FOREST OWLS DETECTED IN THE CENTRAL SIERRA NEVADA

MICHELLE L. CROZIER, MARK E. SEAMANS, and R. J. GUTIÉRREZ, University of Minnesota, Department of Fisheries, Wildlife, and Conservation Biology, 200 Hodson Hall, 1980 Folwell Ave., St. Paul, Minnesota 55108

ABSTRACT: We recorded detections of other species of forest owls while surveying for the Spotted Owl (*Strix occidentalis*) in the central Sierra Nevada from 1 April to mid-August, 1997–2002. During 4562 Spotted Owl surveys, we recorded 355 responses from six other owl species: the Northern Saw-whet (*Aegolius acadicus*), Northern Pygmy (*Glaucidium gnoma*), Flammulated (*Otus flammeolus*), Great Horned (*Bubo virginianus*), Long-eared (*Asio otus*), and Western Screech (*Otus kennicottii*). We did not detect the Great Gray (*Strix nebulosa*) or Barred (*S. varia*). After correcting for annual variation in survey effort, we estimated that detection rates for most species varied annually in a similar pattern. Most owl responses were recorded during April and May. These incidental detections are useful for documenting the presence of owl species in the central Sierra Nevada and suggesting potential future research.

Documenting the presence of forest owls can be difficult because these birds are often found in dense vegetation, may have large home ranges, may inhabit rough terrain, and are nocturnal (Fuller and Mosher 1981, McLeod and Andersen 1998). Owls usually respond most frequently to calls of their own species (Fuller and Mosher 1981, Bosakowski and Smith 1998). Therefore, some researchers recommend broadcasting sequences of different species' calls to estimate composition of owl communities (Fuller and Mosher 1981). Although this approach can be time-consuming, it has merit because it probably elicits species-specific responses. Nevertheless, broadcast surveys of a single species are sometimes used to elicit responses from and to locate other woodland raptors (Fuller and Mosher 1981, McLeod and Andersen 1998). Here we report the complement of other owl species we detected over a large study area during surveys for the Spotted Owl (*Strix occidentalis*).

STUDY AREA AND METHODS

We conducted our study from 1997 to 2002 in the central Sierra Nevada near Georgetown, El Dorado County, California. The 355-km^2 Eldorado Density Study Area (EDSA) lies within the Eldorado National Forest. Its elevation ranges from 366 m to 2401 m. The EDSA is typical of middle-elevation Sierran montane forest as described by Küchler (1977) but has been logged extensively in the past.

We recorded detections of all species of owls in the Sierra Nevada opportunistically as part of a larger demographic study in which Spotted Owls were surveyed annually from 1 April through mid-August by methods described by Forsman (1983) and Franklin et al. (1996). The entire EDSA was surveyed each year, including habitat types not necessarily associated with the Spotted Owl. We established a system of approximately 375 call-

point stations along trails and roads that provided complete coverage of the study area. We used these call-point surveys to elicit responses from Spotted Owls to determine the general locations of their territories. Each point was surveyed twice per year. At each point, observers alternated between imitating Spotted Owl calls and listening for a response for 10 minutes. If a territory was occupied, then a "walk-in" survey was conducted to identify an individual Spotted Owl. These surveys took place at dusk and dawn and entailed an observer's hiking through the forest, actively searching for and visually identifying Spotted Owls.

We conducted surveys at times when Spotted Owls were most likely to be detected, that is, call-point surveys at night, "walk-in" surveys at dawn and dusk. Most surveys (83.9%) were conducted between 1800 and 0100 PST, with 9.7% between 0300 and 0500 (Figure 1). Observers recorded date, time, and location of all owl species detected during surveys. Surveys were not conducted during inclement weather such as precipitation or winds exceeding 30 km/hr. Surveys were conducted within a temperature range of −15° to 27° C. We standardized survey effort by accounting for the number of surveys during the course of the study. Survey effort increased gradually through the study, with approximately 25% more surveys conducted in 2002 than in 1997. In addition, more surveys were conducted later in May, June, or July than in other months. Therefore, we defined detection rate as the number of other owl observations (aural or visual) divided by the total number of Spotted Owl surveys within a given time period. We identified owls primarily by vocalizations (>95%), although we included visual detections. Because these detections were opportunistic, for a variety of reasons they are not suited to statistical analysis.

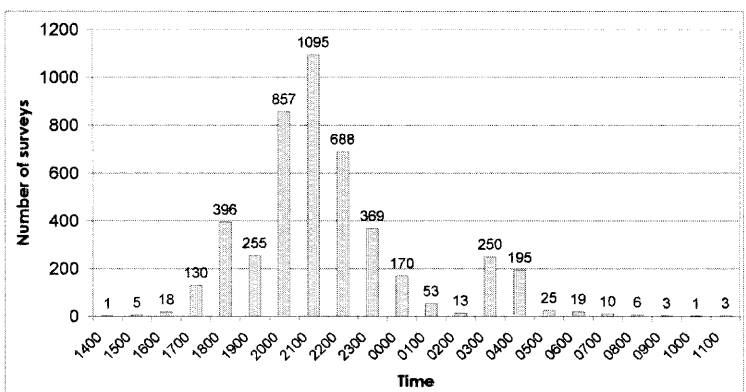

Figure 1. Total number of surveys by hour of survey initiation, 1997–2002. Totals include both "walk-in" and point counts.

RESULTS

We recorded 355 detections of six owl species during 4562 Spotted Owl surveys over the 6-year period. In order of most to least detections, we recorded the Northern Saw-whet Owl (*Aegolius acadicus*), Northern Pygmy-Owl (*Glaucidium gnoma*), Flammulated Owl (*Otus flammeolus*), Great Horned Owl (*Bubo virginianus*), Long-eared Owl (*Asio otus*), and Western Screech-Owl (*Otus kennicottii*). Detection rates varied from year to year. Other owl species were detected during 3.9 to 11.1% of Spotted Owl surveys each year. The annual detection rates of the four most commonly observed species (Northern Saw-whet, Northern Pygmy, Flammulated, and Great Horned) varied in a similar pattern (Figure 2). Species' detection rates also varied seasonally (Figure 3); detection rates were highest in April or May, declined during the summer, but increased again in August.

Forest owl detections were not distributed evenly across the study area. Flammulated Owl detections had limited spatial overlap with Great Horned Owl detections. We encountered the Great Horned Owl primarily on the eastern, higher-elevation side of the study area, the Flammulated primarily on the lower-elevation western side. We detected the Long-eared on the western side, primarily in riparian areas along the Rubicon River. We found

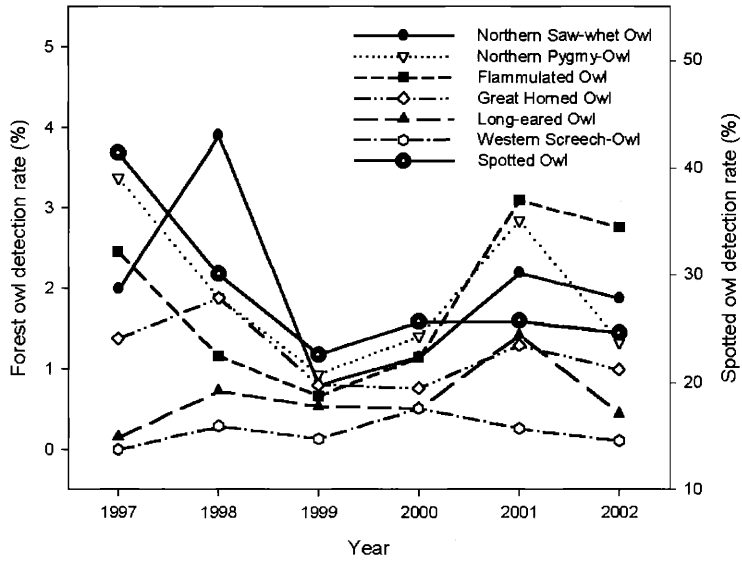

Figure 2. Annual detection rates of forest owl species during Spotted Owl surveys, 1997–2002. Detection rate (%) was calculated as number of responses divided by number of Spotted Owl surveys × 100 during a given year. For comparison of relative changes in detection rate, results for the Spotted Owl are displayed on a different scale.

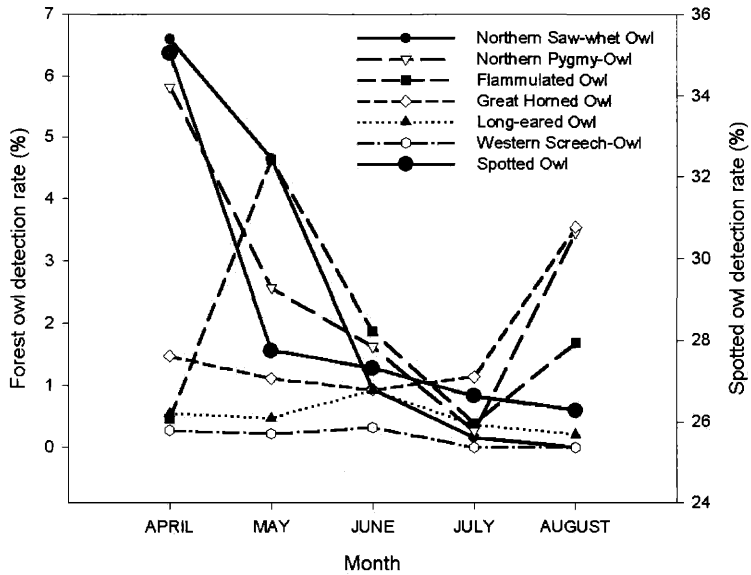

Figure 3. Seasonal detection rates of owl species during Spotted Owl surveys, 1997–2002. Seasonal detection rate was calculated as number of detections divided by number of Spotted Owl surveys × 100 during a given month. For comparison of relative changes in detection rate, results for the Spotted Owl are displayed on a different scale.

Northern Saw-whet Owls and Northern Pygmy-Owls throughout the study area.

DISCUSSION

Owl species we detected in this area were similar to those expected (Verner and Boss 1980). Although we did not find the Great Gray Owl (*Strix nebulosa*) or Barred Owl (*Strix varia*), habitat suitable for these two species probably exists within the EDSA. Verner and Boss (1980) noted that the mixed conifer and red fir habitat in Placer and El Dorado counties could support the Great Gray. Most of our surveys were completed by 0100, but Mikkola (1983) reported that Great Gray Owls may be more responsive later at night. Thus we may not have been surveying at an ideal time for detecting the Great Gray. Because our survey effort was most concentrated between 1800 and 0100, we may have also failed to detect owls with different activity cycles. For example, the Northern Pygmy-Owl is largely diurnal (Holt and Petersen 2000), while the Great Horned may be most responsive after midnight (Morrell et al. 1991, but see Houston et al. 1998). The Long-eared Owl in particular may be most responsive from 0200 to 0400, a time when

our survey effort was much lower (Jon Winter pers. comm.). For this reason, we cannot infer abundance from our observations but can only compare relative responsiveness by month and year, intervals for which survey effort can be standardized, and denote presence but not absence of owls in these areas.

The Barred Owl's range expansion is of particular interest because this species may affect the Spotted Owl negatively (Dark et al. 1998). Barred Owls have expanded recently into the Pacific Northwest and California (Evans and LaValley 1982, Dark et al. 1998). More recently, Barred Owls have been located in the Sierra Nevada (G. Gould, California Dept. of Fish and Game, pers. comm.). Because Barred Owls respond to vocal imitations of Spotted Owls (Herter and Hicks 2000), it was of considerable interest that we detected no Barred Owls in the EDSA. However, a "Sparred Owl," or Spotted × Barred Owl hybrid, was found in the study area in 2003 (Seamans et al. unpublished data). Continued surveys are needed to monitor the Barred Owl's range expansion.

From 1997 to 2002, the annual variation in detection patterns of small owl species (Northern Saw-whet, Flammulated, and Northern Pygmy) resembled that in the Spotted Owl (Gutiérrez et al. 2002, Franklin et al. in press). Although Spotted Owl detection rates were much higher than those for other species because we were actively seeking the Spotted, all owl detections declined sharply in 1999, a year when both reproduction and recapture rates for the Spotted Owl were very low (Seamans et al. 2001, Franklin et al. in press). Since the area, survey method, and survey effort were similar each year, we hypothesize that the same biological or environmental factors are linked to these changes in all four species. In the Spotted Owl, changes in reproduction and survival have been correlated with weather, particularly precipitation (Franklin et al. 2000, Seamans et al. 2002). Weather could affect the owls indirectly (rainfall affecting dynamics of the owls' primary prey) or directly (increasing energetic demands or impeding hunting success) (Franklin et al. 2000).

Our detections cannot be used as indices of owl abundance because each species may vary in its response to Spotted Owl calls. Marcot and Hill (1980) noted that Flammulated Owls respond readily to Spotted Owl calls. Johnson (1993) reported that Great Horned Owls also respond to Spotted Owl calls, although at approximately one fourth the rate of response to calls of conspecifics.

Our results suggest that biologists interested in evaluating the entire forest owl community could survey most efficiently in April or May when many owls, particularly the smaller species, responded most frequently. The schedule of vocalizations, related largely to the courtship period, closely followed our expectations of seasonal activity patterns based on a review of the literature. Spotted Owl detections were higher in April because we conducted more "walk-in" surveys at this time; we deliberately surveyed areas where Spotted Owls were detected in the previous year first in order to increase the chance of encountering banded individuals again. However, higher detection rates may be confounded by interactions between survey effort and changes in the owls' responsiveness while courting and nesting. We detected Northern Saw-whet Owls primarily during the courtship period

ending in early May, although unmated males can sing into May or June (Cannings 1993, Clark and Anderson 1997). We detected Northern Pygmy-Owls and Flammulated Owls most frequently during April and May respectively, but they vocalized throughout the season (Holt and Petersen 2000, Marcot and Hill 1980, McCallum 1994). Great Horned Owls, which breed in winter, were heard consistently throughout the season, with no peak in May and a slight increase in detections during August. Houston et al. (1998) reported that male Great Horned Owls begin advertising in late September or early October. Thus, we probably missed the peak of Great Horned Owl calling.

We noted differences between the distributions of the Great Horned and Flammulated Owls in comparison with the general distribution of forest habitat (Verner and Boss 1980). Besides differences in habitat use, Great Horned Owls may have reduced Flammulated Owl abundance by predation, and/or the presence of Great Horned Owls may have suppressed vocalizing by Flammulated Owls. Johnson (1993) detected Great Horned Owls at elevations higher than the average elevation of his calling stations (elevation break occurred above 945 m). In Mono County, California, Shuford and Fitton (1998) found the Great Horned Owl widespread (41 of 74 atlas blocks), the Flammulated sparse (only 4 of 74 atlas blocks). Limited spatial overlap between territories has also been observed in other studies of owl communities (Solonen 1993, Galeotti and Gariboldi 1994), but irregularities in nest spacing may be due to uneven distribution of suitable habitat (Solonen 1993).

These data suggest future avenues of investigation for those interested in the distribution, abundance, and status of all owl species in the Sierra Nevada. They also suggest that for several species of owls surveys would be best conducted during May.

ACKNOWLEDGMENTS

This study was funded by the U.S. Forest Service (contract #FS53-91S8-00-EC14 to Gutiérrez) and the University of Minnesota. We thank the many technicians who assisted with this project. Andrea Chatfield, Jennifer Fox, and Guthrie Zimmerman read drafts of this paper or provided helpful suggestions. We thank Tim Manolis, Jon Winter, and Bruce Webb for helpful comments during the review process.

LITERATURE CITED

Bosakowski, T., and Smith, D. G. 1998. Response of a forest raptor community to broadcasts of heterospecific and conspecific calls during the breeding season. Can. Field-Nat. 112:198–203.

Cannings, R. J. 1993. Northern Saw-whet Owl (*Aegolius acadicus*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 42. Acad. Nat. Sci., Philadelphia.

Clark, K. A., and Anderson, S. H. 1997. Temporal, climatic and lunar factors affecting owl vocalizations of western Wyoming. J. Raptor Res. 31:358–363.

Dark, S. J., Gutiérrez, R. J., and Gould, G. I. Jr. 1998. The Barred Owl (*Strix varia*) invasion in California. Auk 115:50–56.

Evans, J., and LeValley, R. 1982. Middle Pacific Coast region. Am. Birds 36:890.

Forsman, E. D. 1983. Methods and materials for locating and studying Spotted Owls. U.S. Forest Serv. Gen. Tech. Rep. PNW-162. U.S. Forest Serv. Pacific Northwest Region, Portland, OR 97208.

Franklin, A. B., Anderson, D. R., Forsman, E. D., Burnham, K. P., and Wagner, F. F. 1996. Methods for collecting and analyzing demographic data on the Northern Spotted Owl, in Demography of the Northern Spotted Owl (E. D. Forsman, S. DeStefano, M. G. Raphael, and R. J. Gutiérrez, eds.) Studies Avian Biol. 17:12–20.

Franklin, A. B., Anderson, D. R., Gutiérrez, R. J., and Burnham, K. P. 2000. Climate, habitat quality, and fitness in Northern Spotted Owl populations in northwestern California. Ecol. Monogr. 70:539–590.

Franklin, A. B, Gutiérrez, R .J., Nichols, J. D., Seamans, M. E., White, G. C., Zimmerman, G. S., Hines, J. E., Munton, T. E., LaHaye, W. S., Blakesley, J. A., Steger, G. N., Noon, B. R., Shaw, D. W. H., Keane, J. J., McDonald, T. L., and Britting, S. In press. Population dynamics of the California Spotted Owl (*Strix occidentalis occidentalis*): A meta-analysis. Ornithol. Monogr.

Fuller, M. R., and Mosher, J. A. 1981. Methods of detecting and counting raptors: A review. Studies Avian Biol. 6:235–246.

Galeotti, P., and Garibaldi, A. 1994. Territorial behaviour and habitat selection by the Scops Owl *Otus scops* in a karstic valley (NE Italy), in Raptor Conservation Today (B.-U. Meyburg and R. D. Chancellor, eds.), pp. 501–505. Pica Press, East Sussex, England.

Gutiérrez, R. J., Seamans, M. E., and Bond, M. 2002. Population ecology of the California Spotted Owl in the central Sierra Nevada: Annual results 2001. Unpubl. report to U.S. Forest Serv., Region 5, Vallejo, CA 94592.

Herter, D. R., and Hicks, L. L. 2000. Barred Owl and Spotted Owl populations and habitat in the central Cascade Range of Washington. J. Raptor Res. 34:279–286.

Holt, D. R., and Petersen, J. L. 2000. Northern Pygmy-Owl (*Glaucidium gnoma*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 494. Acad. Nat. Sci., Philadelphia.

Houston, C. S., Smith, D. G., and C. Rohner. 1998. Great Horned Owl (*Bubo virginianus*), In The Birds of North America (A. Poole and F. Gill, eds.), no. 372. Acad. Nat. Sci., Philadelphia.

Johnson, D. H. 1993. Spotted Owls, Great Horned Owls, and forest fragmentation in the Central Oregon Cascades. M.S. thesis, Ore. State Univ., Corvallis.

Küchler, A. W. 1977. The map of natural vegetation of California, in Terrestrial Vegetation of California (G. Barbour and J. Major, eds.), pp. 909–938. Wiley, New York.

McCallum, D. A. 1994. Flammulated Owl (*Otus flammeolus*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 93. Acad. Nat. Sci. Philadelphia.

McLeod, M. A., and Andersen, D. E. 1998. Red-shouldered Hawk broadcast surveys: Factors affecting detection of responses and population trends. J. Wildlife Mgmt. 62:1385–1397.

Marcot, B. G., and Hill, R. 1980. Flammulated Owls in northwestern California. W. Birds 11:141–149.

Mikkola, H. 1983. Owls of Europe. Buteo Books, Vermillion, SD.

Morrell, T. E., Yahner, R. H., and Harkness, W. L. 1991. Factors affecting detection of Great Horned Owls by using broadcast vocalizations. Wildlife Soc. Bull. 19:481–488.

Seamans, M. E., Gutiérrez, R. J., and May, C. A. 2002. Mexican Spotted Owl (*Strix occidentalis*) population dynamics: Influence of climatic variation on survival and reproduction. Auk 119:321–334.

Seamans, M. E., Gutiérrez, R. J., Moen, C. A., and Peery, M. Z. 2001. Spotted Owl demography in the central Sierra Nevada. J. Wildlife Mgmt. 65:425–431.

Shuford, W. D., and Fitton, S. D. 1998. Status of owls in the Glass Mountain region, Mono County, California. W. Birds 29:1–20.

Solonen, T. 1993. Spacing of birds of prey in southern Finland. Ornis Fennica 70:129–143.

Verner, J., and Boss, A. S. 1980. California wildlife and their habitats: Western Sierra Nevada. Gen. Tech. Rep. PSW-37. U.S. Forest Serv., Pacific Southwest Forest and Range Experiment Station, Berkeley, CA 94701.

Accepted 3 October 2003