WILDLIFE ECOLOGY TEAM
WILDLIFE HABITAT RELATIONSHIPS
IN WASHINGTON AND OREGON
FISCAL YEAR 2010.

October, 2010

Study

Demography of Spotted Owls on the east slope of the Cascade Range, Washington, 1989-2010

Researchers

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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. in press.).

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).

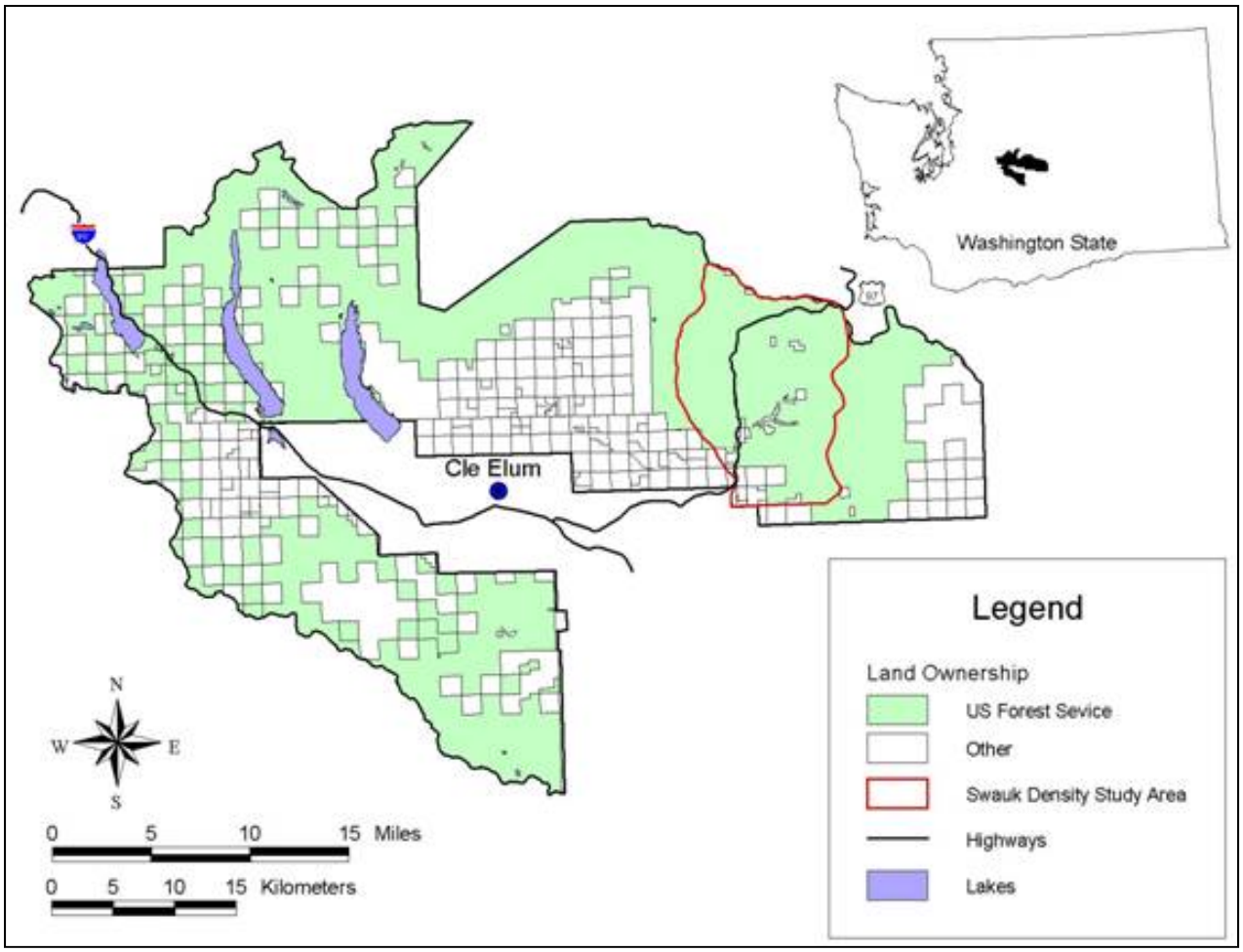

Figure 1. The Cle Elum Study Area, Washington.

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 Spotted Owl calls at each established call station on 3 occasions during the March – August field season

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

(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 continue to collect blood samples from captured owls for future genetic study (Haig et al. 2004, Funk et al. 2009).

In January, 2009, 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. The results of the meta-analysis are in press and will be published in July 2011(Forsman et al. in press).

RESULTS

Population Trends

General Study Area

In 2010 we banded 11 juvenile owls, bringing the total number of owls banded during 1989-2010 to 827 (68 subadults, 158 adults, and 601 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 2010. In 2010, we confirmed the bands of 20 owls and detected another 6 owls on 18 territories. This compares to a high of 120 owls on 64 territories in the same area in 1992 (Figure 3, Table 2).

We have noted a 78% decline in the number of owls detected on the study area since 1992, and a concomitant increase in the number of vacant territories (Figure 4). The rate of population change (λ) calculated by Anthony et al. (2006) for the Cle Elum Study Area for 1989-2003 was 0.938 (SE = 0.019), indicating a population decline of 6.2% per year (95% CI = 2.5 – 10.0% decline). The ratio of male:female Spotted Owls has increased in recent years (Figure 5).

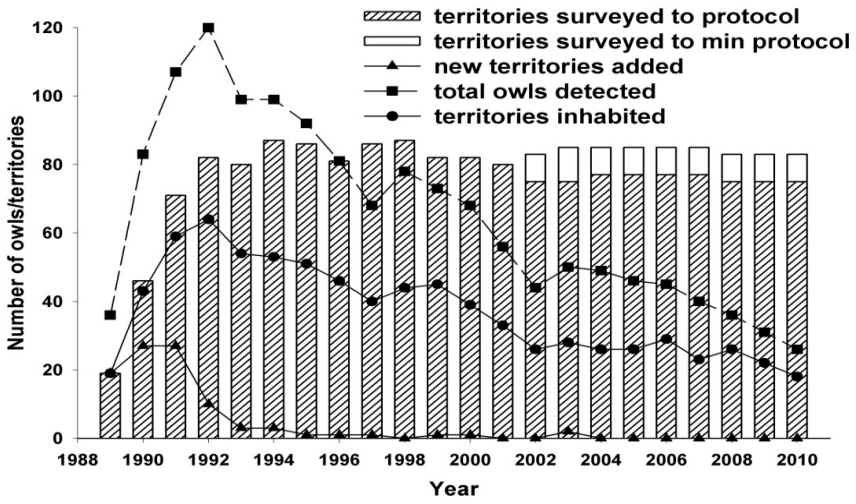

Figure 3. Number of Spotted Owls detected, number of territories in which we detected owls, number of territories surveyed, and number of new territories added by year on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2010. Minimum protocol territories included 8-10 territories 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.

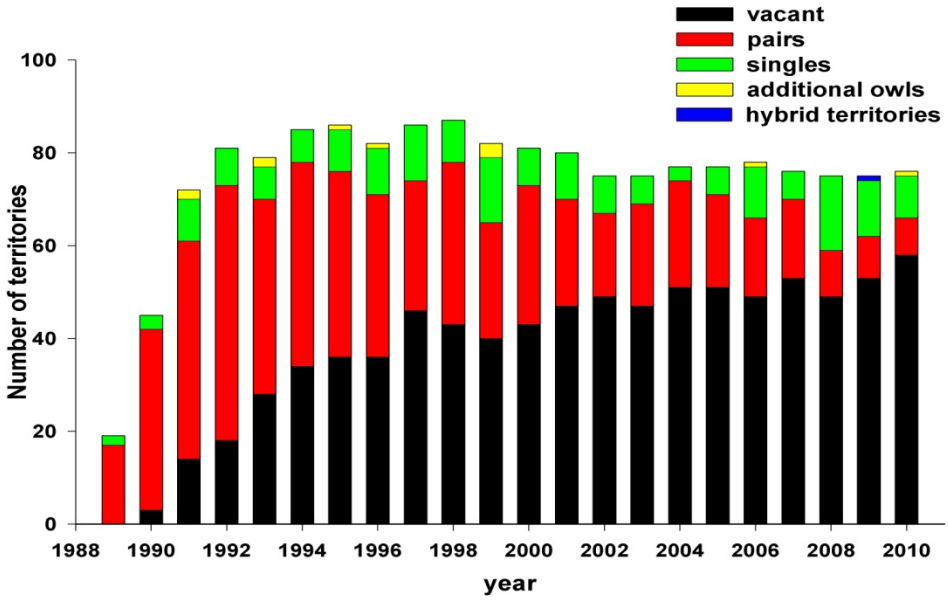

Figure 4. Number of vacant territories, hybrid territories, and number of territories inhabited by singles, pairs, and "additional owls" on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2010. An "additional owl" is counted when a single owl is detected at a territory where a pair 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. Totals do not include 8-10 vacant sites where we made less than 3 complete visits in a year starting in 2002.

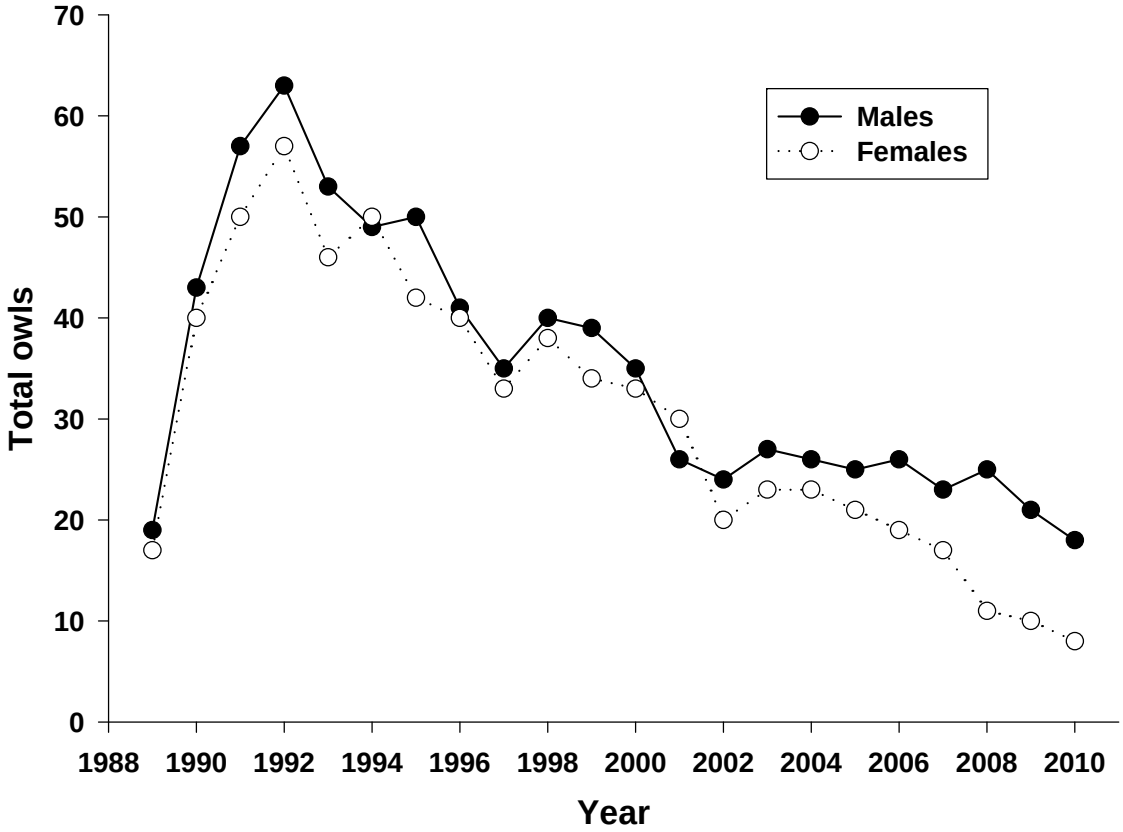

Figure 5. Number of male and female Spotted Owls detected by year on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2010.

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 12 new owls (2 adults, and 10 fledglings) at 20 inhabited territories on the WEN, and changed bands or confirmed bands on another 2 adult owls. We surveyed 28 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). We detected unpaired male owls at night at 4 territories in the DSA this year, but were unable to find the owls during the day to confirm their leg bands. We suspect these responses represent < 4 owls. However, since we did not positively identify the owls, we counted all 4 individuals in the total for the DSA. An additional unpaired male, which has been at the same territory in the DSA for 5 years, was detected at 2 adjacent territories as far as 3.6 km (2.25 mi) from his territory center. We suspect the male was searching for a mate, as is likely the case with the 4 unpaired males mentioned above.

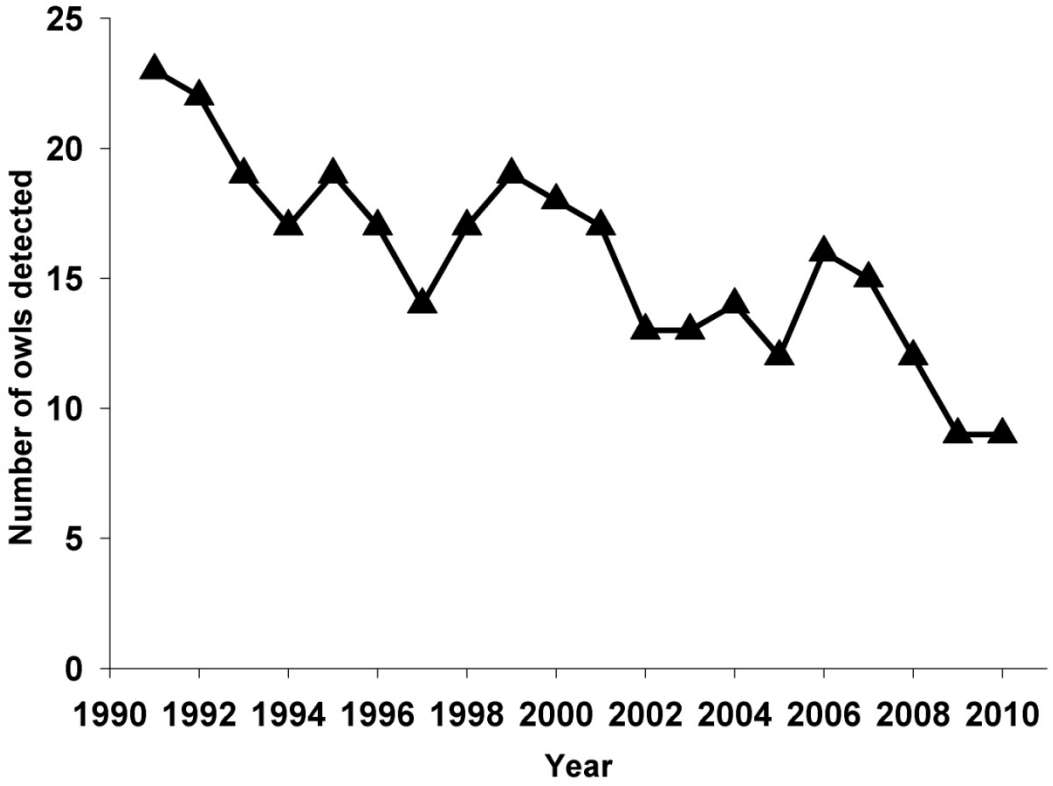

Figure 6. Number of non-juvenile Spotted Owls detected on the 204 km^2 Swauk Density Study Area on the Okanogan-Wenatchee National Forest, Washington, 1991-2010. Points represent actual counts.

West Nile Virus

None of the oral swab or blood samples from owls tested positive for the presence of West Nile Virus. Samples from 2 mosquitoes collected in neighboring Yakima County January 1 through September 15, 2010 tested positive for West Nile Virus (CDC 2010). West Nile Virus was detected in 2 each birds, horses, and mosquitoes from Kittitas

County in 2009, but no specimens tested positive in 2010. 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. 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)

We recorded 23 Barred Owl responses in the GSA in 2010 during our Spotted Owl surveys. Based on how these responses were situated temporally and/or geographically, we believe the responses represent 17 Barred Owl territories. Due to limited resources, we did not attempt to determine whether the responses represented nesting pairs.

To estimate the proportion of Spotted Owl sites that are inhabited by Barred Owls each year in the GSA, we assigned a center location to each Spotted Owl territory that we surveyed each year. If no Spotted Owls were detected, we used the location from the last time the territory was inhabited by a Spotted Owl. We coded the territory as having a Barred Owl response if a Barred Owl responded within 1 km of any of the historic territory centers. We felt this measure of the Barred Owl effect would capture instances where the Barred Owls were displacing Spotted Owls > 1 km between years. The proportion of Spotted Owl territories in the GSA with Barred Owl responses increased from 1989-2002, after which time the proportion has varied among years but not increased above the 2002 level (Figure 7).

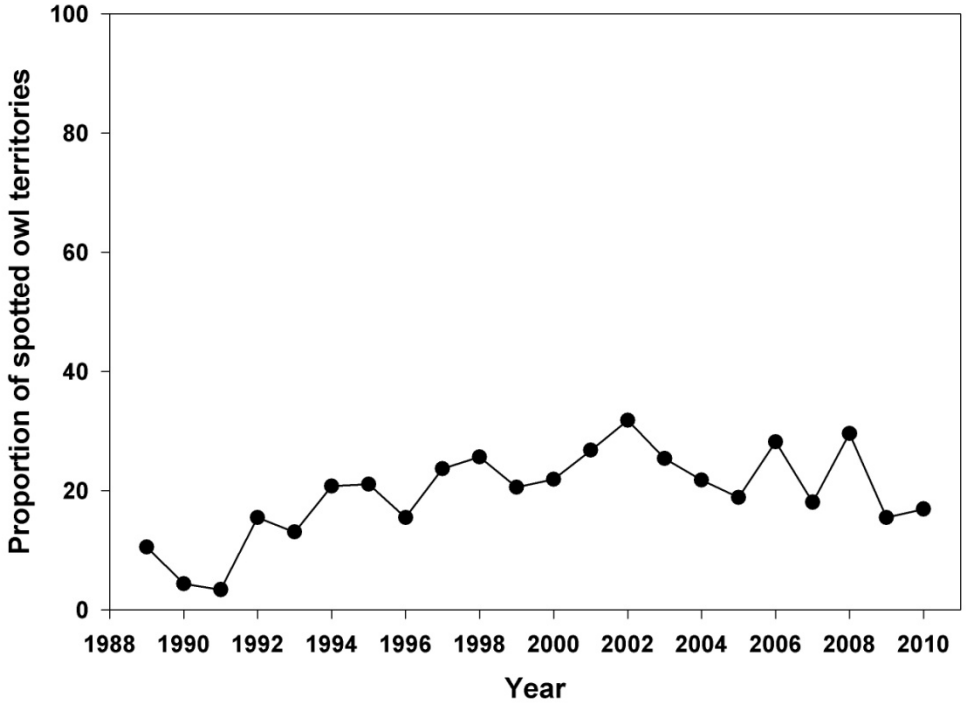

Figure 7. Proportion of Spotted Owl territories with a Barred Owl response within 1 km of any of the historic territory centers, Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2010.

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. The last 2 years, we detected Barred Owls and Spotted Owls at an equal number of territories in the DSA (Figure 8).

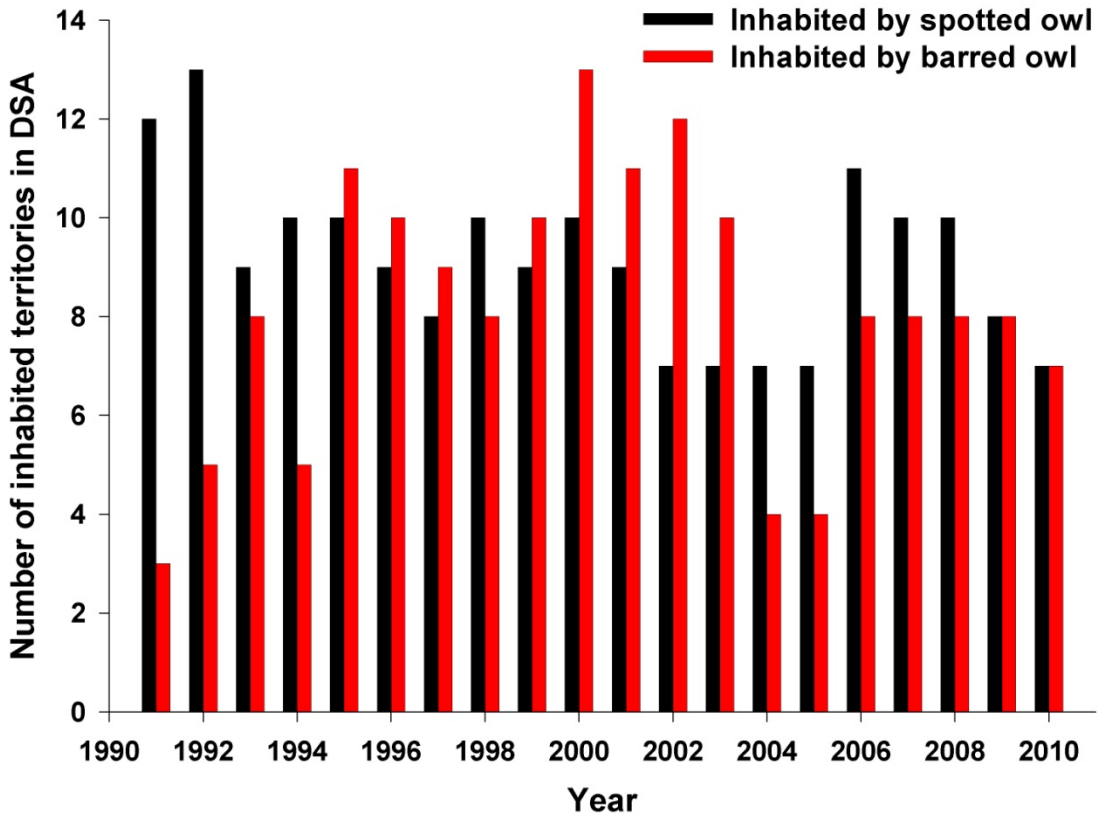

Figure 8. Number of territories in which we detected Spotted Owls and Barred Owls in the Swauk Cr. Density Study Area, Okanogan-Wenatchee National Forest, Washington, 1991-2010 Territories were considered inhabited if an owl of either sex was detected at the territory. The values for 2009 include one territory inhabited by a Spotted owl/Barred owl pair.

"Sparred" owl (Spotted owl x Barred owl hybrid) fledgling, 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.

In December, 2009, the US Fish and Wildlife Service published a notice of intent to prepare an Environmental Impact Statement for a Barred Owl removal study (USFWS 2009). This study, if initiated, will evaluate the effect of Barred Owl removal on vital rates (e.g. survival, reproduction, recruitment) of the Spotted Owl. The Cle Elum Study Area is a candidate for experimental Barred Owl removal under this proposal.

Reproductive Rates

All 5 females for which we determined nesting status in 2010 attempted to nest. Four nests produced young. Average fecundity (number of female young produced per female owl) was 0.75 (SE = 0.16, Table 3). The 2010 values for proportion of females nesting and fecundity were above the average for all years (Figure 9, Table 4). We found the remains of one fledgling on the ground near a nest. This mortality was likely due to predation.

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 9 years (Figure 9, Table 3-4).

Comparing a suite of models including the odd-even year effect, Anthony et al. (2006) noted that models that included a negative time trend in fecundity were a good fit to the data from the Cle Elum Study Area in 1989-2003. This indicates that fecundity decreased during that time period. Since the Anthony et al. (2006) analysis, fecundity on the Cle Elum Study Area has shown less variation among years (Forsman et al. in press).

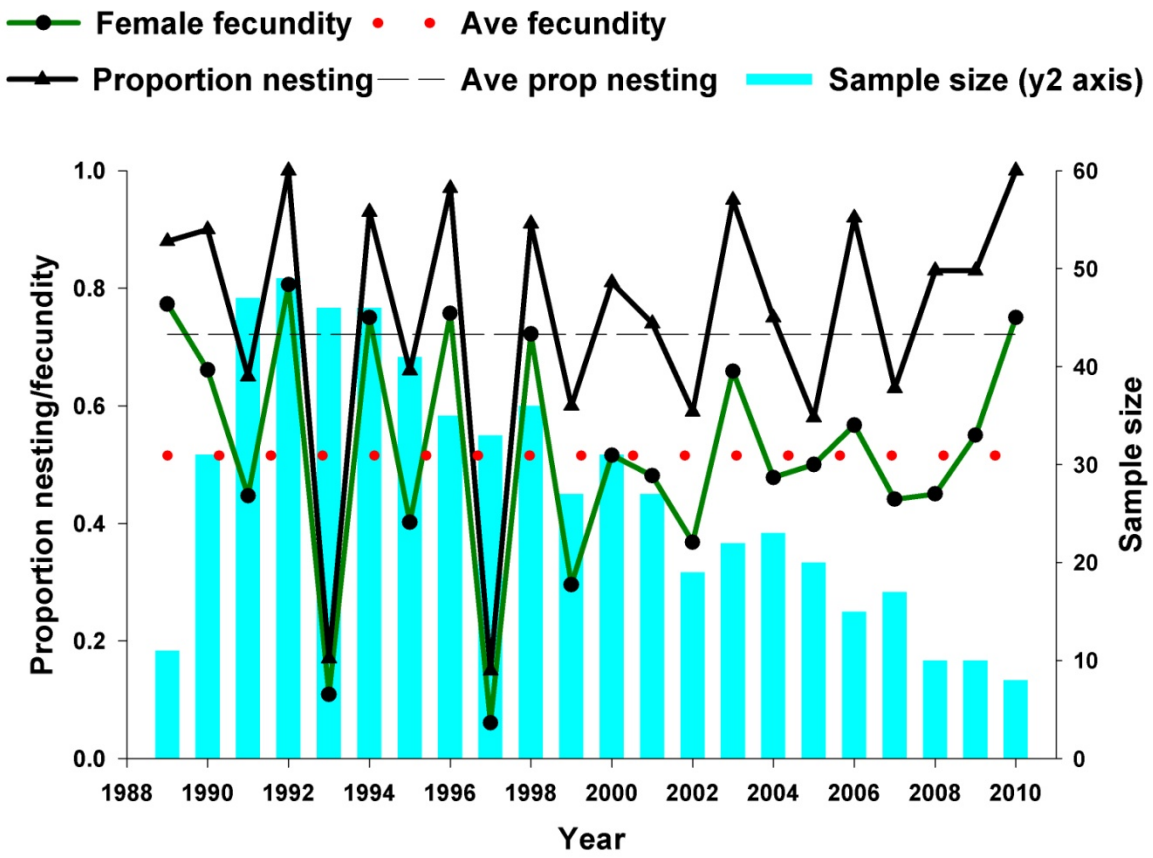

Figure 9. Reproductive indices of Northern Spotted Owls on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2010. Indices shown are: *proportion of females nesting* and *fecundity*. Sample size of females used for fecundity analysis for each year (bars) is plotted on axis Y2. 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 1989-2010) fecundity and proportion nesting, respectively.

During 1989-2010 there were 2 years (1993, 1997) with extremely low reproduction. While the reproductive rates appear to have been somewhat less variable in recent years, the reproductive indices are proportions that apply to 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 (Figure 10). The small number of reproductive females remaining on the study area is 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).

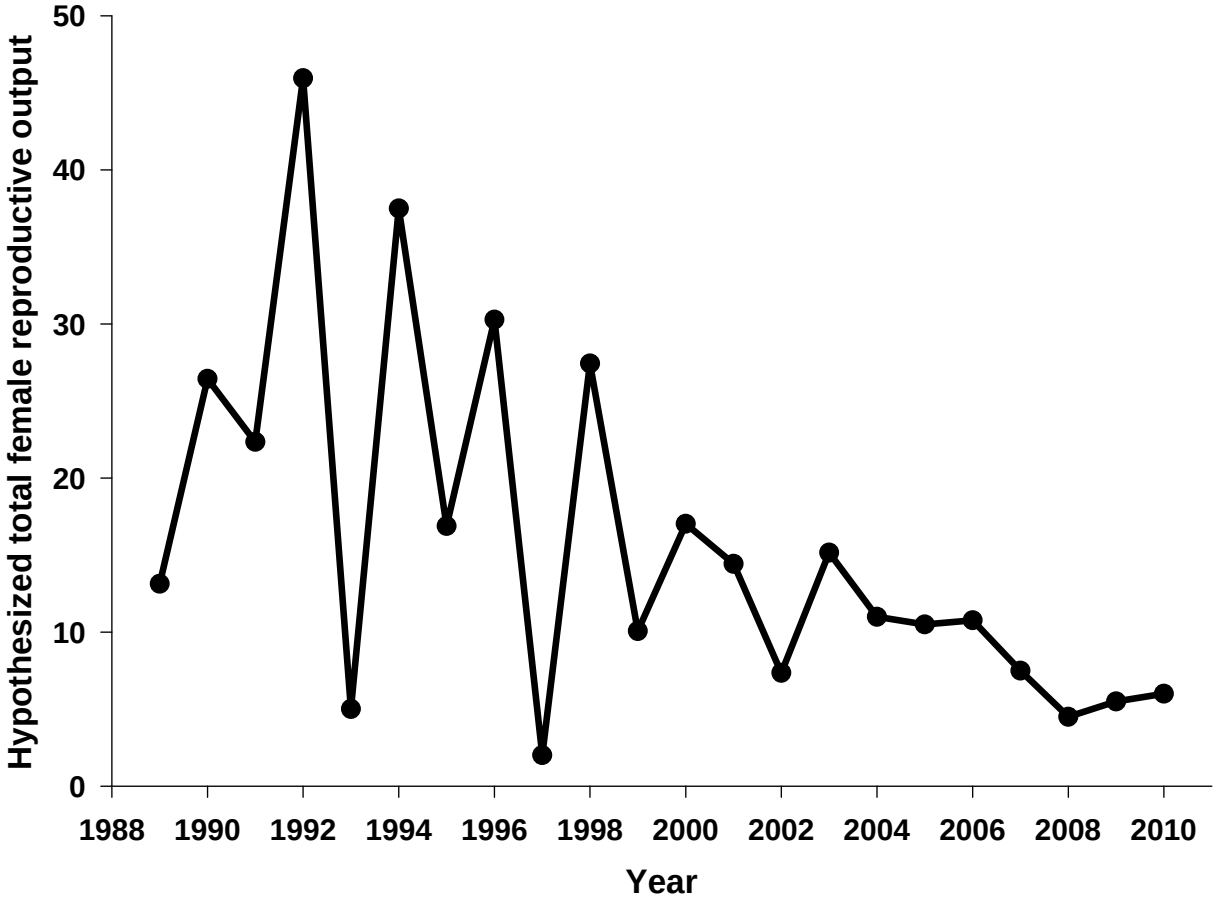

Figure 10. Hypothesized annual female reproductive output (average yearly female fecundity * number of females detected each year), Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2010. Note in the years prior to 1992 the sample of females monitored each year was increasing as we added new territories to the sample.

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 2009). Aerial reconnaissance by WDNR 2000-2009 indicates that as much as 37% 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 in stands that are dominated by Douglas-fir (*Pseudotsuga menzesii*) and grand fir (*Abies grandis)*.

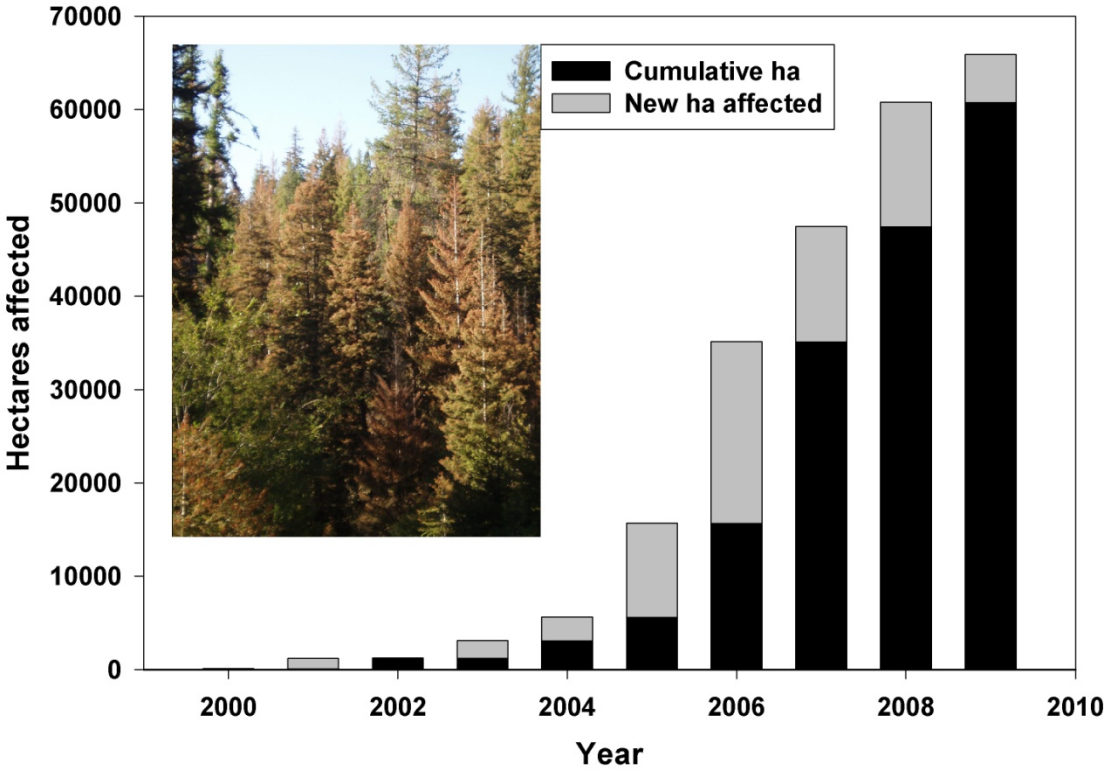

Figure 11. Cumulative area (hectares) of forest affected by western spruce budworm, and new hectares affected by year on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 2000-2009 (WDNR 2009).

The 2009 Spotted Owl Demographic Workshop

A workshop to analyze data from Spotted Owl demography study areas was conducted in January 2009. This analysis included data from the Cle Elum Study Area 1989-2008, 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, however 3 study areas (MAR, WEN, WSR, Figure 12) which provided data in the 2003 Spotted Owl Demography Workshop were discontinued after 2003. The results from the 2009 workshop will be published as a monograph in July 2011(Forsman et al. in press).

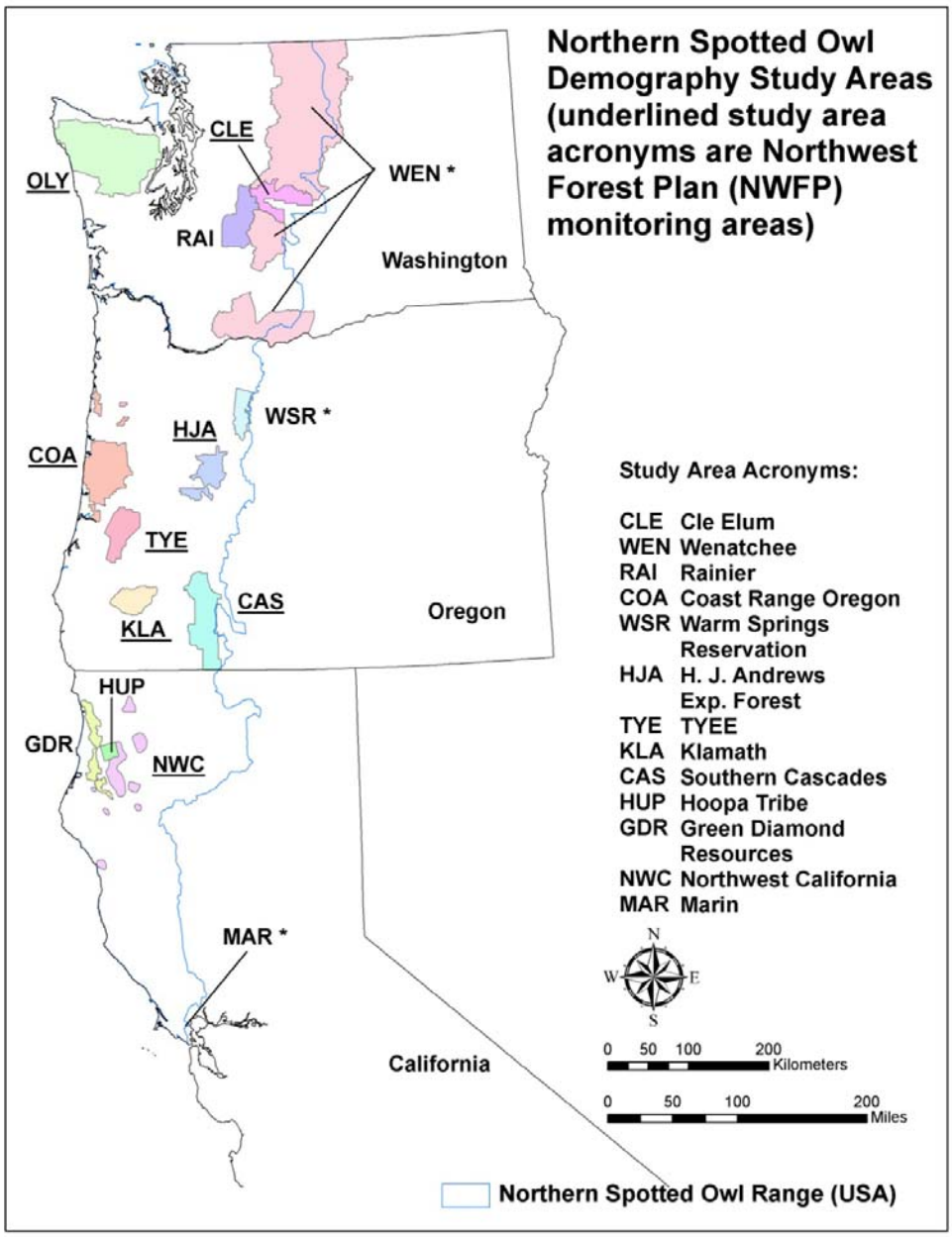

Figure 12. Northern Spotted Owl Demography Study Areas in the range of the Owl. Study areas with asterisks (MAR, WEN, and WSR) were discontinued after the 2003 analysis.

Problems encountered

We were unable to survey on 19 scheduled survey days and/or nights due to inclement weather. Reduced maintenance of Forest Service roads and road closures continue 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.

Recreational hooting by bird enthusiasts at several of our Spotted owl territories is becoming more common as improvements in MP3 players and the ready access to recorded calls increases. A letter to the local Audubon Society chapter to address this issue was written by Janet Millard, USFS biologist at the Wenatchee River Ranger District (Millard, 2010).

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Publications and presentations in Fiscal Year 2010

Habitat use by Northern Spotted Owls during natal dispersal. In prep.

Habitat use and home range of Northern Spotted Owls in Washington. In prep.

Associations between Barred owls, landscape pattern and site occupancy of Northern Spotted Owls in the eastern Cascades of Washington . In prep.

Nest reuse by Northern Spotted Owls on the east slope of the cascades range, Washington. In press. Northwest Naturalist 92(2):xxx-xxx.

Attended a workshop entitled "Creating Stand-Level Prescriptions that Integrate Ecological and Fuel Management Objectives across the Eastern Cascades", Redmond, Oregon, 13 October, 2009.
http://www.fws.gov/oregonfwo/ExternalAffairs/Topics/DryForestWorkshop/2009DryForestWorkshop.asp

"All about Owls". "Nature of Night" program, 21 November, 2009, Central Washington University Center for Excellence in Science and Mathematics Education. A Powerpoint presentation, owl pellet examples, and a live Great horned owl provided by the Kittitas Animal Rehabilitation Group.

Attended the USFWS Provincial Spotted Owl Habitat meeting, Portland Or, 18 December, 2009.

"Spotted owl status in the Teanaway Subarea Planning area", a presentation to the Kittitas County Chapter of the Audubon Society, 18 February, 2010.

Attended a meeting with the USFWS regarding their draft EIS of proposed Barred owl removal, Corvallis, Or., 22 February, 2010.

Leavenworth Spring Birdfest, 14 May, 2010. Led a field tour to find owls, including a discussion that emphasized the danger to owls from broadcasting owl calls to locate them.

Washington Ornithological Society, 11 June, 2010. Led a field tour to a Spotted owl site. This field trip included a discussion that emphasized the danger to owls from broadcasting owl calls to locate them.

Led the Central Washington University biological techniques class to an owl site to describe mark-recapture techniques, 15 June, 2010.

Spent a day with Erik Stokstad, a reporter from Science Magazine.

Spent 3 person-days in August, 2010, doing surveys in support of a highway widening project near an active Spotted Owl nest for Washington Department of Transportation. The project involved blasting a rock face within 1 km of the nest.

Table 1. Number of Spotted owls banded each year on the Cle Elum Study Area, Okanogan-Wenatchee National forest, Washington, 1989-2010.

	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)	2	3 (1,2)	1 (1,0)	9	15
2010	0 (0,0)	0 (0,0)	2	0 (0,0)	0 (0,0)	9	11
Total	25 (16,9)	24 (15,9)	162	133 (68,65)	44 (18,26)	439	827

Table 2. Survey effort for the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2010.

	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

[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

Table 3. Reproductive indices of Spotted owls on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2010.

	Fecundity of female owls[1]			Mean brood size of successful nests[2]		
Year	n	mean	se	n	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	47	0.45	0.07	25	1.68	0.11
1992	49	0.81	0.06	42	1.88	0.09
1993	46	0.11	0.04	6	1.67	0.21
1994	46	0.75	0.08	32	2.16	0.11
1995	41	0.40	0.07	21	1.57	0.11
1996	35	0.76	0.07	30	1.77	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	27	0.48	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	17	0.44	0.11	9	1.67	0.17
2008	10	0.45	0.16	5	1.80	0.20
2009	10	0.55	0.16	6	1.83	0.17
2010	8	0.75	0.16	6	2.00	0.00
Total	604	0.52	0.02	349	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.

[2] Mean brood size of nests that produced at least 1 young, and where the number of fledged young was determined by August 31

Table 4. Reproductive indices of Spotted owls on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2010.

	proportion (π) of females that nested[1]				proportion (π) of nesting females that fledged young[2]				proportion (π) of all females that fledged young [3]			
year	n	π	95% CI [4]		n	π	95% CI [4]		n	π	95% CI [4]	
1989	8	0.88	0.47	1.00	7	1.00	0.59	1.00	11	0.82	0.48	0.98
1990	20	0.90	0.68	0.99	17	0.94	0.71	1.00	31	0.74	0.55	0.88
1991	34	0.65	0.46	0.80	22	0.82	0.60	0.95	47	0.53	0.38	0.68
1992	47	1.00	0.92	1.00	43	0.88	0.75	0.96	49	0.86	0.73	0.94
1993	41	0.17	0.07	0.32	7	0.86	0.42	1.00	46	0.13	0.05	0.26
1994	40	0.93	0.80	0.98	37	0.78	0.62	0.90	46	0.70	0.54	0.82
1995	35	0.66	0.48	0.81	23	0.87	0.66	0.97	41	0.51	0.35	0.67
1996	34	0.97	0.85	1.00	33	0.91	0.76	0.98	35	0.86	0.70	0.95
1997	27	0.15	0.04	0.34	4	0.75	0.19	0.99	33	0.09	0.02	0.24
1998	34	0.91	0.76	0.98	31	0.84	0.66	0.95	36	0.75	0.58	0.88
1999	20	0.60	0.36	0.81	12	0.75	0.43	0.95	27	0.37	0.19	0.58
2000	27	0.81	0.62	0.94	22	0.91	0.71	0.99	31	0.65	0.45	0.81
2001	23	0.74	0.52	0.90	17	0.82	0.57	0.96	27	0.59	0.39	0.78
2002	17	0.59	0.33	0.82	10	0.80	0.44	0.97	19	0.47	0.24	0.71
2003	20	0.95	0.75	1.00	18	0.78	0.52	0.94	22	0.73	0.50	0.89
2004	20	0.75	0.51	0.91	15	0.80	0.52	0.96	23	0.57	0.34	0.77
2005	19	0.58	0.34	0.80	11	0.91	0.59	1.00	20	0.55	0.32	0.77
2006	13	0.92	0.64	1.00	12	0.67	0.35	0.90	15	0.67	0.38	0.88
2007	16	0.63	0.35	0.84	10	0.90	0.55	1.00	17	0.53	0.28	0.77
2008	6	0.83	0.36	1.00	5	0.80	0.28	0.99	10	0.50	0.19	0.81
2009	6	0.83	0.36	1.00	5	1.00	0.48	1.00	10	0.60	0.26	0.88
2010	5	1.00	0.48	1.00	5	0.80	0.28	0.99	8	0.75	0.35	0.97
Total	512	0.73	0.69	0.76	366	0.85	0.81	0.88	604	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)