WILDLIFE ECOLOGY TEAM
WILDLIFE HABITAT RELATIONSHIPS
IN WASHINGTON AND OREGON
FISCAL YEAR 2013.

October, 2013

Study

Demography of Spotted Owls on the east slope of the Cascade Range, Washington, 1989-2013

Researchers

Dr. E.D. Forsman (PI). Lead Biologist: S. Sovern, Oregon State University, Corvallis, Oregon. Biologists M. Taylor, Oregon State University, Corvallis, Oregon; Joan StHilaire and Dale Phipps, USDA Forest Service. Cooperators: Plum Creek Timber Company, Boise Cascade Corporation, American Forest Resources L.L.C., Washington State Department of Natural Resources.

Status

This study is one of eight long-term demographic studies in the Regional Monitoring Program for the Northern Spotted Owl (Lint et al. 1999). The study was initiated in 1989.

Study objectives

Determine demographic trends of Spotted Owls on the east slope of the Cascade Range in Washington, to include age-and-sex-specific survival rates, reproductive rates, and overall population trend.

Potential benefit of the study

This study was designed to collect long-term information on survival and reproductive rates of Spotted Owls on the east slope of the Cascade Mountains in Washington. This information is needed to assess the status of the owl population in this province. In combination with data from other study areas in Washington and Oregon, information from the Cle Elum Study Area is used to assess region-wide trends in the Spotted Owl population (Forsman et al. 1996, Franklin et al. 1999, Lint et al. 1999, Anthony et al., 2006, Forsman et al. 2011).

Study Area and Methods

The Cle Elum Study Area includes a 1,787 km^2 General Study Area (GSA), and a 204 km^2 Density Study Area (DSA) that is contained within the GSA (Figure 1). The U. S. Forest Service administers approximately 60% of the area within the GSA. The GSA and DSA are composed of 34 % and 88 % designated Late Successional Reserves (LSR), respectively. These LSR's were allocated by the Northwest Forest Plan to benefit species associated with late successional forest (USDA and USDI 1994).

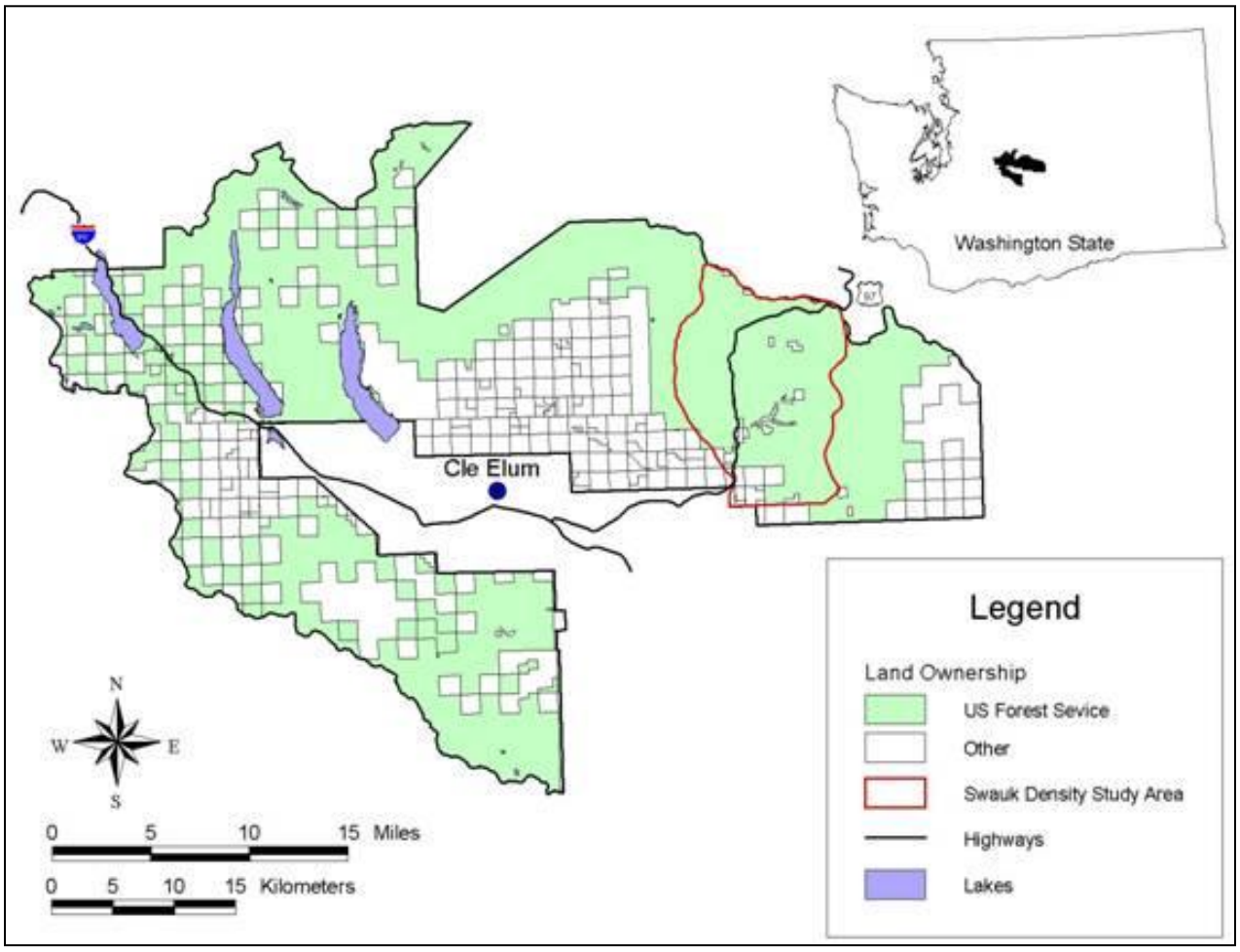

Figure 1. The Cle Elum Study Area, Washington.

Within the GSA we survey all historic owl territories each year using standard protocols to locate and confirm previously banded owls, and to determine the number of young produced at each territory (Forsman 1983, Franklin, et al., 1996, Lint et al., 1999). Any new owls are banded with a numbered USFWS band and a uniquely colored plastic leg band (Figure 2). We attempted a complete count of Spotted Owls in the DSA each year beginning in 1991. The DSA survey involves reproducing

Figure 2. Adult Spotted owl with yellow and black leg band

Spotted Owl calls at each established call station on 3 occasions during the March – August field season (Forsman 1983, Lint et al. 1999, Reid et al. 1999). Call stations are positioned so that we achieve a 100 % auditory coverage of the entire DSA.

In 2005 and 2006, we collected blood samples and oral swabs from most owls we captured to test for the presence of West Nile Virus. West Nile Virus has been identified as a potentially significant source of mortality among Spotted Owls (Courtney et al. 2004). We collected blood samples from some captured owls for future genetic study 2006-2010 (Haig et al. 2004, Funk et al. 2009).

In January, 2014, we participated in a meta-analysis of Northern Spotted Owl data in Corvallis, Oregon. The meta-analysis included data from 8 monitoring areas funded through the Northwest Forest Plan, plus 3 additional study areas in the range of the Northern Spotted Owl. In the meta-analysis, we used mark-recapture data to estimate age-and sex-specific survival and recruitment, and population growth rate. We also included an occupancy analysis for the first time this year. The results of this workshop will be compiled and submitted to a peer-reviewed journal for publication. The last workshop occurred in 2009, and the results from that analysis were published in Forsman et al. (2011).

RESULTS

Population Trends

General Study Area

In 2013 we banded 3 juvenile owls and 1 adult owl, bringing the total number of owls banded during 1989-2013 to 850 (69 subadults, 159 adults, and 622 juveniles, Table 1).

Our monitoring effort has remained relatively consistent after 1992, except for 8-10 territories we began monitoring with only 1 visit per year beginning in 2002. None of these “minimum-protocol” territories contained owls in 2013. We confirmed the bands of 12 Spotted Owls, and detected another 9 Spotted Owls on 14 territories. This compares to a high of 120 owls on 64 territories in the same area in 1992 (Figure 3, Table 2). It is somewhat encouraging that the number of owls detected this year was slightly higher than 2012 (21 vs 20) and the count has remained relatively stable for 3 years.

We have noted an 82.5 % decline in the number of Spotted Owls detected on the study area since 1992, and a concomitant increase in the number of vacant territories (Figure 4). The high male:female ratio observed in 2008-2010 appears to have waned in the last 3 years. (Figure 5).

Key findings of the 2009 meta-analysis of Spotted Owl demography data (Forsman et al. 2011) were: 1) there was strong evidence of population declines in Spotted Owls on

7 of 11 study areas examined (including the Cle Elum Study Area); and 2) Barred Owl presence had a generally negative effect on demographic rates of Spotted Owls. The estimate of the finite rate of population change (λ) for the Cle Elum Study Area was 0.937 (95% CI 0.91 – 0.96), indicating an annual population decline of 6.3% (95% CI 4-9%). This estimate of population change closely predicts the empirical estimates of population size that we collect each year (Figure 3).

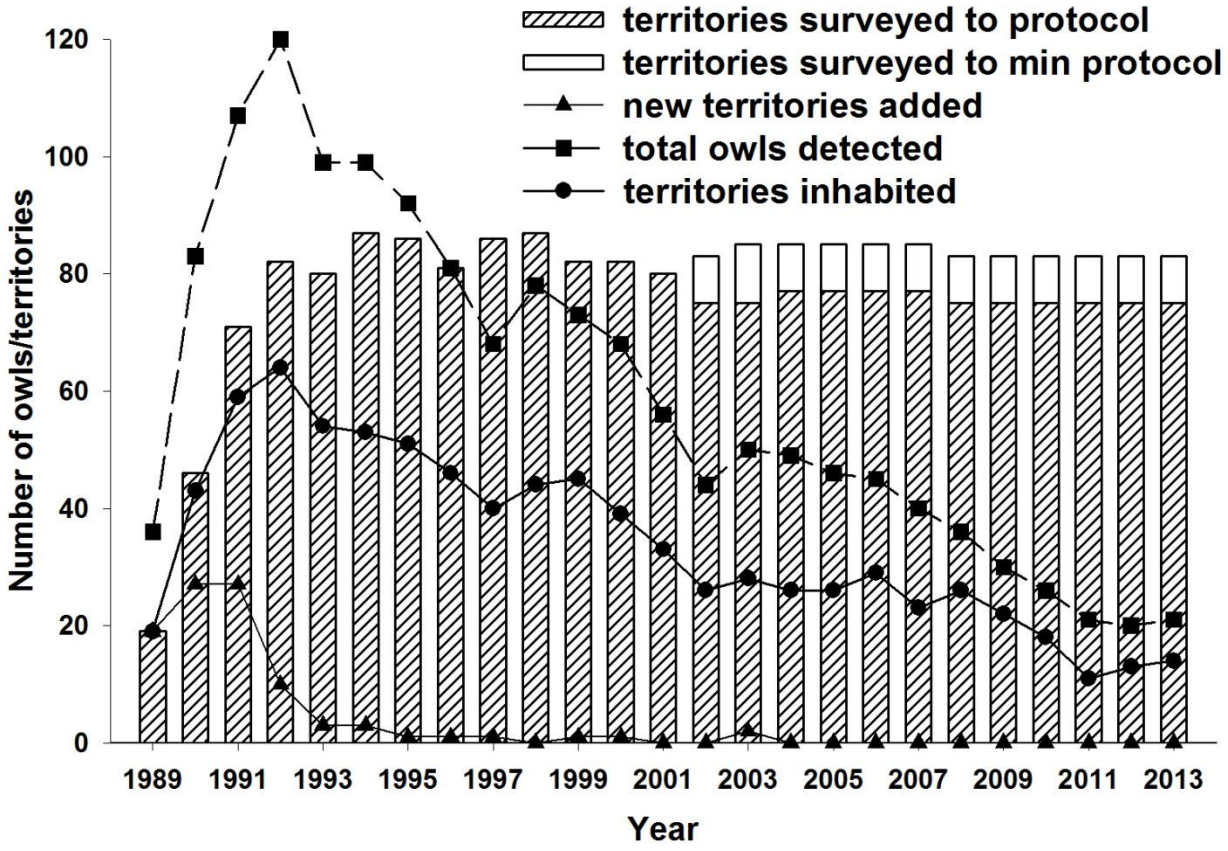

Figure 3. Number of Spotted Owls detected, number of territories in which we detected owls, number of territories surveyed, and number of new territories added by year on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2013. Minimum protocol territories included 8-10 territories that we visited only once per year beginning in 2002. A territory was considered inhabited if a single owl response was detected which was not associated with a neighboring territory.

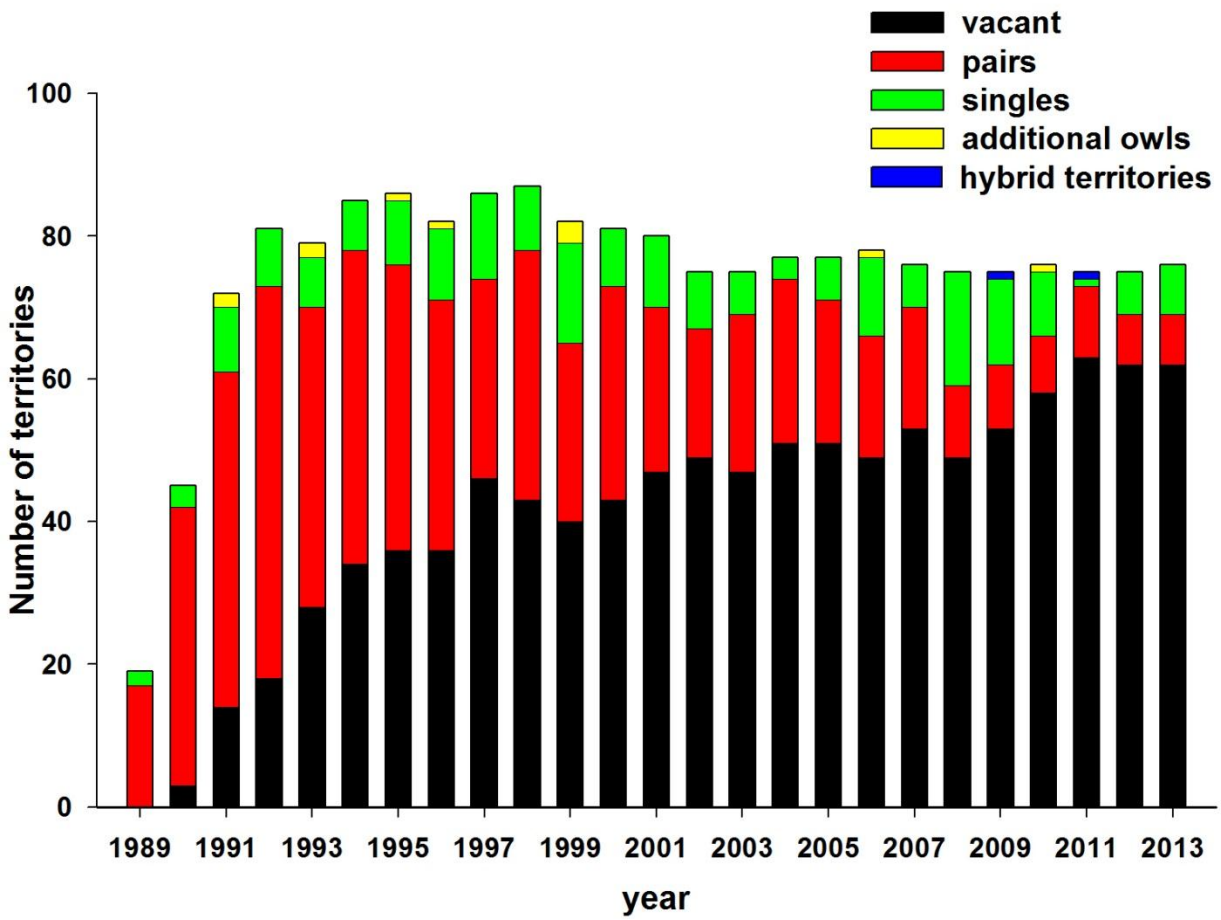

Figure 4. Number of vacant territories, hybrid territories, and number of territories inhabited by singles, pairs, and "additional owls" on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2013. An "additional owl" is counted when a single owl is detected at a territory where a pair or territorial owl has already been confirmed, and the single owl response cannot be attributed to an adjacent territory. A hybrid territory is one inhabited by a Spotted owl/Barred Owl pair or a hybrid owl (Spotted Owl x Barred Owl). Totals do not include 8-10 vacant sites where we made less than 3 complete visits in a year starting in 2002.

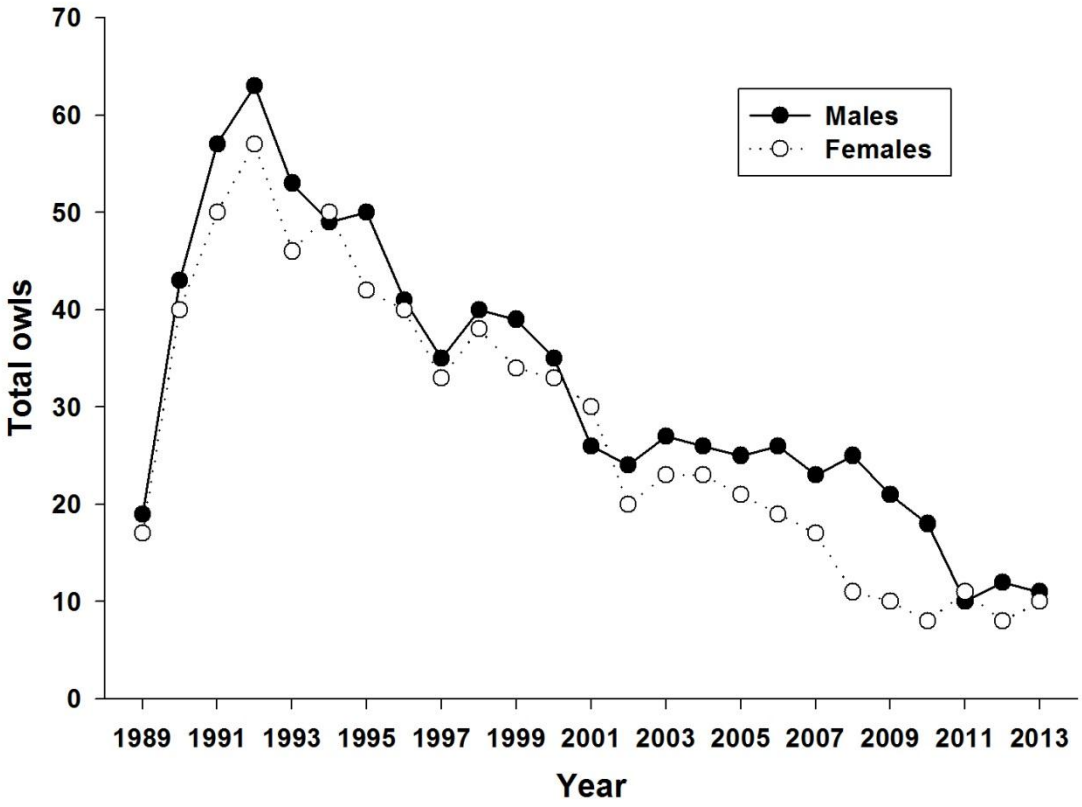

Figure 5. Number of male and female Spotted Owls detected by year on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2013.

Elsewhere on the Okanogan-Wenatchee National Forest, we continued banding owls on a portion of what was the Wenatchee Demography Study Area (WEN, Figure 12). The WEN was monitored by National Council for Air and Stream Improvement from 1990-2003, in cooperation with the Wenatchee National Forest. We banded 3 new owls at 10 inhabited territories on the WEN, and changed bands or confirmed bands on 3 adult owls. We surveyed 23 territories to protocol.

Density Study Area

The DSA survey data indicate an overall decline in the number of owls detected in the DSA since 1991 (Figure 6). However, we detected 2 more owls in 2013 than in 2012.

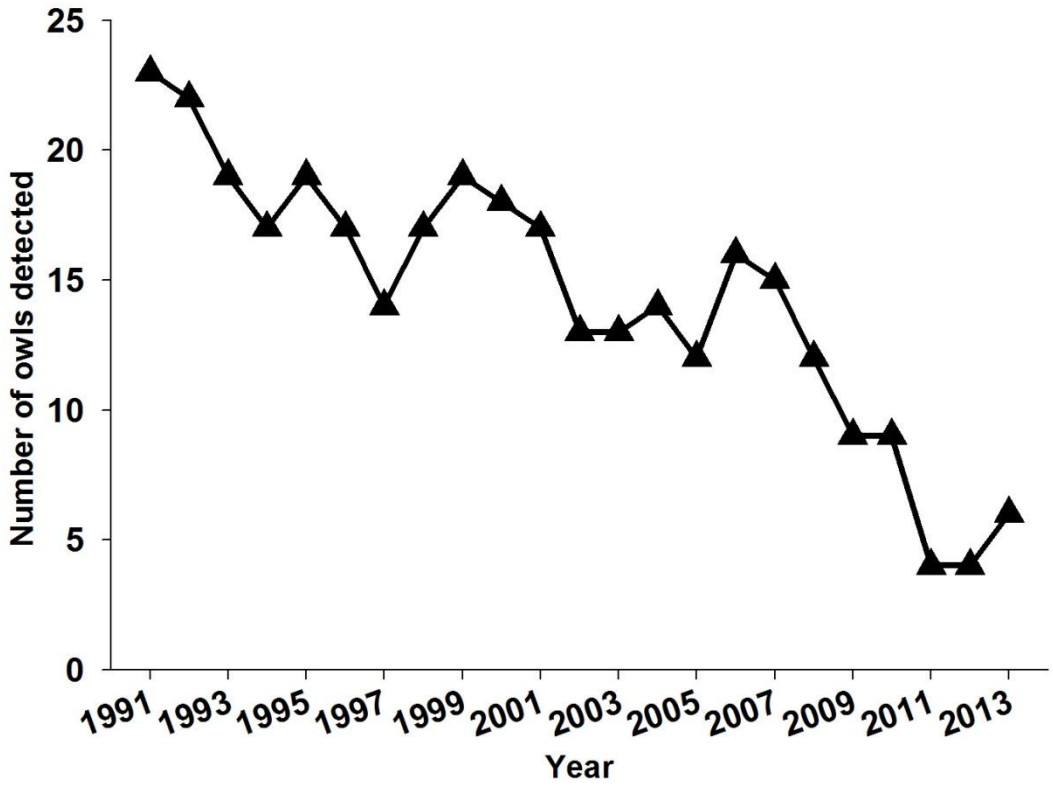

Figure 6. Number of non-juvenile Spotted Owls detected on the 204 km^2 Swauk Density Study Area on the Okanogan-Wenatchee National Forest, Washington, 1991-2013. Points represent actual counts.

West Nile Virus

None of the oral swab or blood samples from owls tested positive for the presence of West Nile Virus. The impact of West Nile Virus on the Spotted Owl population on the Cle Elum Study Area remains unknown.

Barred Owls and Spotted Owls

The range of the Barred Owl now overlaps the range of the Northern Spotted Owl, and the potential for the Barred Owl to negatively affect the Spotted Owl population has been a concern for many years (Taylor and Forsman 1976, Courtney et al. 2006). Kelly et al. (2003) found that apparent occupancy and reproduction of Spotted Owls were lower when Barred Owls were detected nearby, and recent analyses have documented competition between Barred Owls and Spotted Owls (Dugger et al. 2011). Thus, monitoring the number of inhabited Barred Owl territories is an important index to measure the effect of Barred Owls on Spotted Owl population trends (Olson et al. 2005)

Barred Owl (*Strix varia*) (photo by Steve Sleep)

General Study Area

We recorded 46 Barred Owl responses in the GSA in 2013 during our Spotted Owl surveys. Based on how these responses were situated temporally and/or geographically, we believe the responses represent 39 Barred Owl territories. Due to limited resources, we did not attempt to determine whether the responses represented nesting pairs.

During the 2014 meta-analysis, we developed a study-area specific Barred Owl covariate for use in estimating survival and population growth rate of Spotted Owls. We generated Theissen polygons from Spotted Owl territory centers, overlaid Barred Owl responses on these polygons, and calculated the proportion of the Spotted Owl territory centers which were inhabited by Barred Owls. While the proportion of Spotted Owl territories with Barred Owl responses has increased on the Cle Elum Study Area (Figure 7), the increase is not as sharp as in other study areas within the range of the Spotted Owl.

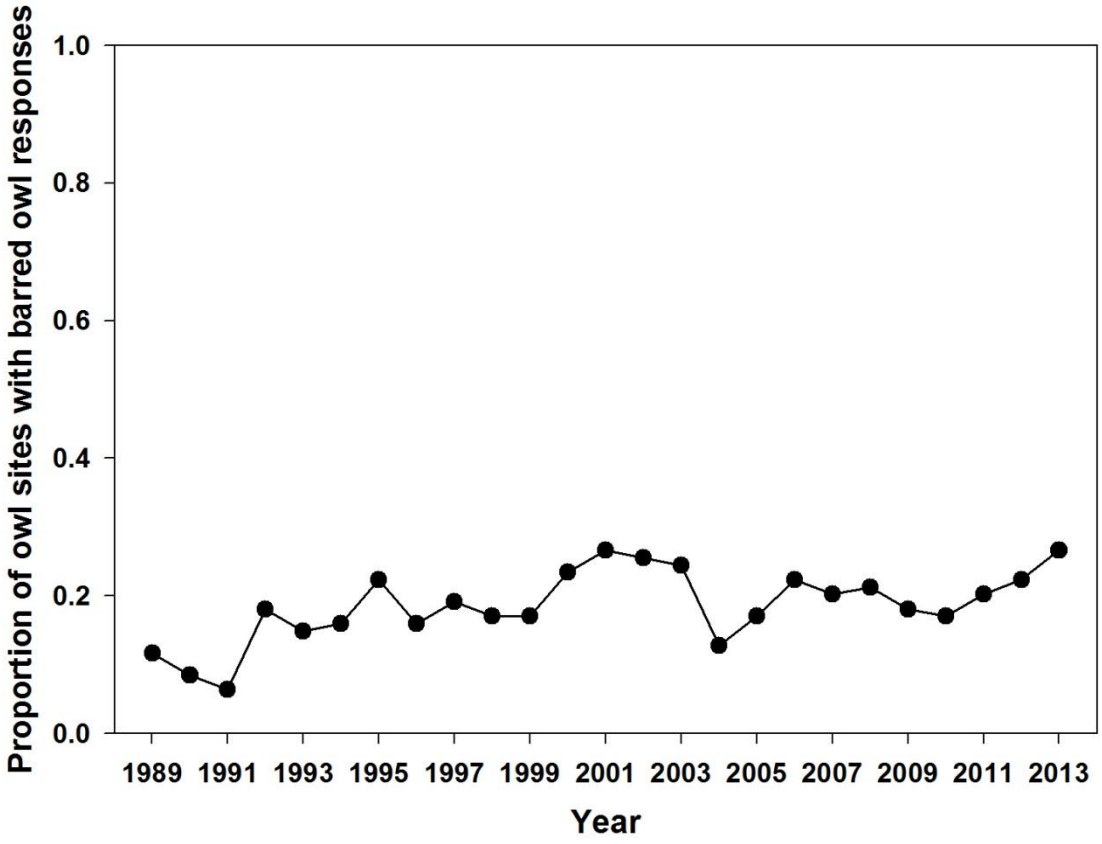

Figure 7. Proportion of 94 Spotted Owl territories with a Barred Owl response, Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2013.

Density Study Area

By completely surveying the Density Study Area each year, we were able to estimate which portions of the DSA were inhabited by Barred Owls and which portions were inhabited by Spotted Owls. The apparent number of inhabited Barred Owl territories in the DSA increased in 1991-2000 (Figure 8), outnumbering inhabited Spotted Owl territories in several years. This year, we found slightly fewer Barred Owls, but Barred Owls territories still outnumbered Spotted Owl territories by a ratio of more than 4:1 (Figure 8).

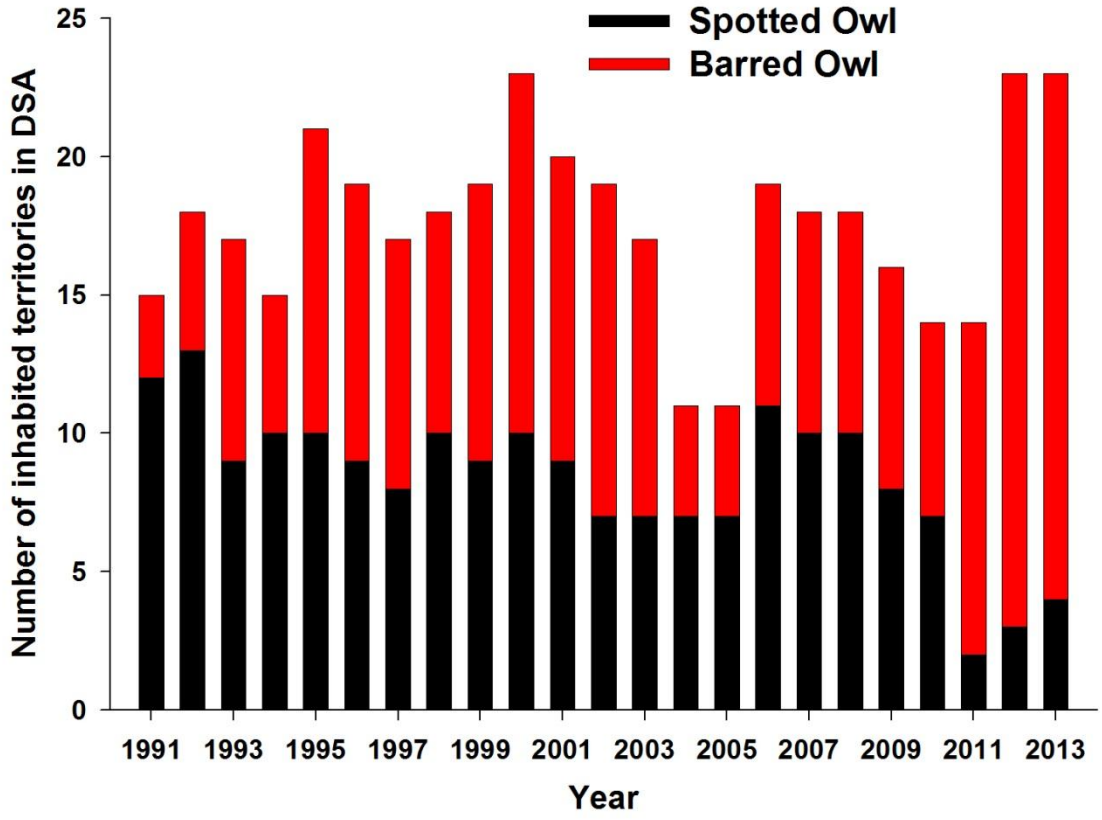

Figure 8. Number of territories in which we detected Spotted Owls and Barred Owls in the Swauk Cr. Density Study Area, Okanogan-Wenatchee National Forest, Washington, 1991-2013.Territories were considered inhabited if an owl of either sex was detected at the territory. The values for Barred Owls in 2009 include one territory inhabited by a Spotted owl/Barred Owl pair.

"Sparred" owl (Spotted owl x Barred Owl hybrid) fledgeling, 22 July, 2009

Although we have detected Barred Owls on the General Study Area since 1989, we documented our first case of a Spotted owl/Barred Owl pair in 2009. The pair included a male Spotted owl and a female Barred Owl—the most common pair formation when Spotted Owls and Barred Owls hybridize (Haig et al. 2004, Kelly et al. 2004). The pair nested and produced 2 young. One of those young was verified at an historic Spotted Owl territory in 2011.

In September, 2013, the US Fish and Wildlife Service published its Record of Decision to begin a Barred Owl removal study (USFWS 2013). This study will evaluate the effect of Barred Owl removal on vital rates (e.g. survival, reproduction, recruitment) of the Spotted Owl. The USFWS chose the Cle Elum Study Area as 1 of 4 study areas to participate in the removal study. The USFWS will begin removing Barred Owls in fall, 2014.

Reproductive Rates

Three of the 5 females for which we determined nesting status in 2013 nested. We found young at an additional territory late in the season. Of these 4 nesting territories, 3 produced young. Average fecundity (number of female young produced per female owl) was 0.36 (SE = 0.18, Table 3). The 2013 values for proportion of females nesting and fecundity were below the average for all years (Figure 9, Table 4).

The pronounced odd-even year pattern of nesting and fecundity seen in 1989-1999—a pattern that was evident in many studies throughout the range of the Spotted Owl--has waned somewhat in the last 12 years (Figure 9, Table 3-4).

Forsman et al. (2011) found that models that included a time trend covariate were among the competing models for fecundity on the Cle Elum Study area. The 95% confidence intervals around the negative beta estimate (-0.005) for trend in fecundity barely overlapped zero (-0.017 – 0.006, Forsman et al. 2011:25). Thus, these estimates provide suggestive evidence that fecundity has declined over time on this study area.

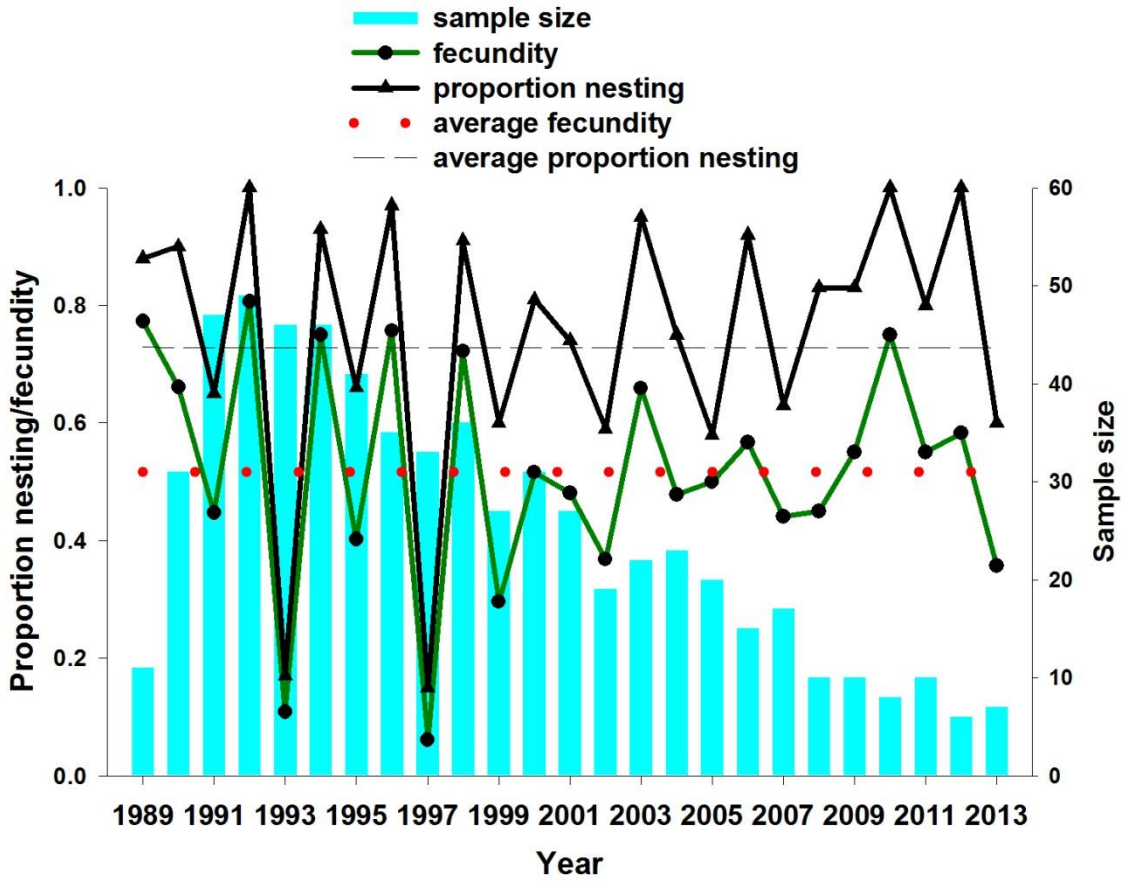

Figure 9. Reproductive indices of Northern Spotted Owls on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2013. Indices shown are: *proportion of females nesting* and *fecundity*. Sample size of females used for fecundity analysis for each year (bars) is plotted on the y axis on the right side of the graph. Fecundity is the number of females produced per female owl, assuming a 50:50 sex ratio. The dotted and dashed lines show the average (all years 1989-2013) fecundity and proportion nesting, respectively.

While the reproductive rates appear to have been somewhat less variable in recent years, these reproductive indices are estimated from a declining pool of reproductive owls. Thus, the reproductive potential of the Spotted Owl population on the Cle Elum Study Area has declined over time. At the current population size, the number of young produced in a good reproductive year (e.g. 2010) is nearly equal to the worst reproductive years when the population was much larger (e.g. 1993, 1997) (Figure 10). The small number of reproductive females remaining on the study area is clearly a cause for concern should this situation persist, given recent analyses that suggest there is a genetic bottleneck in this region (Funk et al. 2009). Additionally, small populations can have a depressed capacity to withstand environmental variation (Soule and Mills' 1998).

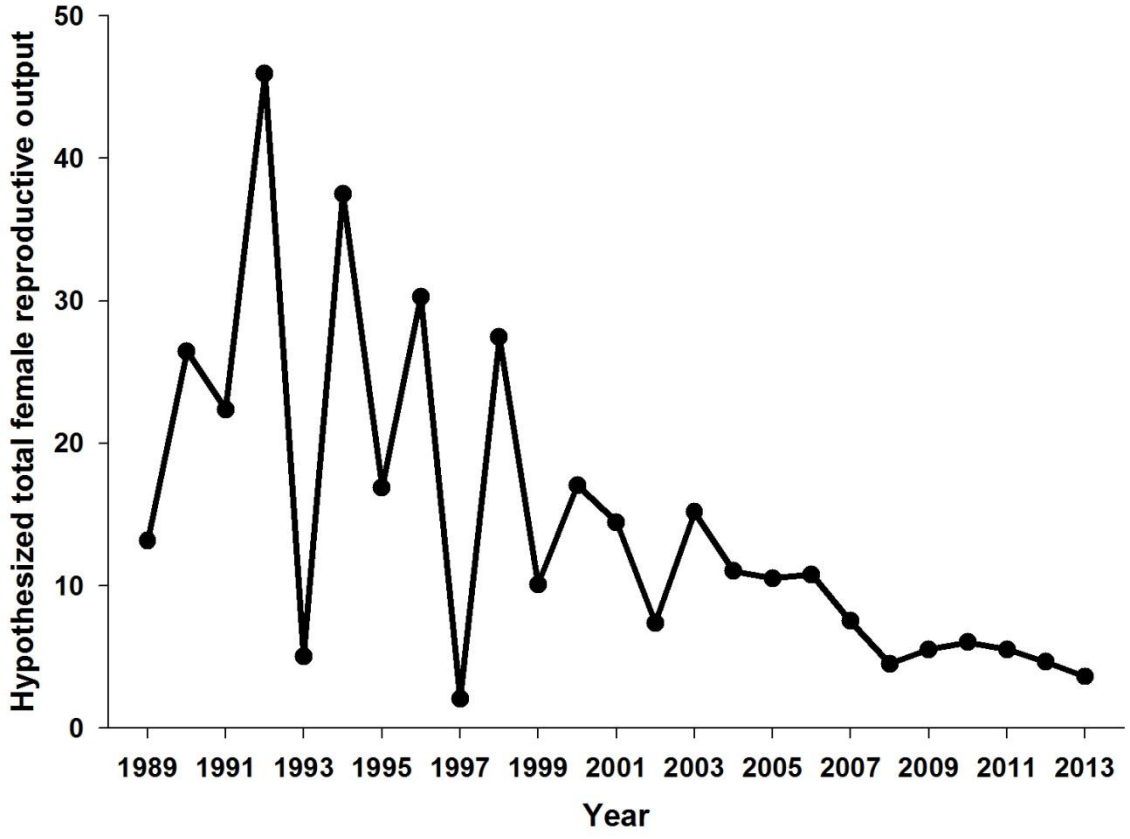

Figure 10. Hypothesized annual female reproductive output (average yearly female fecundity * number of females detected each year), Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2013. Note in the years prior to 1992 the sample of females monitored each year was increasing as we added new territories to the sample.

Western Spruce Budworm

An outbreak of the western spruce budworm (*Choristoneura occidentalis)* began on the Cle Elum Study Area in 2000, and the amount of area affected by the budworm has increased each year (WDNR 2011). Aerial reconnaissance by WDNR 2000-2011 indicates that as much as 48 % of the GSA has been affected by the budworm at some point since 2000 (figure 11). Defoliation by the budworm has the potential to reduce Spotted Owl habitat quality by decreasing canopy closure. Stands that are dominated by Douglas-fir (*Pseudotsuga menzesii*) and grand fir (*Abies grandis)* are particularly susceptible to defoliation. It appears that the spruce budworm outbreak may be subsiding as yearly defoliation was less noticeable in 2013.

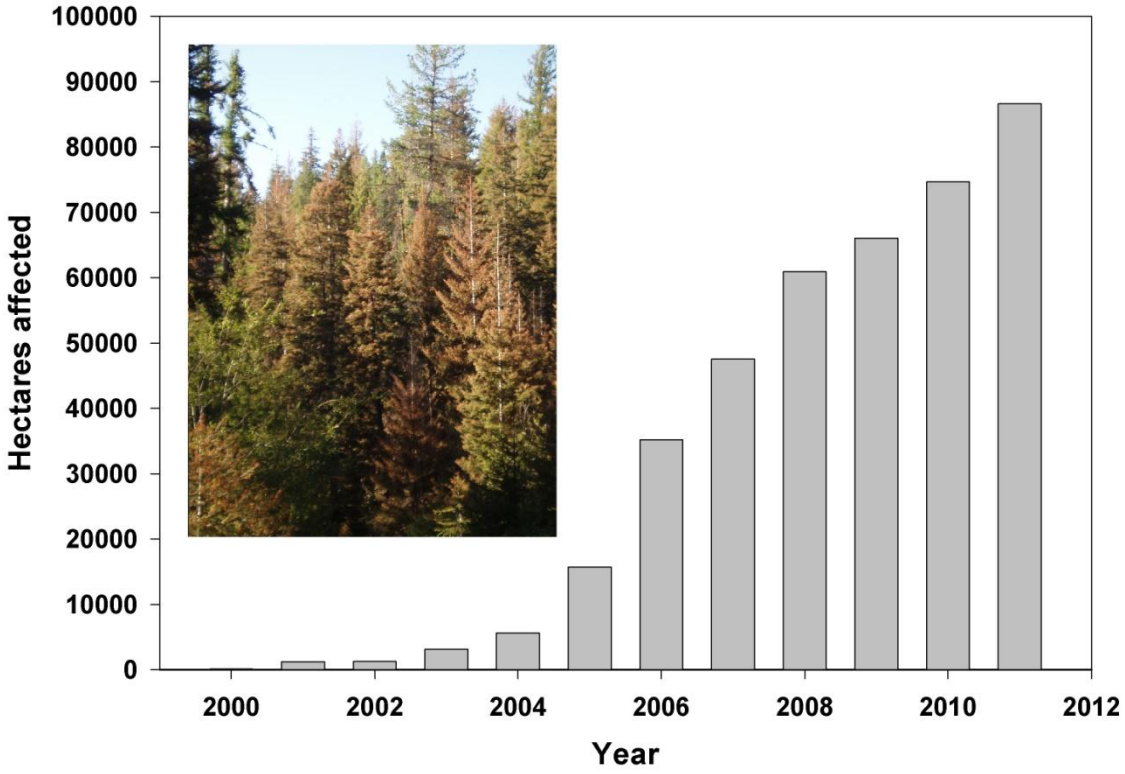

Figure 11. Cumulative area (hectares) of forest affected by western spruce budworm by year on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 2000-2011 (WDNR 2011).

The 2014 Spotted Owl Demographic Workshop

A workshop to analyze data from Spotted Owl demography study areas was conducted in January 2014, and the results from the analysis will be published in a peer-reviewed journal. This analysis included data from the Cle Elum Study Area 1989-2013, as well as 7 other Spotted Owl demography study areas funded under the Northwest Forest Plan (Figure 12). Three additional study areas also participated in the workshop.

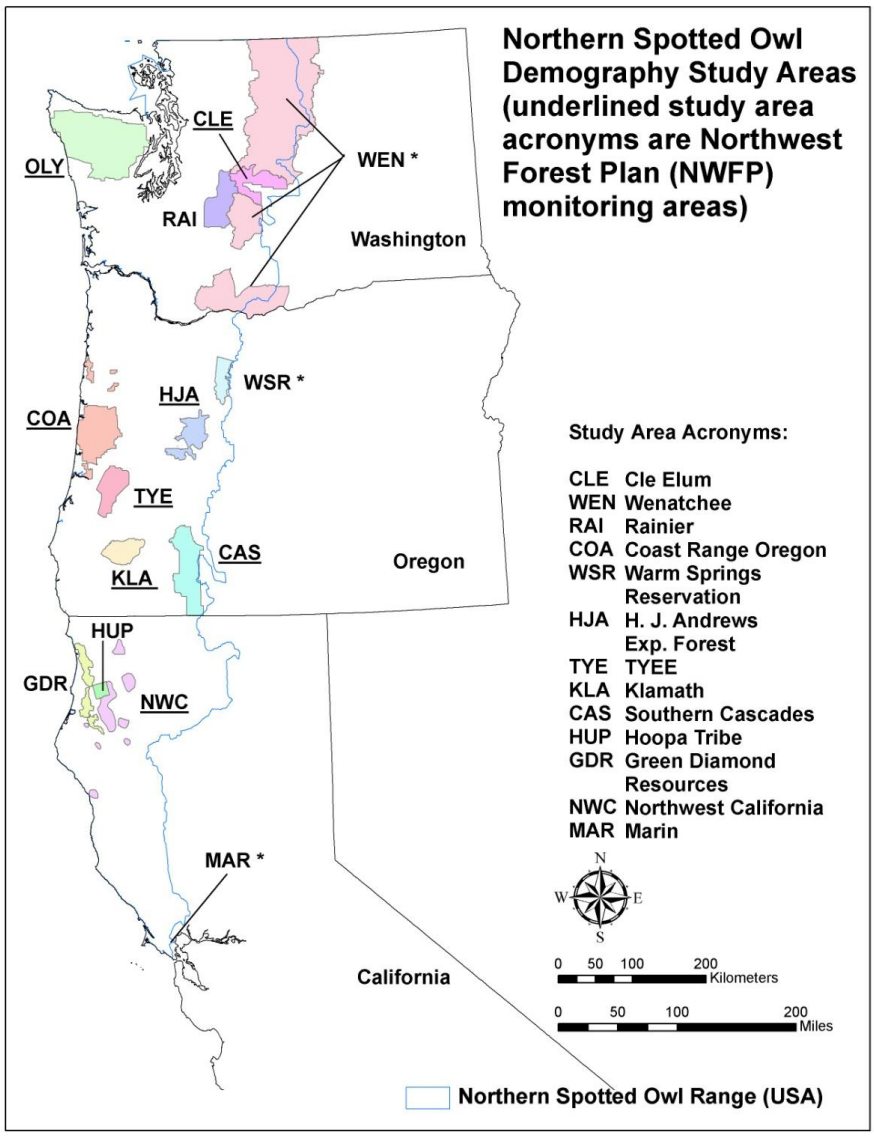

Figure 12. Northern Spotted Owl Demography Study Areas in the range of the Owl. Study areas with asterisks (MAR, WEN, and WSR) were discontinued after the 2003 analysis.

Problems encountered

We were unable to survey on 9 scheduled survey days and/or nights due to inclement weather, resulting in a loss of 16 person-days of survey.

Reduced maintenance and decommission of Forest Service roads continues to reduce vehicle access. This often necessitates other means of travel (e.g. foot, bicycle, ATV) to our calling stations, which increases time spent for each survey.

As owl territories have become vacant, we have had to increase our number of nocturnal visits in order to achieve valid surveys. In addition, surveys done by

cooperating organizations to monitor owl territories in our sample have largely ceased. The combination of these 2 developments has increased the overall workload for accomplishing this study. These difficulties are not likely to change in the near future.

Literature cited

Anthony, R. G., E. D. Forsman, A. B. Franklin, D. R. Anderson, K. P. Burnham, G. C. White, C. J. Schwarz, J. D. Nichols, J. E. Hines, G. S. Olson, S. H. Ackers, L. S. Andrews, B. L. Biswell, P. C. Carlson, L. V. Diller, K. M. Dugger, K. E. Fehring, T. L. Fleming, R. P. Gerhardt, S. A. Gremel, R. J. Gutiérrez, P. J. Happe, D. R. Herter, J. M. Higley, R. B. Horn, L. L. Irwin, P. J. Loschl, J. A. Reid, and S. G. Sovern. 2006. Status and trends in demography of northern Spotted owls, 1985-2003. Wildlife Monographs 163.

Collett, D. (1991), Modeling Binary Data, London: Chapman & Hall

Courtney, S. Pl, J A Blakesley, R E Bigley, M L Cody, J P Dumbacher, R C Fleischer, A B Franklin, J F Franklin, R J Gutiérrez, J M Marzluff, L Sztukowski. 2004. Scientific evaluation of the status of the Northern Spotted Owl. Sustainable Ecosystems Institute, Portland, Oregon.

Crozier, M. L., M. E. Seamans, R. J. Gutiérrez , P. J. Loschl, R. B. Horn, S. G. Sovern, and E. D. Forsman. Does the presence of Barred owls suppress the calling behavior of spotted owls? Condor 108:760-769.

Dugger, K. M., R. G. Anthony, and L. S. Andrews. 2011. Transient dynamics of invasive competition: Barred Owls, Spotted Owls, habitat, and the demons of competition present. Ecological Applications 21:2459-2468.

Forsman, E. D. 1983. Methods and materials for locating and studying Spotted Owls. Gen. Tech. Rep. PNW-162. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 8 pp.

Forsman, E. D., DeStefano, S., Raphael, M. G., and Gutiérrez, R. J., Eds. 1996. Demography of the northern Spotted Owl. Studies in Avian Biology 17. 122 pp.

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 the northern spotted owl. Studies in Avian Biology 40.

Franklin, A. B., D. R. Anderson, E. D. Forsman, K. P. 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., Burnham, K. P., White, G. C., Anthony, R. G., Forsman, E. D., Schwartz, C., Nichols, J. D., and Hines, J. 1999. Range-wide status and trends in northern Spotted Owl populations. Unpublished report. 71 pp.

Funk, W. C., E. D. Forsman, M. Johnson, T. D. Mullins, and S. M. Haig. 2009. Evidence for recent population bottlenecks in northern spotted owls (Strix occidentalis caurina). Conservation Genetics DOI 10.1007/s10592-009-9946-5.

Haig, S. M., T. D. Mullins, E. D. Forsman, P. W. Trail, and L. Wennerberg. 2004. Genetic identification of Spotted Owls, Barred Owls, and their hybrids: legal implications of hybrid identity. Conservation Biology 18: 1347-1357.

Kelly, E. G., E. D. Forsman, and R. G. Anthony. 2003. Are Barred Owls displacing Spotted Owls? Condor 105:45-53.

Kelly, E. G., and E. D. Forsman. 2004. Recent records of hybridization between Barred Owls (*Strix varia*) and Northern Spotted Owls (*S. occidentalis caurina*). Auk 121:806-810.

Lint, J., Noon, B., Anthony, R., Forsman, E., Raphael, M., Collopy, M., and Starkey, E. 1999. Northern Spotted Owl effectiveness monitoring plan for the Northwest Forest Plan. Gen. Tech. Rep. PNW-GTR-440. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 43p.

Olson, G. S., R. G. Anthony, E. D.Forsman, S. H. Ackers, P. J. Loschl, J. A. Reid, K. M. Dugger, E. M. Glenn, W. J. Ripple. 2005. Modeling of site occupancy dynamics for Northern Spotted Owls, with emphasis on the effects of Barred Owls. Journal of Wildlife Management 69:918-932.

Olson, G. S., E. D. Forsman, R. G. Anthony, S. G. Sovern, and B. Biswell. Northern Spotted Owl site occupancy in eastern Washington: the effects of Barred owls and landscape pattern. In prep.

Reid, J. R., R. B. Horn, and E. D. Forsman. 1999. Detection rates of Spotted Owls based on acoustic-lure and live-lure surveys. Wildl. Soc. Bull. 27:986-990.

Soule, M. E., and L. S. Mills. 1998. No need to isolate genetics. Science 282:1658-1659. doi: 10.1126/science.282.5394.1658

SAS Institute Inc. 2009. Cary, NC, USA.

Taylor, A. L., and E. D. Forsman. 1976. Recent range extensions of the Barred owl in western North America, including the first records for Oregon. Condor 78:560-561.

U.S. Department of Agriculture, Forest Service, and U. S. Department of the Interior, Bureau of Land Management [USDA and USDI]. 1994. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. 74pp.

U.S. Fish and Wildlife Service (USFWS). 2013. Experimental removal of barred owls to benefit threatened northern spotted owls; Record of decision for final environmental impact statement. Federal Register 78:57171-57173.

U.S. Fish and Wildlife Service (USFWS). 2011. Protocol for surveying proposed management activities that may impact spotted owls. USDI Fish and Wildlife Service, Portland, OR. 38 pp.

Washington State Department of Natural Resources (WDNR). 2011. GIS data center. http://www.dnr.wa.gov/ResearchScience/Topics/ForestHealthEcology/Pages/rp_foresthealth.aspx

Publications and presentations in Fiscal Year 2013

Sovern, S. G., E. D. Forsman, K. M. Dugger, and M. Taylor. Roost Habitat use by Northern Spotted Owls during natal dispersal. In review.

Sovern, S.G., E. D. Forsman, M. Taylor, and B. L. Biswell. Habitat use and home range of Northern Spotted Owls on the east slope of the Cascades Mountains, Washington, 1989-1990. In review.

Sovern, S. G., E. D. Forsman, G. S. Olson, B. L. Biswell, M. Taylor, and R. G. Anthony. Associations between Barred owls, landscape pattern and site occupancy of Northern Spotted Owls in the eastern Cascades of Washington. In review.

Attended a field trip with Washington State Department of Natural Resources at White Salmon, WA, 23 April, 2013. The field trip involved participating in a discussion of strategies for managing several forested stands that had undergone a variety of harvests.

Presented a lecture on Spotted Owl biology and population trends to the Lincoln City chapter of the Audubon Society, Cascade Head Ranch, Otis, OR, 13 June, 2013.

“Nature of Night” program, 23 November, 2013, Central Washington University Center for Excellence in Science and Mathematics Education. A poster presentation, owl pellet examples, and a live Great horned owl provided by the Kittitas Animal Rehabilitation Group.

The Cle Elum Ranger District staff was given weekly updates of our owl surveys and information as needed in support of District projects.

Apppendix 1

Table 1. Number of Spotted owls banded each year on the Cle Elum Study Area, Okanogan-Wenatchee National forest, Washington, 1989-2013. Total for juveniles includes 2 hybrid Spotted x Barred Owl hybrids banded in 2009.

	Density Study Area					General Study Area					
Year	Adults	(M,F)	Subadults	(M,F)	Juveniles	Adults	(M,F)	Subadults	(M,F)	Juveniles	Total
1989	12	(7,5)	3	(1,2)	10	16	(10,6)	2	(0,2)	10	53
1990	5	(3,2)	2	(1,1)	12	38	(21,17)	4	(2,2)	28	89
1991	5	(4,1)	2	(2,0)	7	20	(11,9)	12	(3,9)	34	80
1992	0	(0,0)	2	(1,1)	16	16	(7,9)	2	(0,2)	60	96
1993	1	(0,1)	1	(1,0)	2	7	(1,6)	4	(1,3)	8	23
1994	0	(0,0)	1	(1,0)	14	4	(2,2)	2	(1,1)	52	73
1995	0	(0,0)	2	(2,0)	8	4	(3,1)	2	(2,0)	23	39
1996	0	(0,0)	1	(0,1)	12	2	(0,2)	0	(0,0)	39	54
1997	0	(0,0)	0	(0,0)	0	4	(2,2)	3	(2,1)	3	10
1998	0	(0,0)	1	(0,1)	9	2	(1,1)	2	(1,1)	43	57
1999	0	(0,0)	1	(0,1)	7	1	(0,1)	1	(1,0)	8	18
2000	0	(0,0)	2	(2,0)	11	1	(1,0)	3	(0,3)	18	35
2001	1	(1,0)	0	(0,0)	9	2	(1,1)	0	(0,0)	15	27
2002	0	(0,0)	0	(0,0)	5	1	(1,0)	1	(1,0)	11	18
2003	0	(0,0)	1	(1,0)	13	5	(3,2)	1	(1,0)	16	36
2004	0	(0,0)	1	(1,0)	5	2	(0,2)	1	(0,1)	14	23
2005	0	(0,0)	0	(0,0)	7	1	(0,1)	1	(1,0)	11	20
2006	0	(0,0)	1	(1,0)	5	1	(0,1)	0	(0,0)	11	18
2007	1	(1,0)	2	(1,1)	3	3	(3,0)	2	(1,1)	11	22
2008	0	(0,0)	1	(0,1)	3	0	(0,0)	0	(0,0)	6	10
2009	0	(0,0)	0	(0,0)	4	3	(1,2)	1	(1,0)	9	17
2010	0	(0,0)	0	(0,0)	2	0	(0,0)	0	(0,0)	9	11
2011	0	(0,0)	0	(0,0)	2	0	(0,0)	1	(0,1)	7	10
2012	0	(0,0)	0	(0,0)	2	0	(0,0)	0	(0,0)	5	7
2013	0	(0,0)	0	(0,0)	2	1	(1,0)	0	(0,0)	1	4
Total	25	(16,9)	24	(15,9)	170	134	(69,65)	45	(18,27)	452	850

Table 2. Survey effort for the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2013.

	territories surveyed to minimum protocol [1]	territories surveyed to protocol [2]	new territories added	total owls detected	territories inhabited [3]	hybrid territories [4]
1989	0	19	19	36	19	0
1990	0	46	27	83	43	0
1991	0	71	27	109	59	0
1992	0	82	10	120	64	0
1993	0	80	3	101	54	0
1994	0	87	3	99	53	0
1995	0	86	1	93	51	0
1996	0	81	1	82	46	0
1997	0	86	1	68	40	0
1998	0	87	0	78	44	0
1999	0	82	1	76	45	0
2000	0	82	1	68	39	0
2001	0	80	0	56	33	0
2002	8	75	0	44	26	0
2003	10	75	2	50	28	0
2004	8	77	0	49	26	0
2005	8	77	0	46	26	0
2006	8	77	0	46	29	0
2007	8	77	0	40	23	0
2008	8	75	0	36	26	0
2009	8	75	0	31	22	1
2010	8	75	0	26	18	0
2011	8	75	0	21	11	1
2012	8	75	0	20	13	0
2013	8	75	0	21	14	0

[1] Minimum protocol consisted of one visit to the territory.
[2] Territories surveyed to protocol as outlined in Lint et al. (1999)
[3] A territory was considered inhabited if one owl was detected during the survey period, March-August
[4] Hybrid territories are those inhabited by a pair composed of a Spotted and a Barred Owl or by a Spotted Owl/Barred Owl hybrid

Table 3. Reproductive indices of Spotted owls on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2013. Fecundity and mean brood size of successful nests.

	Fecundity			Mean brood size of successful nests		
Year	**N[1]**	**Mean**	**SE**	**N[2]**	**Mean**	**SE**
1989	11	0.77	0.12	9	1.89	0.11
1990	31	0.66	0.08	23	1.78	0.09
1991	46	0.45	0.07	24	1.71	0.11
1992	50	0.79	0.06	42	1.88	0.09
1993	43	0.12	0.05	6	1.67	0.21
1994	40	0.74	0.09	27	2.19	0.13
1995	38	0.42	0.07	20	1.60	0.11
1996	33	0.76	0.07	28	1.79	0.09
1997	33	0.06	0.04	3	1.33	0.33
1998	36	0.72	0.09	27	1.93	0.13
1999	27	0.30	0.08	10	1.60	0.16
2000	31	0.52	0.08	20	1.60	0.11
2001	26	0.50	0.09	16	1.63	0.13
2002	19	0.37	0.11	9	1.78	0.15
2003	22	0.66	0.10	16	1.81	0.14
2004	23	0.48	0.10	13	1.69	0.13
2005	20	0.50	0.11	11	1.82	0.12
2006	15	0.57	0.12	10	1.70	0.15
2007	16	0.47	0.12	9	1.67	0.17
2008	9	0.39	0.16	4	1.75	0.25
2009	10	0.55	0.16	6	1.83	0.17
2010	7	0.86	0.14	6	2.00	0.00
2011	10	0.55	0.16	6	1.83	0.17
2012	6	0.58	0.15	5	1.40	0.24
2013	7	0.36	0.18	3	1.67	0.33
Total	609	0.52	0.02	353	1.79	0.03

[1] Sample size (n) includes those females checked for reproductive status by August 31. Fecundity is the number of females fledged per female, assuming a 50:50 sex ratio. Values have changed from previous versions due to ignoring owls wearing tailmount transmiters.

[2] Mean brood size of nests that produced at least 1 young, and where the number of fledged young was determined by August 31. Values have changed from previous versions due to ignoring owls wearing tailmount transmiters.

Table 3 (cont). Reproductive indices of Spotted owls on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2013. Proportion of females that nested.

Year	N[1]	Proportion	95% CI[4]	
1989	8	0.88	0.47	1.00
1990	21	0.86	0.64	0.97
1991	33	0.64	0.45	0.80
1992	47	1.00	0.92	1.00
1993	39	0.18	0.08	0.34
1994	34	0.91	0.76	0.98
1995	32	0.66	0.47	0.81
1996	32	0.97	0.84	1.00
1997	27	0.15	0.04	0.34
1998	34	0.91	0.76	0.98
1999	20	0.60	0.36	0.81
2000	27	0.81	0.62	0.94
2001	23	0.74	0.52	0.90
2002	17	0.59	0.33	0.82
2003	20	0.95	0.75	1.00
2004	20	0.75	0.51	0.91
2005	19	0.58	0.33	0.80
2006	13	0.92	0.64	1.00
2007	15	0.67	0.38	0.88
2008	5	0.80	0.28	0.99
2009	6	0.83	0.36	1.00
2010	5	1.00	0.48	1.00
2011	5	0.80	0.28	0.99
2012	4	1.00	0.40	1.00
2013	5	0.60	0.15	0.95
Total	511	0.73	0.69	0.76

[1] Sample size (n) includes females that were checked for nesting status before June 15
[2] Sample size (n) includes nesting females that were checked for reproductive status by August 31
[3] Sample size (n) includes all females that were checked for reproductive status by August 31. The sample size for this index is commonly larger than other indices because we often cannot make the required visits to determine nesting status before the June15 cutoff due to limited access or low response rates for non-nesting females.
[4] Exact confidence limits for the binomial proportion using the F distribution, Collett (1991)
Values are different than previous annual reports due to excluding owls with tailmount radio-transmitters in these estimates.

Table 3 (cont). Reproductive indices of Spotted owls on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2013. Proportion of nesting females fledging young.

Year	N[2]	Proportion	95% CI[4]	
1989	7	1.00	0.59	1.00
1990	17	0.94	0.71	1.00
1991	21	0.81	0.58	0.95
1992	44	0.86	0.73	0.95
1993	7	0.86	0.42	1.00
1994	31	0.77	0.59	0.90
1995	21	0.90	0.70	0.99
1996	31	0.90	0.74	0.98
1997	4	0.75	0.19	0.99
1998	31	0.84	0.66	0.95
1999	12	0.75	0.43	0.95
2000	22	0.91	0.71	0.99
2001	17	0.82	0.57	0.96
2002	10	0.80	0.44	0.97
2003	18	0.78	0.52	0.94
2004	15	0.80	0.52	0.96
2005	11	0.91	0.59	1.00
2006	12	0.67	0.35	0.90
2007	10	0.90	0.55	1.00
2008	4	0.75	0.19	0.99
2009	5	1.00	0.48	1.00
2010	5	0.80	0.28	0.99
2011	4	0.75	0.19	0.99
2012	4	1.00	0.40	1.00
2013	3	0.67	0.09	0.99
Total	366	0.84	0.80	0.88

[1] Sample size (n) includes females that were checked for nesting status before June 15
[2] Sample size (n) includes nesting females that were checked for reproductive status by August 31
[3] Sample size (n) includes all females that were checked for reproductive status by August 31. The sample size for this index is commonly larger than other indices because we often cannot make the required visits to determine nesting status before the June15 cutoff due to limited access or low response rates for non-nesting females.
[4] Exact confidence limits for the binomial proportion using the F distribution, Collett (1991)
Values are different than previous annual reports due to excluding owls with tailmount radio-transmitters in these estimates.

Table 3 (cont). Reproductive indices of Spotted owls on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2013. Proportion of females fledging young.

Year	N[3]	Proportion	95% CI[4]	
1989	11	0.82	0.48	0.98
1990	31	0.74	0.55	0.88
1991	46	0.52	0.37	0.67
1992	50	0.84	0.71	0.93
1993	43	0.14	0.05	0.28
1994	40	0.68	0.51	0.81
1995	38	0.53	0.36	0.69
1996	33	0.85	0.68	0.95
1997	33	0.09	0.02	0.24
1998	36	0.75	0.58	0.88
1999	27	0.37	0.19	0.58
2000	31	0.65	0.45	0.81
2001	26	0.62	0.41	0.80
2002	19	0.47	0.24	0.71
2003	22	0.73	0.50	0.89
2004	23	0.57	0.34	0.77
2005	20	0.55	0.32	0.77
2006	15	0.67	0.38	0.88
2007	16	0.56	0.30	0.80
2008	9	0.44	0.14	0.79
2009	10	0.60	0.26	0.88
2010	7	0.86	0.42	1.00
2011	10	0.60	0.26	0.88
2012	6	0.83	0.36	1.00
2013	7	0.43	0.10	0.82
Total	609	0.58	0.54	0.62

[1] Sample size (n) includes females that were checked for nesting status before June 15
[2] Sample size (n) includes nesting females that were checked for reproductive status by August 31
[3] Sample size (n) includes all females that were checked for reproductive status by August 31. The sample size for this index is commonly larger than other indices because we often cannot make the required visits to determine nesting status before the June15 cutoff due to limited access or low response rates for non-nesting females.
[4] Exact confidence limits for the binomial proportion using the F distribution, Collett (1991)
Values are different than previous annual reports due to excluding owls with tailmount radio-transmitters in these estimates.