

SPOTTED OWL MONITORING IN OLYMPIC NATIONAL PARK: 2013 ANNUAL REPORT



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Cover Photograph: The Godkin River spotted owl pair occupies one of a handful of sites where barred owls have not been found. The same pair has occupied the site since 1996, and remains within 200m of where they were first located.

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EXECUTIVE SUMMARY

This report summarizes progress on the northern spotted owl (*Strix occidentalis caurina*) monitoring program in Olympic National Park (ONP) in 2013. Monitored spotted owl territories in the national park, together with those visited by U.S. Forest Service Pacific Northwest Research Station in the surrounding Olympic National Forest, make up the Olympic Peninsula Demographic Study Area. This is one of eight study areas called for in the Northwest Forest Plan to estimate spotted owl population trends from demographic data and monitor the effectiveness of the plan. The spotted owl territories in the NPS portion of the study have now been monitored over 21 years on average.

In 2013, National Park Service personnel monitored and managed data on a sample of 52 spotted owl territories (hereafter “sites”) to determine their occupancy and reproductive status. Crews made 223 monitoring visits to spotted owl sites and 91% of visits were daytime surveys. We detected spotted owl pairs at three sites and single spotted owls at eight sites and all detections were from sites that were also occupied in 2012. This was the lowest number of pairs and total owls encountered during any year of this study. We documented no nest attempts, and banded three new adult/subadult spotted owls. At sites where any spotted owls responded, they were found on an average of 38% of monitoring visits, well below the 20 year average rate of 61%.

Data collected on the eleven northern spotted owl demography studies 1990-2008 were analyzed at a workshop in Corvallis, OR in January of 2009. This analysis estimated a range-wide rate of population decline of 2.9% a year, and a 4.3% annual decline for the Olympic Peninsula. Female fecundity appeared stable in the Olympics, but the more important estimate of adult survival was declining here and on nine of 10 other areas studied. The next meta-analysis of spotted owl demography data is scheduled for January of 2014.

Barred owls (*Strix varia*) were first documented on the Olympic Peninsula in 1985, and have now been detected within 800 meters of 91% of the monitored spotted owl sites in ONP. Competition with this species is now the primary threat to the conservation of spotted owls in protected areas. Occupancy rates of spotted owls in ONP have declined significantly following the first detection of barred owls at a site. Spotted owls that have persisted on territories following detections of barred owls have both moved farther and increased in elevation relative to sites where barred owls are absent. Although barred owls now occupy portions of most spotted owl territories here, most remaining spotted owls are found greater than 800 meters from any previous barred owl detection. While spotted owls have shown the ability to move within their territories to avoid barred owl competition, barred owls occupy new portions of some spotted owl sites each year and the area available to spotted owls continues to be reduced. Models suggest that barred owls are less likely to occupy spotted owl sites on the steepest, driest slopes, and the movement of spotted owls to the steepest portions of their territories is making access and complete survey of the remaining activity centers more difficult.

INTRODUCTION

Olympic National Park (ONP) is located on the Olympic Peninsula in northwest Washington State. The park consists of 922,653 acres, of which roughly 756,000 acres are forested valleys naturally fragmented by high elevation peaks and ridges. Due to the lack of historic timber harvest or recent stand-replacing natural disturbance, most of the forested landscape is dominated by stands older than 100 years. There is a steep precipitation gradient from rainforest valleys in the southwest to rainshadow areas in the northeast, resulting in two very different habitat strata. Drier, east-side forests tend to be younger and dominated by Douglas-fir (*Pseudotsuga menziesii*). West-side forests have a lower frequency of fire and contain more shade-tolerant species such as western red-cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), and Pacific silver fir (*Abies amabilis*), with varying amounts of Douglas-fir.

The Olympic Peninsula Demographic Study Area consists of 54 northern spotted owl (hereafter spotted owl) sites monitored by National Park Service crews in Olympic National Park and 45 sites monitored by U.S. Forest Service Pacific Northwest Research Station (PNW) crews in the surrounding Olympic National Forest. Each “site” is roughly equivalent to a spotted owl territory, and can have multiple activity centers occupied by spotted owls in different years up to 2 or more kilometers from the initial activity center. Site selection for the ONP portion of the study was not strictly random. Initially, all known sites were monitored. As additional sites were located in the course of surveying randomly located inventory plots, these were added to the sample if they were within a one day hike of a site already being monitored. Forty percent of the current sample of sites were monitored by 1990 and no sites were added or dropped after 1996. Funding and the logistics involved in monitoring sites as far as 24 miles from a trailhead determined the total number of sites that were feasible to monitor and we have continued to monitor sites regardless of their occupancy status.

This study area, including both Park and Forest Service managed lands, is generally representative of habitat conditions on federal lands on the Olympic Peninsula, although the proportion of suitable habitat in the study area is somewhat higher than outside, owing to the higher proportion of National Park land (Appendix F, Anthony et al., 2006). It is not representative of state, private and tribal lands on the Olympic Peninsula, where there is little suitable habitat and few or no remaining spotted owls.

This report summarizes results of fieldwork, cooperative efforts and administration of National Park Service run portion of Olympic Peninsula Demography Study during the 2013 breeding season. It is intended as a summary of results for administrators and cooperators, but does not present detailed methodologies or data analysis. In general, crews visit historically occupied spotted owl territories calling for spotted owls. Spotted owls are color banded, and mark-recapture methods are used to calculate survival rates and population trends

based on resighting histories of these banded owls. Behavior of the owls when they are offered live mice allows the determination of nesting and reproductive status. More detailed methods are described in Franklin et al. (1996).

Results through 2012 from the PNW administered portion of the Olympic Peninsula study are available at:

<http://www.fs.fed.us/pnw/olympia/wet/team-research/owl-res/index.shtml>

Reports from most cooperators in the Northwest Forest Plan's Northern Spotted Owl Effectiveness Monitoring Program are available at:

<http://www.reo.gov/monitoring/reports/northern-spotted-owl-reports-publications.shtml>

OBJECTIVES

The Olympic Peninsula Demography Study is one of eight areas where demographic rates are monitored to assess the effectiveness of the Northwest Forest Plan in preventing a further decline in spotted owl populations. ONP also provides a unique opportunity to understand the ecology of the northern spotted owl in a large area of suitable habitat with almost no history of timber harvest. The specific objectives of the study are to:

1) Document age-specific survival and fecundity to contribute to a range-wide assessment of spotted owl population trends, as required by the effectiveness monitoring component of the Northwest Forest Plan.

2) Monitor the effects of increasing barred owl populations on spotted owls.

2013 RESULTS

General Monitoring and Site Status

The project employed six full-time biological technicians, one intern, and the project lead. Crews made 223 visits to 54 monitored spotted owl sites (site locations, Figure 1) and the mean number of visits per site was 4.1 (range 2-9). Two of these sites were formerly monitored by PNW, and they continue to manage those data. We report these site visits here, but the sample size for most analyses is 52 except where noted. Most visits (91%) were daytime searches where crews focused their efforts on recently occupied activity centers, covering suitable habitat out to 2 km as time permitted. The remaining visits were night or twilight surveys from roads or trails. We accounted for most of the 6% "sequester" budget reduction by limiting the amount of late season fieldwork. The full field crew (4 one or two-person teams) visited owl sites between March 26 and July 9, with only 5 additional visits in late July and August.

After several years of above average spring snowpack in the Olympics, 2013 conditions were much closer to normal, with little of the late winter snowfall that characterized the last two years. The April 1 snowpack was 130% of average (NWCC, 2012), but there was little snow at owl sites below 2500' elevation. Early spring was rainy but mild, and the field season ended with a warm and dry June and early July (WRCC, 2012). Precipitation was recorded on 42% of site visits in the form of snow (4%) and rain or drizzle (37%). We completed at least one visit to 47 of 54 sites prior to May 15, the end of the nesting season. Consistently high flows in the Hoh River delayed access to one site until July. The lack of a functioning radio repeater complicated visits to five sites in the Quinault that were not accessed until June, and the continued closure of the Dosewallips Road added 5.5 miles to the approach hike at four sites.

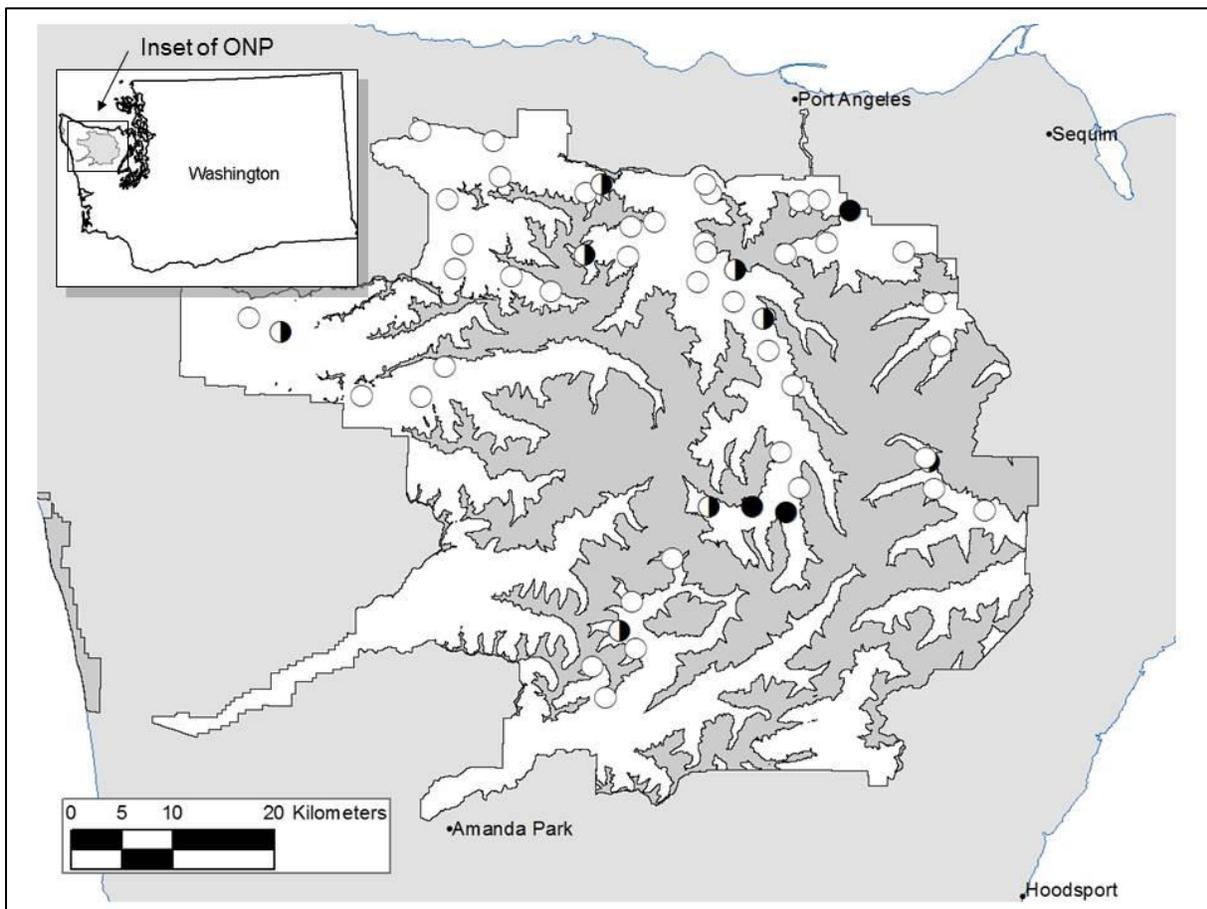


Figure 1. Location and occupancy status of 52 monitored spotted owl territories in Olympic National Park, 2013. Black circles are spotted owl pairs, half-filled circles are single owls and white circles are monitored sites with no response. Shaded area within the park boundary is high elevation non-habitat.

One or more spotted owls were detected at 11 (21%) of monitored sites and pairs were located at three of these (Figure 2). This is the third consecutive year that we detected more single owls than pairs. At sites where spotted owls were found this year, they were located on 38% of visits, which is a considerably lower rate than the 20 year average of 61%. In the last five years at least one spotted owl was detected at 33 sites and pairs were detected at 21 of these. Of the 14 spotted owls detected this year, four were female and ten were male. Ten of these were adults three years of age or older, two were sub-adults and two were of unknown age.

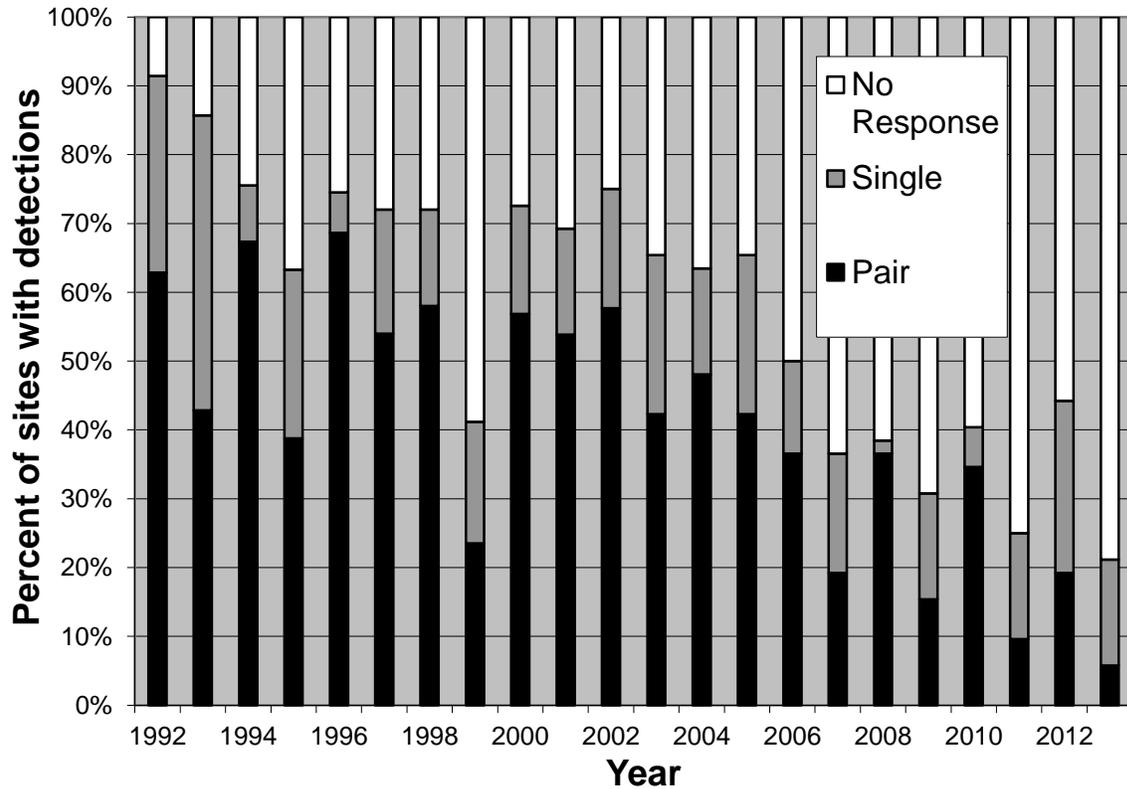


Figure 2. Percent of monitored spotted owl sites with 0, 1, or 2 adult owls detected, Olympic National Park, 1992-2013.

The 52 spotted owl sites monitored in 2013 represented a sample of roughly 23% of the 229 spotted owl territories estimated to occur in ONP as of 1995 (Seaman et al., 1996). The mean length of record is now 21.4 years (range 18-22), not including years prior to 1992 when monitoring to current protocols began at most sites.

Since 1994, the mean elevation of occupied spotted owl activity centers has increased 459' to 2585' and the mean slope within 200 meters has increased from 24° to 30° (when calculated on the 49 sites monitored in both 1994 and 2012). These changes result from both declining occupancy at sites that are lower in elevation and less steep, and the movement of spotted

owls to the steeper and higher elevation areas within monitored sites. While there is clearly a relationship between elevation and the likelihood that a spotted owl site has remained occupied, models indicate that slope and topographic moisture explain more of the variance in occupancy than elevation alone (Gremel, 2005). It is likely that these topographic variables are simply correlates for barred owl occupancy (see later section). Regardless of the factors responsible, spotted owl distribution in the Olympics has changed dramatically over the course of this study. This has implications for both conservation efforts and our ability to monitor spotted owl sites safely and effectively.

Nest and Reproductive Monitoring

Spotted owl productivity (fecundity) is calculated as the number of female young produced per territorial female, assuming a 50:50 sex ratio of offspring. We determined the reproductive status of 3 of 4 female spotted owls on monitored territories, and none of these attempted to nest. The average fecundity of adult females was 0.00 ($N = 3$). Spotted owl fecundity in the Olympics has been highly variable, with years of high productivity often followed by years with few or no nesting attempts (Figure 3). We found no successful reproduction in eight of the last 22 years. The high year-to-year variation in female

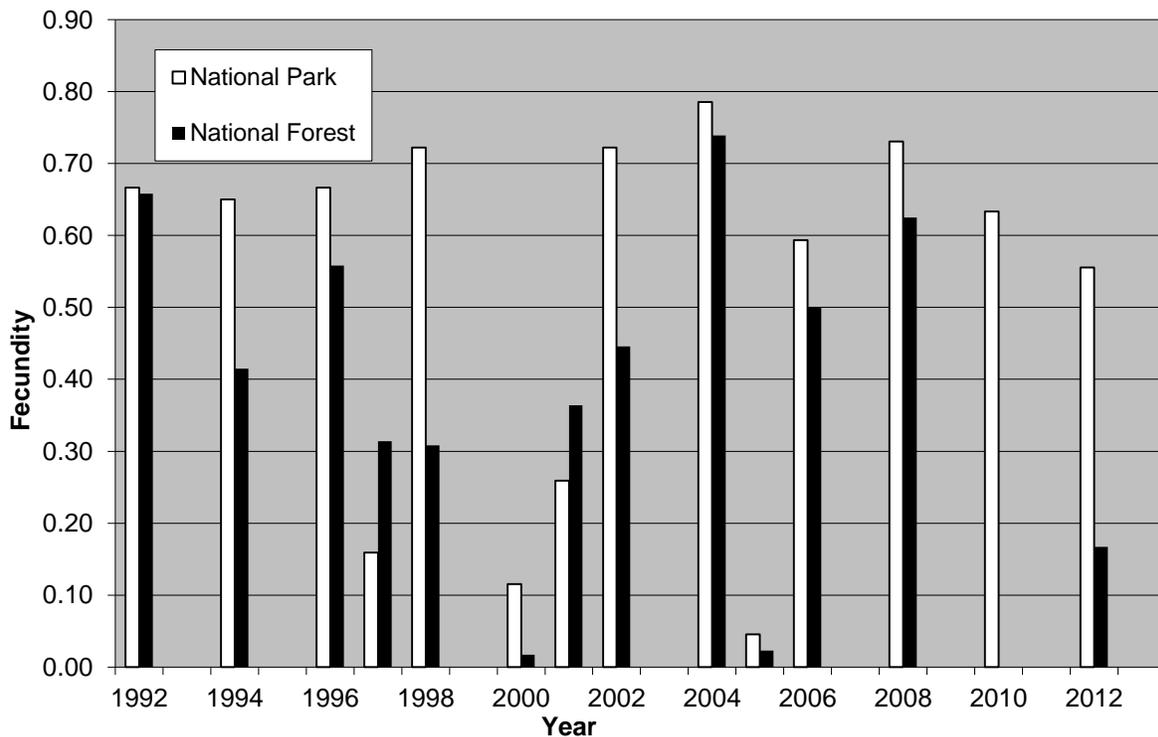


Figure 3. Olympic Peninsula adult spotted owl fecundity (mean # of female offspring/territorial female), 1992-2013. Includes both National Park (white bars) and National Forest (black bars).

fecundity has been driven by the proportion of the population attempting to nest, and to a lesser extent the productivity of those nests, rather than the rate of nest success which has averaged 91% (Appendix 1). The mean annual fecundity rate for adult female spotted owls in ONP ($N = 22$ years) was 0.33 (SE 0.070), the estimate over the range of the northern spotted owl was also 0.33 (SE 0.025) (Forsman, et al., 2011). It is important to note that this estimate is the rate per adult female spotted owl, and is derived from a decreasing number of individuals. The actual number of juveniles produced in a recent year with high fecundity like 2012 (10) is much smaller than it was in the early years of the study when 30-40 juveniles fledged from monitored sites in normal nesting years.

Banding and Capture

Banding owls is necessary to identify individuals and estimate survival rates. All captured owls are fitted with a unique U.S. Fish and Wildlife Service number band. Adult and sub-adult owls are marked with a color band unique to a 16-km radius from the capture site, which enables field crews to identify these individuals without recapturing them. Juveniles receive a standard color band, which is changed if these birds are re-captured as adults on a new territory. We use established capture techniques for spotted owls (Franklin et al., 1996), and emphasize owl safety during training.

ONP crews captured and banded three spotted owls in 2013. Of the 14 spotted owls detected at monitored sites, three were new territorial individuals, nine were “recaptures” based on sightings of marked owls from previous seasons and two were unknown. Since 1988, ONP crews have performed 539 captures and banded 393 spotted owls. We captured and banded under ONP master station banding permit 22633 and U.S. Fish and Wildlife Service 10(a)(1)(a) “take” permit TE842449-4.

Juvenile Dispersal

We did not recapture any juveniles banded in previous years. Nineteen of the 173 spotted owls banded as juveniles by ONP crews prior to 2013 have been recaptured as adults or sub-adults on the Olympic Peninsula. Five dispersed to Olympic National Forest, the others were found within ONP. The median dispersal distance for this sample was 15.8 km (mean 19.1 km, SD 10.0, range 5.3-41.8 km). The mean dispersal distance of females was 44% greater than that of males, but this difference was not statistically significant. The greater dispersal distance for females is consistent with results reported by Forsman et al. (2002) for a large sample of juveniles in Washington and Oregon. The mean age at recapture was 3.2 years, implying that most spotted owls spend several years as non-territorial “floaters” or on territories outside of our study sites before being detected. To date, we have documented no dispersal of spotted owls between the Olympic Peninsula and Cascade provinces.

Barred Owls and Hybrids

The first documented occurrence of barred owls on the Olympic Peninsula was on the west side of ONP in 1985 (Sharpe, 1989). This species now occurs across the entire range of the northern spotted owl and is considered to be the greatest threat to spotted owl conservation within protected reserves. Barred owls are dominant in competitive interactions with spotted owls and evidence from many areas suggests that barred owls displace spotted owls from otherwise suitable habitat (Dark et al., 1998; Hamer, 1988; Kelly, 2001, Gremel, 2005).

Most biases associated with our incidental data on barred owl occupancy, pair and reproductive status likely lead to underestimates of these parameters. For example, although we attempt to revisit every past activity center at a spotted owl site, more of those visits cover where the spotted owls were most recently located. Since current locations are often a result of spotted owls moving to areas of lower barred owl activity, less of our monitoring is devoted to the areas where barred owls are most abundant. Also, as barred owl densities have increased, it has become more difficult to discern the number of adjacent territories. Barred owls are not banded and we conservatively lump clusters of sightings within two kilometers of each other as one territory (“site”) until we get simultaneous evidence of multiple pairs. Many barred owl sites with single occupancy were not visited frequently enough to determine pair status, or at the proper time to document reproduction.

In some years we have done a limited number of barred owl surveys using recorded barred owl calls. These were done at the end of the season after spotted owl surveys were completed with no response by either species at a site. We have also used programmable field recorders for the last five seasons to improve survey coverage in the areas of the study away from current spotted owl activity centers (see next section). Data from these methods are tracked separately from the demographic monitoring data, so as not to bias comparisons of barred owl detections with previous years.

We recorded barred owls on 51 separate occasions representing an estimated 39 barred owl territories in 2013. To standardize for variable survey effort between years, the annual count of occupied barred owl sites is divided by the number of spotted owl site visits to derive an index of barred owl abundance (Fig. 4). The rate of increase in this index, calculated from the log of the slope from 1992-2013, was 11.1 % a year. Additional detections resulting from calling for barred owls (3 detections, no additional barred owl sites) are not included in these totals. We did no formal barred owl surveys this year due to limited resources, and field recordings have not been processed.

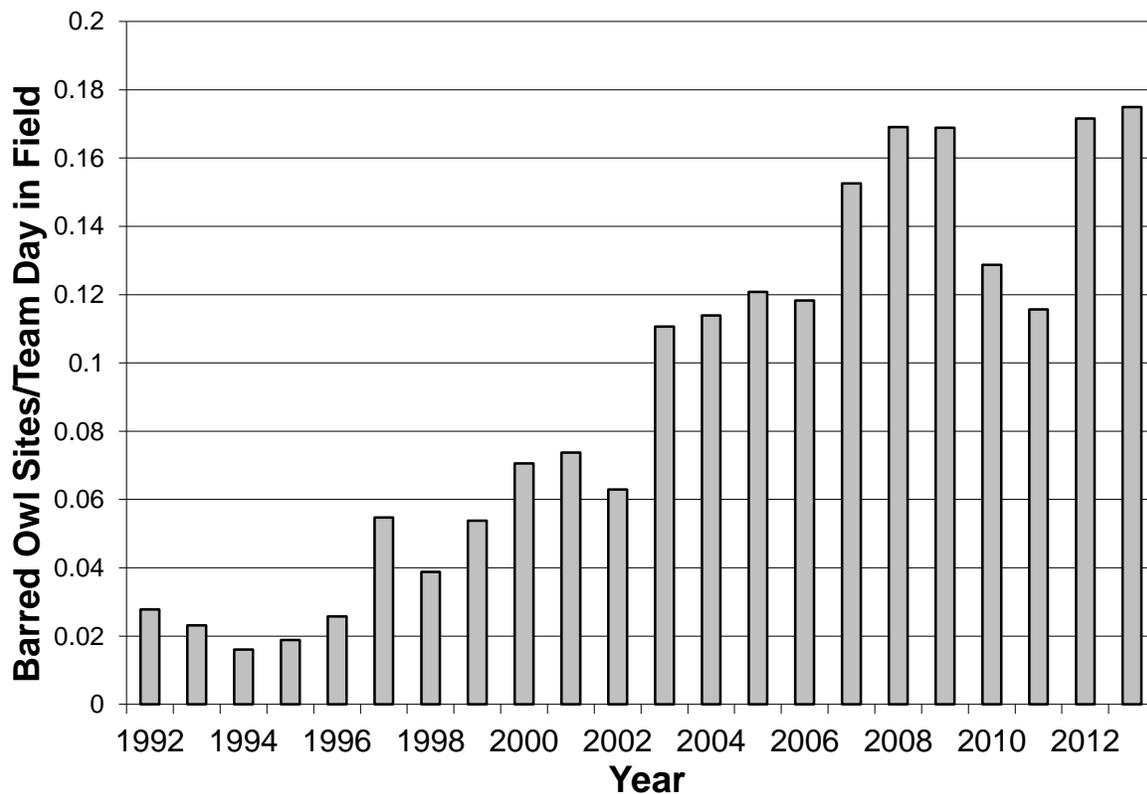


Figure 4. Number of occupied barred owl sites detected, standardized by survey effort, Olympic National Park, 1992-2013. Excludes sites detected as a result of using barred owl calls, radio-telemetry, or acoustic monitoring devices.

When including barred owls located by all methods, 11 barred owl pairs and 28 single barred owls were detected. This is not a complete count, only the number of barred owl territories detected in regions of the park covered by the spotted owl monitoring program. We observed no barred owl juveniles during the field season, but did receive reports of single juveniles at two known sites in late July. An index of barred owl reproduction (the number of juveniles detected/occupied barred owl site) correlated significantly with annual rates of spotted owl fecundity from 1992-2006 at ONP (Spearman’s rho = 0.726, $p < 0.01$).

Hybridization between barred and spotted owls has been documented, but appears to be infrequent after the initial period of colonization (Hamer et al. 1994; Herter and Hicks, 2000; Kelly and Forsman, 2004). No hybrids were observed this season.

Monitoring with Field Recorders

Since 2010 we have investigated the use of acoustic field recorders to augment the occupancy data derived from the demographic monitoring program. In 2010-2011 we experimented with the use of these recorders at sites with known occupancy by barred and spotted owls to

estimate detection probabilities and develop protocols for analysis. In 2012 we specifically focused on documenting the presence of barred owls in spotted owl sites and evaluating the effectiveness of this method for detecting barred owls when they are present. At 24 sites known to be occupied by barred owls, the mean probability of detection on a four hour recording was 0.19.

This season we installed recorders at sites occupied by spotted owls in 2012, with the objective of better estimating a probability of detection for this species. The protocols were the same as those used in 2012. Each sample was a four hour recording beginning either 10 minutes before sunset or ending ten minutes after sunrise, recorded in 1 channel at a sample rate of 16 khz. We visually browsed recordings in the program Raven with 8 minute page intervals, noting the presence of every owl species and marbled murrelets. Length of time recorders were left out was based on the logistics of installing and removing the units during our demographic monitoring visits.

We installed recorders at 21 sites, and collected 400 four hour recordings (mean per site 19, range 12-34). After analyzing 245 of these recordings, we have detected spotted owls on 21% of samples from 8 sites known to be occupied in 2013. When all recordings have been browsed, we plan to analyze the results with those from the monitoring work in a multi-method occupancy analysis. This will allow the inclusion of covariates for weather, background noise, and time of year, all of which likely influence detection probability.

Effects of Barred Owls on Spotted Owls

At ONP, rates of pair occupancy have declined at spotted owl sites following the first barred owl detection there. At sites where spotted owls have remained after barred owls were detected, they have both moved farther from their original location and shifted to higher elevations, relative to spotted owl sites without barred owls (Gremel, 2005).

In 2013 we detected barred owls at 32 spotted owl sites, defined here as the area within 800m of the activity centers occupied between 1990 and 2013 (Fig. 5). No barred owl surveys were conducted, and field recordings have not been processed, so this number represents only barred owls encountered incidentally during spotted owl surveys. Barred owls were detected for the first time at one site, and have now been detected at 47 of 52 spotted owl sites (91%) in at least one year of the study, and 42 of 52 spotted owl sites (81%) in the last three years. Without sufficient resources to thoroughly survey all spotted owl sites for barred owls, annual measures of barred owl detection are likely to be poor and probably biased indicators of actual barred owl presence/absence. We consistently find that when we perform surveys using barred owl calls, night-time visits, or field recorders at sites where barred owls were found in the past, barred owls are still present.

**Detection of barred owls at monitored spotted owl sites (N= 52),
Olympic NP, 1992-2013**

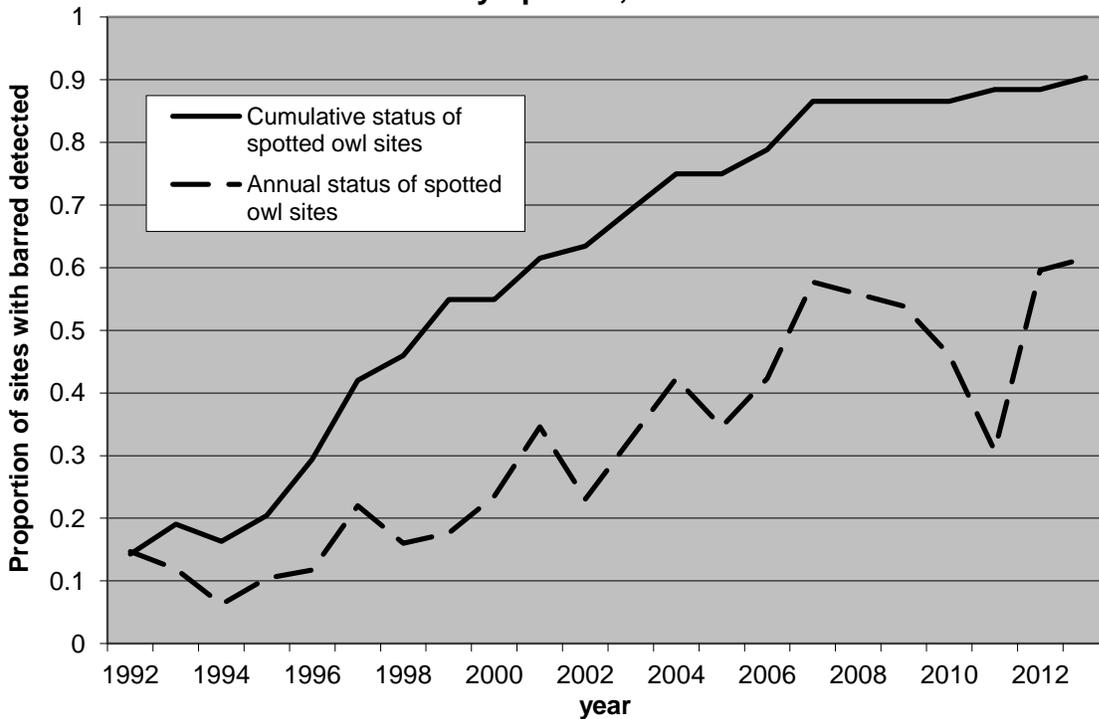


Figure 5. Proportion of monitored spotted owl sites (N=52) with barred owls detected, Olympic N.P., 1992-2013. The solid line is the proportion of sites where barred owls have been detected in any year, and the broken line is the proportion of sites where barred owls were detected in each year during spotted owl monitoring visits.

Spotted owls and barred owls were found within 800m of each other this year at only one of the 11 occupied sites. Seven of the 11 spotted owl sites occupied this year were located greater than 800m from a barred owl detection in any year.

Other Species

In addition to barred and spotted owls, we also record incidental responses by northern goshawks (*Accipiter gentilis*) and great-horned owls (*Bubo virginianus*). The number of occupied goshawk sites encountered during owl monitoring has ranged from 0-6 per year. This year we encountered goshawks at three sites, a pair and two single birds, all on the west side of the park. We detected a great-horned owl at one site.

COOPERATIVE EFFORTS

2009 Spotted Owl Demography Workshop

We participated in the northern spotted owl demographic workshop, held January 2009 in Corvallis, OR. This was the fifth analysis to examine data from the spotted owl demography studies being conducted across the species range. Data from federal lands on the Olympic Peninsula (ONP and Olympic National Forest combined) were analyzed along with those from 10 other demographic studies to estimate age-specific rates of fecundity, survival and population trends across the range of the northern spotted owl. Results of this analysis were published in 2011 (Forsman, et al., 2011).

The rate of fecundity on the Olympic Demographic Study Area was stable and best explained by the tendency of spotted owls to reproduce in alternate years here (even/odd year effect). Annual apparent survival of territorial females declined over time at Olympic, and at nine of the ten other studies, with declines most pronounced for many areas in recent years. The steepest declines in apparent survival were on the three studies in Washington State. Although varying by year, there has been no time trend in annual spotted owl recapture probabilities on the Olympic area, which have generally ranged between 0.6-0.8 (Anthony, et al., 2006).

Range-wide, the decline in numbers of territorial northern spotted owls was estimated to be 2.9% a year. Point estimates for all study indicated declining populations, and there was evidence for a statistically significant population decline at seven of eleven studies, including Olympic. The estimated rate of decline in the Olympic demographic study was 4.3% a year. Overall, it appeared that spotted owl populations in Washington were faring worse than those in Oregon and California.

Northern Spotted Owl Presence/Absence Monitoring

The need for a more extensive survey method, designed to track both population trends and changes in distribution, is a priority for the NPS. Beginning in 2005, these surveys were implemented as part of a long-term landbird monitoring program in the three large national parks in Washington State: Olympic, North Cascades and Mount Rainier. Crews from The Institute for Bird Populations survey randomly located 1.8 km-long transects, using protocols developed for a spotted owl inventory conducted at ONP in the early 1990s. After conducting point counts for landbirds at stations along these transects, surveyors call for spotted owls at five stations located 400 meters apart. Stations are called for 10 minutes and all stations in forested habitat are called, regardless of elevation. These surveys are providing an

inexpensive test of the feasibility and statistical power of implementing a larger scale presence/absence survey.

Overall response rates by spotted owls have been quite low (Appendix 2). One spotted owl was detected during call surveys this year at ONP. Between 2005-2013, surveys in these parks resulted in 7 detections of spotted owls and 31 detections of barred owls on 480 transects.

Other Interagency Activities and Outreach

- Presented talk on the management of barred and spotted owls in Olympic National Park to the Olympic Peninsula Audubon society, May 15, 2013.
- Spoke to Peninsula College Biology class February 4 on issues surrounding spotted owl conservation.
- Was interviewed by a Western Washington University student for a documentary film on the Northwest Forest Plan.
- Provided records of all field visits to the Washington Department of Fish and Wildlife for a state-wide spotted owl database.
- Worked with interagency partners to prepare data for the five year analysis workshop to be held this winter in Corvallis, OR.

BUDGET

All funding was provided by the NPS through the Regional Ecosystem Office of the Northwest Forest Plan. Funding for spotted owl monitoring was provided at the level of \$132,977 in FY 2013. This was a reduction of \$8623.00 (6.09%) from the 2012 budget as a result of across the board federal “sequester” cuts. An additional \$4695.00 was provided to support NPS participation in northern spotted owl recovery planning and other regional projects as needed.

ACKNOWLEDGMENTS

The project is only possible due to the hard work, skill and dedication of the field crew. Declining spotted owl numbers require an increasing number of daylong no response searches in roadless wilderness and often difficult weather conditions. J.S. Busiek, L.H. Graham, S.A. Gremel, J.D. Herndon, A.R. Hokit, T.J. Kay, E.R. Kohler and B.R. Louke performed the fieldwork in 2013. Patti Happe, ONP Wildlife Branch Chief, provided overall project

supervision and administration, T.J. Kay and L.H. Graham assisted with coordination and supervision of the field work, and R.A. Hoffman and K.F. Beirne provided GIS support and analysis. Liz Kelly of the USFWS generously provided the program used to map barred owl locations relative to spotted owl sites.

LITERATURE CITED

- Forsman, E. D., R. G. Anthony, K. M. Dugger, E. M. Glenn, A. B. Franklin, G. C. White, C. J. Schwarz, K. P. Burnham, D. R. Anderson, J. D. Nichols, J. E. Hines, J. B. Lint, R. J. Davis, S. H. Ackers, L. S. Andrews, B. L. Biswell, P. C. Carlson, L. V. Diller, S. A. Gremel, D. R. Herter, J. M. Higley, R. B. Horn, J. A. Reid, J. Rockweit, J. Schaberl, T. J. Snetsinger, and S. G. Sovern. 2011. Population Demography of Northern Spotted Owls. *Studies in Avian Biology* 40.
- Dark, S.J., R.J. Gutierrez, and G.I.J. Gould. 1998. The barred owl (*Strix varia*) invasion in California. *The Auk* 115(1):50-56.
- Forsman, E.D., R.G. Anthony, J.A. Reid, P.J. Loschl, S.G. Sovern, M. Taylor, B.L Biswell, A. Ellingson, E.C. Meslow, G. S. Miller, K.A. Swindle, J.A. Thrailkill, F.F. Wagner, and D.E. Seaman. 2002. Natal and breeding dispersal of northern spotted owls. *Wildl. Monog.* 149.
- Franklin, A.B., D.R. Anderson, E.D. Forsman, K.B. Burnham, and F.W. Wagner. 1996. Methods for collecting and analyzing demographic data on the northern spotted owl. *Studies in Avian Biology* 17:12-20.
- Franklin, A.B., K.P. Burnham, G.C. White, R.G. Anthony, E.D. Forsman, C. Schwarz, J.D. Nichols and J. Hines. 1999. Range-wide status and trends in northern spotted owl populations. Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, Corvallis, OR.
- Gremel, S.A. 2005. Factors controlling distribution and demography of northern spotted owls in a reserved landscape. MS thesis, University of Washington, Seattle, WA.
- Hamer, T.E. 1988. Home range size of the northern barred owl and northern spotted owl in western Washington. MS Thesis, Western Washington University, Bellingham, WA.
- Hamer, T.E., E.D. Forsman, A.D. Fuchs, and M.L. Walters. 1994. Hybridization between barred and spotted owls. *The Auk* 111(2):487-492.

- Herter, D.H. and L.L. Hicks. 2000. Barred owl and spotted owl populations and habitat in the central Cascade Range of Washington. *J. Raptor Res.* 34(4):279-286.
- Kelly, E.G. 2001. The range expansion of the Northern Barred Owl: An evaluation of the impact on Spotted Owls. MS Thesis, Oregon State University, Corvallis, OR.
- Kelly, E.G. and E.D. Forsman. 2004. Recent records of hybridization between barred owls and northern spotted owls. *The Auk* 121(3):806-810.
- Western Regional Climate Center, 2012. Cooperative Climatological Data Summaries. Available at: <http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wa2548> (accessed 1 August, 2013)
- National Water and Climate Center, 2012. SNOTEL Data & Products. Available online: <http://www.wcc.nrcs.usda.gov/snotel/Washington/washington.html> (accessed 1 August, 2013).
- Seaman, D.E., S.A. Gremel, S.L. Roberts, and D.W. Smith. 1996. Spotted owl inventory-monitoring in Olympic National Park, final report. Unpubl. NPS report, 34 pp.
- Sharpe, D.U. 1989. Range extension of the barred owl in western Washington and first breeding record on the Olympic Peninsula. *J. Raptor. Res.* 23(4): 179-180.

APPENDIX 1- Nest Success

Nesting status and success rate of female spotted owls of all age classes, at monitored sites in Olympic National Park, 1992-2013.

	Non-nesting	Nesting	Unknown nest status	Total females	Proportion nest status known	Proportion females nesting	Nest success ¹
1992	1	15	7	23	0.70	0.94	0.93
1993	16		5	21	0.76	0	*
1994	3	24	7	34	0.79	0.89	0.92
1995	15		6	21	0.71	0	*
1996	5	28	3	36	0.92	0.85	0.92
1997	15	8	6	29	0.79	0.35	0.75
1998	1	24	5	30	0.83	0.96	0.91
1999	9		5	14	0.64	0	*
2000	17	10	4	31	0.87	0.37	0.56
2001	16	8	4	28	0.86	0.33	1.00
2002	3	27		30	1.00	0.90	0.92
2003	23		2	25	0.92	0	*
2004	2	21	4	27	0.85	0.91	0.95
2005	20	1	3	24	0.88	0.05	1.00
2006	1	16	2	19	0.89	0.94	0.94
2007	13		1	14	0.93	0	*
2008	1	16	2	19	0.89	0.94	0.94
2009	8		1	9	0.89	0	*
2010	4	14		18	1.00	0.78	0.93
2011	5		1	6	0.83	0	*
2012	2	7	2	11	0.82	0.78	1.00
2013	3		1	4	0.75	0	*
Total²	183	219	71	473	0.84	0.45	0.91

¹ Proportion of nest attempts that result in at least one fledgling, calculated on nests with known outcomes

² Where totals are calculated on proportions, they are the unweighted averages of the annual means

APPENDIX 2- IBP Owl Survey Results

Results of presence/absence owl surveys performed by The Institute for Bird Populations' landbird monitoring crews. This includes barred and spotted owls detected at or associated with owl calling stations, as well as incidental detections outside of formal survey or while conducting point counts. Multiple owls at a point are recorded as a single detection.

Year	National Park	Transects Called	Stations Called	Barred Owl Detections			Spotted Owl Detections		
				At Stations	Between Stations	Incidental	At Stations	Between Stations	Incidental
2005	Mt. Rainier	9	40	0	1	0	0	0	0
	N. Cascades	11	53	0	0	0	0	0	0
	Olympic	8	34	0	0	0	0	0	1
2006	N. Cascades	12	57	1	1	0	1	0	0
	Olympic	10	44	3	0	0	1	0	0
2007	Mt. Rainier	19	114	0	1	1	0	0	0
	N. Cascades	22	104	2	1	2	0	0	0
	Olympic	21	95	0	0	0	0	0	0
2008	Mt. Rainier	20	94	1	1	0	0	0	0
	N. Cascades	20	96	3	0	0	0	0	0
	Olympic	21	95	0	0	3	1	1	0
2009	Mt. Rainier	16	69	1	0	0	0	0	0
	N. Cascades	23	97	0	0	0	0	0	0
	Olympic	22	91	2	0	2	1	0	1
2010	Mt. Rainier	17	74	1	0	0	0	0	0
	N. Cascades	19	80	1	0	0	0	0	0
	Olympic	22	95	0	0	1	1	0	0
2011	Mt. Rainier	12	50	1	1	1	0	0	0
	N. Cascades	21	101	2	0	1	0	0	0
	Olympic	20	93	0	0	4	0	0	0
2012	Mt. Rainier	20	99	1	0	0	0	0	0
	N. Cascades	24	114	4	0	3	0	0	0
	Olympic	24	114	0	0	2	0	0	0
2013	Mt. Rainier	19	85	1	0	0	0	0	0
	N. Cascades	23	104	0	0	6	0	0	0
	Olympic	24	116	1	0	0	1	0	0