The Condor 92:491–495

DISTRIBUTION, DENSITY, AND AGE STRUCTURE OF SPOTTED OWLS ON TWO SOUTHERN CALIFORNIA HABITAT ISLANDS[1]

R. J. GUTIÉRREZ AND JOHN PRITCHARD[2]
Department of Wildlife, Humboldt State University, Arcata, CA 95521

Abstract. We estimated the distribution and density of California Spotted Owls (*Strix occidentalis occidentalis*) occurring on Mt. San Jacinto during 1988 and 1989 and on Palomar Mountain during 1988, southern California. Spotted Owls on Mt. San Jacinto were well distributed above 1,000 m in forested habitats. In contrast, owl distribution appeared to be affected by recent fires on Palomar Mountain. Densities on Mt. San Jacinto were estimated to be 0.16 owls/km^2 in 1988 and 0.19 owls/km^2 in 1989. The density estimate for Palomar Mountain was 0.64 owls/km^2. The proportion of subadults in both of these isolated populations was over twice that reported for large contiguous populations of Spotted Owls which suggested a higher adult mortality in the insular populations. The fecundity of these insular populations was either lower than or similar to the Northern Spotted Owl (*S. occidentalis caurina*).

Key words: Distribution; density; age structure; fecundity; California Spotted Owl; Strix occidentalis; *insular ecology.*

INTRODUCTION

A great deal of research has focused on the ecology of the Northern Spotted Owl (*Strix occidentalis caurina*) because of its decline following logging of old-growth coniferous forests in the Pacific Northwest (Gutiérrez and Carey 1985, Dawson et al. 1987). Thus, we know much about the natural and life history of this bird (Forsman et al. 1984; Gutiérrez et al. 1984; Gutiérrez 1985; Franklin et al., in press). In contrast, much less is known about the ecology of the California Spotted Owl (*S. o. occidentalis*) and its response to environmental perturbations (Laymon 1988, Bias 1989).

Unlike the northern subspecies, the California Spotted Owl occurs as "island" populations on isolated mountain ranges in southern California. Studies of such island populations could provide insight to the question of viable population management as well as the demography of insular populations in general. The response of these populations to geographic isolation and small population size also may provide clues to the potential response of Northern Spotted Owls to habitat fragmentation and population reductions following logging. Therefore, we estimated the density, fecundity, distribution, general habitat occupation, and age structure of two isolated populations of California Spotted Owls on Mt. San Jacinto, Riverside County, and Palomar Mountain, San Diego County, California.

STUDY AREAS AND METHODS

Mt. San Jacinto (MSJ) and Palomar Mountain (PM) are two mountains rising above the surrounding lowlands 30 km south of Banning, Riverside County, and 40 km northeast of San Diego, California, respectively. These mountains contain natural isolates of high elevation forested habitats. Both areas are affected by two climatic patterns; Mediterranean to the west and desert to the east. Precipitation falls primarily as winter rain, with snow common at the highest elevations. These areas are hot and dry during the summer.

Most of these mountains are covered with chaparral vegetation. Mixed conifer, pine (*Pinus* sp.), fir (*Pseudotsuga* sp.), and hardwood (*Quercus* sp. primarily) stands are present at higher elevations (above 1,000 m on MSJ and 700 m on PM), and live oak and riparian forests are found in some of the deeper canyons.

Forested habitat on the mountains was delineated on aerial photographs. All habitats within the forest zone were then surveyed according to Forsman (1983) and Franklin et al. (in press). Two types of night surveys were used to locate

[1] Received 30 November 1989. Final acceptance 1 February 1990.
[2] Present address: Box 10-0707, 1000 Monrovia 10, Liberia, West Africa.

TABLE 1. Age and sex composition of two isolated populations of banded Spotted Owls in southern California during 1988 and 1989. AM = Adult male; SAM = Subadult male; UM = Unknown-aged male; AF = Adult female; SAF = Subadult female; UF = Unknown-aged female; J = Juvenile of unknown sex.

Area and year	AM	SAM	UM	AF	SAF	UF	J
Mt. San Jacinto							
1988[1]	10	1	2	8	5	2	4
1989[2]	12	2	3	8	6	2	7
Palomar Mountain							
1988[2]	5	0	1	3	3	0	0

[1] Includes only banded birds.
[2] Includes auditory detections for two males and one female.

owls: point and cruise surveys (Franklin et al., in press). Once a bird(s) was heard calling we attempted to find it the following morning during a "walk-in" survey (Franklin et al., in press). Birds were then captured using noose poles or mist nets (Forsman 1983). Birds that we were unable to capture during day surveys, we attempted to capture at night using mist nets. All birds were sexed by voice and aged by plumage characters (Forsman 1981); captured birds were banded with U.S. Fish and Wildlife Service locking aluminum bands on one leg and a unique color band on the other. Spotted Owl density was calculated as the number of adult and subadult owls divided by the total area sampled (173 km^2 on MSJ and 33 km^2 on PM). In addition, we estimated the fecundity of each population by dividing the number of female young (assuming a 1:1 sex ratio) fledged by the number of paired females. Uncaptured birds and birds captured at night were not aged. Owl locations were plotted on 1:24,000 topographic maps to the nearest UTM (universal transverse mercator) coordinate (approximately 50 m accuracy).

We classified habitats into five broad categories (conifer, conifer-hardwood, hardwood, chaparral, and grassland) according to the dominant vegetation. Habitats containing owls were classified by the actual roosting site. A random selection of UTM coordinates (200-m intervals) equal to the number of owl roost locations on MSJ was classified to habitat type using U.S. Forest Service habitat type maps and aerial photographs. These distributions of observed and expected habitat use were compared using chi-square analysis (Neu et al. 1974). This comparison could not be made on PM because U.S. Forest Service habitat maps were not suitable for categorizing habitats, and there were no aerial photographs available following the extensive fires of 1987.

RESULTS

DENSITY

Mt. San Jacinto. Eighty-six surveys in 1988 and 118 surveys in 1989 were conducted within all habitats above 1,000 m on MSJ. Thirty-two and 17 Spotted Owls were captured and banded during 1988 and 1989, respectively, on MSJ. Four juveniles fledged from three nests in 1988 while seven juveniles fledged from five nests in 1989. In 1988 we found 12 pairs and four single birds at 16 locations; in 1989 we found 12 pairs and nine single birds at 21 locations. We banded every bird detected in 1988 whereas four birds were detected but not banded in 1989. In addition, not all of the single bird locations were surveyed adequately to be certain that the birds had no mates. Estimated density on MSJ was 0.16 owls/km^2 in 1988 and 0.19 owls/km^2 in 1989. Because we increased our sampling between years within the same limited habitat area and only recorded one additional bird we feel confident that we were recording greater than 90% of the territorial owl population. The estimated fecundity of this population was 0.17 female young fledged per paired female in 1988 and 0.29 female young per paired female in 1989.

Palomar Mountain. We conducted 83 surveys in all habitats above 700 m on PM. Twelve owls were banded on PM (Table 1), and nine additional adults and three juveniles from two pairs were not captured. We only included observations of unbanded birds if their responses were separated by at least 2.4 km. Thus we estimated a minimum of 21 adults and subadults which produced at least three juveniles on PM. We believed that these birds represented eight pairs and five single birds at 13 locations. Again, our survey effort was not adequate to determine if all these single birds had no mates. The estimated density of all Spotted Owls detected on PM was 0.64 owls/km^2. We estimated the fecundity of this population to be 0.37 female young per paired female in 1988.

DISTRIBUTION AND HABITAT USE

Spotted Owls were found throughout the forested canyons on both study areas. They occurred above

TABLE 2. Habitats used and available to Spotted Owls on Mt. San Jacinto and Palomar Mountain, California during 1988 and 1989.

Area	Observed[1]	Expected[2]
Mt. San Jacinto		
Conifer	21	11
Hardwood	5	5
Chaparral	0	11
Palomar Mountain[3]		
Conifer	2	–
Hardwood	1	–
Conifer-hardwood	11	–
Chaparral	0	–
Grassland	0	–

[1] Observed = number of Spotted Owls observed roosting in habitat type. Observations of roosting pairs were treated as a sample of one.
[2] Expected = number of observations for an equal sample of randomly selected habitat types.
[3] Only observed habitat use was recorded (see text for explanation).

1,200 m and 900 m elevation on MSJ and PM, respectively. We located owls in almost all major drainages on MSJ. In contrast, 6,478 ha of forest on the west side of PM burned in 1987, and no owls were found in these burned areas. There was a significant difference ($\chi^2 = 20.09, P < 0.005$) between the distribution of habitats in which owls were located and a random selection of habitats on MSJ (Table 2). Eighty percent of the owls on MSJ roosted in conifer habitats, 20% in hardwood stands, and no owls roosted in chaparral. Habitats were more varied on PM, yet the owls roosted most often (79%) in conifer-hardwood stands (Table 2). Neither chaparral nor grassland were used by roosting owls on PM.

DISCUSSION

Spotted Owls were recorded as early as 1908 on MSJ (Grinnell and Swarth 1913) and 1892 on PM (Stephens 1892). Several sites that we surveyed were occupied by owls 6 years ago on MSJ and 7 years ago on PM (Gould et al. 1987). In fact, only one site (Thomas Mountain, MSJ) on either area with previously documented observations did not have owls in 1988, and that area burned in 1975. Thus, Spotted Owls apparently have persisted as isolated populations on these mountains for nearly 100 years and at specific sites for the past 6 or 7 years. Long-term site occupancy also has been well documented for Northern Spotted Owls (Forsman et al. 1984).

Spotted Owls were found primarily in conifer and hardwood stands within conifer forests. A few birds were observed in live oak forests in deep canyons. Spotted Owl habitats on MSJ were similar in structure and composition to those found in the San Bernardino Mountains to the north (unpubl. data), whereas PM habitats contained more hardwoods. As in other studies of Northern and California Spotted Owl populations (Solis 1983, Forsman et al. 1984, LaHaye 1988, Bias 1989), the birds did not use grasslands, chaparral, or open-canopied habitats on either MSJ or PM.

The density of owls on MSJ was similar to that reported for both a Northern and a Sierra Nevada California Spotted Owl population (0.235 owls/km^2, Franklin et al., in press; 0.20 owls/km^2, Bias and Gutiérrez 1987), while the density of Spotted Owls on PM was over twice these estimates. Since we believe more territorial owls still exist on both areas (see below), these density estimates should increase slightly with additional sampling.

There were several possible explanations for the high density on PM. First, several previously occupied sites were destroyed by fire during 1987. Several pairs of owls could have been displaced into areas already occupied by owls because 6,477 ha burned on PM in 1987. Although we were unable to survey PM in 1989, the status of this population will be important to monitor because an additional 6,353 ha burned in 1989. Second, since not all the birds were banded on PM we could have double sampled a few birds. We eliminated nighttime observations if they were closer than 2.4 km to avoid the possibility of double sampling. Therefore, we believe that overestimation of the number of owls was not a significant factor in our density estimate. Third, Spotted Owl habitat on PM was disjunct. If habitat isolation (i.e., forest islands within large areas of chaparral) restricts home-range size, then the overall density of the population may be higher. A combination of these factors also may account for the high Spotted Owl density on PM. Nevertheless, this density represents a marked deviation from typical densities recorded for Spotted Owls throughout the rest of their California range.

The proportion of subadults on MSJ was of particular interest. Although the number of birds we observed was small, it was a very large sample relative to the total territorial population on MSJ. Therefore, we were approximating the true population age and sex composition. Twenty-one percent and 24% of the population on MSJ were subadult in 1988 and 1989, respectively. In ad-

dition, 33% and 38% of the females on MSJ were subadults in 1988 and 1989, respectively. While the data for PM were not as extensive, the trend was the same as on MSJ with 50% of the six banded females being subadult. These proportions were considerably higher than those estimated for contiguous populations of Northern Spotted Owls (11% subadult; Franklin and Gutiérrez, unpubl. data) and California Spotted Owls in the Sierra Nevada (4% subadult; unpubl. data). This suggested that there was a higher turnover rate (i.e., mortality rate), particularly among females, in these isolated populations than in contiguous populations. Noon and Biles (in press) suggested that variation in female mortality should be the most important parameter affecting population dynamics in Northern Spotted Owls.

The demographic response of these two populations to isolation may provide insight to the future of the Spotted Owl in managed forests. Current management plans allow for a major reduction in Spotted Owl numbers (Franklin et al., in press). These small insular populations appear to have lower survival rates than contiguous Spotted Owl populations. The lower survival rates we observed may be the result of (1) short-term demographic responses (i.e., a series of poor years which resulted in higher adult mortality); (2) different evolutionary histories and subsequent differences in population dynamics; or (3) natural demographic responses to isolation. Regardless of the reason for these lower survival rates, if these populations are stable, they must compensate for lower adult survival rates through higher fecundity and/or juvenile survival in order to persist through time. Since the fecundity of Spotted Owls on MSJ and on PM appears to be lower than or similar to northwestern California (Franklin et al. 1989), juvenile survival must be a key element in the dynamics of this population. Spotted Owls on these isolated mountains are not experiencing the level of dynamic fragmentation resulting from logging that faces the northern and Sierra Nevada population of Spotted Owls. In addition, because these areas are small, dispersing juvenile Spotted Owls probably have the capability of searching most of the available habitat for vacant territories (Gutiérrez et al. 1985). Thus, the ecological conditions under which these populations exist are very different than those in the populations inhabiting the Sierra Nevada and the Pacific Northwest. Although Lande (1988) and Noon and Biles (in press) suggest that adult survival rate may be the key demographic factor influencing Northern Spotted Owl populations, we predict that the ability of juveniles to search for and find vacant habitat will be a critical factor not only in the dynamics of isolated populations but also to those populations inhabiting managed forests.

ACKNOWLEDGMENTS

We would like to thank William LaHaye, Richard Smith, and Lori Leatherbury for field assistance. John Stephenson, Steve Loe, Helen Howell, and others from the U.S. Forest Service as well as Douglas Call provided various forms of assistance. Gordon I. Gould, Jr. from the California Fish and Game Department facilitated the project and critiqued the manuscript. Leonard Brennan, Evelyn Bull, Alan Franklin, Joseph Ganey, and K. T. Westcott also reviewed the paper. Funding for this project was provided by a 1987 Special Legislative Spotted Owl Allocation to the Nongame Bird and Mammal Section of the Wildlife Management Division (Job II.A.2), California Fish and Game Department; the Pacific Southwest Forest and Range Experiment Station, Fresno (contract PSW-89-0018CA), Southern California Edison Company; and the San Bernardino Audubon Society.

LITERATURE CITED

BIAS, M. A. 1989. Habitat use by California Spotted Owls in the central Sierra Nevada. M.Sc.thesis, Humboldt State Univ., Arcata, CA.

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. California Dept. Fish and Game. Sacramento, CA.

DAWSON, W. R., J. D. LIGON, J. R. MURPHY, J. P. MYERS, D. SIMBERLOFF, AND J. VERNER. 1987. Report of the Scientific Advisory Panel on the Spotted Owl. Condor 89:205–229.

FORSMAN, E. D. 1981. Molt of the Spotted Owl. Auk 98:735–742.

FORSMAN, E. D. 1983. Methods and materials for locating and studying Spotted Owls. Gen. Tech. Rep. PNW-162 USDA. Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, OR.

FORSMAN, E. D., E. C. MESLOW, AND H. M. WIGHT. 1984. Distribution and biology of the Spotted Owl in Oregon. Wildl. Monogr. 87:1–64.

FRANKLIN, A. B., J. A. BLAKESLEY, AND R. J. GUTIÉRREZ. 1989. Population ecology of the Northern Spotted Owl (*Strix occidentalis caurina*) in Northwest California: preliminary results, 1988. Unpubl. Rep. Nongame Bird and Mammal Section, Wildlife Management Division, Calif. Dept. of Fish and Game, Sacramento, CA.

FRANKLIN, A. B., J. P. WARD, R. J. GUTIÉRREZ, AND G. I. GOULD, JR. In press. Density of Northern

Spotted Owls in northwest California. J. Wildl. Manage. 54.

GOULD, G. I., JR., K. ROBERTS, AND C. ROBERTS. 1987. Southern California Spotted Owl survey, 1987. Unpubl. Tech. Rep. California Dept. Fish and Game. Sacramento, CA.

GRINNELL, J., AND H. S. SWARTH. 1913. An account of the birds and mammals of the San Jacinto area of southern California: with remarks upon the behavior of geographic races on the margins of their habitats. Univ. Calif. Publ. Zool. 10:197–406.

GUTIÉRREZ, R. J. 1985. An overview of recent research on the Spotted Owl, p. 39–49. *In* R. J. Gutiérrez and A. B. Carey [eds.], Ecology and management of the Spotted Owl in the Pacific Northwest. Gen. Tech. Rep. PNW-185 USDA. Forest Service, Pacific Northwest Forest and Range Experiment Station Portland, OR.

GUTIÉRREZ, R. J., AND A. B. CAREY [EDS.]. 1985. Ecology and management of the Spotted Owl in the Pacific Northwest. Gen. Tech. Rep. PNW-185 USDA. Forest Service, Pacific Northwest Forest and Range Experiment Station Portland, OR.

GUTIÉRREZ, R. J., A. B. FRANKLIN, W. LAHAYE, V. J. MERETSKY, AND J. P. WARD. 1985. Juvenile Spotted Owl dispersal in Northwestern California: preliminary results, p. 60–65. *In* R. J. Gutiérrez and A. B. Carey [eds.], Ecology and management of the Spotted Owl in the Pacific Northwest. Gen. Tech. Rep. PNW-185 USDA. Forest Service, Pacific Northwest Forest and Range Experiment Station Portland, OR.

GUTIÉRREZ, R. J., D. M. SOLIS, AND C. SISCO. 1984. Habitat ecology of the Spotted Owl in Northwestern California: implications for management, p. 368–373. *In* Proc. Soc. Am. For., Natl. Conv., 16–20 October 1983. Portland, OR.

LAHAYE, W. 1988. Nest site selection and nesting habitat of the Northern Spotted Owl (*Strix occidentalis caurina*) in northwestern California. M.Sc.thesis, Humboldt State Univ., Arcata, CA.

LANDE, R. 1988. Demographic models of the northern spotted owl (*Strix occidentalis caurina*). Oecologia 75:601–607.

LAYMON, S. A. 1988. Ecology of the Spotted Owl in the central Sierra Nevada, California. Ph.D.diss., Univ. of California, Berkeley.

NOON, B. R., AND C. M. BILES. In press. The mathematical demography of the Spotted Owl in the Pacific Northwest. J. Wildl. Manage.

NEU, C. W., C. R. BYERS, AND J. M. PEEK. 1974. A technique for analysis of utilization-availability data. J. Wildl. Manage. 38:541–545.

SOLIS, D. M., JR. 1983. Summer habitat ecology of Spotted Owls in northwestern California. M.Sc.thesis, Humboldt State Univ., Arcata, CA.

STEPHENS, F. 1892. Notes on *Syrnium occidentale*. Auk 9:392–393.