US Department of Agriculture Forest Service
Pacific Northwest Research Station
Cle Elum Spotted Owl Demography Study
2016 Annual Report
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1. Title

Demography of Spotted Owls on the east slope of the Cascade Range, Washington, 1989-2016.

2. Principal Investigator and Research Team

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3. Introduction

Background and potential benefits or utility of the study

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. 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, Dugger et al. 2016). In addition, the long-term dataset obtained during this study has provided the baseline for a pilot study of the effect of Barred Owl removal on Spotted Owl demographics (see below).

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.

4. Study Area

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 currently 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).

In October 2013, the Washington State Department of Natural Resources purchased more than 20,000 ha (~ 50,000 acres) of private land located mostly in the Teanaway River Drainage. The most recent landowner of these parcels was American Forest Holdings LLC., but the land was originally owned by Boise Cascade Corp. In October, 2014, The Nature Conservancy purchased over 19,000 ha (~ 48,000 acres) of land formerly owned by Plum Cr. Timber. These two purchases effectively assigned the management of nearly all private lands within the GSA to these two entities.

5. Methods

Survey design

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). The extent of the survey of owl territories accounts for neighboring owls, but generally encompasses approximately a 2.5 km radius around historic site centers. Any new owls as well as young of the year are banded for mark-recapture analysis. 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 three occasions during the March – August field season (Forsman 1983, Lint et al. 1999, Reid et al. 1999). Call stations are positioned to achieve a 100% auditory coverage of the entire DSA.

Field methods

Our owl surveys consist of broadcasting or imitating owl calls at mapped calling stations distributed throughout the study area. Calling stations last 10 minutes. Usually initial calling stations are surveyed at night, but in some cases, such as poor access or other safety or logistical concerns, stations are surveyed during the day only. When Spotted Owls are heard responding to our calls at night, we return for a follow-up visit, usually the next day, to attempt to locate the owl. If we locate owls during daytime visits, we offer the owl mice and attempt to capture and band the owl, if necessary. By offering the owls mice, we are generally able to determine nesting status and locate fledglings. Our field protocols are outlined in Franklin, et al. (1996) and Lint et al. (1999).

Owls were captured with a noose pole (Forsman 1983), and banded with a numbered USFWS 7B locking aluminum band and a colored plastic band. This banding method generally allowed us to determine the identity of owls in successive years without having to recapture them. During handling, owls were weighed and a variety of measurements were taken. Owls were released within 20 minutes in the immediate vicinity of where they were captured.

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. 2004). 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, Sovern et al. 2014, Wiens et al. 2014, Dugger et al. 2016). 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). During our Spotted Owl surveys, we record data for Barred Owl responses, as well as other owl species.

Analytical methods

Every five years, a meta-analysis of Spotted Owl mark-recapture data is conducted. This meta-analysis includes data from 8 monitoring areas funded through the Northwest Forest Plan, plus three additional study areas in the range of the Northern Spotted Owl. The meta-analysis includes Cormack-Jolly_Seber open population modeling of mark-recapture data (Lebreton et al. 1992), a reparameterization of the Jolly-Seber capture- recapture model to estimate annual population change and recruitment (Pradel 1996), a mixed effects linear model of reproductive data, and a two-species territory occupancy model (MacKenzie et al. 2002). The results of the most recent workshop can be found in Dugger et al. (2016). The previous workshop occurred in 2009, and the results from that analysis were published in Forsman et al. (2011).

A USGS study to test the response of the Spotted Owl population to the removal of Barred Owls began on the GSA this year (USFWS 2011). This study involves surveying the entire General Study Area for Barred Owls by broadcasting Barred Owl calls, and removing Barred Owls from a portion of the study area while monitoring the population of Barred Owls in the remaining portion of the study area without Barred Owl removal (a Before-After-Control-Impact study design).

6. Results

Population Trends

Key findings of the 2014 meta-analysis of Spotted Owl demography data (Dugger et al. 2016) were: 1) there was strong evidence of population declines in Spotted Owls on most 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 mean annual rate of population change (λ) for the Cle Elum Study Area was 0.916 (95% CI 0.894 – 0.938), indicating an annual population decline of 8.4% (95% CI 6.2 – 10.6%. This estimate shows a steeper decline in Spotted Owl numbers than the estimate in Forsman et al. 2011 (6.3%).

Number of territories where Spotted Owls were detected

General Study Area

In 2016, we banded four juvenile owls and six adult or subadult owls, bringing the total number of owls banded during 1989-2016 to 875 (168 adults, 70 subadults, and 637 juveniles, Table 1). Our monitoring effort has remained relatively consistent after 1992, except for seven-ten territories we began monitoring with only one visit per year beginning in 2002. None of these “minimum-protocol” territories contained owls in 2016. We confirmed the bands of 15 Spotted Owls, and detected 18 Spotted Owls on 14 territories (Figure 2). This compares to a high of 120 owls on 64 territories in the same area in 1992 (a decline of 85 %, Figure 2, Table 2). The ratio of males:females has increased again in the last two years (Figure 8).

Elsewhere on the Okanogan-Wenatchee National Forest, we continued banding owls on a portion of what was the Wenatchee Demography Study Area. The WEN was monitored by National Council for Air and Stream Improvement from 1990-2003, in cooperation with the Wenatchee National Forest. We banded five new owls at 11 inhabited territories on the WEN, and changed bands or confirmed bands on three adult owls. We surveyed 39 territories to protocol.

Density Study Area

We detected six Spotted Owls on the DSA in 2016. The DSA survey data indicate an overall decline in the number of owls detected since 1991. However, in 2015 the number of owls detected on the DSA was greater than in previous years (Figure 3).

Age distribution

We can accurately age Spotted Owls if they are originally banded as fledglings or subadults. We can only estimate the age of unbanded adult immigrants. The average age of males and females of known age appears to have increased over the duration of the study (Figure 7). However, most of the adults we band each year are unbanded immigrants, thus these owls do not contribute to the estimate of average age.

Barred owls

<u>General Study Area</u>

We recorded 43 Barred Owl responses in the GSA in 2016 during our Spotted Owl surveys. Based on how these responses were situated temporally and/or geographically, we believe the responses represent 25 inhabited Barred Owl territories. Due to limited resources, we did not attempt to determine whether the responses represented nesting pairs. The proportion of Spotted Owl territories where we detected at least one Barred Owl has increased through time on the Cle Elum Study Area. However, the increase is not as sharp as in other study areas within the range of the Spotted Owl (Dugger et al. 2016).

The Barred Owl removal project crew removed 125 Barred Owls from the treatment portion of the Cle Elum Study Area in winter, 2015–2016.   Estimates of the number of pairs of Barred Owls in the General Study Area showed less Barred Owl pairs in 2016 compared to 2015. The decline in Barred Owl numbers is likely a combination of the removal efforts and lower Barred Owl survival over the winter.

<u>Density Study Area</u>

By completely surveying the DSA each year, we were able to estimate which portions of the DSA were inhabited by Barred Owls and/or Spotted Owls. We detected Barred Owls on 13 occasions in the DSA in 2016. Based on how these responses were distributed spatially and/or temporarily, we estimate there were 7 inhabited Barred Owl territories in the DSA. The apparent number of inhabited Barred Owl territories in the DSA increased in 1991–2000 (Figure 6), outnumbering inhabited Spotted Owl territories in several years. Since 2000, the number of inhabited Barred Owl territories has varied among years. In 2015, before the Barred Owl removal project began, we estimated there were 25 inhabited barred owl territories on the DSA. The DSA is within the treatment portion of the Barred Owl removal study, and it is likely that Barred Owl removals during the winter account for most of the decrease in our Barred Owl detections. A decrease in Barred Owl survival over the winter could also be related to the decrease in Barred Owl detections.

<u>Spotted-Barred Owl Hybrids</u>

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 two young. We found one of the hybrid offspring (a male) from this pair on our study area in 2011. This owl dispersed about 44 km. In 2014, we detected a hybrid Spotted x Barred male at night but were unable to determine if it was from the 2009 hybrid pair. A hybrid male was again detected at night near the 2014 location in 2015, and again this year.

Reproduction

Two of the three females for which we determined nesting status in 2016 nested. Of these two nesting females, both produced young. Average number of young fledged was two (Table 3). The 2016 estimates for proportion of females nesting and number of young fledged were below the average for all years (Figure 4, Table 3,4). The pronounced odd-even year pattern of nesting and number of young fledged 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 16 years (Figure 4, Table 3,4). We used blood samples to sex 131 fledglings (Flemming et al. 1996). Of the fledglings sampled, 59 were male and 72 were female. The male:female ratio among fledglings was not significantly different than 1:1 for all fledglings (chi square 1.3, $P = 0.29$), or among years (Fisher's exact $P = 0.89$).

Dugger et al. (2016) found that models that included a time trend covariate were among the competing models for number of young produced on the Cle Elum Study area. The 95% confidence intervals around the negative beta estimate (-0.004) for trend in the number of young fledged barely overlapped zero (-0.013–0.005, Dugger et al. 2016:82). Thus, these estimates provide suggestive evidence that reproduction has declined over time on this study area. Other covariates that seemed to influence estimates of the number of young fledged on the Cle Elum Study Area included age of the female (adult females produced more young than subadults), early nesting season temperature (higher monthly minimum temperatures were related to more young produced) , and the amount of suitable habitat present in the study area (more cover of habitat was related to more young produced).

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 total number of young produced in an above-average reproductive year (e.g. 2014) is only slightly greater than the worst reproductive years when the population was much larger (e.g. 1993, 1997, Figure 5). 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).

Nest tree characterization

Sovern et al. (2011) classified 276 Spotted Owl nests on the Cle Elum Study Area into one of three structures: platform, side cavity, or stovepipe (top) cavity. Most (90.2%) nests were on platforms, usually associated with dwarf mistletoe (primarily *Arceuthobium douglasii*) brooms. In 250 cases where the species of nest tree was recorded, most (89.6%) nests were in Douglas-fir (*Pseudotsuga menziesii*) trees. In sequential nesting attempts, owls used different nests 81% of the time, but switched to nests known to have been used previously 19.2% of the time. Owls were more likely to reuse cavity nests in sequential nesting attempts than other nest types (odds 4.7 times greater, 95% CI 2–11 times).

Diet

Forsman et al. (2001) analyzed prey remains in pellets collected at 34 Spotted Owl territories in the eastern Cascades of Washington, and determined most (85%) of the diet was mammals. Of the mammals consumed, 40.7% of prey numbers and 52.5% of prey biomass was Northern flying squirrels (*Glaucomys sabrinus*). Woodrats (*Neotoma cinerea*) were the 2nd most important mammal by number and biomass. Nearly all (92.1%) of the mammals consumed were nocturnal. Insects (mostly *Cyphoderris monstrosa* and *Ergates spiculatus*) accounted for 10.6% of prey items by number, but only 0.7% of prey by biomass. We have found pellets composed almost entirely of insect exoskeletons, probably *C. monstrosa* remains, indicating that these insects are an important prey item in the eastern Cascades, at least when they are available. We continue to collect pellets whenever possible.

Study area specific results

An outbreak of the western spruce budworm (*Choristoneura occidentalis)* began on the Cle Elum Study Area in 2001. Aerial detection surveys by Washington Department of Natural Resources have recorded heavy spruce budworm damage on as much as 20% of the GSA in at least one year in 2001–2014 (WDNR 2015). The mean percentage of owl core areas recorded with heavy budworm defoliation was 37% (SE = 2.9, range 0–96%). Defoliation by the budworm could reduce Spotted Owl habitat quality by decreasing canopy closure and affecting recruitment of younger trees, particularly in stands that are dominated by Douglas-fir (*Pseudotsuga menzesii*) and grand fir (*Abies grandis*). Currently, the effect of budworm defoliation on owl habitat quality is highly variable among owl core areas depending on the magnitude and duration of budworm defoliation, and the species and age composition of the stands. Yearly defoliation was less noticeable in 2013–2016, and aerial surveys in 2014 recorded less area as heavily damaged by spruce budworm compared to previous years. Thus, it appears the spruce budworm outbreak is subsiding.

7. Discussion

Trends

Empirical estimates of Spotted Owl population size on the Cle Elum Study Area indicate a decline in owl numbers since the early 1990's. These empirical estimates closely parallel population growth rates estimated by more rigorous analytical methods, which show an annual population decline of 8.4% (95% CI 6.2–10.6% Dugger et al. 2016).

Summary

The Cle Elum Study Area is one of 8 study areas conducting long-term monitoring of Spotted Owl populations. We completed year 27 of monitoring this year, visiting 77 owl territories, including a 204km^2 Density Study Area, which is completely surveyed for Spotted Owls. The territorial population of Spotted Owls on the Cle Elum Study Area has declined approximately 85% since the sample of owl territories was established in 1992. Barred Owl removals will continue this fall/winter. The next meta-analysis of Spotted Owl data will occur after the 2018 field season.

8. Acknowledgments

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10. Tables

Table 1. Number of male (M) and female (F) adult (Ad), subadult (S-Ad), and juvenile (Juv) Spotted Owls banded each year on the Cle Elum Study Area, Okanogan-Wenatchee National forest, Washington, 1989-2016. Total for juveniles includes 2 hybrid Spotted x Barred Owl hybrids banded in 2009.

	Density Study Area					General Study Area					
Year	Ad	(M,F)	S-Ad	(M,F)	Juv	Ad	(M,F)	S-Ad	(M,F)	Juv	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
2014	1	(1,0)	0	(0,0)	0	1	(0,1)	0	(0,0)	5	7
2015	0	(0,0)	0	(0,0)	2	2	(2,0)	0	(0,0)	4	8
2016	1	(1,0)	0	(0,0)	2	4	(3,1)	1	(1,0)	2	10
Total	27	(18,9)	24	(15,9)	174	141	(74,67)	46	(19,27)	463	875

Table 2. Number of territories surveyed and Spotted Owls detected by survey effort for the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2016.

Year	1 visit[a]	Protocol met[b]	New[c]	Total detected	Occupied[d]	Hybrid[e]
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
2014	8	75	0	18	11	1
2015	6	77	0	27	20	0
2016	7	77	0	18	14	1

[a] Number of territories visited only one time to meet minimum protocol.
[b] Number of territories surveyed to protocol as outlined in Lint et al. (1999).
[c] Number of new territories surveyed.
[d] A territory was considered occupied if one Spotted Owl was detected during the survey period, March-August.
[e] Number of territories occupied by a pair composed of a Spotted Owl and a Barred Owl or by a Spotted Owl/Barred Owl hybrid.

Table 3. Number of young fledged and mean brood size of successful nests of Spotted Owls on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2016.

	Number of young fledged			Mean brood size		
Year	N[a]	Mean	SE	N[b]	Mean	SE
1989	11	1.55	0.25	9	1.89	0.11
1990	31	1.32	0.16	23	1.78	0.09
1991	46	0.89	0.14	24	1.71	0.11
1992	50	1.58	0.12	42	1.88	0.09
1993	43	0.23	0.09	6	1.67	0.21
1994	40	1.48	0.19	27	2.19	0.13
1995	38	0.84	0.14	20	1.60	0.11
1996	33	1.52	0.14	28	1.79	0.09
1997	33	0.12	0.07	3	1.33	0.33
1998	36	1.44	0.17	27	1.93	0.13
1999	27	0.59	0.16	10	1.60	0.16
2000	31	1.03	0.16	20	1.60	0.11
2001	26	1.00	0.18	16	1.63	0.13
2002	19	0.84	0.22	9	1.78	0.15
2003	22	1.32	0.20	16	1.81	0.14
2004	23	0.96	0.19	13	1.69	0.13
2005	20	1.00	0.22	11	1.82	0.12
2006	15	1.13	0.24	10	1.70	0.15
2007	16	0.94	0.23	9	1.67	0.17
2008	10	0.90	0.31	5	1.80	0.20
2009	10	1.10	0.31	6	1.83	0.17
2010	8	1.50	0.33	6	2.00	0.00
2011	10	1.10	0.31	6	1.83	0.17
2012	6	1.17	0.31	5	1.40	0.24
2013	7	0.71	0.36	3	1.67	0.33
2014	6	1.67	0.42	5	2.00	0.32
2015	8	0.75	0.37	3	2.00	0.00
2016	4	1.00	0.58	2	2.0	0.00
Total	631	1.03	0.04	364	1.79	0.03

[a] Sample size (N) includes those females checked for reproductive status by August 31.
[b] 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 excluding owls wearing tail-mount transmitters.

Table 4. Proportion of female Spotted Owls that nested on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2016.

Year	N[a]	Proportion	95% CI[b]	
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	16	0.63	0.35	0.85
2008	6	0.83	0.36	1.00
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
2014	5	0.80	0.28	0.99
2015	8	0.63	0.24	0.91
2016	3	0.67	0.09	0.99
Total	529	0.72	0.68	0.76

[a] Sample size (N) includes females that were checked for nesting status before June 15.
[b] Exact confidence limits for the binomial proportion using the F distribution, Collett (1991).

Values have changed from previous versions due to excluding owls with tailmount radio-transmitters in these estimates.

Table 5. Proportion of nesting female Spotted Owls fledging young on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2016.

Year	N[a]	Proportion	95% CI[b]	
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	5	0.80	0.28	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
2014	4	1.00	0.40	1.00
2015	5	0.60	0.15	0.95
2016	2	1.00	0.16	1.00
Total	378	0.84	0.80	0.88

[a]Sample size (N) includes females that were checked for nesting status before June 15.
[b] Exact confidence limits for the binomial proportion using the F distribution, Collett (1991).

Values have changed from previous versions due to excluding owls wearing tail-mount transmitters.

Table 6. The proportion of female Spotted Owls fledging young on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2016

Year	N[a]	Proportion	95% CI[b]	
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	10	0.50	0.19	0.81
2009	10	0.60	0.26	0.88
2010	8	0.75	0.35	0.97
2011	10	0.60	0.26	0.88
2012	6	0.83	0.36	1.00
2013	7	0.43	0.10	0.82
2014	6	0.83	0.36	1.00
2015	8	0.38	0.09	0.76
2016	4	0.50	0.68	0.93
Total	631	0.58	0.54	0.62

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

Values have changed from previous versions due to excluding owls wearing tail-mount transmitters.

11. <u>Figures</u>

Figure 1. The Cle Elum Study Area showing General Study Area, (black outline), Density Study Area (blue outline), and major land owners.

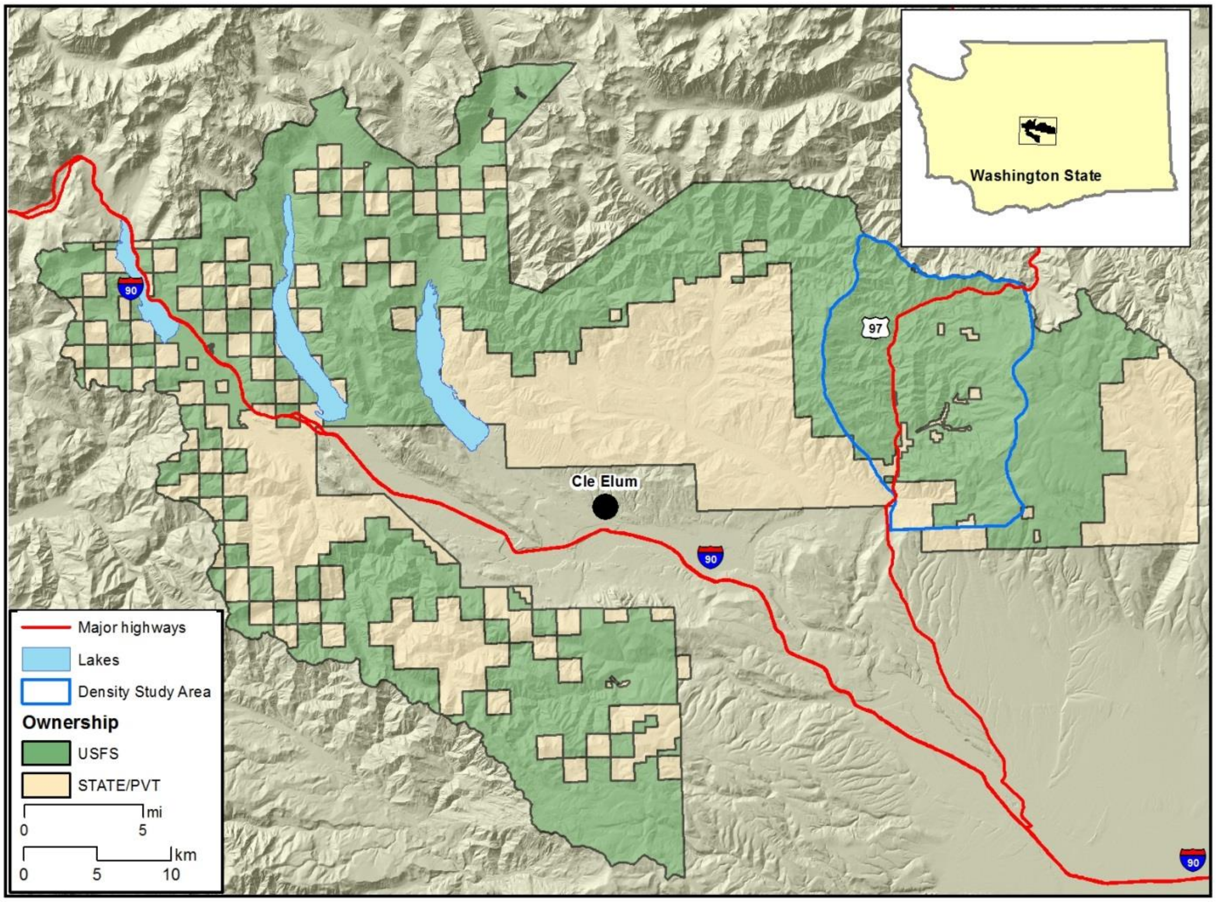


Figure 2. Number of Spotted Owls detected in the General Study Area of the Cle Elum Spotted Owl Demography Study Area, Okanogan-Wenatchee National Forest, 1989-2016.

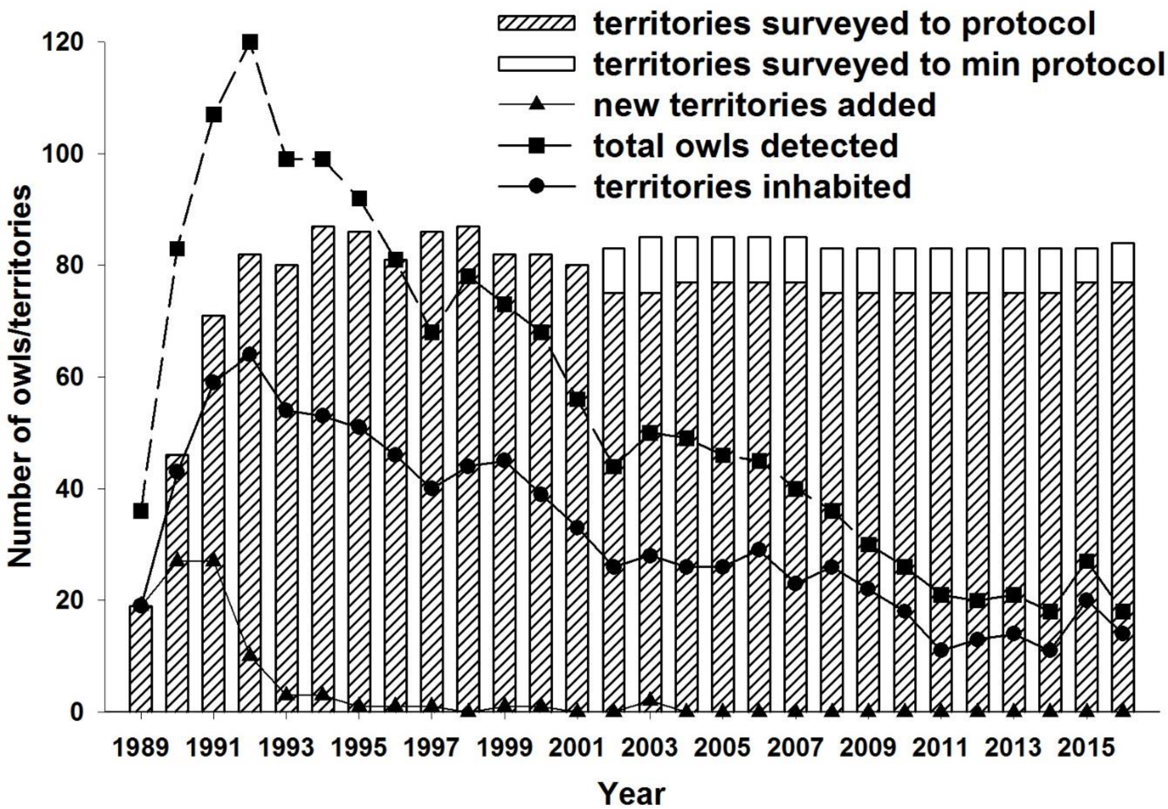


Figure 3. Number of owls detected in the 205 km^2 Swauk Density Study Area, Cle Elum Study Area, Okanogan-Wenatchee National Forest, 1991-2016.

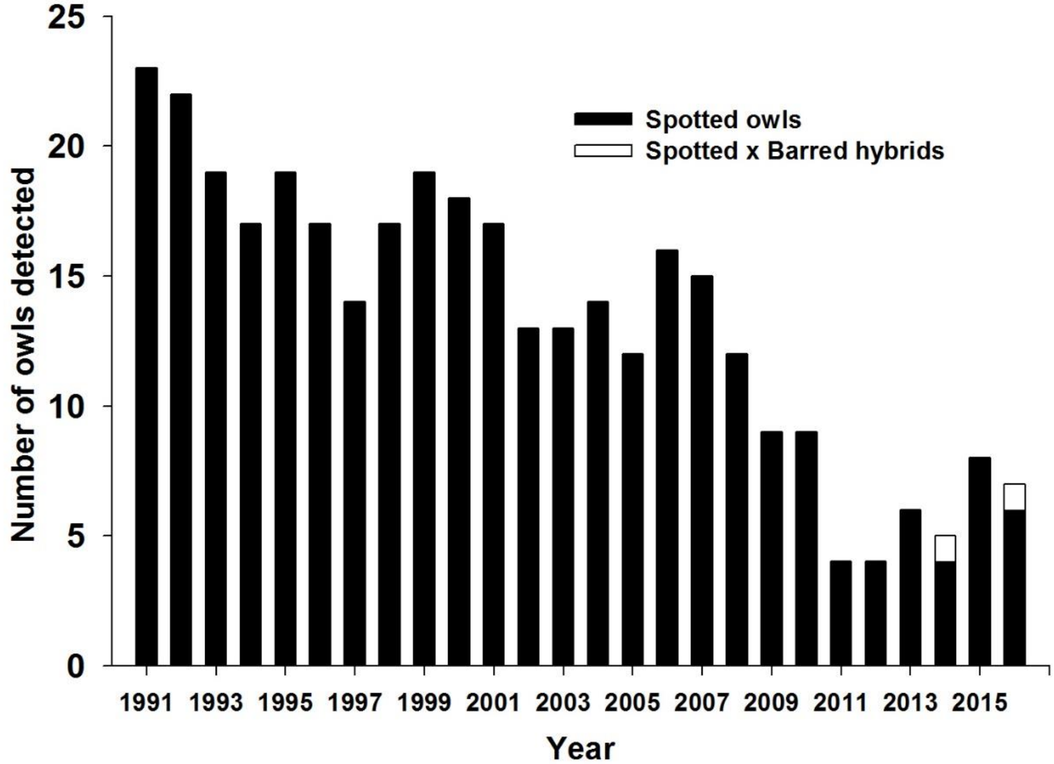


Figure 4. Reproductive indices of Spotted Owls on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2016. Indicies shown are proportion nesting (solid black lines) and average number of young fledged per female (solid red lines). The averages for both these indices are shown as dashed lines.

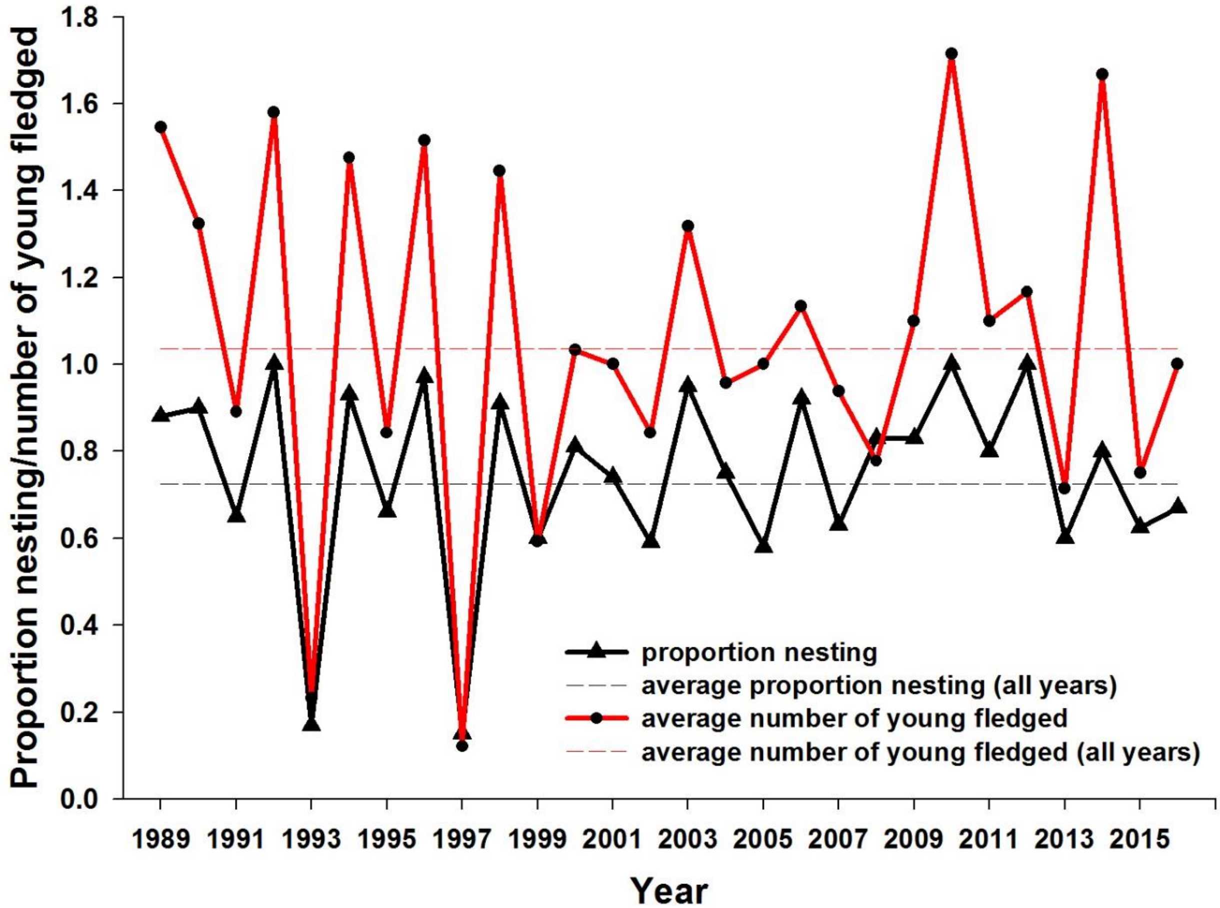


Figure 5. Hypothesized potential female reproductive output (average number of young fledged per female Spotted Owl * the number of female Spotted Owls present in the population) by year, Cle Elum Study Area, Okanogan-Wenatchee National forest, Washington, 1989-2016. Points with red outlines represent years where the average number of young produced per female was above the average for all years.

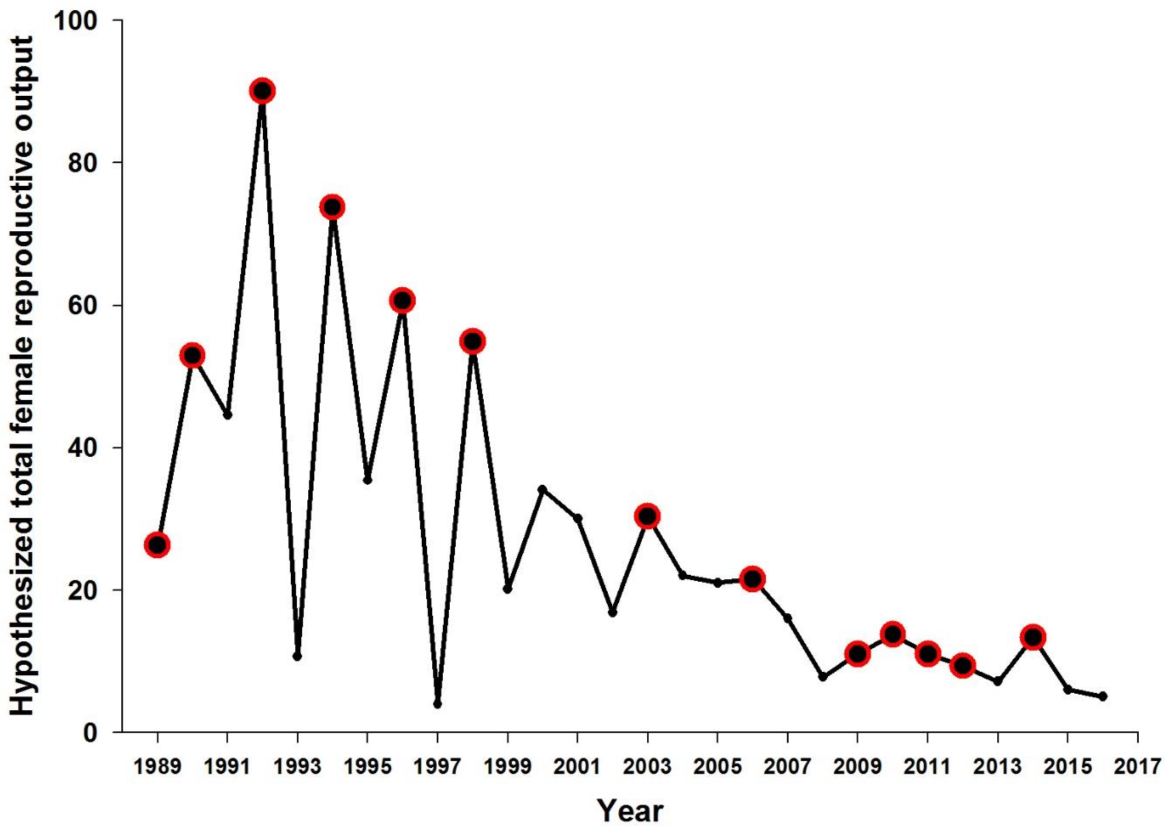


Figure 6. Number of inhabited Spotted Owl territories and Barred Owl Territories in the 204 km^2 Density Study by year, Cle Elum Study Area, Okanogan-Wenatchee National forest, Washington, 1991-2016. A territory was considered inhabited if 1 response was heard in a given year.

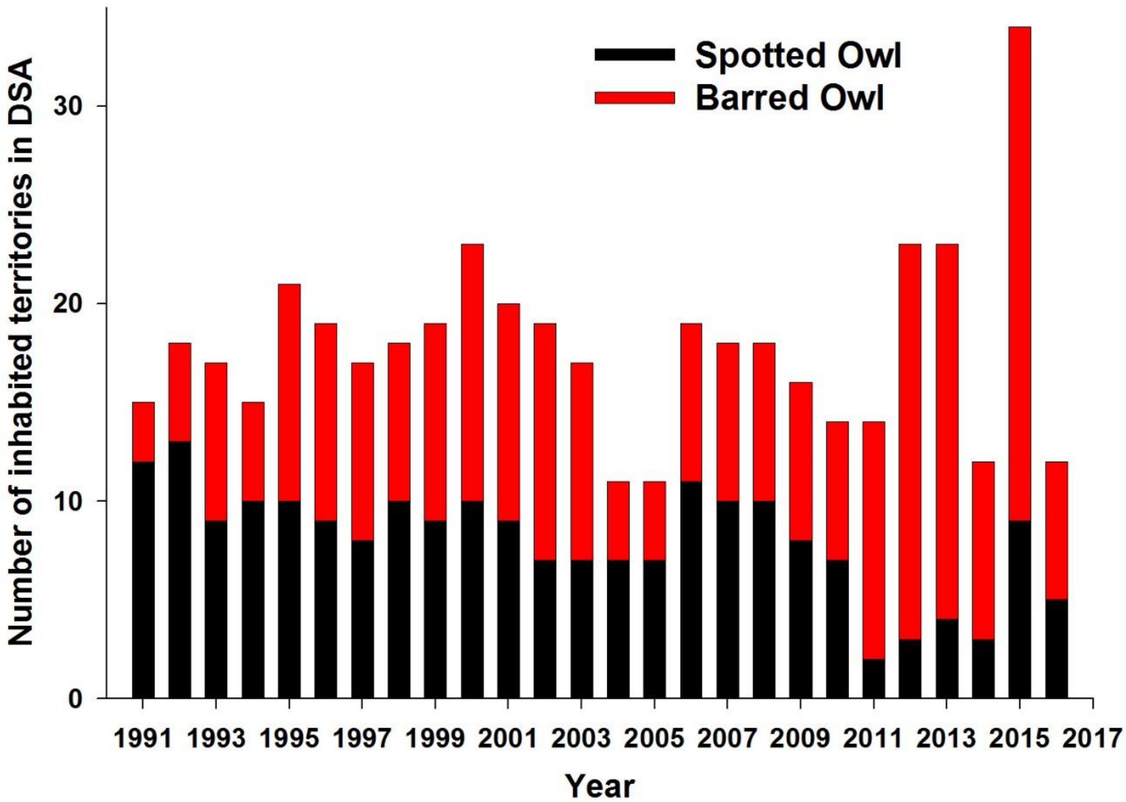


Figure 7. Average age of known-aged Spotted Owls in the Cle Elum Demography Study, Okanogon-Wenatchee National Forest, Washington, 1989-2016.

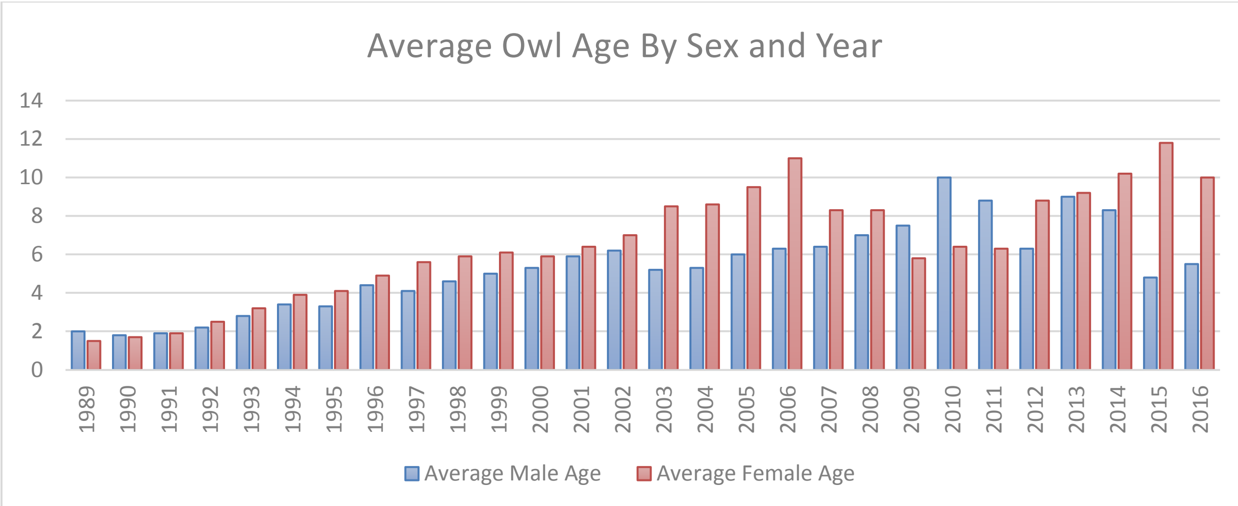
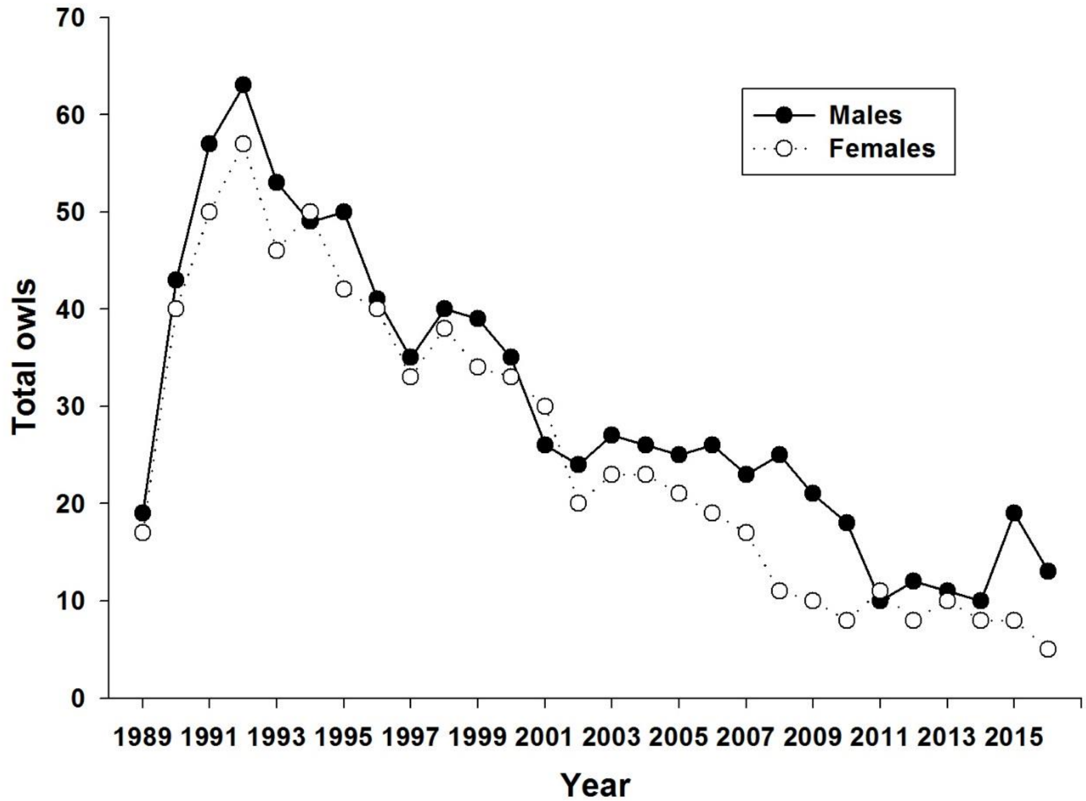


Figure 8. The number of Spotted Owls detected on the Cle Elum Study Area, Okanogon-Wenatchee National Forest, Washington, 1989-2016, divided by sex.



12. Publications, Presentations, and Data Transfer during Fiscal Year 2016

Sovern, S., E. D. Forsman, K. M. Dugger, and M. Taylor. Habitat use and selection by Northern Spotted Owls during natal dispersal. Presentation at the 87th Annual meeting of the Northwest Scientific Association, March 26, 2016, Bend, Oregon.

Sovern, S., and A. Mikkelsen. "Nature of Night" program, 19 November, 2016, Central Washington University Center for Excellence in Science and Mathematics Education. A poster presentation and owl pellet examples.

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

13. Interesting Observations and Problems Encountered

A female Spotted Owl that was detected on our study area for five years and produced five young during that period was found on the Naches Ranger District approximately 75 km away. This female was not detected in 2015 and was presumably in the process of breeding dispersal (Forsman et al. 2002) last year. She nested and produced one young this year.

Problems encountered

We were unable to survey on five scheduled survey days and/or nights due to inclement weather, resulting in a loss of ten person-days of survey. This is about the average number of days we lose each year due to weather. A strong series of storms in December, 2015 dumped a significant amount of heavy, wet snow throughout the study area. In some areas, this storm toppled many trees across Forest Service roads, necessitating a large amount of chainsaw work to be able to travel the roads. This year marked the worst case of downed logs in the duration of this study.

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 often 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 two developments has increased the overall workload for accomplishing this study. These difficulties are not likely to change in the near future, however, once again this year, the Washington State Department of Wildlife and Washington Department of Natural Resources surveyed several owl territories.

14. No Appendices