

SPOTTED OWL MONITORING IN OLYMPIC NATIONAL PARK: 2011 ANNUAL REPORT



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Cover Photograph: Adult northern spotted owl near Deception Creek in the Dosewallips River Valley.

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EXECUTIVE SUMMARY

This report summarizes progress on the northern spotted owl (*Strix occidentalis caurina*) monitoring program in Olympic National Park in 2011. 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.

National Park Service personnel monitored and managed data on a sample of 52 spotted owl territories (hereafter “sites”) in 2011 to determine their occupancy and reproductive status. Five sites were occupied by spotted owl pairs, and eight by single spotted owls, the lowest number of owls detected in any year of this study. We documented no nesting attempts. One new adult spotted owl was banded. At sites where any spotted owls responded in 2011, they were found on an average of 35% of monitoring visits, an unusually low rate of that suggests we were less effective than average at locating spotted owls when they were actually present. Rates of detection were similarly low in 1999, another year with near record snowpack, and may be a result of changes in behavior or site fidelity related to the extreme weather conditions. Still there has been no overall trend in the per visit detection rate over time, and the drop in numbers of spotted owls detected over the course of the study represents a real decline in the number of individuals on our study area.

Data collected 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.

Barred owls (*Strix varia*) were first documented on the Olympic Peninsula in 1985, and competition with this species is now the primary threat to the conservation of spotted owls in protected areas. Barred owls have been detected within 800 meters of 88% of monitored spotted owl sites in Olympic National Park. Although barred owls now occupy all or part of most spotted owl territories here, only one occupied spotted owl activity center was found within 800 meters of a barred owl detected this year, and none of the remaining spotted owls were found within 800 m of any previous barred owl detection. Occupancy of spotted owl sites has declined significantly following the first detection of barred owls in the area. Spotted owl territories which have remained occupied following detections of barred owls have both moved farther and increased in elevation relative to sites where barred owls are absent. Extensive areas of Olympic National Park that formerly supported spotted owls, including much of the western Olympics, now appear to support only barred owls. Most remaining spotted owls are found on steep, well-drained sites above 2000' elevation.

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 marked precipitation gradient from rainforest valleys in the southwest to rainshadow areas in the northeast, resulting in two very different strata (hereafter east- and west-side). 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) territories monitored by National Park Service crews in Olympic National Park and 45 territories monitored by U.S. Forest Service Pacific Northwest Research Station (PNW) crews in the surrounding Olympic National Forest. 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. We have continued to monitor sites regardless of their occupancy status and have also tried to keep them well distributed throughout the park, although we monitor fewer sites on the park's west side due to the lower density of spotted owls there. 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 2011 breeding season. It is intended as a summary of results for administrators and cooperators, but does not present detailed methodologies or data analysis. Methods are described in Franklin et al. (1996).

Results from the PNW administered portion of the Olympic Peninsula study will be posted 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.

2011 RESULTS

General Monitoring and Site Status

The project employed six full-time biological technicians, one Student Conservation Association intern, and the project lead. Crews made 242 visits to 54 monitored spotted owl sites (Figure 1). The mean number of visits per site was 4.5 (range 1-9). 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 (90%) 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. The full field crew (4-5 one or two-person teams) visited owl sites between March 29 and July 12, with some additional work continuing through August.

La Nina conditions dominated the weather in late winter, and by the beginning of April Olympic snowpack was 180% of normal (NRCS data). April through June brought little relief, with near-record cold and wet conditions across the region. For the entire field season, precipitation was recorded on 38% of site visits, in the form of heavy rain (10%), light rain (19%) or snow/hail (9%). Snowpack actually increased into May, and combined with low rates of melting led to snow water equivalents of over 400% of average by June 1. By the end of April, when we have often made at least one visit to all monitored sites, we had still not

reached 10 sites. Many locations below 2500' elevation still had four to six feet of unconsolidated fresh snow at this time. Five sites were not visited until after June 1.

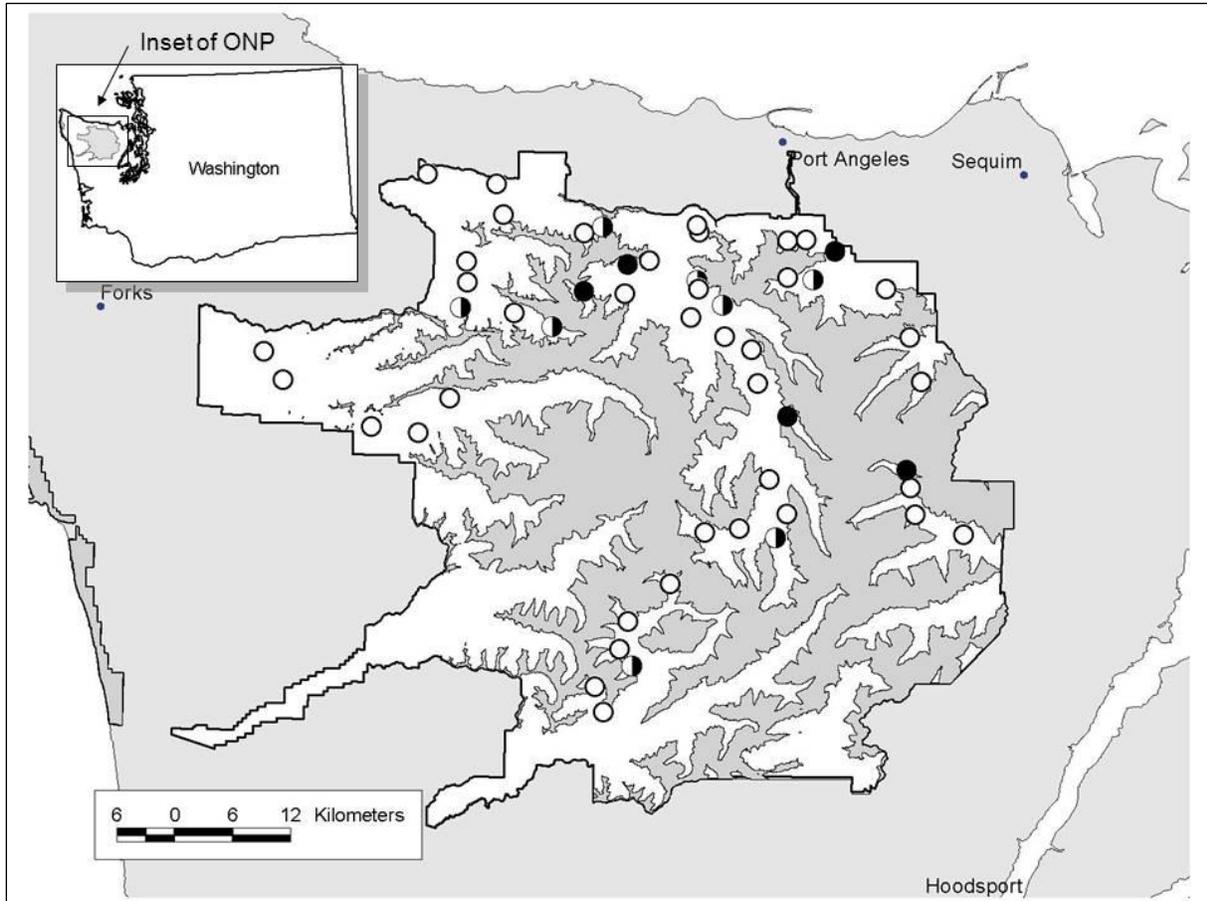


Figure 1. Location and occupancy status of 52 monitored spotted owl territories in Olympic National Park, 2011. Black dots are spotted owl pairs, half-filled circles are single owls and white circles are monitored sites with no response. Shaded area within the park boundary is high elevation non-habitat.

In addition to the weather, access issues included the continued closure of the Dosewallips Road, which added 5.5 miles to the approach hike at four sites, and road washouts in the Elwha Valley that necessitated using a shared shuttle vehicle to access trailheads for 13 monitored sites.

One or more spotted owls were detected at 13 (25%) of the monitored sites and pairs were detected at five of these (Figure 2). While the sites where spotted owls are located change somewhat from year to year, there are now 20 sites where no spotted owls have been detected for five or more years. We detected 18 spotted owls, of which 11 were males, six were females, and one was of unknown sex. Of this population, 15 were adults three years of age or older, one was a subadult either one or two years old and two were of unknown age.

Three of the territorial owls detected this year were of known age (range 3-7 years) as a result of initial capture as juveniles or subadults.

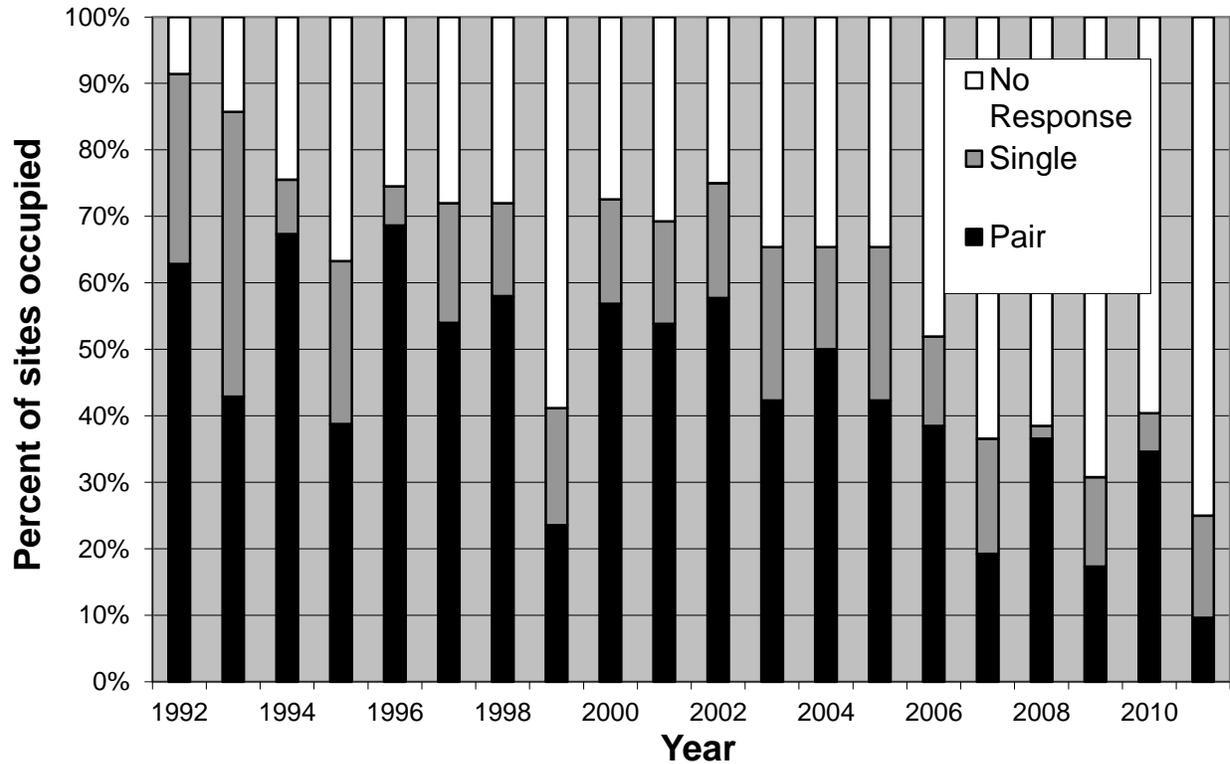


Figure 2. Percent of monitored spotted owl sites occupied by 0, 1, or 2 adult owls, Olympic National Park, 1992-2011.

These overall counts are the lowest since monitoring began here, and are probably due to both the steady decline in the number of owls occupying the study area and an unusually low detection rate because of the extreme weather conditions. In 1999, when snow conditions were most similar to this year, the annual recapture rate for banded owls dropped to 33%, less than half of the long-term average. While we cannot calculate the recapture rate for 2011, the per visit detection rate at sites known to be occupied this year provides another measure of our effectiveness at locating spotted owls. This rate, which usually averages around 60%, was only 35% this year, suggesting that spotted owls were more difficult to detect than usual. This could be due to behavioral differences, less frequent occupancy of the usual activity centers where we survey, or less effective surveys due to poor access.

The 52 spotted owl sites monitored in 2011 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 was 19.4 years (range 16-20), not including years prior to 1992 when monitoring to current protocols began at most sites.

When calculated for a fixed sample of spotted owl sites monitored from 1994-2011 ($N = 49$), the mean elevation of occupied sites has increased 760' to 2885'. This year there were no activity centers located below 2150' elevation. 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). However, in this landscape the steep, dry sites where spotted owls remain tend to occur at higher elevations. It is likely that all of these topographic variables are simply correlates for barred owl occupancy (see later section). Regardless of which factors are responsible, spotted owl distribution in the Olympics has changed radically over the course of this study. Remaining spotted owls are increasingly restricted to the drier north and east Olympics, where they persist on sites with steep slopes at higher elevations, often in headwaters and side drainages.

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 five of six female spotted owls on monitored territories and none attempted to nest. Although there is no evidence that the rate of fecundity has declined over time, 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). 2011 was the seventh year of the study where no successful reproduction was documented. The high year-to-year variation in female 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 averages 90% (Appendix 1).

The mean annual fecundity rate for adult female spotted owls in ONP ($N = 20$ years) was 0.34 (SE 0.074); the estimate for adult females over the range of the northern spotted owl was 0.33 (SE 0.025) (Forsman, et al., 2011).

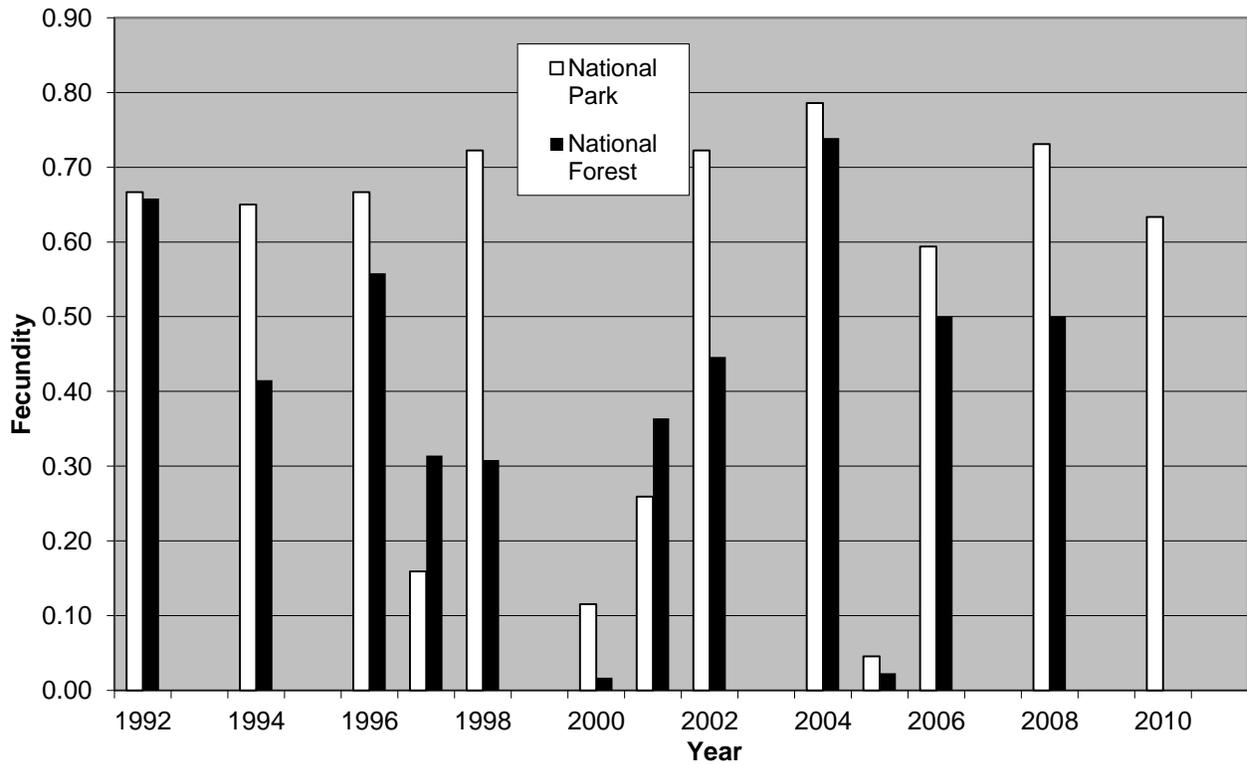


Figure 3. Olympic Peninsula adult spotted owl fecundity (mean # of female offspring/territorial female), 1992-2011. Includes both National Park (white bars) and National Forest (black bars). No young have fledged from monitored sites on the National Forest since 2008.

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 one spotted owl in 2011. Of the 18 spotted owls detected, we confirmed bands on 14 (78%). Two responses were audio only, and two owls were either unbanded or bands could not be identified and the owls could not be captured. Park crews have performed 502 captures and banded 381 spotted owls since 1988.

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 172 spotted owls banded as juveniles by ONP crews prior to 2011 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).

Barred owls are generally more wary of humans and appear to be less responsive to our survey efforts than spotted owls. Most biases associated with our incidental data on barred owl occupancy, reproductive status and rate of increase 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. Consequently, our estimates of barred owl pair and reproductive status should be considered minimum estimates of these values, and are useful only as indices for comparison among years.

We recorded barred owls on 41 separate occasions representing an estimated 28 barred owl territories during spotted owl surveys in 2011. Additional detections resulting from calling for barred owls (4 detections, 3 additional sites) and acoustic monitoring devices (2 detections, 1 additional site) are not included in this total, so as not to bias comparisons of barred owl detections with previous years when these methods were not used. 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 (Fig. 4). The annual rate of increase in this index, calculated from the log of the slope from 1992-2011, was 12.5 % a year.

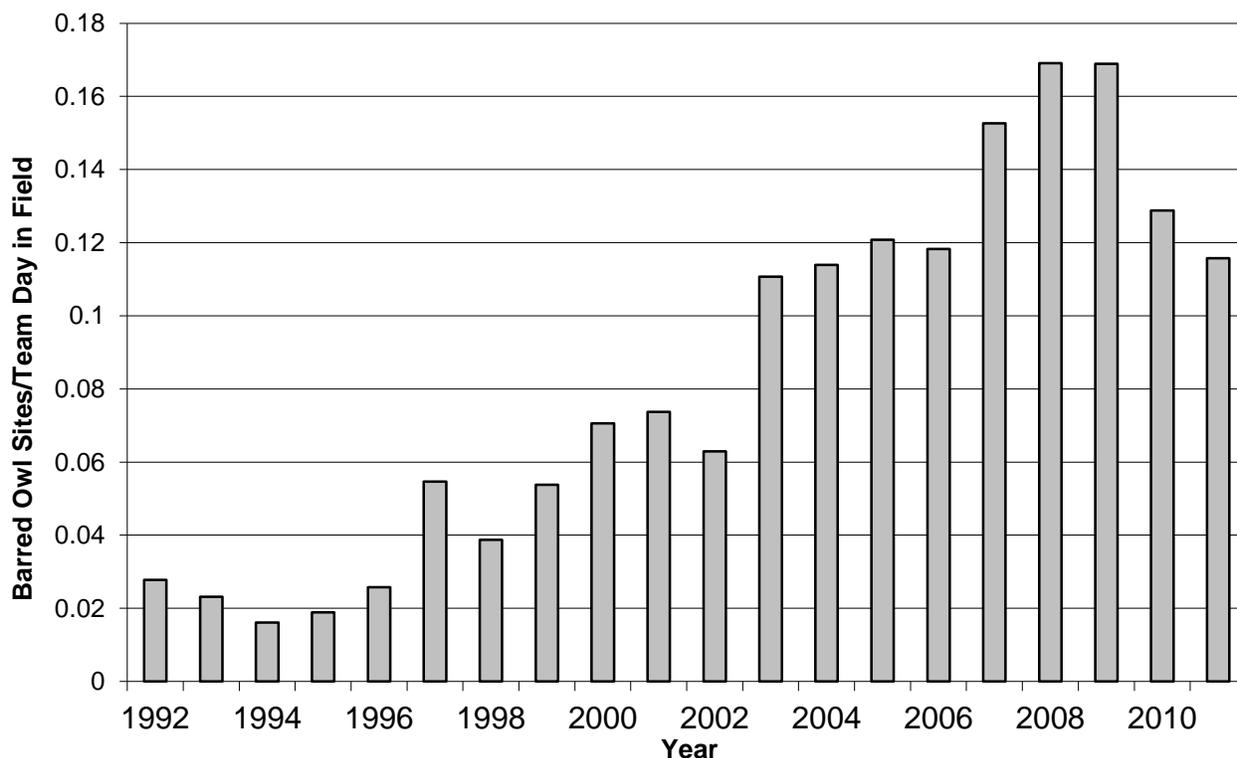


Figure 4. *Number of occupied barred owl sites detected, standardized by survey effort, Olympic National Park, 1992-2011. Excludes sites detected as a result of using barred owl calls, radio-telemetry, or acoustic monitoring devices.*

When considering barred owls detected by all methods, 16 barred owl pairs and 16 single barred owls were detected. One of these was a new territory, bringing the total number of sites where we have detected barred owls to 100. This is not a complete count, only the number of territories where barred owls have been detected that also fall in regions of the park covered by the spotted owl monitoring program. We documented nesting by barred owls at four sites, fledging a minimum of four juveniles. 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). We have confirmed two hybrids in the park, a male and a female, both paired with barred owls inhabiting former spotted owl activity centers. Neither of these banded birds were located this year. A possible additional hybrid was heard once this season but was not relocated for visual confirmation.

Morse Creek Barred Owl Study

We conducted a fifth year of work on a 7000-acre study area in the Morse Creek drainage, where we are monitoring density and space use by barred owls. The area was selected for its combination of both year-round road and trail access and the history of monitoring at all known spotted owl sites. Although we did not receive funding to radio-mark all barred and spotted owls or to continue landscape scale density surveys, we have continued demographic monitoring of the spotted owls in the area and a pilot barred owl radio-telemetry project.

We located one pair and one single spotted owl at five monitored sites in 2011. Surveys prior to 2008 located five pairs of barred owls in this area and we successfully installed backpack radios on one member of each known pair (Table 1). We have had good capture success using a barred owl decoy, taped calls and mist net in early spring, capturing at least one barred owl on nine of ten attempts when they responded. The last radio died this spring, and we did not re-survey for study area for barred owls.

Table 1 : Radio-marked barred owl summary data

Site Name	Sex	Radio on	Radio off (Cause)	Locations
Morse Cr. Flats	F	3/18/08	4/28/10 (battery)	84
Lake Cr. Flats	F	3/12/09	2/2/11 (battery)	79
Lake Dawn	M	3/20/08	3/26/10 (battery)	84
Cox Valley	F	3/22/08	1/29/10 (battery)	75
Ennis Creek	F	3/27/08	12/6/08 (mortality)	34

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).

**Detection of barred owls at monitored spotted owl sites (N= 52),
Olympic NP, 1992-2011**

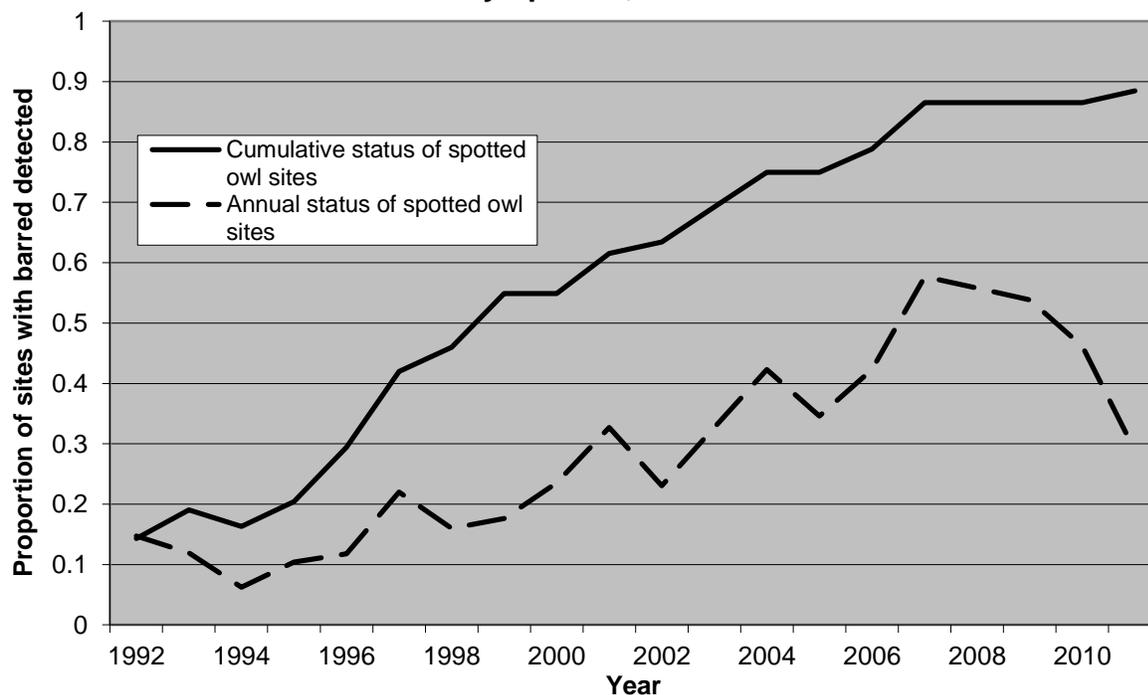


Figure 5. Proportion of monitored spotted owl sites (N=52) with barred owls detected, Olympic N.P., 1992-2011. A spotted owl site is defined as the area within 800m of the activity centers occupied between 1990 and 2011. The solid line is the proportion of sites that have ever had a barred owl detected in this area, the broken line is the annual proportion of sites where barred owls were detected.

Barred owls have now been detected at 46 of 52 monitored spotted owl sites (Fig. 5). In 2011 we detected barred owls within 800 m of 15 monitored spotted owl sites in the course of demographic monitoring, and one of these was a site where the species had not been previously found. Over the last three years (2009-2011), we located barred owls on spotted owl surveys at 38 of the 46 sites where they have ever been detected. Using both barred owl calls and field recorders, we surveyed two of the eight remaining sites without recent barred owl detections and located barred owls at both.

Only one of the 13 occupied spotted owl activity centers was located within 800m of a barred owl detection this year. The 12 remaining activity centers, including all five pairs, were located greater than 800m from any barred owl detections in this or any prior years

We are unsure of the causes of the decline in annual detections of barred owls over the last several years, but consistently find that when we focus surveys using barred owl calls, night-time visits or field recorders on sites where barred owls were found in the past, barred owls are still present. Without sufficient resources to thoroughly survey all spotted owl sites for

barred owls in this way, we believe that annual measures of barred owl detection are poor and biased indicators of actual barred owl presence/absence at these sites. This is due to both the logistics of spotted owl monitoring visits which focus on recent spotted owl locations and probably also low daytime detection rates for barred owls.

Data from ONP suggest that spotted owls are absent from areas occupied by barred owls rather than remaining and going undetected for many years. Although varying by year, there has been no time trend in annual spotted owl recapture probabilities, which have generally ranged between 0.6-0.8 (Anthony, et al., 2006), or per visit detection rate, which has averaged 0.6 over 20 years of monitoring (ONP, unpub. data). While some data suggest that spotted owls are less vocal in the presence of barred owls (Crozier et al., 2006), we frequently detect owls on daytime visits whether or not they vocalize. Since we began recording the information in 2004, 43% of initial spotted owl detections have been visual, often as a result of owls flying in to surveyors, or surveyors investigating mobbing songbirds. We also locate spotted owl roosts by sign including pellets, whitewash, or feathers which can direct searchers to roosting owls, or in the case of some feathers, identify the species occupying a site.

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 five sites, but found no evidence of nesting. We detected great-horned owls at two sites.

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 this year (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.

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 estimate 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 (Table 2). 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

Table 2: 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.

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

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. Final data from 2011 are not available, but no spotted owls were detected by IBP crews this year. Between 2005-2010, surveys in these parks detected 6 spotted owls and 20 barred owls on 292 transects.

Other Interagency Activities

- Served as NPS representative on the Northern Spotted Owl Recovery Plan Implementation Team and Barred Owl Working Group (Gremel).
- Provided records of all field visits and annual site summary information to the Washington Department of Fish and Wildlife for a state-wide spotted owl database.
- Supplied northern goshawk location data to Washington Department of Fish and Wildlife for a study of the genetics of that species in the Olympics.

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 \$141,600 in FY 2011. An additional \$5000 was provided to support NPS participation in northern spotted owl recovery planning and the barred owl workgroup.

ACKNOWLEDGMENTS

The project is only possible due to the hard work, skill and dedication of the field crew. Declining spotted owl numbers have required an increasing number of daylong no response searches in roadless wilderness and often difficult weather conditions. A.R. Bruner, J.S. Busiek, A.E. Farris, L.H. Graham, C.R. Grattan, S.A. Gremel, K.M. Harrigan, T.J. Kay, J.V. Lombardi, and M.E. Salvadalena performed the fieldwork in 2011. Patti Happe, ONP Wildlife Branch Chief, provided overall project supervision and administration, T.J. Kay 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.

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APPENDIX 1

Nesting status and success rate of female spotted owls of all age classes, at monitored sites in Olympic National Park, 1992-2011.

	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		3	26	0.88	0	*
2004	2	22	4	28	0.86	0.92	0.95
2005	20	1	3	24	0.88	0.05	1.00
2006	1	17	2	20	0.90	0.94	0.94
2007	13		1	14	0.93	0	*
2008	1	16	2	19	0.89	0.94	0.94
2009	8		2	10	0.80	0	*
2010	3	14	1	18	0.94	0.82	0.93
2011	5		1	6	0.83	0	*
Total ²	177	214	71	462	0.84	0.46	0.90

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