1990 was not observed in 1991 and was found in Dad Young Spring in 1992. The Grizzly territory female of 1991 moved to Pigeon Roost territory in 1992 and the Grizzly territory was determined to be unoccupied (Appendix 1). The French House female of 1991 moved to Spring Hollow territory in 1992 and the French House territory was also determined to be unoccupied in 1992.

We had one known mortality in 1992. The male in F-Spur territory was identified in 1992 and had 3 juveniles. Later in the summer, he was found on a road near his territory with two broken wings, apparently having been struck by a vehicle. He died enroute to a veterinarian.

Density and Population Size

The mean adult and subadult population size (estimated using program Jolly-model D) was 37.17, with a crude density of 0.10 Spotted Owls/km² for 1986-1992 (Table 1). In contrast, empirical population size for 1992 was 63 Spotted Owls with a density of 0.18 Spotted Owls/km². This discrepancy may be due to the fact that program Jolly estimates are based on capture/recapture rates and not all birds on the Eldorado study area have been captured and marked.

Survival and Turnover

Survival rates for males and females for years 1986-1992 were estimated using empirical data, program Surge (Lebreton et al. 1992), and Jolly-Seber (Brownie et al. 1986) (Table 2). Rates using all three methods are similar and consistent. Except for the first year of study, male survival has been higher than female survival with the survival of males averaging approximately 85 % and that of females averaging about 77 %.

From 1991-1992 26 % of the male and 32 % of the female territory holders were replaced (Table 3). We only evaluated replacement and not abandonment because we did not have sufficient information to quantify abandonment. Overall, there was a 15.5 % mean annual turnover rate for male and 16.0 % for female territory holders on the Eldorado study area from 1986-1992 (Table 3).

Reproduction

We monitored the reproductive status of 25 owl pairs in 1992. Reproduction on the Eldorado study area was relatively high in 1992 (Table 4). Twenty-one of the 25 pairs (84%) successfully nested and produced 44 young for a mean fecundity estimate of 0.88 and mean productivity of 1.05 (Table 5). The pooled estimate for mean fecundity on the Eldorado study area from 1986-1992 is 0.57.

Table 1. Empirical and estimated (Jolly-Seber model D) abundance and empirical density estimates for Spotted Owls between 1986 and 1992 on the Eldorado study area, central Sierra Nevada, California.

Year	Empirical Abundance	Jolly- Seber Abundance		Empirical Density (Owls/km ²)
		Model D	95% CI	
1986	43			0.12
1987	47	27.66	(25 - 35)	0.13
1988	49	32.87	(30 - 36)	0.14
1989	43	32.16	(30 - 34)	0.12
1990	55	39.63	(37 - 42)	0.15
1991	51	41.27	(38 - 45)	0.14
1992	63	49.39	(44 - 55)	0.18
MEAN		37.17		0.14

Table 2. Survival estimates using program Surge, empirical, and Jolly-Seber for California Spotted Owls from 1986-1992 on the Eldorado study area central Sierra Nevada, California.

Year	Male		Female		Sexes Combined
	Surge	Empirical	Surge	Empirical	Jolly-Seber
1986-87	0.69	0.77	0.88	0.83	0.83
1987-88	0.92	0.92	0.54	0.54	0.72
1988-89	0.87	0.88	0.78	0.78	0.83
1989-90	1.00	1.00	0.96	0.93	1.00
1990-91	0.69	0.74	0.64	0.67	0.70
1991-92	0.86	0.83	0.78	0.85	----
MEAN	0.86	0.85	0.76	0.77	0.82

Table 3. Turnover rates for male and female Spotted Owls from 1986-1992 on the Eldorado study area, central Sierra Nevada, California .

Sex	Year	Number of Banded Territory Holders Identified ¹	Number of Turnovers ²	Turnover Proportion (95% CI)
Males	1986-87	12	1	0.08 (0.00-0.24)
	1987-88	11	1	0.08 (0.00-0.24)
	1988-89	16	2	0.12 (0.00-0.29)
	1989-90	16	5	0.25 (0.00-0.45)
	1990-91	22	3	0.14 (0.00-0.29)
	1991-92	17	5	0.26 (0.00-0.46)
Females	1986-87	6	0	0.00 (-----)
	1987-88	13	2	0.15 (0.00-0.35)
	1988-89	13	2	0.13 (0.00-0.13)
	1989-90	14	1	0.07 (0.00-0.20)
	1990-91	15	5	0.29 (0.07-0.51)
	1991-92	16	8	0.32 (0.13-0.51)
Sexes Combined	1986-87	18	1	0.06 (0.00-0.17)
	1987-88	24	3	0.12 (0.00-0.25)
	1988-89	29	4	0.13 (0.01-0.25)
	1989-90	30	6	0.17 (0.04-0.30)
	1990-91	37	8	0.21 (0.08-0.34)
	1991-92	36	13	0.30 (0.16-0.44)

¹ Includes newly-banded birds.

² Note that some territory turnover estimates are affected by time-lag. For example, a male banded in 1989, male heard but not seen in 1990 and 1991, and then a new male banded in 1992 would be reported as a turnover for that territory in 1991-92.

Table 4. Number of pairs checked for reproduction from May through August 1986-1992 and total number of young for the Eldorado study area, central Sierra Nevada, California.		
Year	Number of Pairs Checked	Total Number of Young
1986	10	15
1987	8	3
1988	10	15
1989	9	6
1990	13	16
1991	15	5
1992	25	44

Table 5. Estimates of California Spotted Owl nesting proportion ¹ , mean fecundity ² , and mean productivity ³ , for 1986-1992 on the Eldorado study area, central Sierra Nevada, California. Sample size (n) is in parentheses.			
Year	Proportion Nesting	Mean Fecundity	Mean Productivity
1986	0.75 (12)	0.75 (10)	0.83 (9)
1987	0.15 (13)	0.19 (8)	0.75 (2)
1988	0.36 (12)	0.75 (10)	0.93 (8)
1989	0.27 (15)	0.33 (9)	0.66 (6)
1990	0.63 (19)	0.54 (13)	0.72 (11)
1991	0.25 (16)	0.17 (15)	0.62 (4)
1992	0.84 (25)	0.88 (25)	1.05 (21)
¹ The number of successful nests/ number of pairs checked for reproduction (n).			
² The number of female young (assuming a 1: 1 sex ratio, therefore one-half the total number of young)/ number of females checked for reproduction (n).			
³ The number of female young/the number of adult females who produced young (n).			

The methods described by Forsman (1983) for estimating reproduction were developed for the northern subspecies and we have found over the past seven years that the criteria are difficult to meet with the California subspecies on this study area. This difficulty may be explained by the evidence that indicates that California Spotted Owl diet is somewhat different than the diets of the northern subspecies (Barrows 1980, Thraillkill and Bias 1989). In addition, California Spotted Owls appear to behave differently than Northern Spotted Owls (pers. obs.). Therefore, our estimates of fecundity and productivity are based on nests or young detected throughout the field seasons which ranged from April and May through August 1986-1992. We are currently working on a more appropriate criteria for determining reproduction in the central Sierra Nevada.

Lambda Estimation

Survival estimates (Table 2) were used to calculate estimates of lambda (λ), or the finite (annual) rate of population growth (Table 6). We used a combination of survival estimates (Surge and Jolly-Seber), and juvenile survival rates (Lutz 1992, LaHaye pers. comm.), along with the formulas from Noon et al. (1992) to estimate lambda. When we used Lutz' estimate of juvenile survival based on radio-telemetry data, we estimated a significantly declining population (Table 6). We currently do not have a good estimate of juvenile survival. This is due to the fact that no banded juveniles have ever been recovered from the Eldorado study area even though 47 juveniles have been banded from 1986-1992. This fact, however, may also suggest that a low rate of juvenile survival is a good estimate of the parameter.

Table 6. Estimates of lambda (λ) for California Spotted Owls from 1986-1992 on the Eldorado study area, central Sierra Nevada, California. S_J = Juvenile survival, S_A = adult and subadult survival, and b = fecundity. LaHaye (pers. comm.), Lutz (1992).				
Source S_A	Jolly Seber, Sexes Combined		Surge, Females	
Source S_J	LaHaye	Lutz	LaHaye	Lutz
S_J	0.296	0.16	0.296	0.16
S_A	0.82	0.82	0.78	0.78
b	0.57	0.57	0.57	0.57
LAMBDA	0.964	0.903	0.922	0.863
$H_0: \lambda \geq 1$	$P = 0.1841$	$P = 0.0838$	$P = 0.0708$	$P = 0.0375$

Habitat

During surveys at owl roost locations an ocular estimation was made of the dominant overstory and understory characteristics and size and species of dominant trees were recorded. Of 90 visits to the roost locations in 27 territories (visits in which habitat type was noted), 84 (93%) had overstories dominated by trees >52.4 cm dbh (diameter at breast height).

DISCUSSION

The two methods used (empirical and Jolly-Seber) to estimate California Spotted Owl abundance on the Eldorado study area were not in agreement (Table 1). Since all owls on the study area have not been captured and banded, the increasing abundance shown in the Jolly-Seber estimates could be a function of more birds being captured and banded each year. The empirical estimates also indicate a steadily increasing abundance and density of Spotted Owls from 1986-1992. This could be a function of the increased survey effort and experience of researchers on the study area (Table 7). The number of surveys on the study area has increased as well as the number of owls detected although there was not a significant correlation (Spearman's $r=0.52$; $.50 < P < .20$). In addition, if the population was actually increasing at the rate suggested by the empirical estimates, the estimates of lambda would have also reflected the increase. Over the six years of the study, reproduction has been high and low in consistently alternate years (Table 4). Laymon and Barrett (1982) speculated that this variation may be due to fluctuations in the prey base or weather conditions but we have no empirical bases on which to evaluate this alternating pattern.

Table 7. Survey effort (total number of each type of survey) relative to the number of owls detected from 1986-1992 on the Eldorado Study Area, central Sierra Nevada, California.

	1986	1987	1988	1989	1990	1991	1992
Point	79	73	357	287	250	227	515
Walkin	69	74	140	130	102	81	115
Leapcruise ¹	235	73	42	36	98		
Cruise ²					62	46	31
Total Surveys	383	220	539	453	512	354	661
No. Owls Detected	43	47	49	43	55	51	63

¹ Leapcruise surveys were conducted by an observer walking along a section of road while attempting to elicit responses from Spotted Owls. This method has been replaced by point surveys.

² Cruise surveys were conducted through an area where an owl was detected via a point survey but the owl was not detected again during the cruise survey. (Had the owl been detected, the survey would have been a "Walkin").

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Appendix 1. Location, occupancy, and total number of young produced for 39 California Spotted Owl territories on the Eldorado study area, central Sierra Nevada, California, from 1986 through 1992. M = male, F = female, P = pair, * = owls detected from night surveys, no day roost locations, U = insufficient data to determine presence or absence of young. General legal description is for most recent location.

Territory	Location	1986	1987	1988	1989	1990	1991	1992	Total young
BELIX	13N,13E,33	P							2
BIGCR	13N,12E,01					P	P	P	2
BIGMD	14N,14E,08	M	P			P	P	P	3
BLKFL	13N,12E,14	M*	M*	P*			M*	M*	U
BRUSH	13N,12E,02	P	P	P	P	P	P	P	3
BUNKH	14N,14E,22							P*	U
CHARS	13N,14E,05	P	F	P	P	P	P	P	5
DADSP	13N,12E,17	M	P	P		P	P	P	4
ELLIC	13N,13E,14	P*	M*		M*		M*	P	U
FRNCH	14N,13E,22						P		0
FSPUR	13N,13E,23	M	P	P	M	P	P	P	6
GERLE	13N,14E,10	P	P	P	P	P	P	P	10
GRIZZ	13N,13E,19		P	P	P	P	P		3
HALES	13N,13E,01						M	P*	U
HELLH	14N,14E,04	P	P	P	M	M		P	5
LAWTR	13N,13E,34	P	M	P	P	P	P	P	6
LITCR	14N,13E,32							P	U
LGRIZ	13N,12E,26		P*			M*			U
LWALL	13N,13E,18		P	P	P	P	P	P	5
LCANN	14N,13E,34	P	P	P	P	P		P	4
MCCUL	13N,13E,21	M							U
MIDMD	14N,14E,18	P	P	P	P	P	P	P+F	3
NFKLC	14N,13E,26	P	P	P	P	P		P	2
NWALL	13N,13E,02	M		P	M	P			1
PRSLY	14N,14E,32		P	P	P	P	P	P	6
PGNRN	13N,13E,30						P	P	2
PGNRT	13N,13E,31	P	P	P	P	P	P	P	2
RALSC	13N,12E,06						P*	P	2
RALSE	13N,12E,04	P*	F*			M*		P	2
RMCRS	13N,13E,08	M	P	P	P	P	P	P	4
SFKLC	14N,13E,26					F	P	M*	U
SFRUB	13N,14E,20	P	P	P	P	P	P	P	7
SFRCG	13N,14E,22		P*	P*	P*	P*			U
SWALL	13N,13E,11	P	P	P	P	P	P	P	8
SPILL	14N,14E,20	P	P	P*	M*	P*	M*	P	U
SPHAL	14N,13E,28	M*		M*	M*	P*	P*	P	2
STONY	13N,14E,18	M		P	M	P	P	P	2
WALPK	14N,14E,30	P	P	P	P	P	P	P	3
ZUVER	13N,12E,13	P	P	P	P	P	M	P	2