BREEDING-SEASON HOME RANGES OF SPOTTED OWLS IN THE SAN BERNARDINO MOUNTAINS, CALIFORNIA

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Home ranges of the Northern Spotted Owl (*Strix occidentalis caurina*) in the Pacific Northwest (Forsman et al. 1984, Solis and Gutiérrez 1990, Carey et al. 1992, Zabel et al. 1995), of the Mexican Spotted Owl (*S. o. lucida*) in the southwestern U.S. (Ganey and Balda 1989, Zwank et al. 1994, Ganey et al. 1999), and of the California Spotted Owl (*S. o. occidentalis*) in the Sierra Nevada (Call et al. 1992, Zabel et al. 1992) have all been quantified. No home-range estimates exist, however, for isolated populations of the California Spotted Owl in the southern portion of its range (Gutiérrez and Pritchard 1992, Gutiérrez et al. 1995). Therefore, we report breeding-season home-range size for two pairs of radio-marked Spotted Owls in the San Bernardino Mountains, which support the largest population of the subspecies in southern California (LaHaye et al. 1997).

Our study area is approximately 140 km east of Los Angeles, California (34° 15′ N, 117° 55′E). The San Bernardino Mountains are oriented east/west with elevations ranging from 800 to 3500 m and are surrounded by desert and chaparral vegetation (Barbour and Major 1988). The climate is Mediterranean, with most precipitation falling during the winter in the form of snow above 2000 m and rain at lower elevations. Precipitation, influenced by elevation and slope aspect, ranges from 25 to 100 cm (Minnich et al. 1995). Vegetation grades from Mojave desert scrub and coastal scrub at lower elevations to alpine at higher elevations (Barbour and Major 1988). Within this continuum, local aspect and topography form a complex mosaic of forest, chaparral, desert, and wetland vegetation. In this range, Spotted Owls occur between 800 and 2600 m and occupy forests composed of Canyon Live Oak (*Quercus chrysolepis*), Black Oak (*Q. kelloggii*), Big-cone Douglas Fir (*Pseudotsuga macrocarpa*), White Fir (*Abies concolor*), Incense Cedar (*Calocedrus decurrens*), Jeffrey Pine (*Pinus jeffreyi*), Ponderosa Pine (*P. ponderosa*), and Sugar Pine (*P. lambertiana*).

Using radio telemetry, we monitored two pairs of Spotted Owls from July 1987 to August 1988. We captured the owls with noose poles or mist nets. Each owl was fitted with a radio transmitter (Telonics Inc., Mesa, Arizona) by means of a backpack harness (Guetterman et al. 1991). The total mass of the transmitter package was approximately 18 g. We received transmitter signals through TR-2 receivers and four-element hand-held Yagi antennas (Telonics Inc.). Otis and White (1999) demonstrated that autocorrelation of telemetry locations does not bias estimates of home ranges when animals are considered the sampling unit. Nonetheless, we separated all owl locations in this study by at least 24 hours. We followed techniques outlined by Guetterman et al. (1991) and estimated nocturnal locations from triangulation of three to six compass bearings taken from fixed telemetry points. Triangulations resulting in polygons larger than 2 ha were removed from analyses.

We defined a breeding-season home range as the area used by owls during their nightly activities (Burt 1943) between March and August. We used the program CALHOME (Kie et al. 1996) to estimate home ranges with a minimum convex polygon (MCP) and the program KERNELHR (Seaman et al. 1998) to produce fixed-and adaptive-kernel (Worton 1989) estimates. We used kernel estimators because they require no unrealistic assumptions about space use (Worton 1989) and perform better than other estimators in simulations (Worton 1995). The fixed-kernel estimator with least-squares cross validation outperformed the adaptive-kernel estimator in simulations (Seaman and Powell 1996, Seaman et al. 1999), so we focused our results and discussion on home ranges estimated with this procedure. The adaptive kernel (Ganey et al. 1999) and MCP have been used commonly as home-range estimators in studies of Spotted Owls (e.g., Forsman et al. 1984, Call et al. 1992, Zabel et al. 1995). Thus, given similar sample sizes, the adaptive kernel and MCP provided estimates comparable to those of other studies. We calculated the 95% fixed kernel, 95% adaptive kernel, 95% MCP, and 100% MCP for individual owls. We combined locations from individuals of each pair to estimate the pairs' home ranges (Table 1). We used the field techniques outlined by Franklin et al. (1996) to assess reproductive activity of radio-marked owls.

The number of locations per owl varied from 51 to 65 (Table 1). Fixed-kernel estimates of individual owls' home ranges varied from 223 to 654 ha. Considered individually or as a pair, the Pine Knot owls had a larger range than the Fawnskin owls. Fixed-kernel estimates for the pairs indicated that the Pine Knot pair's home range was almost twice as large as the Fawnskin pair's (Table 2). The Fawnskin pair nested during both years of the study, the Pine Knot pair during only the first year, but 60% of the latter's telemetry locations were obtained the second year when they did not nest. Furthermore, locations for the Pine Knot pair during the first year were concentrated near the center of the home range and nest; the second year the female used a larger area.

Kernel home ranges are estimates based on probability-density functions and are subject to sampling error (Seaman et al. 1999), which decreases as sample size increases. Seaman et al. (1999) reported that the bias and variance of kernel estimators reached an asymptote at ≥50 locations and recommended that home-range estimates be based on 50 or more locations. All home-range estimates in our analysis were based on >50 locations. However, our fixed- and adaptive-kernel estimates of home-range size for each pair may be slightly underestimated. By combining locations from members of a pair, we assumed that nocturnal locations of pairs are independent. If foraging locations for individuals of mated pairs are dependent, the sample size will be smaller than the sum of locations of members of the pair because the pair is acting as a single unit (Burnham and Anderson 1998:52).

Table 1 Home-range Estimates (ha) Based on Nocturnal Radiotelemetry Locations for Individual Spotted Owls during the Breeding Season in the San Bernardino Mountains, 1987–1988

		Estimation Method[a]			
Territory	Locations	100% MCP	95% MCP	95% FK	95% AK
Fawnskin					
Female	51	153	122	223	262
Male	65	325	229	430	568
Pine Knot					
Female	65	660	495	654	831
Male	63	648	377	448	619

[a]MCP, minimum convex polygon; FK, fixed kernel; AK, adaptive kernel.

Table 2 Home-range Estimates (ha) Based on Nocturnal Radiotelemetry Locations for Pairs of Spotted Owls during the Breeding Season in the San Bernardino Mountains, 1987–1988

		Estimation Method[a]			
Territory	Locations	100% MCP	95% MCP	95% FK	95% AK
Fawnskin	116	325	210	333	415
Pine Knot	128	816	632	598	810

[a]MCP, minimum convex polygon; FK, fixed kernel; AK, adaptive kernel.

However, Forsman et al. (1984) reported that paired Spotted Owls they studied foraged at the same locations only 4% to 10% of the time, indicating largely independent foraging behavior in this species. In contrast, if the pair's foraging locations in our study were not independent, we believe that the bias in our estimates of home-range size is small because we have >50 independent locations for each pair.

Pairs of Spotted Owls are more strongly associated with a central place (nest or roost area) during the breeding season than during the nonbreeding season (Forsman et al. 1984). Consequently, home ranges during the breeding season are smaller (e.g., Forsman et al. 1984, Zabel et al. 1992, Gutiérrez et al. 1995).

Our 100% MCP estimates of breeding-season home ranges for individual California Spotted Owls are larger than estimates reported for the Mexican Spotted Owl (range 278–361 ha; Zwank et al. 1994, Willey and van Riper 1995, respectively) but smaller than most estimates for the Northern Spotted Owl (range 413–817 ha; Solis and Gutiérrez 1990, Zabel et al. 1995, respectively). In general, our estimates are smaller than most previous estimates for California Spotted Owls. Reported home ranges for California Spotted Owls range from 289 ha in the southern Sierra Nevada (Zabel et al. 1992) to 2195 ha in the northern Sierra Nevada (Zabel et al. 1992). Zwank et al. (1994) reported home ranges about 30% smaller than ours for an isolated population of Mexican Spotted Owls in New Mexico. Our estimates of pairs' home ranges differ from those of other studies in a pattern similar to that described for individuals. Differences in home-range size of Spotted Owls among study areas may be due to variations in habitat (Zabel et al. 1992), prey base (Zabel et al. 1995), foraging behavior, or weather.

The variation in home-range size within our study is consistent with other studies of Spotted Owls (Forsman et al. 1984, Ganey and Balda 1989, Call et al. 1992, Zabel et al. 1995). Hypotheses for differences in size of home ranges include differences in habitat (Forsman et al. 1984, Carey et al. 1992), prey type and abundance (Zabel et al. 1995), prey-renewal rates (Carey et al.1992), and habitat fragmentation (Carey et al. 1992). Home-range size may also be related to nesting status, with nesting owls having smaller home ranges because they are strongly associated with the nest.

Densities of the Dusky-footed Woodrat (*Neotoma fuscipes*), the primary prey of Spotted Owls in our study area (Smith et al. 1999), can vary greatly (Williams et al. 1992). The habitat in both territories we studied is similar, and both pairs nested during the study. Therefore, we suspect that the differences in home-range size between the two pairs were due to differences in prey availability or random variation within the population. We could not investigate whether prey, habitat, nesting status, or the combination of these factors correlated with home-range size because our sample size is small. However, this study is the first to document home ranges of California Spotted Owls from isolated populations in southern California.

NOTES

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