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WILDLIFE HABITAT RELATIONSHIPS
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Study

Demography of Spotted Owls on the east slope of the Cascade Range, Washington, 1989-2009

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. 2009.).

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 2). 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. Adult spotted owl with yellow and black leg band

Within the GSA we survey all historic owl territories each year to locate and confirm previously banded owls, determine the number of young produced at each territory, and band new owls (Forsman 1983, Franklin, et al., 1996, Lint et al., 1999). We conduct a complete survey of the DSA each year in order to estimate the number of resident owls within the area. On both areas we use standard protocols to confirm bands of owls that are relocated and we band all new owls with a numbered USFWS band and a uniquely colored plastic leg band (Figure 1).

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. The meta-analysis uses mark-recapture data to estimate age- and sex-specific survival and recruitment, and population growth rate.

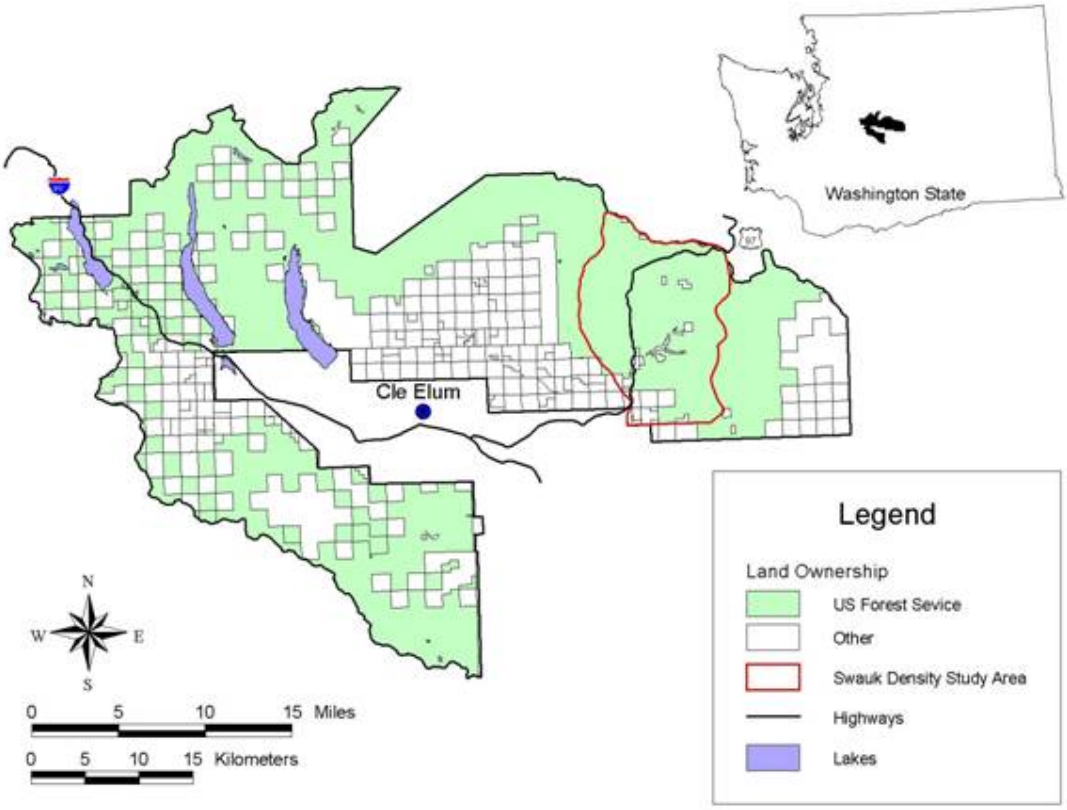

Figure 2. The Cle Elum Study Area, Washington.

RESULTS

Population Trends

General Study Area

We banded 11 juvenile owls 3 adults, and 1 subadult in 2009 bringing the total number of owls banded during 1989-2009 to 816 (67 subadults, 159 adults, 590 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 were occupied in 2009. In 2009, we confirmed the bands of 27 owls and detected another 4 owls on 22 occupied 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 decline of approximately 74 % in the number of owls detected on the study area since 1992. 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).

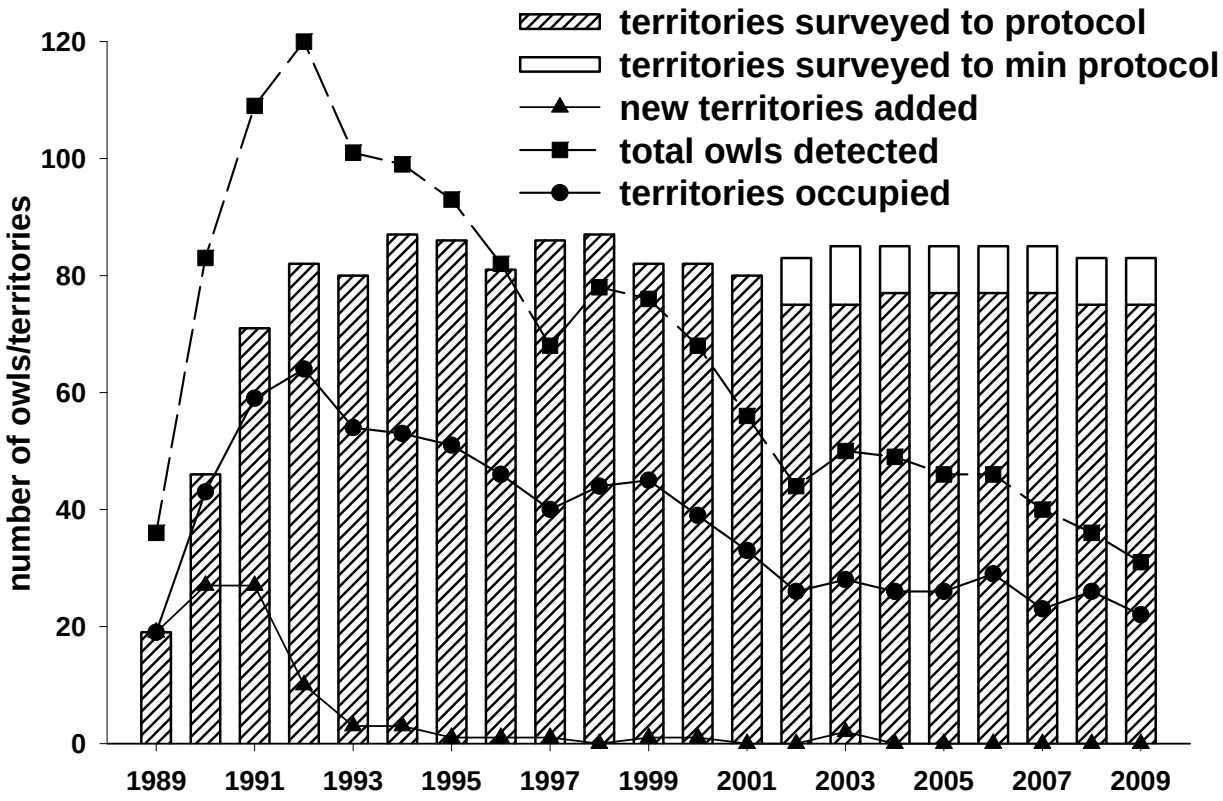

Figure 3. Number of Spotted Owls detected, number of territories occupied, number of territories surveyed, and number of new territories added by year on the Cle Elum Study Area, Wenatchee National Forest, Washington, 1989-2009. Minimum protocol territories included 8-10 territories that we visited only once per year beginning in 2002. A territory was considered occupied if a single owl response was detected which was not associated with a neighboring territory.

Elsewhere on the 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 8 new owls (3 adults, and 5 fledglings) at 21 occupied territories on the WEN, and changed bands or confirmed bands on another 42 adult owls. We surveyed 45 territories to protocol.

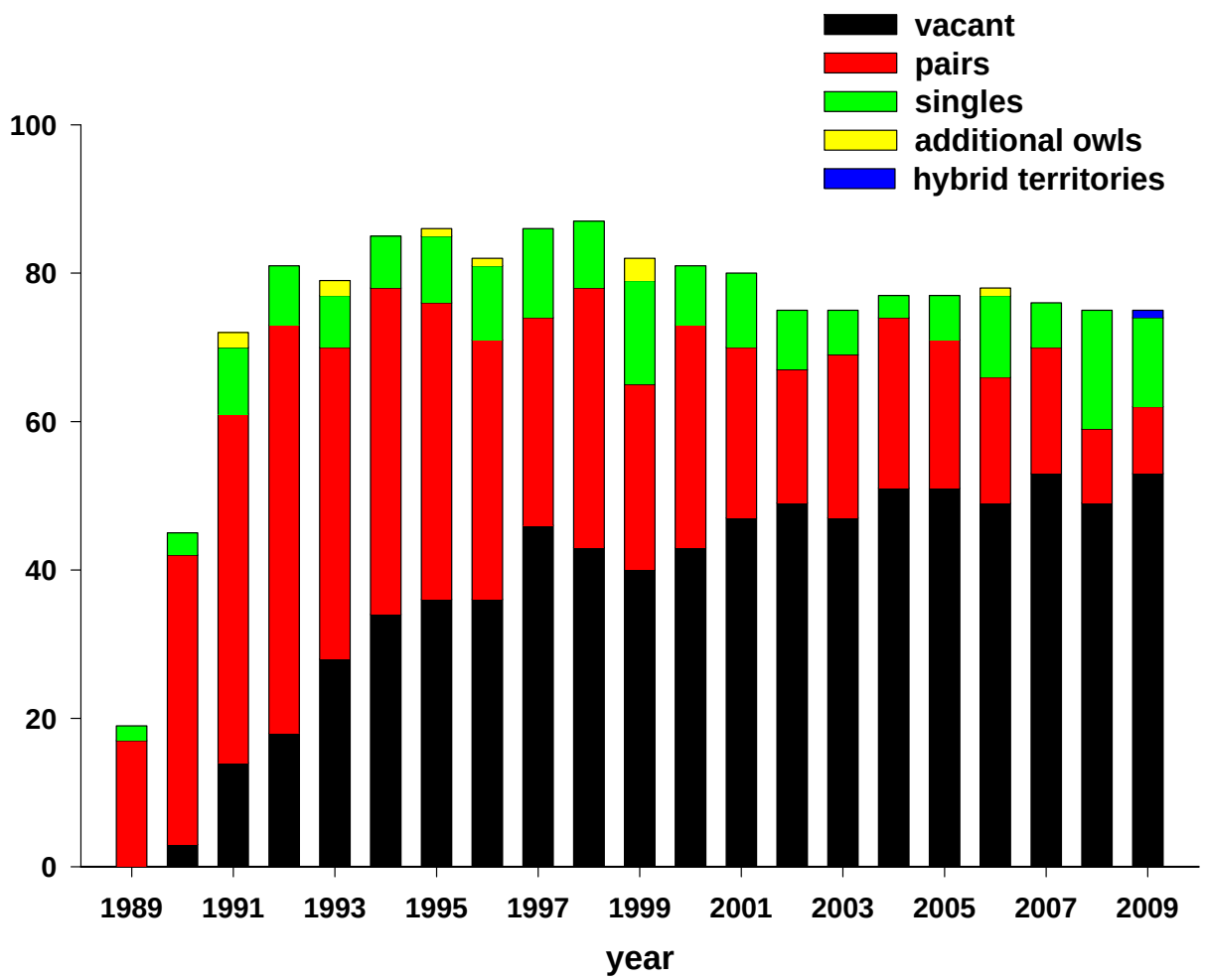

Figure 4. Number of vacant territories, hybrid territories, and number of territories occupied by singles, pairs, and "additional owls" on the Cle Elum Study Area, Wenatchee National Forest, Washington, 1989-2009. An "additional owl" is counted when a single owl is detected at a territory where a pair has already been confirmed, and the single owl response cannot be attributed to an adjacent territory. A hybrid territory is one occupied 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.

Density Study Area

We attempted a complete count of Spotted Owls in the 204 km^2 Swauk Creek Density Study Area (Figure 2) 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 (Forsman 1983, Lint et al. 1999, Reid et al. 1999). The call stations are positioned so that we achieve a 100 % auditory coverage of the entire DSA. The DSA survey data indicate an overall decline in the number of owls detected in the DSA since 1991 (Figure 5).

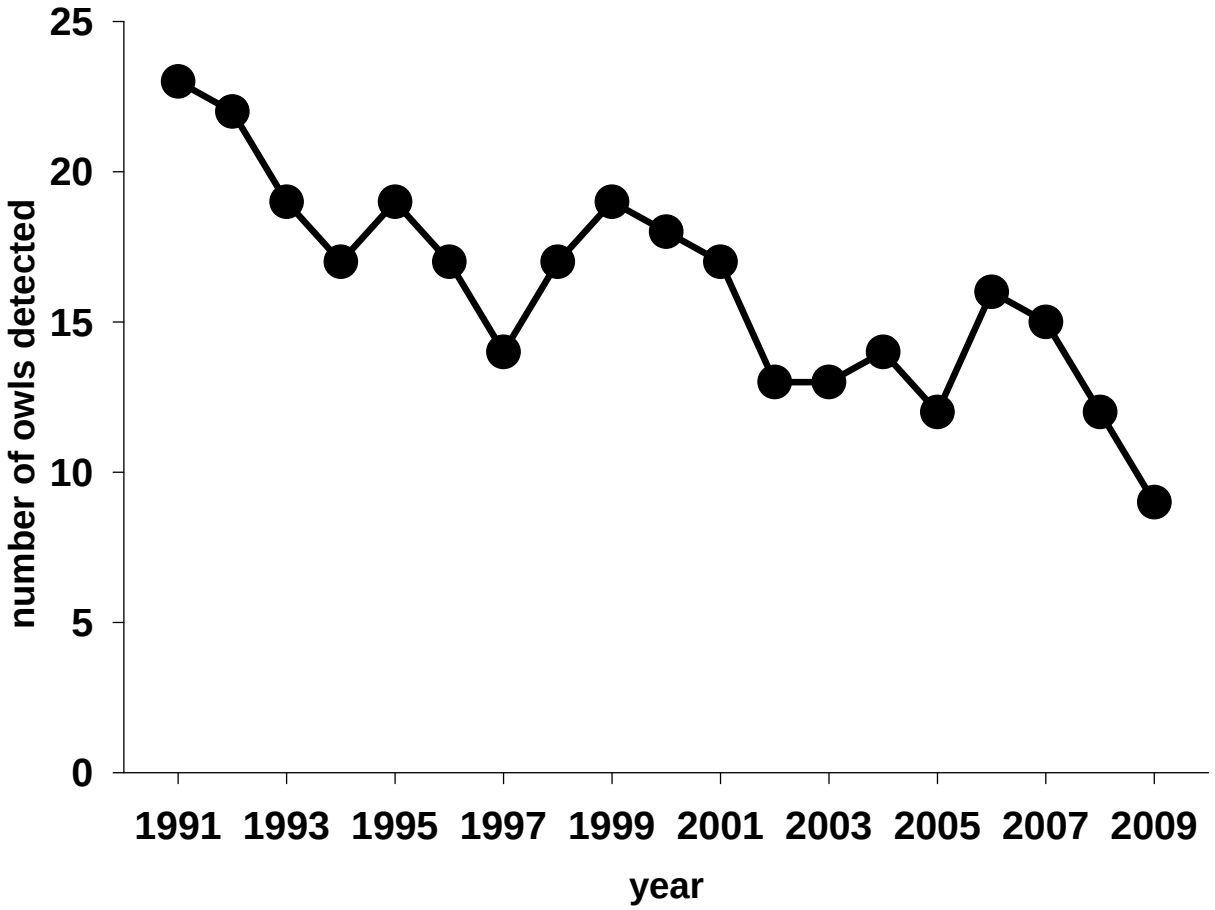

Figure 5. Number of non-juvenile owls detected on the 204 km^2 Cle Elum Density Study Area on the Okanogan-Wenatchee National Forest, Washington, 1991-2009. Points represent actual counts.

West Nile Virus

None of the oral swab or blood samples from owls tested positive for the presence of West Nile Virus. Samples from other animals collected January 1 through September 15, 2009 and analyzed by the Center for Disease Control show the West Nile Virus is present in the area: 2 cases of West Nile Virus were reported in horses, 2 cases in birds, and 2 cases in mosquitoes from Kittitas County; and 8 cases in horses, 4 cases in humans, and 142 cases in mosquitoes from neighboring Yakima County (CDC 2009). 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 site occupancy and reproduction of Spotted Owls were lower when barred owls were detected nearby. Thus, monitoring the number of occupied Barred Owl territories is an important index to measure the effect of Barred owls on Spotted Owl territory occupancy (Olson et al. 2005)

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

We recorded 27 Barred Owl responses in the General Study Area in 2009 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.

The apparent number of occupied Barred Owl territories in the DSA increased in 1991-2000, and then decreased until 2005. This year, we detected the same number of occupied Barred owl territories (8) as in the last 3 years (Figure 6).

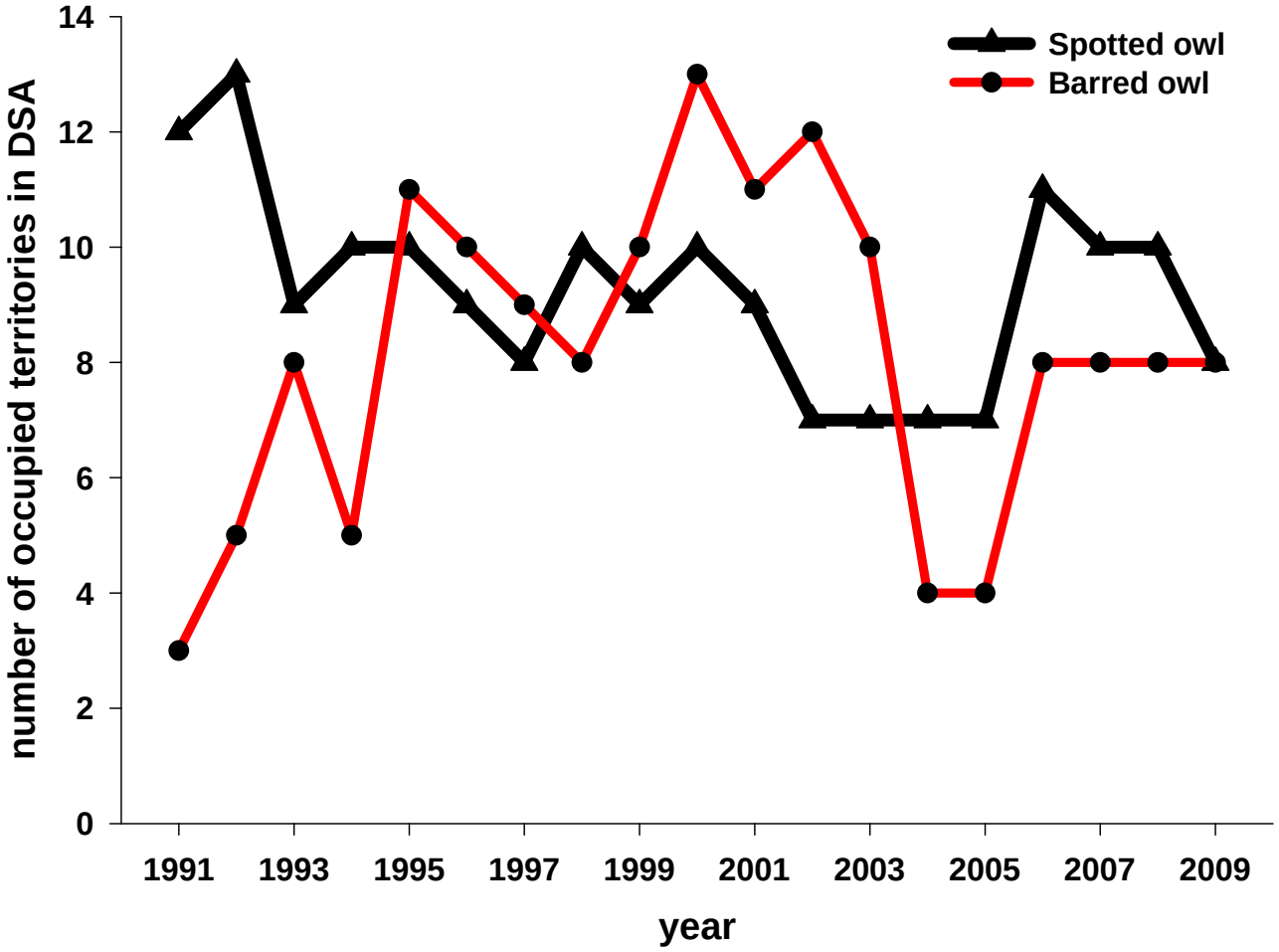

Figure 6. Number of occupied Spotted Owl territories and Barred Owl territories in the Swauk Cr. Density Study Area, Wenatchee National Forest, Washington, 1991-2009. Territories were considered occupied if an owl of either sex was detected at the territory. The values for 2009 include one territory occupied by both spotted and barred owl.

To calculate the proportion of Spotted Owl sites that are occupied by Barred Owls each year in the GSA , we assigned a center location to each Spotted Owl territory we surveyed each year. If no Spotted Owls were detected, we used the location from the last time the territory was occupied 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 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).

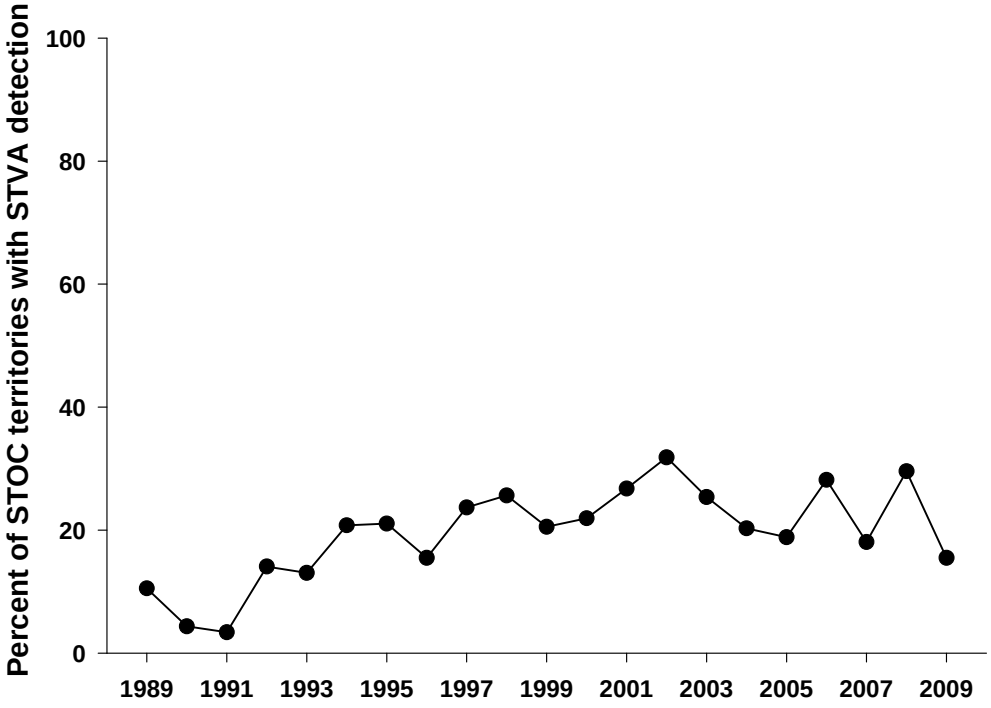

Figure 7. Proportion of Spotted Owl territories with a Barred Owl response within 1 km of any of the historic territory centers, Cle Elum Study Area, Wenatchee National Forest, Washington, 1989-2009.

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 this year. The pair was composed of 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 ratio of male:female Spotted Owls has increased in recent years (Figure 8), thus it could be that this first hybrid pair is the result of a paucity of female Spotted Owls in the population. The pair nested and produced 2 young.

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

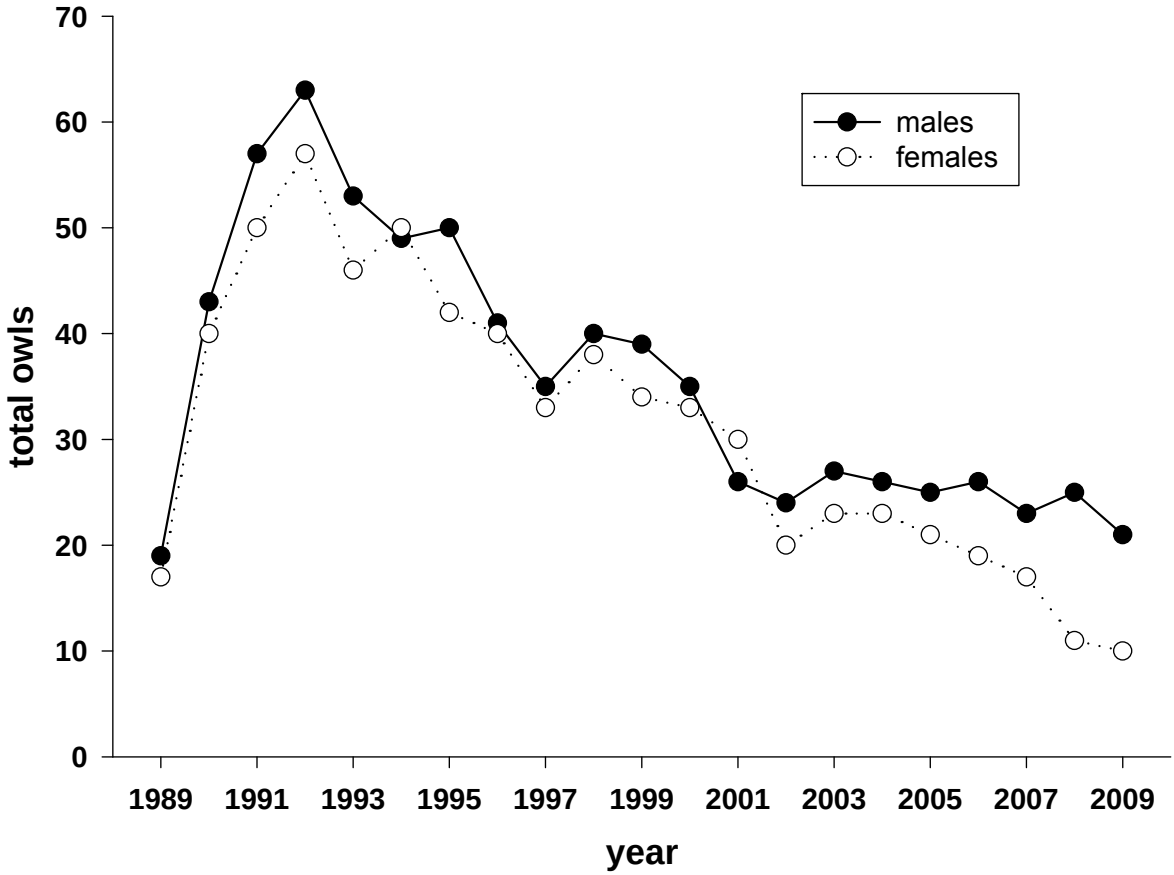

Figure 8. Number of male and female Spotted Owls detected by year, Cle Elum Study Area, Wenatchee National Forest, Washington, 1989-2009.

The nest tree used by the Spotted/Barred Owl pair was atypical for a Spotted Owl: the nest was in a top cavity in a snag approximately 4 m tall, in an advanced stage of decay, and in a fairly open forest stand (Figure 8). Most (82 %) of the Spotted Owl nests found on the Cle Elum Study Area are associated with dwarf mistletoe (*Arceuthobium spp*.) brooms or other platform structures, and most are in stands with higher canopy cover than the hybrid nest. Few (33%) of the 24 cavity nests that Spotted Owls have used during the course of this study have been in dead trees, and none were in trees with this degree of decay. Buchanan et al. (2004) noted that Barred Owls used cavities for nesting more often than Spotted Owls in this region.

Figure 8. Snag used as nest by Spotted Owl/Barred Owl pair. Photo by Margy Taylor

Reproductive Rates

Of the 6 non-juvenile females for which we determined nesting status in 2009, 5 (83 %). attempted to nest, and all 5 nests produced young. Average fecundity (number of female young produced per female owl) was 0.55 (SE = 0.16, Table 3). The 2009 values for proportion of females nesting and fecundity were slightly above the average for all years (Figure 10, 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 9 years (Figure 10, 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 has 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.

Female Spotted Owl and fledglings. Photo by Michael Frank

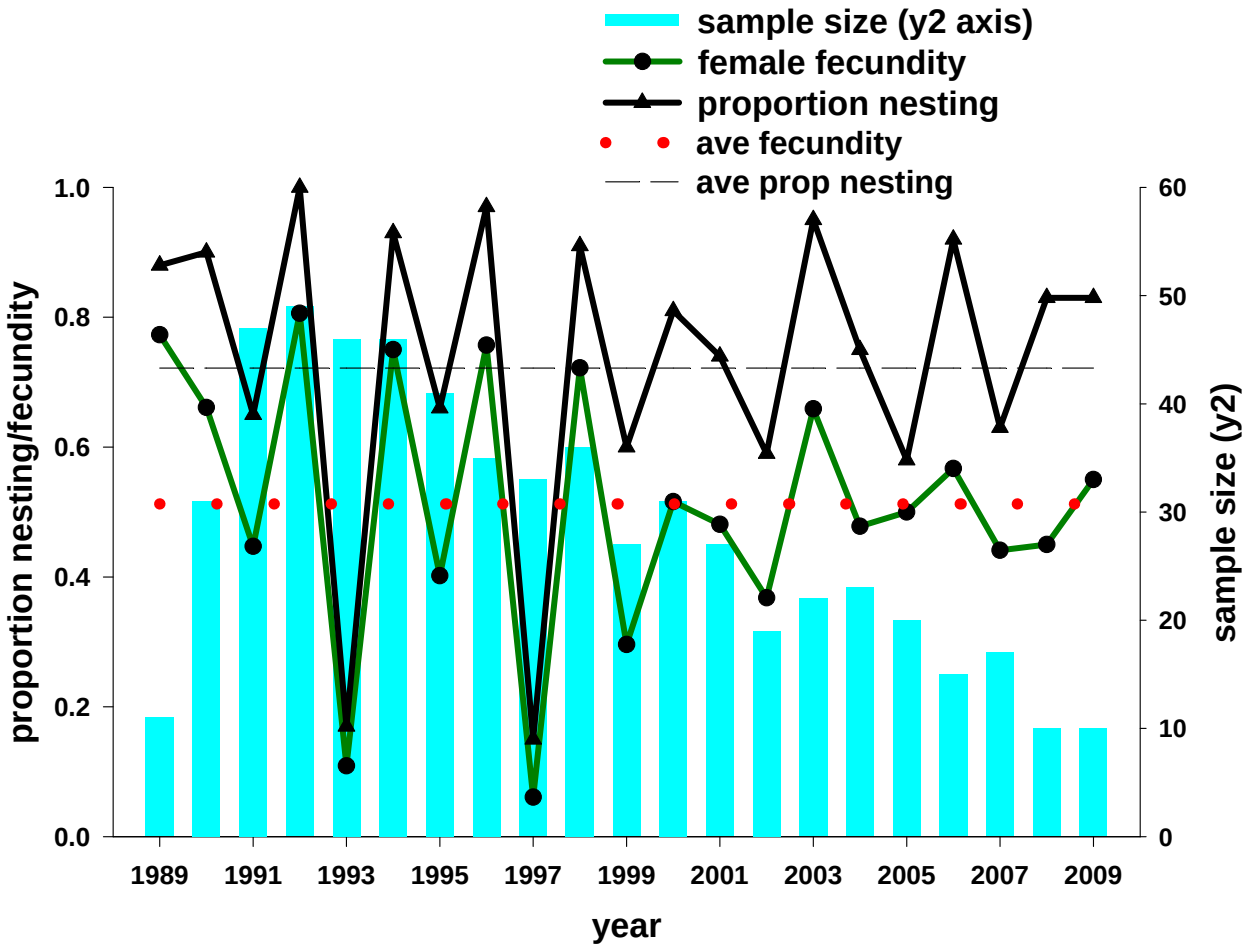

Figure 10. Reproductive indices of Northern Spotted Owls on the Cle Elum Study Area, Wenatchee National Forest, Washington, 1989-2009. Indices shown are: *proportion of females nesting* and *fecundity*. Sample size of females used for fecundity analysis for each year (bars) is plotted on axis Y2. Fecundity is the number of females produced per female owl, assuming a 50:50 sex ratio. The dotted and dashed lines show average (all years 1989-2008) for fecundity and proportion nesting, respectively.

During the years 1989-2009 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 11). 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).

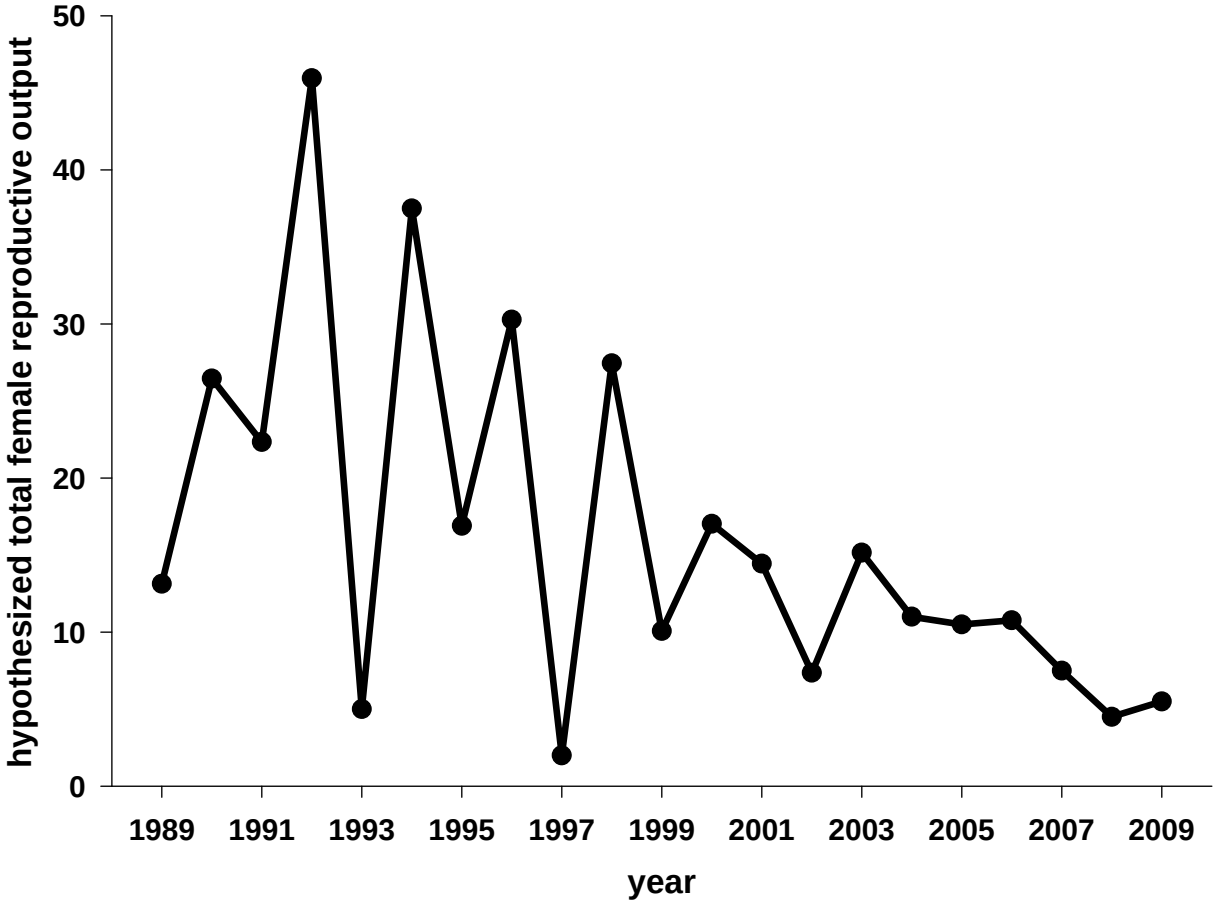

Figure 11. Hypothesized total female reproductive output (average yearly female fecundity * number of females detected each year), Cle Elum Study Area, Wenatchee National Forest, Washington, 1989-2008. Note in the years prior to 1992 the total sample of females monitored each year was increasing as we added new territories to the sample.

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 10). Three additional study areas also participated in the workshop, however 3 study areas (MAR, WEN, WSR, Figure 10) which provided data in the 2003 Spotted Owl Demography Workshop were discontinued after 2003. The results from the 2009 workshop will be available to the public in Winter, 2009.

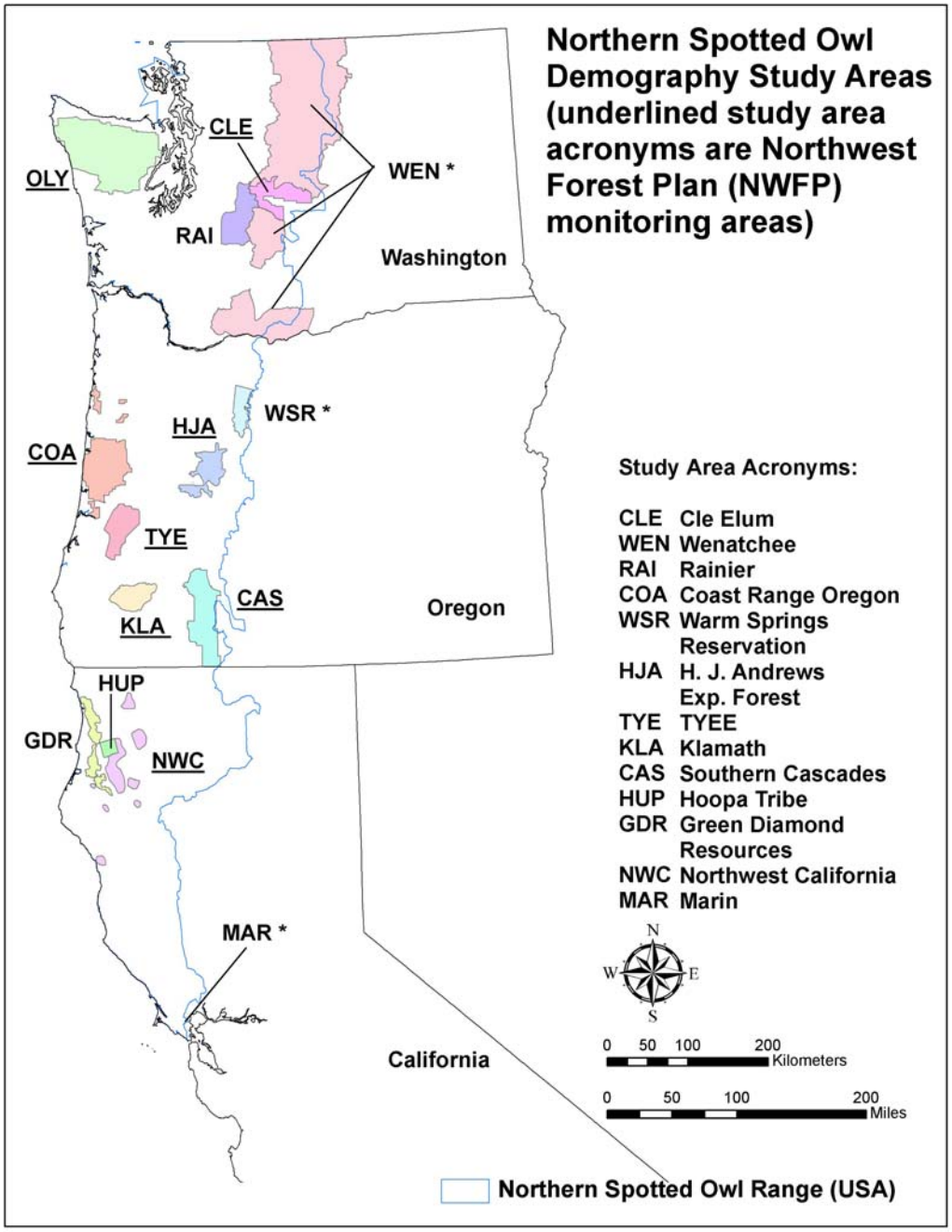

Figure 12. Northern Spotted Owl Demography Study Areas in the range of the Owl. The study areas with asterisks (MAR, WEN, and WSR) were discontinued after the 2003 analysis.

Problems encountered

We were unable to survey on 15 scheduled survey nights due to inclement weather or restricted access due to snow. Reduced maintenance of Forest Service roads and road closures continue to reduce vehicle access. This often necessitates other means of travel (foot, bicycle, ATV) to our calling stations, which increases time spent for each survey. A significant flood event in January, 2009 permanently closed one road to vehicle access and delayed access to other roads until repairs were made after the snow melted off in the spring.

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Publications and presentations in Fiscal Year 2008

Dispersal habitat of Northern Spotted Owls in Washington. 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.

“All about Owls”. A Powerpoint presentation, owl pellet examples, and a live Great horned owl provided by the Kittitas Animal Rehabilitation Group, presented at the “Nature of Night” program, November 22, 2008, Central Washington University Center for Excellence in Science and Mathmatics Education.

Demographic Trends of Northern Spotted Owls: A Meta-analysis, 1985-2008. In prep.

Table 1. Number of spotted owls banded each year on the Cle Elum Study Area, Okanagon-Wenatchee National forest, Washington, 1989-2009.

	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	39 (21,18)	3 (2,1)	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
Total	25 (16,9)	24 (15,9)	160	134 (67,64)	43 (17,25)	430	816

Table 2. Survey effort for the Cle Elum Study Area, Okanagon-Wenatchee National Forest, Washington, 1989-2009.

	territories surveyed to minimum protocol [1]	territories surveyed to protocol [2]	new territories added	total owls detected	territories occupied [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

[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 occupied if one owl was detected during the survey period, March-August
[4] Hybrid territories are those occupied by a pair composed of a spotted and a barred owl

Table 3. Reproductive indices of spotted owls on the Cle Elum Study Area, Okanagon-Wenatchee National Forest, Washington, 1989-2009.

	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
Total	596	0.51	0.02	343	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, Okanagon-Wenatchee National Forest, Washington, 1989-2009.

	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
Total	507	0.72	0.68	-	0.76	361	0.85	0.81	-	0.88	596	0.58	0.53	-	0.61

[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
[4] Exact confidence limits for the binomial proportion using the F distribution, Collett (1991)