

STATUS AND DISTRIBUTION OF THE BARRED OWL IN MARIN COUNTY, CALIFORNIA

SCOTT JENNINGS, RENÉE L. CORMIER, and THOMAS GARDALI, PRBO Conservation Science, 3820 Cypress Dr., Suite 11, Petaluma, California 94954; sjennings@prbo.org

DAVID PRESS, National Park Service, Point Reyes National Seashore, 1 Bear Valley Road, Point Reyes Station, California 94956

WILLIAM W. MERKLE, National Park Service, Golden Gate National Recreation Area, Bldg. 201, Fort Mason, San Francisco, California 94123

ABSTRACT: Marin County, California, is the southern limit of the range of the Northern Spotted Owl (*Strix occidentalis caurina*), listed as threatened by the U.S. Fish and Wildlife Service. The density of the Marin population of the Northern Spotted Owl is unusually high, the population breeds in unique habitat associations, and it is genetically isolated from other Spotted Owl populations. Unlike elsewhere in the Northern Spotted Owl's range, habitat loss to logging is not an issue in Marin County. The Barred Owl (*Strix varia*) has been detected in Marin County only since 2002 and may pose a threat to the Northern Spotted Owl through competition and/or interbreeding. We amassed information on the distribution and abundance of the Barred Owl in Marin County via published literature, by consulting local birders, and primarily through data we obtained during our monitoring of the Northern Spotted Owl in Marin County. Monitoring, continuous since 1996, provides an opportunity for an evaluation of the effect of the Barred Owl invasion on the Northern Spotted Owl there. We estimate the county's current population of the Barred Owl at four to seven individuals, including one territorial pair and a single territorial male. We documented two nestings, with four young fledged. Two pairs of the Northern Spotted Owl have been displaced from territories. These results are of concern for an otherwise stable population of the Northern Spotted Owl.

The Barred Owl (*Strix varia*) began expanding its range from eastern North America into western provinces and states in the late 1800s, arriving in the northern portion of range of the Northern Spotted Owl (*Strix occidentalis caurina*) by 1950 (Livesey 2009). The Barred Owl has subsequently expanded west and south through British Columbia, Washington, Oregon, and northern California, to occupy the Northern Spotted Owl's entire range (Gutiérrez et al. 2007).

A growing body of theoretical and empirical work predicts and documents the effects of the Barred Owl on both the Northern and California (*S. o. occidentalis*) Spotted Owls. Displacement and direct competition for food and space are thought to be the largest threats to the Northern Spotted Owl (Kelly et al. 2003, Crozier et al. 2006, Gutiérrez et al. 2007). The Barred Owl also interbreeds with (Hamer et al. 1994, Haig et al. 2004, Kelly and Forsman 2004), and possibly preys upon, both the Northern and California Spotted Owls (Leskiw and Gutiérrez 1998). In much of its range the Northern Spotted Owl continues to decline despite federal protection, and the Barred Owl was identified as a major threat in the 2010 draft revised recovery plan for the Northern Spotted Owl (USFWS 2010).

Across most of its range, the Northern Spotted Owl inhabits mature, relatively undisturbed coniferous forests with a closed canopy (Gutiérrez et

STATUS OF THE BARRED OWL IN MARIN COUNTY, CALIFORNIA

al. 1995). In contrast, where the two species are sympatric, the Barred Owl uses a wider range of habitat types including regenerated coniferous and deciduous forests, areas of lower elevation and flatter topography, and areas of human use and occupation (Hamer et al. 2007, Livesey 2007, Livesey and Flemming 2007). This broader niche may facilitate the Barred Owl outcompeting the Spotted (Livesey and Flemming 2007). Interestingly, in Marin County the Northern Spotted Owl occupies not only mature coniferous forest but second- and third-growth coniferous and broadleaf forests and areas along the urban-wildland interface (Stralberg et al. 2009). While the size of Marin County's Spotted Owl population is not known, surveys of much of the suitable habitat on public land, completed in 1999 before the Barred Owl's arrival, revealed the Spotted Owl at 83 distinct sites, with 53 of these occupied by pairs (Press et al. 2011).

We describe the Barred Owl's colonization of Marin County, estimate its population size, report known attempts at breeding, describe interactions between the Barred and Spotted Owls, and discuss the Barred Owl's invasion in the context of the unique attributes and threats to the Marin population of the Northern Spotted Owl.

METHODS

Data for this study were gained primarily through the detection of Barred Owls during monitoring of the Spotted Owl on land managed by the federal and county governments. Widespread monitoring in Marin County by the National Park Service and PRBO Conservation Science began in 1996, though some limited surveys began in 1993. Inventories (1996–1999 and 2006) and demographic monitoring (1999–present) followed standard protocols (USFWS 1992), modified to minimize the practice of calling and feeding mice to owls while increasing visual searching, in order to reduce the owls' habituation to people (Press et al. 2010). Mimicking owl calls with the human voice or playing calls with electronic devices are widely used for locating Spotted Owls, and live mice are often presented to Spotted Owls to determine the birds' nesting status or nest location (USFWS 1992).

We obtained additional data from local experts Ryan DiGaudio, Jules Evens, Keith Hansen, Steve N. G. Howell, Dave MacKenzie, W. David Shuford, and Rich Stallcup. Additionally, we searched the North Bay Birds e-mail list-serve (<http://groups.yahoo.com/group/northbaybirds>), eBird (www.ebird.org), *North American Birds* since 1994, and Christmas Bird Count data since 2001 for Barred Owl observations.

We evaluated the observations to determine the birds' sex, age, and numbers. We identified the birds' sex by voice whenever possible. Individuals observed visually were often distinguished as adult or subadult (1 to 2 years old) by the shape and color of the tips of the central rectrices (Moen et al. 1991, Pyle 1997). We estimated the population's upper limit by tallying the number of locations where Barred Owls were detected in a given year and adding individuals where appropriate when multiple birds were observed together. We estimated the lower limit by evaluating the geography, habitat, and distance between locations of detection to consider if observations at different locations may have represented the same individual.

STATUS OF THE BARRED OWL IN MARIN COUNTY, CALIFORNIA

We used GPS receivers to record locations of Barred Owls detected during Spotted Owl monitoring. For Barred Owls for which the observer provided no coordinates, we mapped the location in ArcView 3.2 from the observer's description of the site.

RESULTS

Barred Owls were detected on at least 107 occasions between April 2002 and August 2010, primarily in the southern and western portions of Marin County (Figure 1). Of these detections, 67 were the result of Spotted Owl monitoring, 10 were from the list-serve, 4 were from eBird, 23 were from direct communication with local birders, and 3 were our observations made outside Spotted Owl monitoring. Additional observations, for which specific dates were not recorded, were made in Muir Woods National Monument, Olema Valley, and to a lesser extent near Point Reyes Station. We did not map observations lacking dates, but because Barred Owls were observed frequently in these areas, these individuals are likely represented by the other detections on the map.

Barred Owls have been observed at Muir Woods every year since the county's first record there in 2002, and they have been observed yearly since 2004 in the southern Olema Valley. Barred Owls were detected near Point Reyes Station in 2003, 2005, and yearly from 2008 to 2010, and in Mill Valley in 2009 and 2010. They have also been detected at several other locations across the southern and western parts of the county (Figure 1), though never in consecutive years. All of these locations, except Point Reyes Station, are also occupied by Spotted Owls.

A male and female Barred Owl were detected together in 2005 in Olema Valley, without evidence of nesting. In 2006 a male and female were detected in Muir Woods, again with no evidence of nesting. In 2007, a pair and two fledglings were found together in Muir Woods, but the nest was not located. In 2008, a nest was found in Muir Woods, both parents were confirmed as Barred Owls, and two young fledged. In 2008, a subadult Barred Owl was detected in Muir Woods, and in 2009 one was found in Mill Valley, 1.2 km from Muir Woods.

We estimate that as of August 2010 there were between four and seven Barred Owls within Marin County (Figure 2), including a territorial pair at Muir Woods, a territorial male in Olema Valley, one to two individuals around Point Reyes Station, and one or two in Mill Valley, though there may be some overlap between this site and Muir Woods.

In Marin County, more individual Barred Owls have been identified as males than as females, and only one pair has been found in any year, possibly implying a male-biased population. In many sightings, however, the bird's sex was not determined (see below regarding limitations of our data), so the true sex ratio of the population is not known. Barred Owls were classed as subadult on only two occasions, and these may represent different detections of the same bird. In spite of the number of birds of unknown age, the Marin Barred Owl population appears to be composed primarily of adults.

Hybrid Barred \times Spotted Owls have not been conclusively identified in Marin County. But Jules Evens and Rich Stallcup (pers. comm.) reported

STATUS OF THE BARRED OWL IN MARIN COUNTY, CALIFORNIA

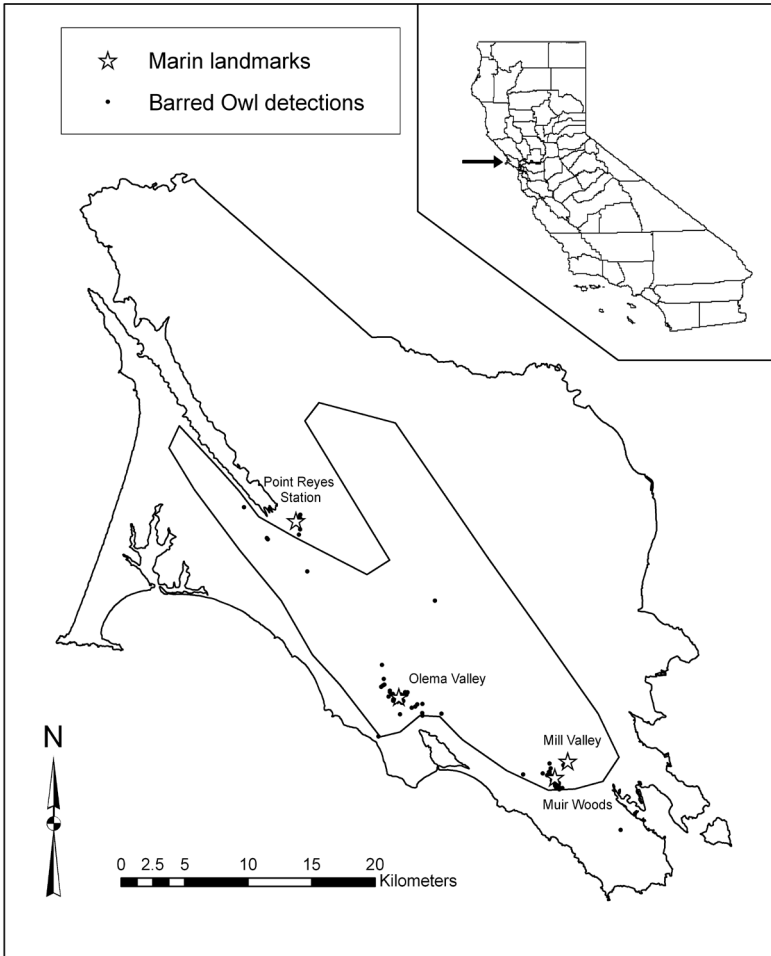


Figure 1. Locations in Marin County, California, of 89 Barred Owl observations (circles) for which specific dates and locations were recorded, 2002–2010. Stars mark the locations of landmarks referred to in the text, and the study area outline shows land covered by surveys monitoring the Northern Spotted Owl.

hearing calls intermediate between those of the Spotted and Barred near Point Reyes Station in the falls of 2005, 2006, 2007, and 2010. For example, Stallcup reported hearing a call that started with the first three notes of the Spotted Owl's standard four-note call but then proceeded into the caterwauling ending characteristic of the Barred Owl. Evens noted that he could not confidently identify the owl as Barred, but he was sure it was not a pure Spotted. Via the list-serve, Ken Burton also reported an unidenti-

STATUS OF THE BARRED OWL IN MARIN COUNTY, CALIFORNIA

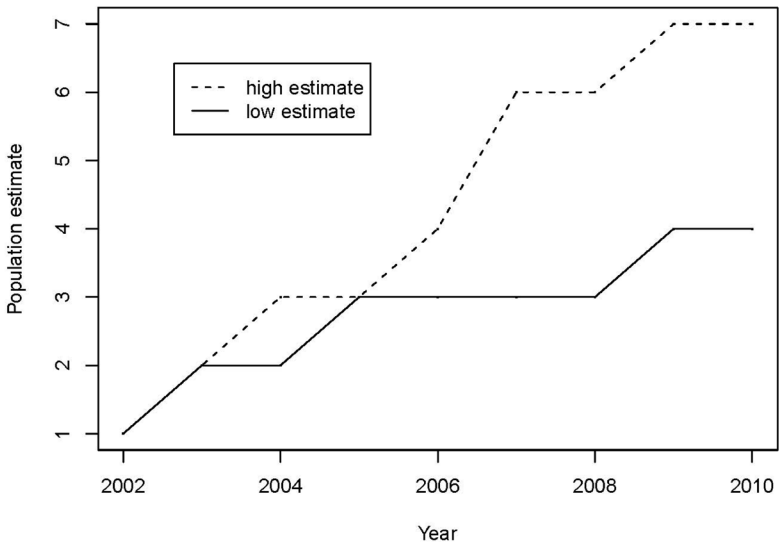


Figure 2. Estimates of the population of the Barred Owl in Marin County, California, 2002–2010. Dashed line, maximum number estimated; solid line, minimum number estimated.

able call of *Strix* in Mill Valley. In all these cases, the owl making the calls was not seen.

On multiple occasions Barred and Spotted Owls were heard calling in the same vicinity, but the extent of interaction is not known. On three daytime surveys, we and other biologists observed notable interactions between the two species: (1) both members of a pair of Spotted Owls charged and dove at a Barred Owl, (2) a Barred Owl chased a female Spotted Owl, and (3) an aerial “clash” between a Barred and a Spotted Owl.

In Muir Woods Barred Owls were observed foraging during daylight hours, hunting for crayfish (*Pacifastacus* spp.) in a stream on multiple occasions and foraging while walking on the ground.

DISCUSSION

The Barred Owl population in Marin County is currently small but well established, and it has continued to grow steadily since the species was first detected in 2002. Two home ranges have been established, one in Muir Woods and one in Olema Valley. In 2007 and 2008, Barred Owls successfully fledged two young each year from nests in Muir Woods. The 2007 Barred Owl nest is of particular interest because in that year only two of 37 monitored Spotted Owl pairs attempted nesting. Barred Owls may nest more often and produce more offspring per nesting attempt than the Northern Spotted Owl (Livesey and Fleming 2007, Wiens et al. 2009).

STATUS OF THE BARRED OWL IN MARIN COUNTY, CALIFORNIA

Hybridization between the two species in Marin County appears to be low or none; no mixed pairs have been observed, and no hybrids have been confirmed. Hamer et al. (1994) predicted hybridization to be more likely in the early stages of Barred Owl invasion, because there are few Barred Owls to make single-species pairs, but they also noted that isolating mechanisms between the two species are likely to keep hybridization to a minimum.

Our estimate of the Barred Owl's population in Marin County is conservative. The Barred Owl may not be sampled adequately by Spotted Owl monitoring (Livesey and Fleming 2007). Additionally, while most of the habitat suitable for the Spotted Owl on public land in Marin County is well covered through demographic monitoring, the Barred Owl has been detected in other habitats within the county, such as riparian. Last, little is known about the Barred Owl's occurrence on private lands. Uneven detectability and spatial distribution by sex or age class may have influenced our estimates of population size. However, given the extent and effort of Spotted Owl monitoring and of general bird watching in Marin County, we feel confident that the majority of Barred Owls present have been detected.

The presence and increasing abundance of Barred Owls at the southern limit of the Northern Spotted Owl's range in Marin County is troubling. The Marin County population of the Northern Spotted Owl may be an especially important one because it is geographically and genetically isolated from both the Northern Spotted Owl farther north in northern California and from the California Spotted Owl in the Sierra Nevada and in southern California (Barrowclough et al. 2005). Additionally, in Marin the population density of breeding Northern Spotted Owls is higher than elsewhere, the population's fecundity is consistently high, and the population uses a wider variety of habitats than does the Northern Spotted Owl in other areas (Anthony et al. 2006, Stralberg et al. 2009). Finally, the traditional threat of habitat loss and degradation due to logging is nonexistent in Marin County, and the existing pressures there (e.g., recreation, noise disturbance, urban encroachment, rodenticide use, increased risk of human-caused wildfire) have not been severe enough to cause population declines. The Marin population appears to be stable (Stralberg et al. 2009, Jensen et al. 2010).

Our early observations suggest that the Barred Owl may be affecting the Northern Spotted Owl in Marin County in ways similar to those reported elsewhere, including displacement and potential suppression of the Spotted Owl's response to mimicked calls (Kelly et al. 2003). In Muir Woods a single pair of Barred Owls now occupies the core area where two pairs of the Spotted held territories prior to the arrival of the Barred. Both pairs of the Spotted appear to have relocated to nearby areas. Additionally, the Spotted Owls have become more difficult to detect in Muir Woods and Olema Valley since the Barred Owl's arrival. In Marin, Barred Owls have been observed exploiting a diet (including crayfish) more diverse than the Spotted's, and the nesting in 2007 suggests higher fecundity. Both of these factors are thought to facilitate the Barred Owl outcompeting the Spotted (Livesey and Flemming 2007). Currently, Barred Owls occupy a small number of Spotted Owl territories and to date appear to affect individuals rather than the entire Marin population of the Spotted Owl.

STATUS OF THE BARRED OWL IN MARIN COUNTY, CALIFORNIA

The effect of the Barred Owl on the Northern Spotted Owl in Marin County is cause for concern. We recommend continued monitoring of the Spotted Owl throughout Marin County, the addition of surveys designed to improve detection of the Barred Owl, and that citizen scientists report Barred Owls sightings vigilantly.

ACKNOWLEDGMENTS

We thank the biologists who have studied the Spotted Owl in Marin County, especially Katie Fehring, Dawn Adams, Heather Jensen, and Mia Monroe. We also thank the Marin Municipal Water District, the Marin County Open Space District, Canon USA, Inc., Expedition into the Parks, the National Park Service, the National Park Foundation, Golden Gate National Parks Conservancy, Point Reyes National Seashore Association, and the David and Vicki Cox Foundation for funding Spotted Owl research. Ryan DiGaudio, Jules Evens, Keith Hanson, Steve N.G. Howell, Rick Johnson, Dave MacKenzie, W. David Shuford, Rich Stallcup, Francis Taroc, and Jim White contributed data. We thank the contributors to, moderators of, and editors of the North Bay Birds list serve, eBird, and *North American Birds* for maintaining records of Barred Owls observed outside of Spotted Owl monitoring.

Dave MacKenzie, Libby Porzig, and Dave Quady provided helpful comments on earlier drafts of the manuscript. This is PRBO contribution number 1811.

LITERATURE CITED

- Anthony, R. G., Forsman, E. D., Franklin, A. B., Anderson, D. A., Burnham, K. P., White, G. C., Schwartz, C. J., Nichols, J. D., Hines, J. E., Olson, G. S., Achers, S. H., Andrews, L. S., Biswell, B. L., Carlson, P. C., Diller, L. V., Dugger, K. M., Fehring, K. E., Fleming, T. L., Gerhardt, R. P., Gremel, S. A., Gutiérrez, R. J., Happe, P. J., Herter, D. R., Higley, J. M., Horn, R. B., Irwin, L. L., Loschl, P. J., Reid, J. A., and Sovern, S. G. 2006. Status and trends in demography of Northern Spotted Owls, 1985–2003. *Wildlife Monogr.* 163.
- Barrowclough, G. F., Groth, J. G., Mertz, L. A., and Gutiérrez, R. J. 2005. Genetic structure, introgression, and a narrow hybrid zone between Northern and California Spotted Owls (*Strix occidentalis*). *Molec. Ecol.* 14:1109–1120.
- Crozier, M. L., Seamans, M. E., Gutiérrez, R. J., Loschl, P. J., Horn, R. B., Sovern, S. G., and Forsman, E. D. 2006. Does the presence of Barred Owls suppress the calling behavior of Spotted Owls? *Condor* 108:760–769.
- Gutiérrez, R. J., Franklin, A. B., and LaHaye, W. S. 1995. Spotted Owl (*Strix occidentalis*), in *The Birds of North America* (A. Poole and F. Gill, eds.), no. 179. Acad. Nat. Sci., Philadelphia.
- Gutiérrez, R. J., Cody, M., Courtney, S., and Franklin, A. B. 2007. The invasion of Barred Owls and its potential effect on the Spotted Owl: a conservation conundrum. *Biol. Invasions* 9:181–196.
- Hamer, T. E., Forsman, E. D., Fuchs, A. D. and Walters, M. L. 1994. Hybridization between Barred and Spotted Owls. *Auk* 111:487–492.
- Hamer, T. E., Hays, D. L., Senger, C. M., and Forsman, E. D. 2001. Diets of Northern Barred Owls and Northern Spotted Owls in an area of sympatry. *J. Raptor Res.* 35:221–227.
- Haig, S. M., Mullins T. D., Forsman, E. D., Trail, P.W., and Wennerberg, L. 2004. Genetic identification of Spotted Owls, Barred Owls, and their hybrids: Legal implications of hybrid identity. *Cons. Biol.* 18:1347–1357.
- Kelly, E. G., Forsman, E. D., and Anthony, R. G. 2003. Are Barred Owls displacing Spotted Owls? *Condor* 105:45–53.

STATUS OF THE BARRED OWL IN MARIN COUNTY, CALIFORNIA

- Jensen, H. J., Merkle, W. W., and Press, D. 2010. Monitoring Northern Spotted Owls on federal lands in Marin County, California: 2008 annual report. Natural Resources Technical Report NPS/SFAN/NRTR—2010/312. National Park Service, Fort Collins, CO (download from http://science.nature.nps.gov/im/units/sfan/vital_signs/Spotted_Owl/birds.cfm).
- Kelly, E. G., and Forsman, E. D. 2004. Recent records of hybridization between Barred Owls (*Strix varia*) and Northern Spotted Owls (*S. occidentalis caurina*). *Auk* 121:806–810.
- Leskiw, T., and Gutiérrez, R. J. 1998. Possible predation of a Spotted Owl by a Barred Owl. *W. Birds* 29:225-226.
- Livesey, K. B., and Fleming, T. L. 2007. Effects of Barred Owls on Spotted Owls: The need for more than incidental detections and correlational analysis. *J. Raptor Res.* 41:319–325.
- Livesey, K. B. 2009. Range expansion of Barred Owls, part I: Chronology and distribution. *Am. Midland Nat.* 161:49–56.
- Moen, T. A., Franklin, A. B., and Gutiérrez, R. J. 1991. Age determination of subadult Northern Spotted Owls in northwest California. *Wildlife Soc. Bull.* 19:489–493.
- Press, D., Adams, D., Jensen, H., Fehring, K., Merkle, W., Koenen, M., and Starcevich, L. A. 2010. San Francisco Bay area network Northern Spotted Owl monitoring protocol, version 6.4. Natural Resource Report NPS/SFAN/NRR—2010/245. National Park Service, Fort Collins, CO.
- Press, D., Merkle, W. W., and Jensen, H. J. 2011. Monitoring Northern Spotted Owls on federal lands in Marin County, California: 2009 annual report. Natural Resources Technical Report NPS/SFAN/NRTR—2011/423. National Park Service, Fort Collins, CO.
- Pyle, P. 1997. Identification Guide to North American Birds, part 1. Slate Creek Press, Bolinas, CA.
- Stralberg, D., Fehring, K. E., Pomara, L. Y., Nur, N., Adams, D. B., Hatch, D., Geupel, G. R., and Allen, S. 2009. Modeling nest-site occurrence for the Northern Spotted Owl at its southern range limit in central California. *Landscape and Urban Planning* 90:76–85.
- USFWS. 1992. Protocol for surveying proposed management activities that may impact Northern Spotted Owls. 7 March 1991, revised 17 March 1992; www.fws.gov/oregonfwo/species/data/northernspottedowl/Documents/1992Mar17NSOSurveyProtocol.pdf
- USFWS. 2010. Draft revised recovery plan for the Northern Spotted Owl, *Strix occidentalis caurina*. U.S. Fish and Wildlife Service, Portland, OR (download from www.fws.gov/species/nso).
- Wiens, J. D., Graham, S. A., Anthony, R.G., Forsman, E. D., and Fuller, M. R. 2009. Competitive interactions and resource partitioning between Northern Spotted Owls and Barred Owls in western Oregon: 2009 progress report. U.S. Geological Survey, Reston, VA (order from www.usgs.gov/pubprod).

Accepted 29 March 2011