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Wildlife Ecology Team
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Study:

Demographic characteristics of spotted owls (*Strix occidentalis*) on the Olympic Peninsula Study Area, Washington, 1987-2008.

Principal Investigator(s) and Organization(s):

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Study Objectives:

The objectives of this study are to elucidate the population ecology of the northern spotted owl (*Strix occidentalis caurina*) on Forest Service lands on the Olympic Peninsula, Washington, to include estimates of population age structure, reproductive rates, survival rates, and population trends and to document changes in barred owl (*Strix varia*) detections within the study area.

Potential Benefit or Utility of the Study:

The Olympic Peninsula Demographic Study was designed to monitor vital rates and population trends of spotted owls. We have attempted to band all known fledglings produced in the study area since 1987. As a result, we know the origin and ages of most individuals recruited into the population, and have accumulated detailed information on population age structure and internal and external recruitment in the study area. During a regional meta-analysis, these data are used to make inferences regarding detection probabilities, survival rates, habitat suitability and the effects of different landscape conditions on the rates of population changes in spotted owl populations (Forsman et al. 1996, Franklin et al 1999, Anthony et al. 2006).

Study Area and Methods

The Olympic Peninsula Demographic Study is comprised of data collected by the Pacific Northwest Research Station (PNW) on Olympic National Forest lands and data collected by the National Park Service on the Olympic National Park (Gremel 2008). This study is one of eight long-term demographic studies that constitute the federal monitoring program for the northern spotted owl under the Effectiveness Monitoring Program of the Northwest Forest Plan (Lint et al. 1999). Information from the Olympic Peninsula Study Area has been used to assess the status of the owl population in this province, and when combined with data from the other monitoring areas in Washington,

Oregon, and California, is used to assess range-wide trends in the spotted owl population (Forsman et al. 1996, Franklin et al. 1999, Anthony et al. 2006). The most recent published range-wide meta-analysis was conducted in January 2004. Estimates of survival rates and population trends from this analysis were described in the Wildlife Monograph, "Status and Trends in Demography of northern spotted owls, 1985-2003" (Anthony et al. 2006). A reassessment of the demographic data for this species using an additional five years of data is underway and a report is scheduled for release in summer 2009.

Changes in sampling effort: In 2006, the Effectiveness Monitoring Program reduced funding for the PNW portion of the Olympic study resulting in a reduction in the number of areas surveyed from 95 to approximately 44 historic owl territories on the national forest. The sites were selected from the northern half of our original study area and sites selected were those that had the longest continuous survey histories in this portion of the study area whether they were currently occupied or not. Survey responsibility for 2 of these sites was transferred to the Olympic National Park because the current core areas are primarily within the park boundary. However, PNW continues to manage these data. Results provided in this report, including all tables reflect this change in sampling effort for the 2006 field season onward.

The current Olympic Peninsula Study Area included 2228 km² of owl habitat of which approximately 948 km² are principally on public lands administered by the Olympic National Forest (Figure 1). Prior to the establishment of the Northwest Forest Plan in 1994, the national forest within the study area was managed with a primary emphasis on timber production. Subsequent to the adoption of the Northwest Forest Plan, most of the area within the national forest was designated as a Late-Successional Reserve in which the primary objective is to manage for old forest conditions.

Historic owl territories (hereafter "sites") within the study areas are surveyed each year using standardized protocols (Franklin et al. 1996). Monitored sites are surveyed a minimum of 3 times each year to determine if the site is occupied by spotted owls and to determine nesting status and numbers of young produced by each pair of owls. All owls detected within the study area are color-banded with unique bands so that they can be resighted and identified each year without recapture.

Methods used in this study and other demographic studies of spotted owls have been described in a variety of published sources (e.g., Forsman 1983, Franklin et al. 1990, Franklin 1992, Franklin et al. 1999, Reid et al. 1999). Protocols used for determination of reproductive parameters were described in Lint et al. (1999). Sightings and recaptures of previously banded owls are used to estimate survival rates (Pollock et al. 1990, Burnham et al. 1996).

2008 Research Accomplishments:

Number of Areas Where Owls Were Located

During the 2008 field season, we conducted 206 site visits to 48 owl territories (mean = 4.3 visits per site, range 2–8). Twenty-six of these territories are on the eastern slope of

the Olympic Mountains along the north end of the Hood Canal and the remaining sites are on the northwest corner of the peninsula near Forks (Table 1, Figure 1). We confirmed 24 non-juvenile spotted owls (22 adults, 2 undetermined age; Table 2). Of the 48 sites we monitored, 33 (69%) had no responses from spotted owls, 9 (19%) were occupied by pairs, 3 (6%) were occupied by resident single owls and 3 “floaters” were detected (Table 3). The pattern of territory occupancy on the study area indicates a gradual decline in the number of occupied sites from 1990-2006 (Figure 2, Table 3). The decline seems most severe in low elevation areas on the west side of the peninsula on the former Quinault and Soleduck Ranger Districts.

Number of Owls Marked

We confirmed the identity of 17 spotted owls in 2008 based on their color bands and banded 5 new territorial owls. Eleven fledglings were detected and banded in 2008. The newly captured birds bring the total number of owls banded on the study area by PNW biologists in 1987–2008 to 917 birds, including 360 individuals first banded as adults (birds > 2 years old), 76 birds banded as sub-adults, and 481 banded as juveniles (Figure 3, Table 4). In addition, 4 adult barred owls have been banded during the study.

Reproduction

The 2007-08 winter snow pack was over 130% of normal and the accumulation prevented early access to many owl site centers in the spring of 2008. This delay in visiting sites disrupted our sampling schedule and lowered the sample size used to estimate the proportion of females nesting. The proportion nesting is calculated for females whose nesting status has been determined by 15 June. This means that the 2008 estimate of the proportion of the population that nested is probably an underestimate because we were unable to locate and determine nesting status by the cutoff date. However, this year nesting status was determined for only 4 of the 9 territorial females by 15 June and 2 of the 4 females nested (0.50; 95% CI. 0.01– 0.94).

The proportion of females that produced young was 0.78 (95% CI. 0.31– 0.98) which was well above average. Mean brood size for females that produced young was 1.28 ± 0.22 . The annual variation in the proportions of females producing young in 2005–2008 illustrates the extreme annual fluctuation in reproduction on the Olympic Peninsula (Figure 4, Table 5). The proportion of females producing in 2005 was the lowest non-zero year in the history of the study while 2008 is the 2nd highest (Figure 4, Tables 5-6). Over the course of the study, reproduction has followed a boom and bust pattern. In the 22 years from 1987–2008 there were 9 years with high reproductive rates (1989, 1990, 1992, 1994, 1996, 2002, 2004, 2006, 2008), 5 years with low-to-moderate reproduction (1988, 1991, 1997, 1998, 2001), and 8 years in which few or no owls nested (1987, 1993, 1995, 1999, 2000, 2003, 2005, 2007) (Table 5). On average over the course of the study 43 % (SE= 7.0%) of females on the Olympic study areas nested and 36 % (SE = 6.0%) produced young (Table 5).

We estimated fecundity as the number of female young produced per territorial female, assuming a 50:50 sex ratio of nestlings. Fecundity in 2008 on the national forest was

0.61±0.14 (N=9) above the 22-year average (0.27±0.09) (Figure 5, Table 6). The high among-year variation in reproductive rates that we observed is typical of Spotted Owls (Forsman et al. 1984, Franklin et al. 1999). However, in contrast to some other study areas, high and low reproductive years on the Olympic Study Area did not consistently follow an alternate year pattern. For example, there were consecutive years with low reproduction in 1987-1988 and 1999-2000 (Tables 4-5). In addition, the Olympic Study Area differed from most other study areas in having occasional years when no females nested (1993, 1995, 1999, 2003, 2007). Even in the worst years, most other study areas had at least a few females that nested (Anthony et al. 2006).

Barred Owl Detections

We did not specifically survey for barred owls on the study area, but all barred owls detected during spotted owl surveys were recorded and mapped. During 1987–2008, we recorded 476 barred owl detections, including 35 during the 2008 field season (Figures 6–7). Although the number of barred owl detections in 2008 was slightly higher than the 20-year mean (21.7, SE=3.42), the results are not directly comparable with previous years because we surveyed fewer areas in 2006-08 than in early years. However, the trend from 2006-2008 (Figure 6) suggests that barred owl numbers particularly in the Quilcene area are catching up with the numbers of barred owl detections we had in the Quinault area early in the study

To compare the intensity of barred owl activity between spotted owl site centers; we summarized the numbers of barred owl detections within 1000 m of the combined annual site centers¹ for each spotted owl territory as an index. By using this distance-based index, the number of barred owls detections at a given site could be lower or higher than the number recorded during surveys for a particular site because barred owl detections on an adjacent site would be included in the index if the detection was within the 1000 m limit.

Our index of the percentage of spotted owl territories having barred owl detections has steadily grown from less than 10 percent of territories surveyed in 1990 to a high of 40 % in 2008 (Figure 8). Barred owl detection rates on the northern sites that we are currently monitoring have lagged behind detection within the Olympic National Park (Figure 8). Using our detection within 1000 m of a site center index, the park's detection rate has averaged approximately 2.4 times higher than for National Forest.

¹The combined annual site center 1000 m polygons were created by buffering all yearly site centers of a given spotted owl territory by a distance of 1000 m. This process produced a non-circular area that included all areas within 1000 m of all of the annual site centers at each owl territory.

Discussion

The analysis conducted by Anthony et al. (2006) estimated λ_{RJS} for the spotted owl population on the Olympic Peninsula at 0.956 (se 0.032). This estimate suggested a population decline of 4.4% per year on the Olympic Peninsula and is in close agreement with the count data, which suggests that 63% of the historical owl territories in the study area became unoccupied between 1990 and 2005. In the subset of sites sampled in the northern half of the original study area on the Olympic National Forest during 2006-08, the count data suggests that 65 -75% of the historical owl territories were unoccupied.

The fecundity rate in 2008 was higher than the 21 year average for the subset of owl sites that we sampled. The 2008 fecundity rates for adult females on our study were also comparable (0.63 ± 0.16 , N=8 vs. 0.67 ± 0.08 , N=15) to those on the adjacent Olympic National Park study area (Gremel 2008). This high year-to-year variation in fecundity has mostly been a function of the proportion of the population attempting to nest rather than nest failure rates over the duration of the study. We suspect that the extreme annual fluctuation in reproduction on the Peninsula is the result of fluctuations in prey biomass or weather, or both, but there are no long-term data on prey populations on the Peninsula, so a test of the prey hypothesis is not possible.

Problems Encountered

A larger than normal accumulation of snow in 2008 added to the normal problems with road closures, reduced road maintenance, winter blow-down, and loss of bridges on the trail system that continue to reduce access to many sites. We now access many areas on foot that used to be accessible by road. These access issues make it a challenge to complete the annual surveys within the protocol's timeline using just two field biologists.

There were no accidents, no owls were injured during capture and banding, and communication and coordination with our cooperators at the Olympic National Forest, Olympic National Park, and Washington Department of Natural Resources was excellent.

Publications, Presentations and Technology Transfer Completed in FY 2007-08:

Publications:

Funk, W. C., E.D. Forsman, T.D. Mullins, S. M. Haig. 2008. Introgression and dispersal among spotted owl (*Strix occidentalis*) subspecies. *Evolutionary Applications* 1: 161-171.

Funk, W. C, T. D. Mullins, E.D. Forsman, S. M. Haig. 2007. Microsatellite loci for distinguishing spotted owls (*Strix occidentalis*), barred owls (*Strix varia*), and their hybrids. *Molecular Ecology Notes*. 7: 284-286.

Technology Transfer Activities

- a. Detailed summaries of survey results and current occupancy and reproductive status determinations provided to the Olympic National Forest's biologists for project planning purposes.
- b. Summaries and copies of all survey forms showing current occupancy and reproductive status determinations were provided to the Washington Department of Fish and Wildlife.
- c. We provided Washington Department of Transportation's biologist current occupancy and reproductive status information on selected owl sites for environmental assessments of transportation projects on the Olympic Peninsula.
- d. Selected demographic data were shared with various other federal, state, and private timber organizations for their management activities.
- e. Compiled captures histories and occupancy data from the Olympic National Park and Olympic National Forest for use in a cooperative study with K. Dugger and R. Anthony at the Oregon State University Cooperative Wildlife Research Unit.
- f. Contributed spotted owl movement data from the Olympic Peninsula study area for a new analysis of spotted owl movements. M. Johnson and S. Haig, USGS, Corvallis, OR

Duration of the Study:

- a. Initiated in FY 1987.
- b. Contingent upon future funding. This project is part of the long-term northern spotted owl Effectiveness Monitoring Program for the Northwest Forest Plan (Lint et al. 1999) and currently funded through fiscal year 2009.

Acknowledgments

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Table 1. Total number of spotted owl territories surveyed and number of owl pairs, young fledged, and young banded on the Olympic National Forest Study Areas, in 2008.

Study Area	Survey area location (Eastside vs. Westside)	Total number of territories surveyed	Number of occupied territories	Number of territories with owl pairs	Number of young fledged	Number of young banded
Quilcene	East	26	5	4	5	5
Soleduck	West	22	8	5	6	6
Totals		48	13	10	11	11

Table 2. Number of non-juvenile spotted owls detected per year in the Olympic Peninsula Study Area, 1987– 2008. Counts were limited to a subset of owl territories on Forest Service lands that were surveyed most consistently. Age codes indicate adult, subadult, or owls with age unknown.

Year	Number of owl territories	Males			Females			Total number of owls detected
		Adult	Subadult	Unknown	Adult	Subadult	Unknown	
1987	43	20	2	5	17	0	4	48
1988	39	29	4	3	29	0	4	69
1989	61	52	1	2	44	1	3	103
1990	76	55	9	5	57	6	4	136
1991	87	66	5	6	58	5	4	144
1992	87	67	4	5	65	7	2	150
1993	88	60	3	7	52	1	9	132
1994	93	56	3	12	60	2	8	141
1995	90	54	2	6	41	0	7	110
1996	81	49	5	5	48	3	6	116
1997	75	50	1	3	45	1	4	104
1998	71	51	4	5	45	3	7	115
1999	69	17	0	2	17	0	3	39
2000	82	40	1	3	31	0	4	78
2001	86	36	1	12	38	0	8	95
2002	92	37	4	10	31	0	6	88
2003	95	29	1	0	20	1	0	51
2004	95	32	0	3	23	4	5	67
2005	104	27	1	5	25	5	4	67
2006 ^a	45	10	0	1	8	0	1	20
2007	45	9	0	2	4	0	4	19
2008	48	12	0	0	10	0	2	24

^a Starting in 2006 sampling effort on the study was reduced to sites on the northern half of the peninsula.

Table 3. Percent of spotted owl territories on the Olympic Peninsula Study Area in which we located pairs, singles, floaters, or no owls, 1987– 2008. Summary is based on a subset of the total data, including only the most consistently monitored sites on Forest Service and Washington State DNR lands.

Year	Number of territories monitored	Percent with pairs	Percent with single owls	Percent with floaters ^a	Percent with no detections
1987	43	70	26	4	0
1988	61	79	15	3	3
1989	45	82	10	5	3
1990	76	79	12	5	4
1991	87	71	17	4	8
1992	87	82	5	4	9
1993	88	61	18	5	16
1994	93	66	12	5	17
1995	90	46	24	7	23
1996	81	67	6	5	22
1997	75	61	11	7	21
1998	71	71	11	3	14
1999	69	16	23	1	60
2000	82	37	19	0	44
2001	86	45	9	7	39
2002	92	38	9	9	45
2003	95	25	12	10	53
2004	95	34	3	2	61
2005	94	31	5	1	63
2006	45	20	5	0	75
2007	45	11	16	2	71
2008	48	19	6	6	69

^a A “floater” is a single owl that was seen or heard on at least one occasion, but could not be confirmed as a resident on a particular territory.

Table 4. Number of spotted owls banded each year on the Olympic Study Area, 1987– 2008. Non-juveniles are listed by age class (S1= 1 yr old, S2= 2 yrs old). Adult = ≥ 3 yrs old.

Year	Males				Females			Totals
	Juveniles	S1	S2	Adult	S1	S2	Adult	
1987	0	2	1	15	0	0	15	33
1988	13	1	3	11	0	0	13	41
1989	46	1	0	22	0	1	26	96
1990	62	6	3	18	1	7	22	119
1991	31	5	3	17	2	2	15	75
1992	78	1	2	22	0	1	22	126
1993	0	1	1	14	0	0	13	29
1994	32	1	1	8	1	1	11	55
1995	0	3	1	12	0	0	2	18
1996	59	0	2	5	0	3	9	78
1997	25	0	1	2	1	0	6	35
1998	26	1	1	2	2	0	4	36
1999	0	0	0	0	0	0	1	1
2000	1	0	0	6	0	0	5	12
2001	26	1	0	2	1	0	7	37
2002	28	1	0	1	0	0	4	34
2003	0	1	0	5	1	0	1	8
2004	36	0	0	6	1	0	5	48
2005	1	2	0	1	3	3	3	13
2006	6	0	0	0	0	0	0	6
2007	0	0	0	1	0	0	1	2
2008	11	0	0	2	0	0	3	16
Totals	481	27	19	172	12	18	188	917

Table 5. Proportion of female spotted owls that nested, fledged young, and nested and fledged young, on the Olympic Peninsula Study Area, Washington, 1987–2008.

Year	Proportion of females that nested ¹			Proportion of females that produced young ²			Proportion of nesting females that produced young ³		
	N	Mean	95% C. I.	N	Mean	95% C. I.	N	Mean	95% C. I.
1987	16	0.19	0.00 - 0.40	19	0.11	0.00 -	3	0.67	0.00 1.00
1988	19	0.26	0.05 - 0.48	27	0.33	0.14 -	5	1.00	-
1989	20	0.40	0.16 - 0.64	39	0.67	0.51 -	8	1.00	-
1990	35	0.71	0.56 - 0.87	52	0.56	0.42 -	24	0.63	0.42 - 0.83
1991	46	0.41	0.27 - 0.56	53	0.34	0.21 -	19	0.79	0.59 - 0.99
1992	48	0.90	0.81 - 0.99	63	0.78	0.67 -	43	0.86	0.75 - 0.97
1993	51	0.00	-	54	0.00	-	0	0.00	-
1994	49	0.84	0.73 - 0.94	56	0.54	0.40 -	41	0.66	0.51 - 0.81
1995	35	0.00	-	36	0.00	-	0	0.00	-
1996	37	0.89	0.79 - 1.00	50	0.68	0.55 -	33	0.67	0.50 - 0.84
1997	34	0.50	0.32 - 0.68	45	0.36	0.21 -	17	0.76	0.54 - 0.99
1998	43	0.56	0.40 - 0.71	45	0.42	0.27 -	24	0.71	0.51 - 0.90
1999	10	0.00	-	12	0.00	-	0	0.00	-
2000	25	0.12	0.00 - 0.26	30	0.03	0.00 -	3	0.33	0.00 - 1.00
2001	31	0.55	0.36 - 0.73	34	0.44	0.27 -	17	0.88	0.71 - 1.05
2002	29	0.76	0.59 - 0.92	30	0.50	0.31 -	22	0.68	0.47 - 0.89
2003	26	0.00	-	26	0.00	-	18	0.00	-
2004	32	0.78	0.63 - 0.93	32	0.75	0.68 -	25	0.84	0.70 - 0.98
2005	29	0.03	0.00 - 0.19	29	0.03	0.00 -	29	0.03	0.00 - 0.19
2006	8	0.88	0.77 - 1.00	9	0.67	0.54 -	8	0.75	0.52 - 0.98
2007	7	0.00	-	0	0.00	-	0	0.00	-
2008	4	0.50	0.01-0.94	9	0.77	0.31-0.98	4	0.50	0.01-0.94
Mean		0.42	SE 0.07		0.36	SE 0.06		0.53	SE 0.08

¹ Estimates were calculated for females whose nesting status was determined by 15 June.

² Estimates were calculated for females whose reproductive status was determined by 31 August.

³ Estimates were calculated for females whose nesting status was determined by 15 June and reproductive status by 31 August.

Table 6. Estimated fecundity (b) of female spotted owls on the Olympic Peninsula Study Area: 1987– 2008. We defined fecundity as the number of female young produced per female owl, assuming a 50:50 sex ratio of offspring.

Year	Number of territories	Number females			Adults		Subadults		Age unknown		Combined	
		Adult	Subadult	Unk age	b	SE	b	SE	b	SE	b	SE
1987	19	18	0	1	0.083	0.061	-	-	0.000	-	0.079	0.058
1988	27	25	0	2	0.240	0.077	-	-	0.250	0.250	0.241	0.072
1989	39	39	0	0	0.539	0.070	-	-	-	-	0.539	0.070
1990	52	46	5	1	0.467	0.065	0.100	0.100	0.000	-	0.423	0.060
1991	53	50	3	0	0.310	0.064	0.167	0.167	-	-	0.302	0.061
1992	63	57	6	0	0.658	0.053	0.500	0.183	-	-	0.643	0.051
1993	54	49	0	5	0.000	-	-	-	0.000	-	0.000	-
1994	56	53	1	2	0.415	0.057	0.000	-	0.000	0.000	0.393	0.055
1995	36	36	0	0	0.000	-	-	-	-	-	0.000	-
1996	50	43	3	4	0.558	0.067	0.333	0.167	0.500	0.289	0.540	0.062
1997	45	43	0	2	0.314	0.067	-	-	0.000	0.000	0.300	0.064
1998	45	39	3	3	0.308	0.065	0.500	0.289	0.167	0.167	0.311	0.060
1999	12	11	0	1	0.000	-	-	-	0.000	-	0.000	-

Table 6 (Continued). Estimated fecundity (b) of female spotted owls on the Olympic Peninsula Study Area: 1987–2008. We defined fecundity as the number of female young produced per female owl, assuming a 50:50 sex ratio of offspring.

Year	Number of territories	Number females			Adult		Subadult		Age unknown		Combined	
		Adult	Subadult	Unknown age	b	SE	b	SE	b	SE	b	SE
2000	30	29	0	1	0.017	0.017	–	–	0.000	–	0.017	0.017
2001	34	33	0	1	0.364	0.076	–	–	0.000	–	0.382	0.076
2002	30	28	0	2	0.446	0.087	–	–	0.500	0.500	0.450	0.084
2003	26	22	1	1	0.000	–	0.000	–	0.000	–	0.000	–
2004	32	23	4	5	0.739	0.076	0.375	0.239	0.100	0.100	0.594	0.076
2005	29	22	5	2	0.023	0.023	0.000	–	0.000	–	0.017	0.017
2006	9	8	0	1	0.500	0.163	–	–	0.500	–	0.500	0.144
2007	7	7	0	0	0.000	–	–	–	–	–	0.000	–
2008	11	9	0	1	0.625	0.157	–	–	0.50	–	0.611	0.139
Mean					0.300	0.053	0.198	0.067	0.148	0.052	0.288	0.050

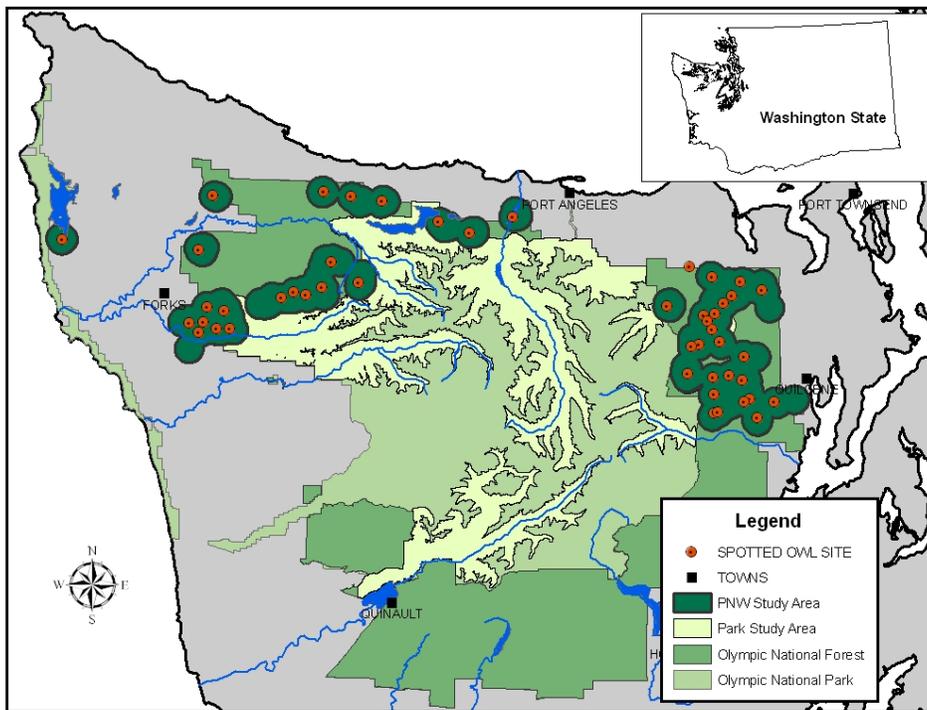


Figure 1. Distribution of spotted owl sites monitored by PNW on the Olympic Spotted Owl Demographic Study Area, 2008.

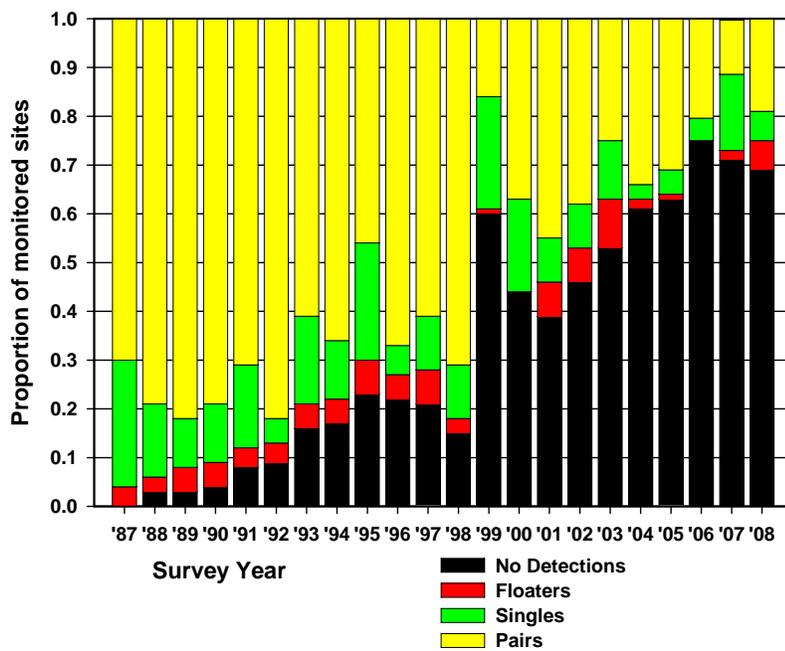


Figure 2. Proportion of monitored owl sites on the Olympic Peninsula Study Area in which we detected pairs, resident singles, floaters, or no spotted owls, 1987–2008

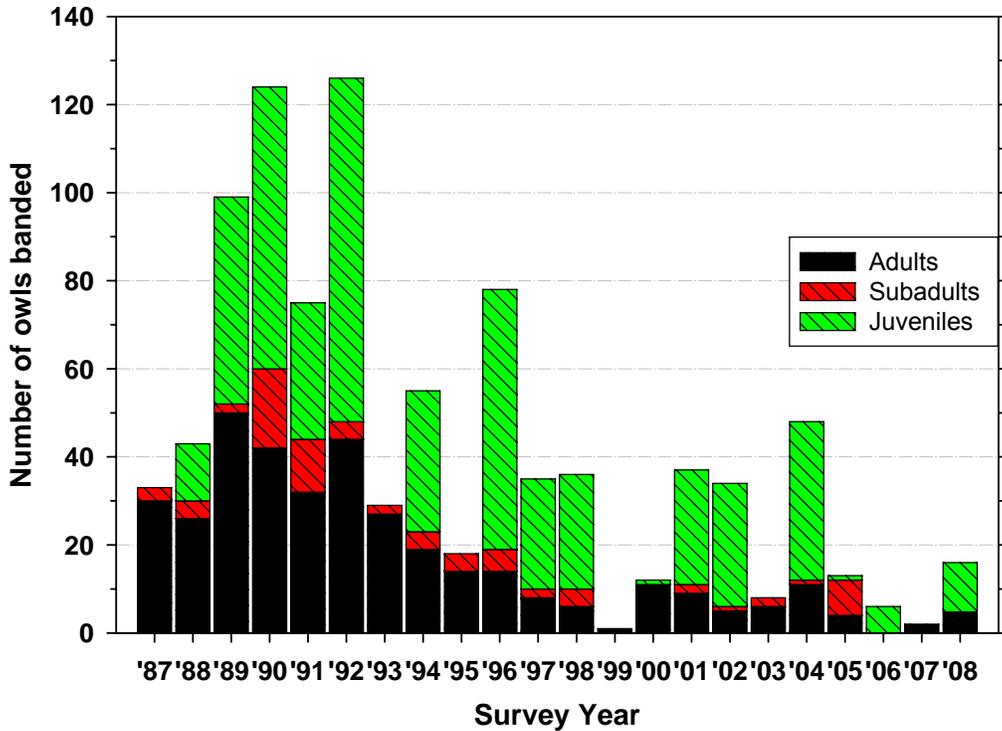


Figure 3. Number of adult, subadult, and juvenile spotted owls banded on the PNW portion of the Olympic Peninsula Study Area, 1987–2008.

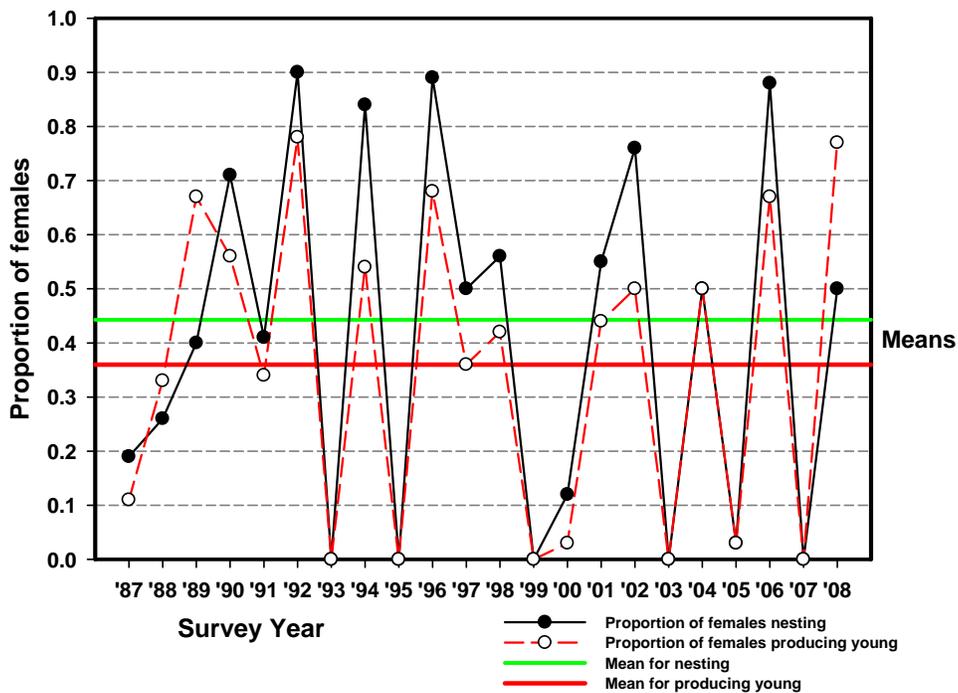


Figure 4. Proportion of female spotted owls nesting and proportion producing young on the National Forest portion of the Olympic Peninsula Study Area, 1987–2008.

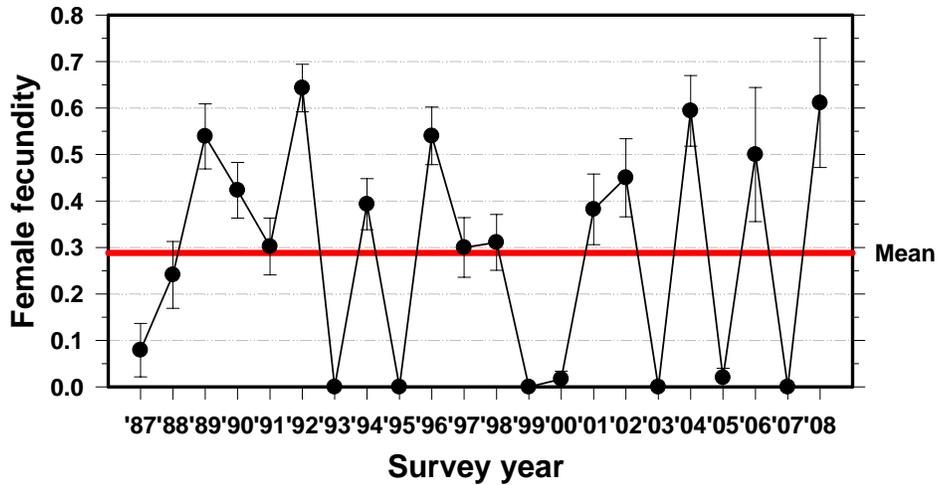


Figure 5. Estimated annual fecundity of female spotted owls on the Olympic National Forest portion of the Olympic Peninsula Demographic Study Area, 1987– 2008. Estimates were based on all age-classes combined.

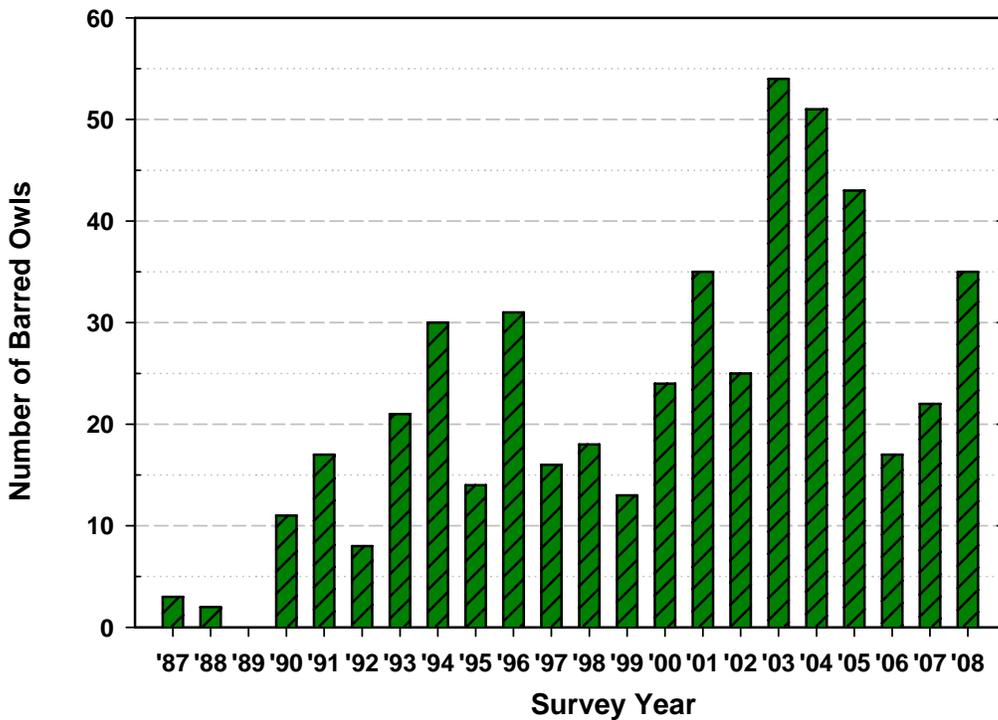


Figure 6. Number of barred owl detections on the PNW portion of the Olympic Peninsula Study Area, 1987–2008. Detections in 2006–08 are only for the reduced number of sites monitored in these years.

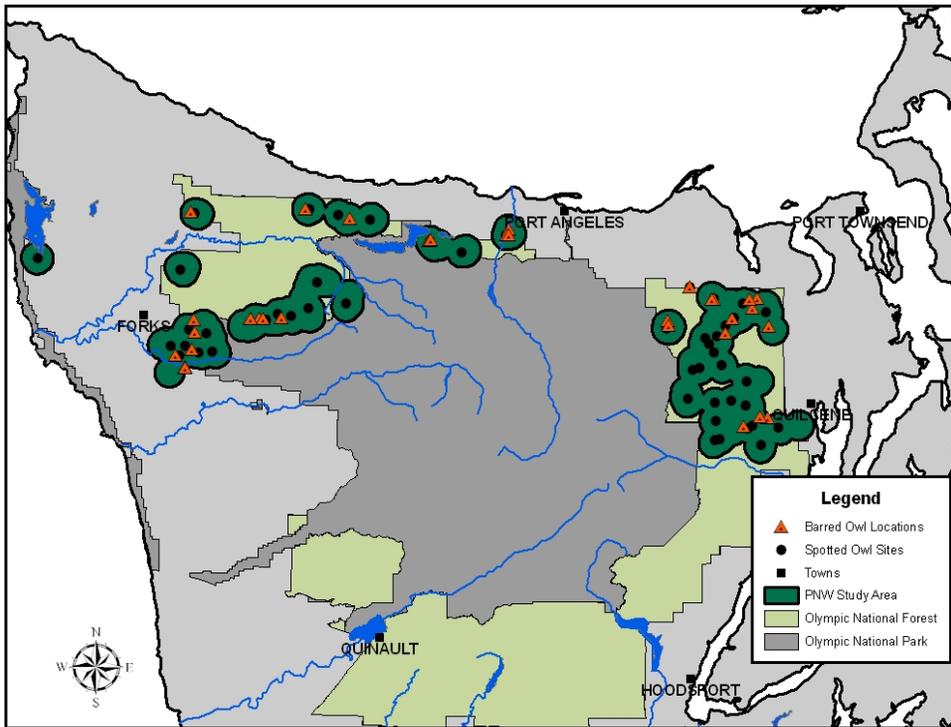


Figure 7. Location of barred owl detections on the Olympic National Forest portion of the Olympic Peninsula Demographic Study Area during the 2008 field season. Black circles indicate spotted owl site centers monitored in 2008.

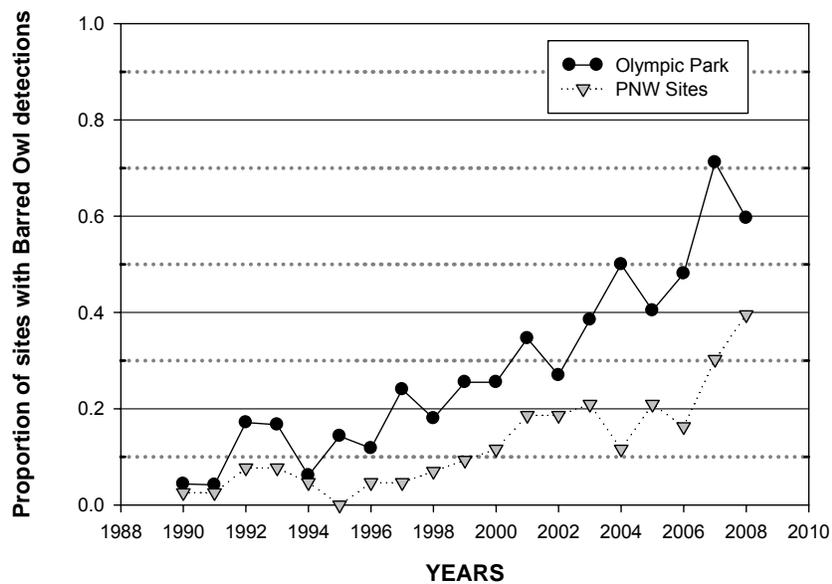


Figure 8. The proportion of spotted owl sites centers by year with barred owl detections within 1000m of the cumulative core areas for the National Forest sites compared to the Olympic National Park sites, 1990–2008.