WILDLIFE HABITAT RELATIONSHIPS
IN WASHINGTON AND OREGON
FY2014

1. Title: Annual Report: Demographic characteristics of northern spotted owls (*Strix occidentalis*) on the Tyee Density Study Area, Roseburg, Oregon: 1985–2014.

2. Principal Investigator(s) and Organization(s): Dr. E. D. Forsman (PI), J. A. Reid (Assistant PI), U. S. Forest Service, Pacific Northwest Research Station. Biologists: S. Sabin, N. Szostak, and K. Wert, Department of Fisheries and Wildlife, Oregon State University.

3. Study Objectives:

a. Elucidate the population ecology of the spotted owl on the Tyee Density Study Area, northwest of Roseburg, Oregon to include estimates of population age structure, reproductive rates, survival rates, and population trends.

b. Document trends in numbers of spotted owls in a bounded study area.

c. Document social integration of juveniles into the territorial population to include age at pair formation and age at first breeding.

d. Document trends in barred owl numbers and interactions with spotted owls.

4. Potential Benefit or Utility of the Study:

The Tyee Density Study Area (DSA) on the Roseburg District of the Bureau of Land Management was designed to monitor age-specific birth and death rates of northern spotted owls, thereby allowing estimates of population trend over time. We also test a variety of ecological covariates such as the amount of owl habitat and the proportion of territories occupied by barred owls in order to determine if those covariates influence trends in spotted owl population. This study is one of eight long-term demographic studies funded through the federal monitoring program for the northern spotted owl (Lint et al. 1999, Anthony et al. 2006, Forsman et al. 2011).

Management of forest lands by the BLM and private landowners within the boundaries of the DSA has led to a reduction of suitable owl habitat during the last 40–50 years (Thomas et al. 1993). Although rates of harvest on BLM lands have declined substantially since the adoption of the Northwest Forest Plan (USDA and USDI, 1994), there has been an increased emphasis on thinning stands on federal lands, and harvest of old forests on non-federal lands has continued. The effects of thinning within close proximity to owl sites is uncertain, but there is evidence that thinning in young stands causes reductions in the density of northern flying squirrels (Wilson, 2010), which are an important prey of spotted owls in the Tyee DSA (Forsman et al. 2004). Although habitat is still an important factor contributing to population stability of spotted owls, other factors such as climate change, increasing numbers of barred owls, and pathogens such as West Nile Virus may also affect the numbers of spotted owls in the study area. While the data collected during this study cannot be used to predict future conditions, they can be used to assess predictive models that examine population projections under varying landscape conditions or management regimes (Forsman et al. 2011).

We have attempted to band all known fledglings produced in the study area since 1985. As a result, we know the origin and age of most individuals that have been recruited into the population, and we have detailed information on population age structure and internal and external recruitment in the study area.

5. Research Accomplishments:

Study Area and Methods

The Tyee DSA northwest of Roseburg, Oregon includes a mixture of federal lands administered by the Bureau of Land Management (BLM) interspersed in a checkerboard pattern with intervening sections of private land (Fig. 1). Total size of the study area is 1,025 km^2 (253,280 acres). We also have monitored known spotted owl territories within a 6-mile buffer area outside the eastern and western boundaries of the DSA to reduce the amount of unknown emigration from the DSA (Reid et al. 1996). The study area includes all or part of 4 Late-Successional Reserves (LSR's) as identified in the Northwest Forest Plan land-use allocations (USDA and USDI, 1994).

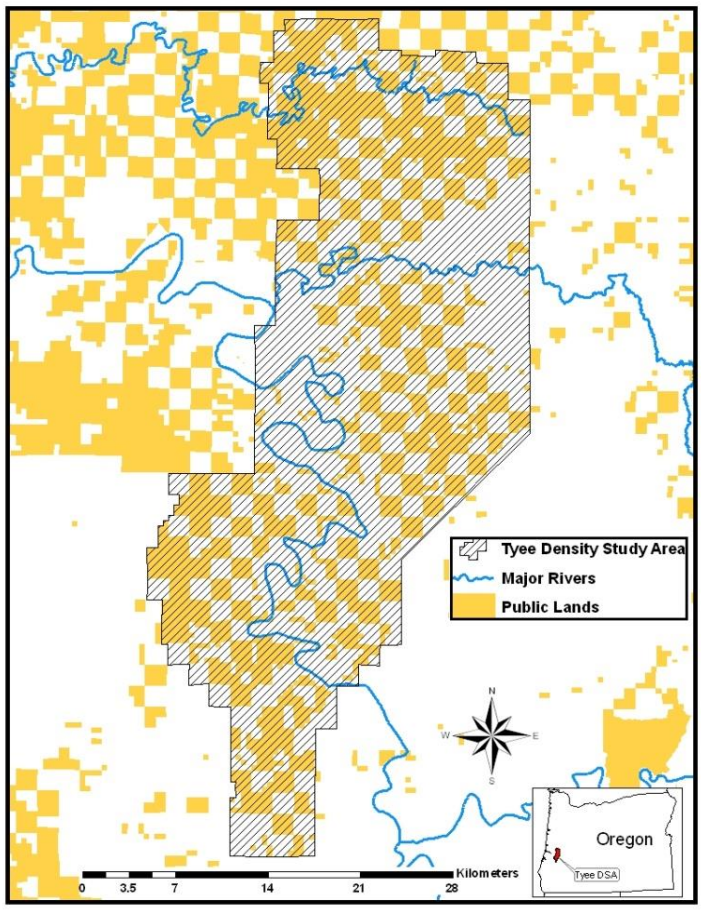

Figure 1. The hatched area represents the Tyee Density Study Area (DSA), Roseburg, Oregon.

Banding was initiated on the study area in 1983 and increased substantially in 1985. Surveys increased in 1987 to include all suitable spotted owl habitat. In 1989, the study area was expanded to include the upper third portion of the present area (Fig. 1). In 1990, we initiated the method in which we survey the entire study area each year (density study). Based on these surveys we estimate the actual number of territorial owls. The number of survey polygons within the DSA (160) has remained relatively constant among years and was determined by the location of historical spotted owl site centers. The size of each survey polygon varies, depending on topography and land ownership, but is roughly equal to the area of a spotted owl territory. Areas between known spotted owl territories were delineated for survey depending on topography, road access, and distance from other known spotted owl sites. In all surveys we document spotted owls as well as all other owls that are seen or heard.

Methods used in this study and other demographic studies of spotted owls have been described in a variety of published sources (e.g., Forsman 1983, Franklin et al. 1990, Franklin 1992, Franklin et al. 1999, Lint et al. 1999). Seemingly unoccupied areas are surveyed with a minimum of 3 complete night visits spaced throughout the survey season (1 March-31 August; Reid et al. 1999). Resightings and recaptures of previously banded owls are used to estimate survival rates (Forsman et al. 2011).

Numbers of owls detected on the DSA

Between 1983 and 2014, we banded 960 spotted owls on the DSA, including 686 juveniles, 96 subadults, and 184 adults. The sex ratio of adults in the banded sample was slightly skewed towards males. By comparison, the sex ratio of subadults was skewed toward females (Appendix 1). The disproportionate number of males in the adult sample was most likely because males, especially unpaired males, were more detectable than females (Reid et al. 1999).

In 2014, we documented 65 non-juvenile spotted owls in the DSA, including 27 pairs and 11 unpaired individuals (Appendix 2). This represents approximately 46% of the number of individuals that were located during the first year of the study in 1990 and was the lowest number of owls detected since inception of the study (Fig. 2). It also represents the first year that the population of spotted owls has dipped below 50% of the original 1990 population level.

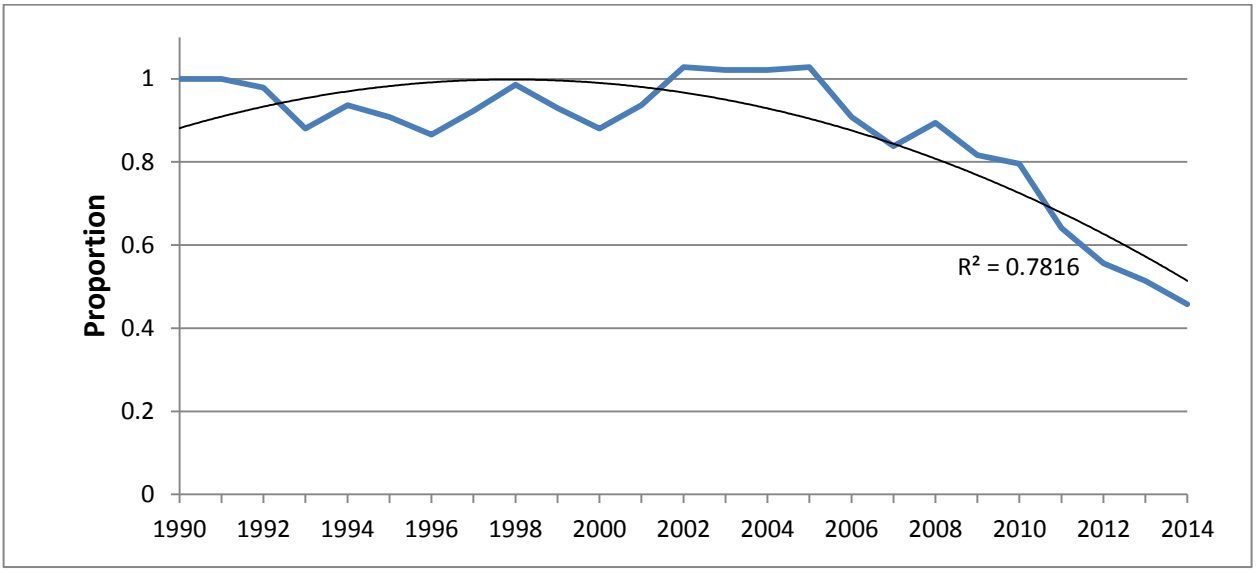

Figure 2. Yearly proportion of non-juvenile spotted owls detected relative to the first year of study, Tyee Density Study Area (DSA), Roseburg, Oregon, 1990-2014.

Population Age Structure

A comparison of the proportions of known-age owls detected in the study area in 1996, 2005, and 2014 indicates an aging population, with low recruitment of young owls in recent years (Fig. 3). Within the DSA we documented only 3 individuals under the age of 5 years old in 2014 as compared to 34 individuals in 1996. Median age in 1996 was 6 years old for males and 7 years old for females. It was very similar in 2005 where the median age for males was 7 years old and for females it was 6 years old. By 2014, the median age had raised to 10 years old for both sexes.

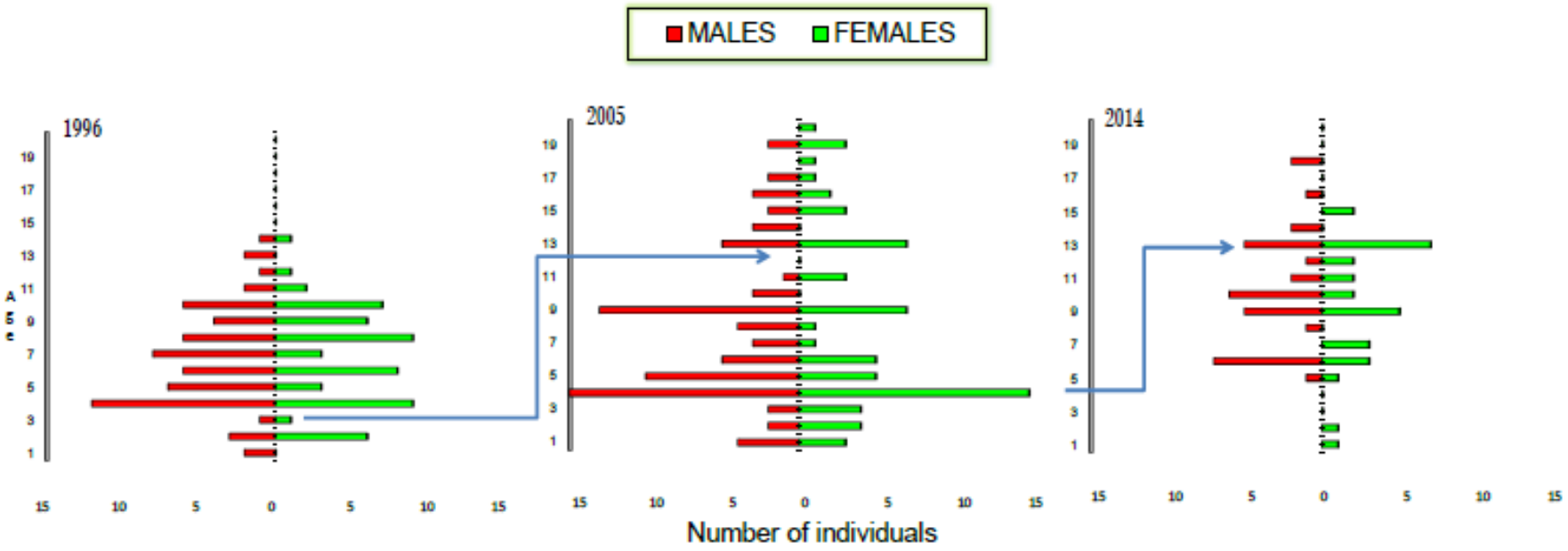

Figure 3. Age class distribution of known age, non-juvenile spotted owls detected in the Tyee DSA in 1996 (left), 2005 (middle), and 2014 (right). Blue lines with arrows indicate where the age class would be represented in the next graph, 9 years later.

Number of sites with spotted owls

We defined a site as an area where a pair of spotted owls was documented in at least one year in the study and defined a pair as 2 individuals of opposite sex that clearly associated during the survey year. The number of sites with pairs declined rapidly after 2005 and had not recovered by 2014 (Appendix. 2). In 2014, the number of pairs and the total number of non-juvenile spotted owls detected was the lowest recorded for the 25 year survey period (Fig. 4). In 2014, approximately 81% of the pairs (N=27) and 64% of the nesting pairs (N=11) in the DSA were located on federal land and 36% were on private land.

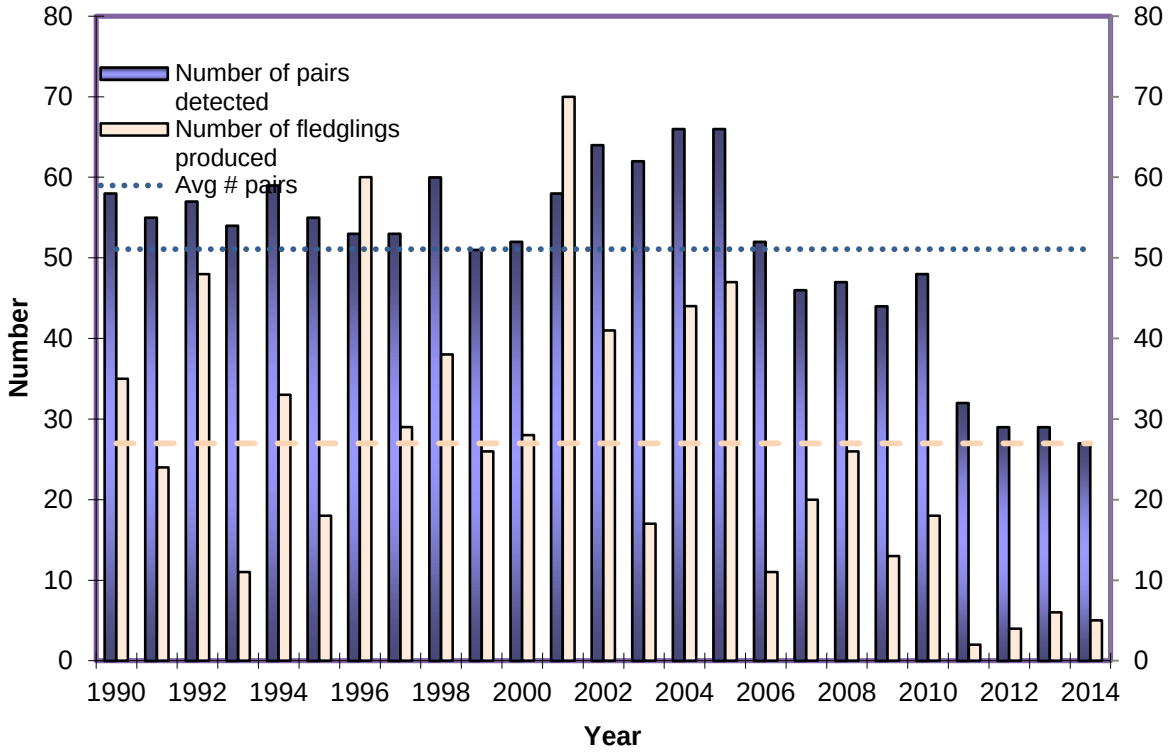

Figure 4. Annual number of spotted owl pairs detected and fledglings produced, Tyee DSA, Roseburg, Oregon: 1990-2014. Horizontal lines indicate means for the entire period.

Barred Owls

Although we survey exclusively using spotted owl acoustic lure techniques, we often detect other owl species during our surveys. We have kept records for these other owl detections on the DSA since 1990, including the increasing trend in barred owl numbers. In 2014, the number of survey areas where we detected barred owls continued to exceed the number of survey areas where we detected spotted owls (Fig. 5). The estimate of sites occupied by barred owls was considered conservative because we did not survey specifically for barred owls, and it was likely that some barred owls were not detected (Wiens et al. 2011).

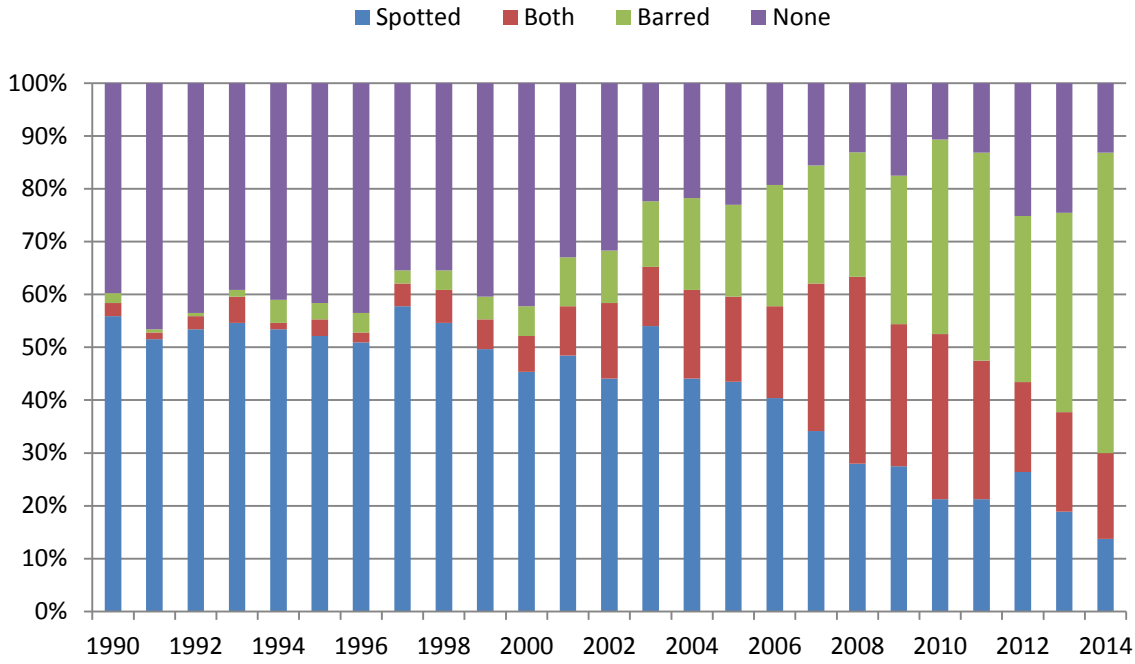

Figure 5. Percent of sites occupied by spotted owls and/or barred owls, Tyee DSA, Roseburg, Oregon: 1990-2014.

The increasing trend in barred owl detections suggests that barred owls are colonizing sites historically occupied by spotted owls and excluding spotted owls from those sites (Yackulic et al. 2014). Resighting rates of spotted owls remained high in all years, but there is evidence of a decline in resighting rates after about 2004 (Fig. 6).

Declining resighting probabilities indicated that an increasing proportion of the population had gone undetected for longer intervals toward the latter part of the study. These declining resighting probabilities could be indicative of a disruption to the long term stability or fidelity of sites as spotted owls were likely excluded from traditional spotted owl core areas and relegated to the margins of the sites or forced to join the nomadic (floater) population (Fig. 6).

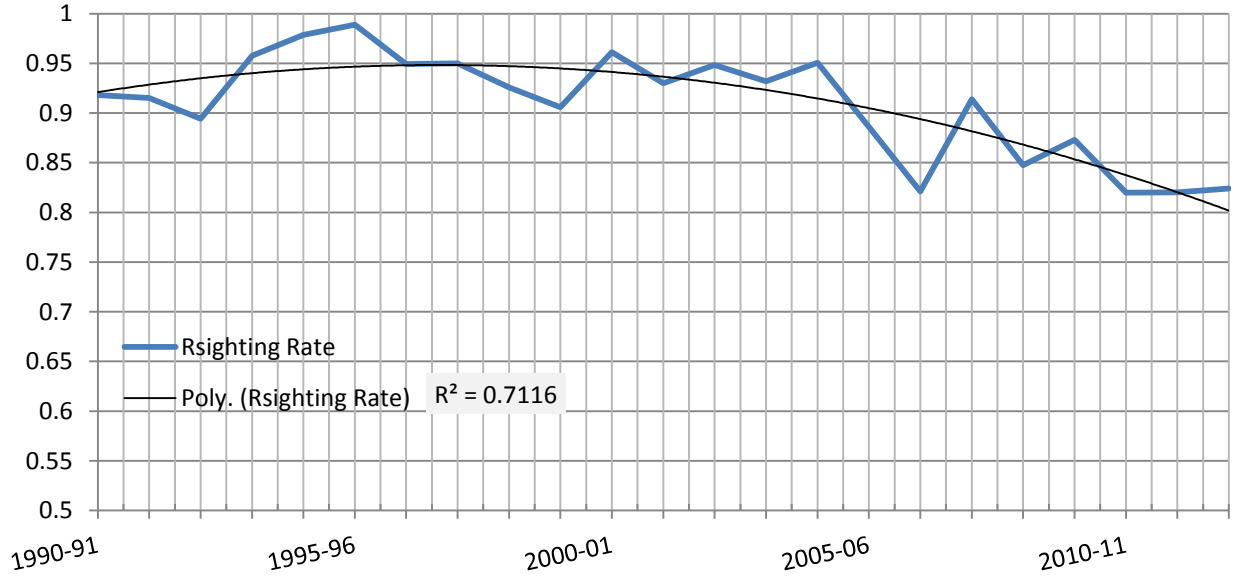

Figure 6. Resighting probabilities of spotted owls {Phi (.), p(t) }, Tyee Density Study Area, 1990-2013.

There was some evidence of a weak relationship between declining spotted owl resighting rates and increasing numbers of barred owls (Fig.7).

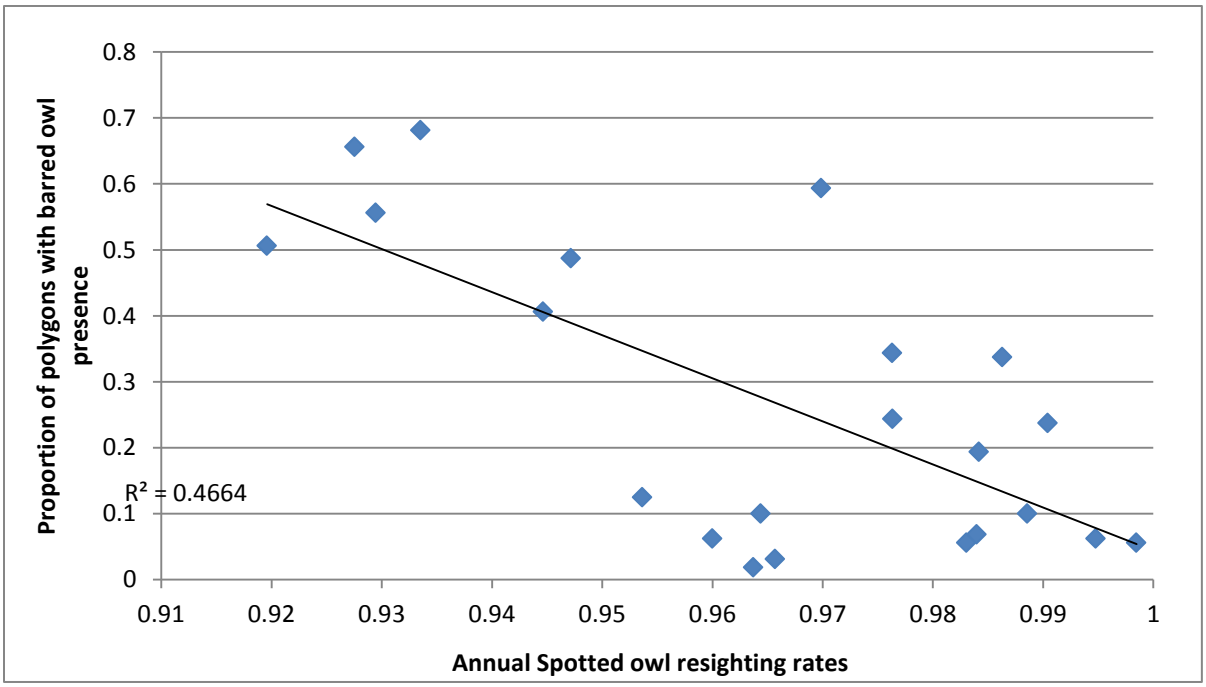

Figure 7. Resighting rates versus the number of polygons where barred owls were detected, Tyee DSA, Roseburg, OR 1990-2014

Reproduction

Although proportion of females nesting in 2014 was higher than the previous year, (0.40, 95% CI = 0.20-0.60), the proportion of those that actually were successful (2 out of 10) was well below the 62.7% average. The number of females actually nesting has severely declined in the last 5 years and remained low as the population of spotted owls continued to decline (Fig. 2). For all years combined, the annual percentage of females that nested averaged 48.6% (N= 25 years, Table 1).

The average number of young produced per female in 2014 was 0.172, which was considerably lower than the average of 0.506 for all years (N=25) (Appendix 3). The data continued to indicate that most measures of reproductive performance of spotted owls were lowest for 1-yr-old owls, intermediate for 2-yr-old owls, and highest for adults (Tables 2–3). Sample size of 1-yr-old females was too small to estimate some parameters (Table 2–3).

Barred owls continue to affect spotted owl occupancy, thereby greatly reducing total reproductive output of spotted owls (Fig. 8). A decline in the number of spotted owl pairs that successfully reproduced has been evident in 8 of the last 9 years (Fig. 8).

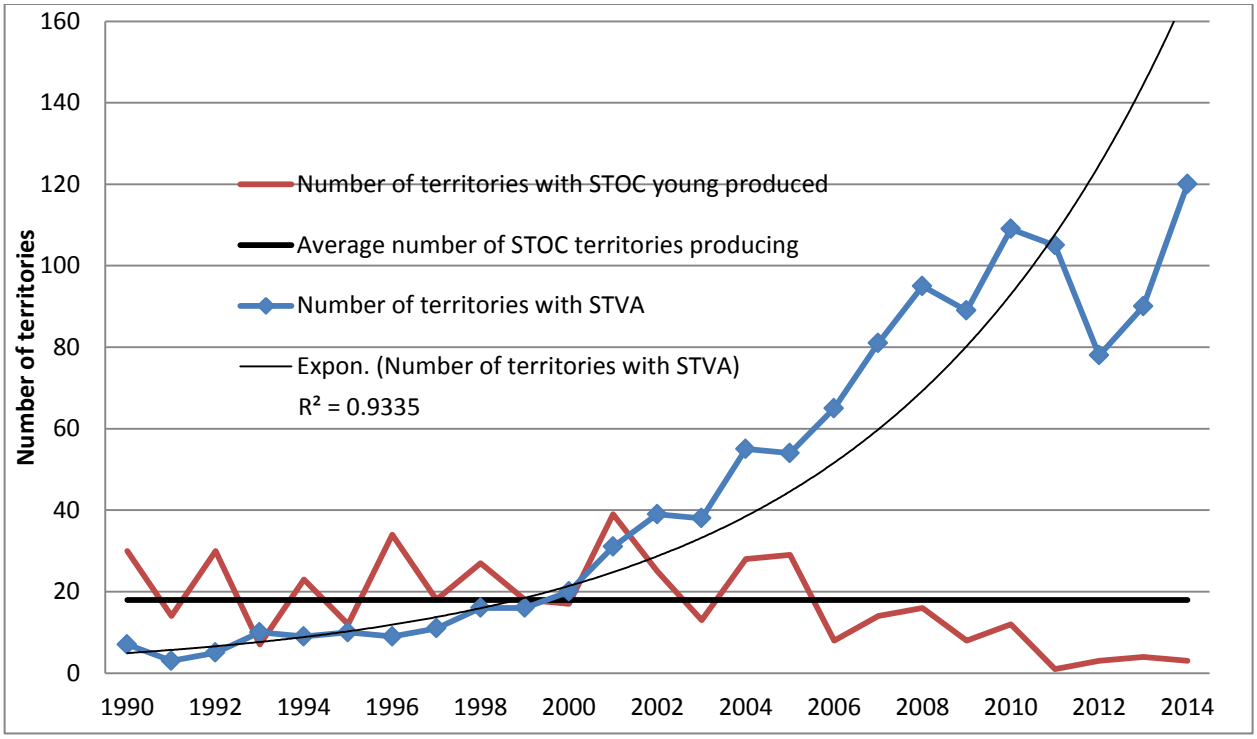

Figure 8. Yearly number of survey polygons in the Tyee DSA where barred owls were detected and where spotted owl reproduction was documented, Tyee DSA, Roseburg, Oregon: 1990-2014.

Table 1. Annual reproductive statistics for female northern spotted owls on the Tyee Density Study Area, Roseburg, Oregon: 1990–2014.

	Proportion nesting [1]				Proportion fledging young [2]				Proportion nesting that fledged young [3]		
Year	N	Prop.	95% C.I.		N	Prop.	95% C.I.		N	Prop.	95% C.I.
1990	53	0.736	0.62–0.86		61	0.475	0.35–0.60		39	0.692	0.55–0.84
1991	56	0.446	0.32–0.58		59	0.237	0.13–0.35		25	0.560	0.36–0.76
1992	58	0.603	0.47–0.73		62	0.484	0.36–0.61		35	0.800	0.67–0.93
1993	47	0.255	0.13–0.38		54	0.130	0.04–0.22		12	0.500	0.20–0.80
1994	58	0.569	0.45–0.71		60	0.383	0.26–0.51		33	0.667	0.50–0.83
1995	53	0.415	0.28–0.55		60	0.200	0.10–0.30		22	0.500	0.29–0.71
1996	48	0.813	0.70–0.93		56	0.607	0.48–0.74		39	0.769	0.64–0.90
1997	51	0.588	0.45–0.72		55	0.327	0.20–0.46		30	0.600	0.42-0.78
1998	61	0.557	0.43–0.68		63	0.429	0.30–0.55		34	0.794	0.66–0.93
1999	45	0.556	0.41–0.70		55	0.327	0.20–0.46		25	0.680	0.49–0.87
2000	50	0.500	0.36–0.64		54	0.315	0.19–0.44		25	0.600	0.40–0.80
2001	54	0.796	0.69–0.90		61	0.639	0.52–0.76		43	0.837	0.73–0.95
2002	56	0.571	0.44–0.71		65	0.385	0.26–0.51		32	0.688	0.52–0.85
2003	57	0.386	0.26–0.51		66	0.197	0.10–0.29		22	0.545	0.33–0.76
2004	63	0.540	0.42–0.66		66	0.424	0.30–0.55		34	0.765	0.62–0.91
2005	61	0.639	0.52–0.76		65	0.446	0.32–0.56		39	0.744	0.60–0.88
2006	54	0.222	0.11-0.33		57	0.140	0.05-0.23		12	0.667	0.39-0.95
2007	44	0.432	0.28-0.58		48	0.292	0.16-0.43		19	0.737	0.53-0.94
2008	41	0.707	0.57-0.85		50	0.320	0.18-0.45		29	0.483	0.30-0.67
2009	41	0.317	0.17-0.46		45	0.178	0.06-0.29		13	0.538	0.26-0.82
2010	43	0.674	0.53-0.84		46	0.261	0.12-0.38		28	0.429	0.24-0.62
2011	30	0.100	0.00-0.21		37	0.027	0.00-0.08		3	0.333	0.00-0.99
2012	28	0.143	0.01-0.27		31	0.097	0.06-0.13		4	0.750	0.26-1.00
2013	26	0.192	0.04-0.35		29	0.138	0.01-0.27		5	0.800	0.41-1.00
2014	25	0.400	0.20-0.60		29	0.103	0.00-0.22		10	0.200	0.00-0.46
Mean	N=25 years	0.486			N=25 years	0.302			N=25 years	0.627	

[1] Estimates were calculated for females whose nesting status was determined by protocol.
[2] Estimates were calculated for females whose reproductive status was determined by 31 August.
[3] Estimates were calculated for females whose nesting status was determined to protocol and reproductive status by 31 August.

Table 2. Average age-specific reproductive parameters of female northern spotted owls on the Tyee Density Study Area, Roseburg, Oregon: 1990–2014.

	Proportion nesting [1]			Proportion fledging young [2]			Proportion nesting that fledged young [3]		
Age	N	Prop.	95% C.I.	N	Prop.	95% C.I.	N	Prop.	95% C.I.
1 year old	55	0.145	0.05–0.24	71	0.028	0.00–0.07	7	0.286	0.00–0.65
2 year old	88	0.443	0.34–0.55	101	0.238	0.15–0.32	38	0.579	0.42–0.74
Adult	1050	0.535	0.51–0.57	1141	0.351	0.32–0.38	561	0.677	0.64–0.72
Unknown	12	0.500	0.20–0.80	21	0.238	0.05–0.42	6	0.167	0.00–0.49

[1] Estimates were calculated for females whose nesting status was determined to protocol.
[2] Estimates were calculated for females whose reproductive status was determined by 31 August.
[3] Estimates were calculated for females whose reproductive status was determined to protocol and reproductive status by 31 August.

Table 3. Average age-specific number of young fledged and brood size of female northern spotted owls on the Tyee Density Study Area, Roseburg, Oregon: 1990–2014.

					Brood size[2]		
	N	No. Young Fledged	Mean		N	Mean	SE
1 year old	71	4	0.056		2	2.000	0
2 years old	101	40	0.396		24	1.667	0.096
Adults	1141	623	0.546		400	1.550	0.025
Unknown	21	7	0.333		5	1.400	0.245

[1] Number of young fledged was defined as number produced per female.
[2] Brood size was based on the number of young seen outside the nest tree, regardless of whether they were dead or alive.

Other owl species recorded

With the spotted owl reproductive output declining, we wanted to examine the relationship of spotted owl nesting to barred owl nesting. Since 1990, incidental observations of other owl species have been recorded, including barred owls. Despite a steady increase in the proportion of sites occupied by barred owls every year, the number of juvenile barred owls detected varied considerably from year to year. In low nesting years for spotted owls, we would conduct more night surveys in order to establish the occupancy status of spotted owl sites. The assumption would be that the number of other owl species, including barred owl, would be greater in years when more night surveys were conducted. Interestingly, years that were poor nesting years for spotted owls also seem to be poor nesting years for barred owls (Fig. 9).

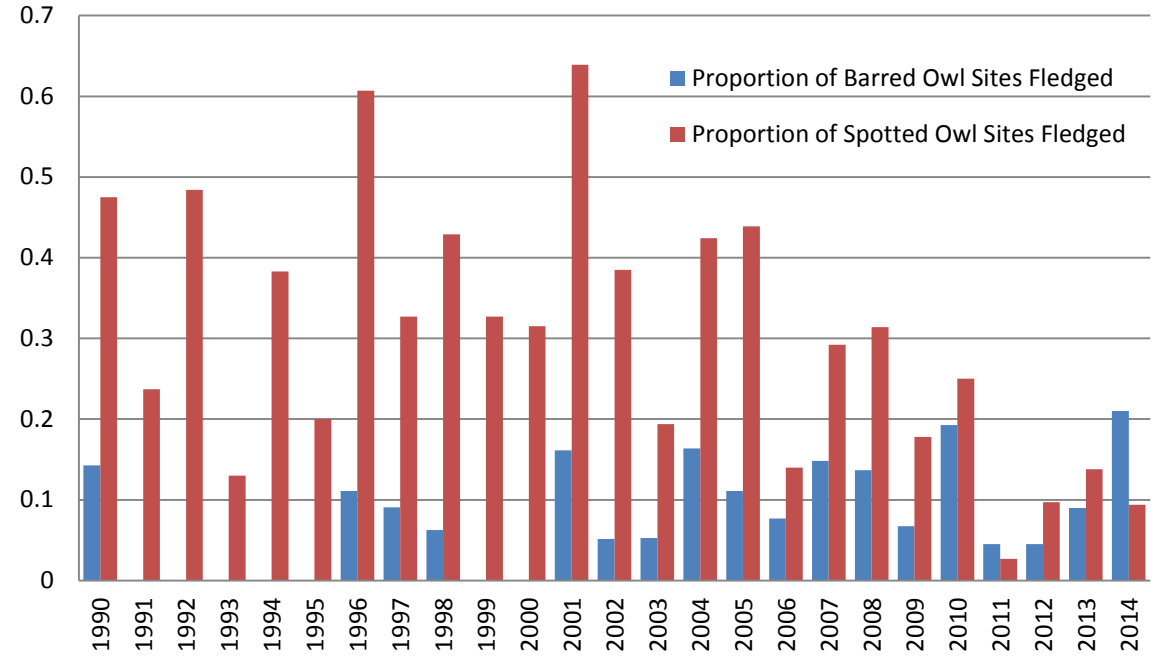

Figure9. Proportion of sites where barred owls and spotted owls fledged young, Tyee DSA, Roseburg, Oregon: 1990-2014.

We also looked at the numbers of individuals detected for four other owl species and found similar declines for most species in the same years, in particular 2012 (Fig 10).

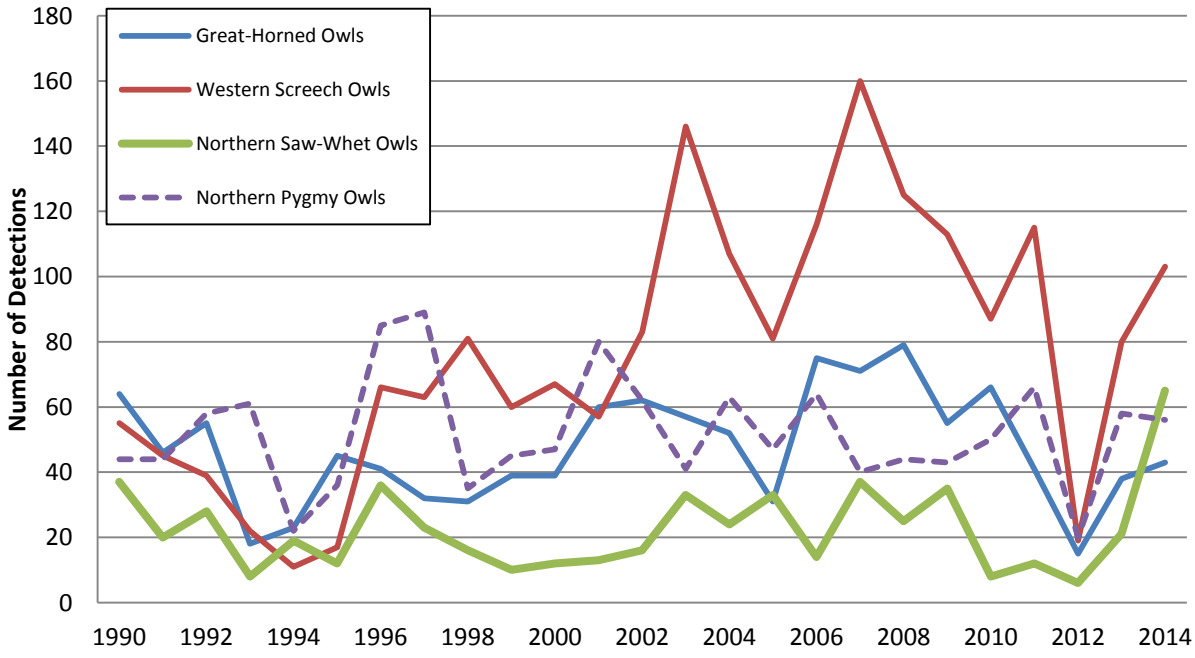

Figure 10. Observations of 4 non-target owl species, Tyee DSA, Roseburg, Oregon: 1990-2014.

Although there have been a number of observers with varying lengths of time as surveyors on the Tyee DSA, one observer, Janice Reid, has remained constant. This allowed us to test the idea of observer bias. We felt that the bias was small since all observers exhibited similar trends in the

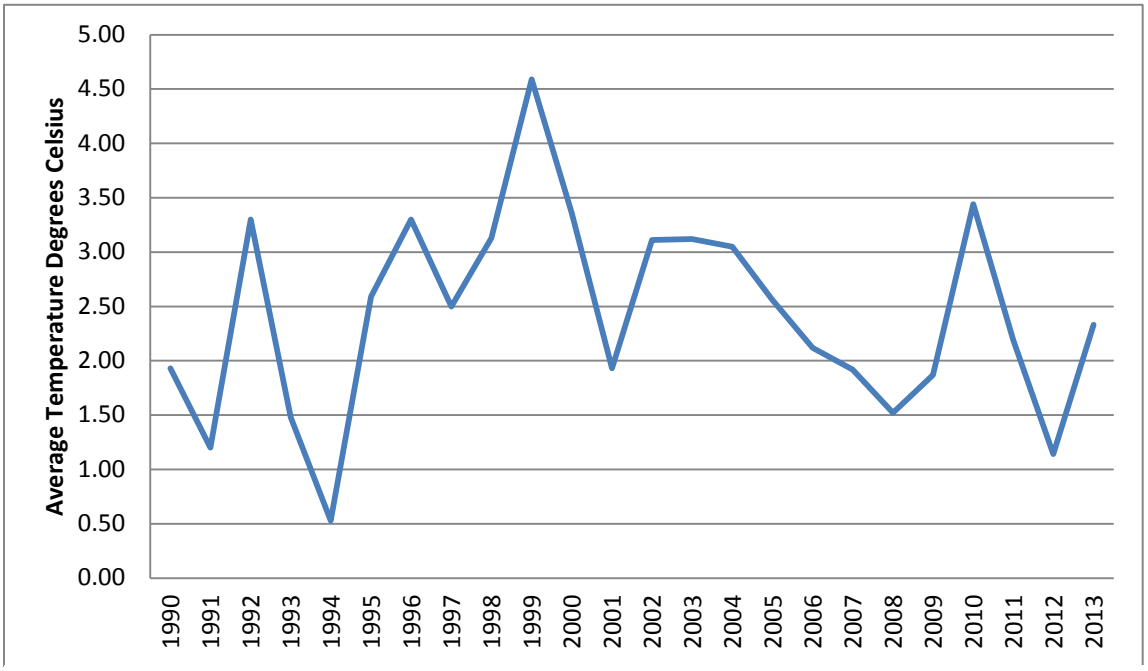

Figure 11. Average minimum winter temperature (Nov-Feb) Tyee DSA, Roseburg, Oregon: 1990-2014.

numbers of recorded detections, most notably in 2012 when the recorded observations of all species was the fewest, including spotted owls and barred owls.

The similar trends in the relative numbers of all owl species, led us to suspect that climate was affecting the trends in the numbers. We compared 10 climate covariates specific to the Tyee DSA. There was very little correlation between the climate covariates and owl detection data or reproductive trends. However, the coldest winters coincided with the declines seen across species in 1993-1994 and 2012 (Fig. 11). Winter was defined as November through February proceeding the breeding season. Years with low late nesting precipitation (May – June) coincided with major increases in great-horned and screech owl detections, but did not explain trends in other species. A more refined and specific climate variable may yield closer correlations with numbers of owls recorded.

Interesting observations and unusual events documented in 2014:

Spotted owls are not usually confrontational, but when nesting can become more aggressive in protecting the nest and young. During one visit to verify nesting status, a female spotted owl had come off of the nest. When the female noticed a raven getting too close to her nest she immediately ignored the researcher and chased the raven out of the nest area.

We located a spotted owl nest in a hole in a small cliff, which is only the 3rd case of cliff nesting that we have documented on the Tyee DSA in 25 years (Fig. 12). Potential nest sites in steep cliffs are not widely available on the study area, which probably explains why they are rarely used. Very little habitat was available for this pair near the cliff nest and it was only 30m from a large clearcut on a south facing slope. The lack of available and more typical tree nest cavities and the south facing site exposure may explain the selection of this nest type for this site.

Figure 12. Spotted owl nest in a hole in a cliff on the Tyee Density Study Area, 2014.

We had the opportunity to observe a spotted owl capture a live dusky-footed woodrat. A noticeable loss of ability to maintain altitude was evident in flight after securing the rat. The owl attempted to land on a branch, but because both talons were evidently needed to secure the rat, the owl used her wing to arrest her descent by draping it over the branch where she had intended to land.

A nesting male spotted owl delivered a prey item to a female barred owl below the nest tree where his spotted owl mate was nesting. The spotted owl pair successfully fledged 2 young. Although this was off of the DSA, it is still worth noting as unusual.

Problems encountered:

Hiring and administrative requirements as well as increased effort for new employees to train and become familiar with the study area continues to decrease the amount of available time for our survey effort. The decline in the numbers of spotted owls has resulted in an increased need for nocturnal surveys in the study area as more and more sites become vacant of spotted owls (Fig. 13). This increase in the need for nocturnal surveys and negative survey results for spotted owls can be discouraging to surveyors and result in high turnover of field crews.

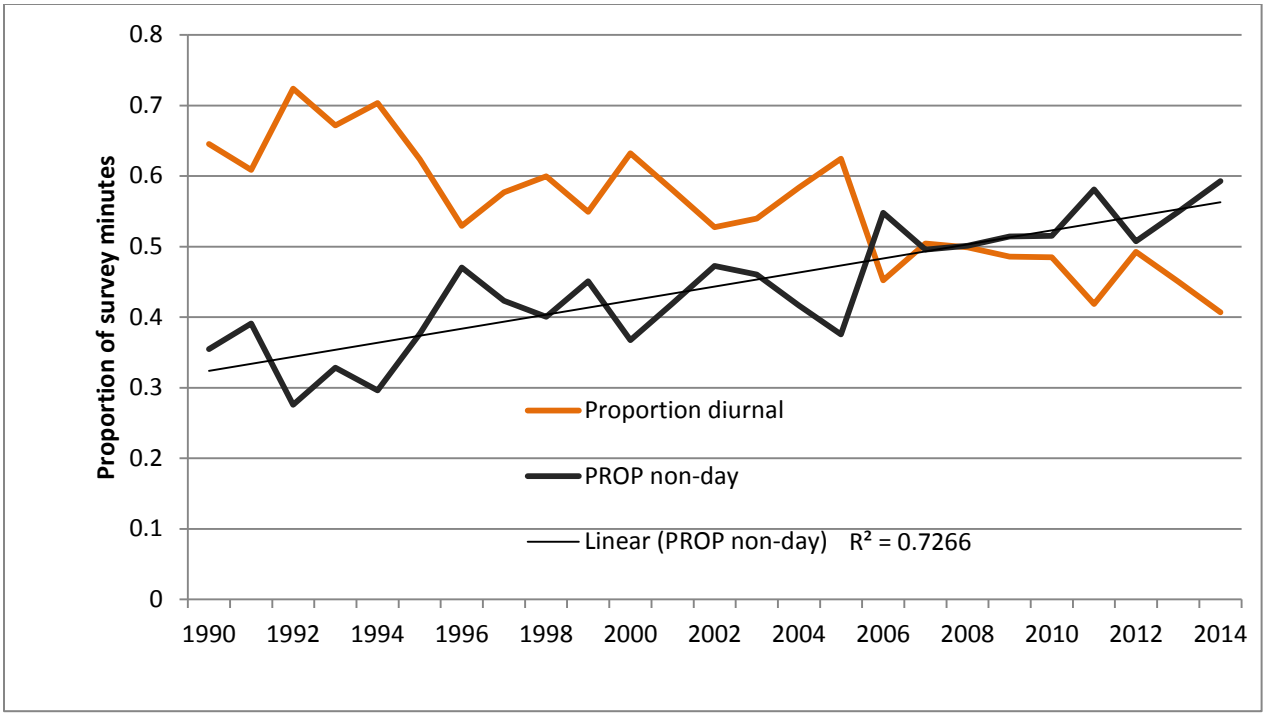

Figure 13. Trends in the proportion of time spent conducting diurnal and nocturnal surveys on the Tyee DSA, 1990-2014.*

*Minutes surveyed includes only the time that it takes to survey and complete a site, including travel time between calling points. Travel time from the office to the first calling station is not included.

We continue to experience problems with deteriorating roads and blocked access on both federal and private lands. New gates, inoperable gates (some because of vandalism), and denial of access are a particular problem, but noise from logging traffic has also increased in recent years and results in rescheduling visits to avoid the problem. All of this leads to decreased survey efficiency and a greater workload.

6. Summary

The number of spotted owls detected on the DSA continued to decline in 2014 (Appendix 4) and, although the proportion of females that attempted to nest was above average, the total number of young produced was very low. The spotted owl population is aging, with low recruitment of young owls in recent years. The increasing median age and low reproductive output in the past several years suggests that the number of spotted owls will not increase substantially in the near future without an increase in reproduction.

The low rate of nesting attempts may be due in part to the unfavorable weather conditions (Franklin et al. 2000), barred owls, or habitat degradation but the decreasing number of pairs in the study area only compounds the effects on total reproductive output. Although harvest of older forest on Federal land has decreased in the past, habitat within spotted owl sites on the Tyee DSA are continuing to experience degradation, as young, mature, and mixed age stands on BLM lands are thinned and forests on private lands are clearcut, even within the nest patch of successfully reproducing spotted owl sites (Appendix 5). Older forests on federal land are currently being selected for future clearcutting (regeneration harvest) which will further decrease the available high quality habitat available for the remaining spotted owls in the population.

Barred owls almost certainly compete with spotted owls for both food and space (Hamer et al. 2007, 2001, Wiens et al. 2014). Our surveys continue to document increasing numbers of barred owls and it appears that this may be correlated with increased social instability, lower overall reproductive output, apparent abandonment of territories, and possibly lower detection rates of spotted owls (Bailey et al. 2009, Yackulic, et al. 2014). As habitat remains the same or decreases and barred owl numbers remain the same or increase, the spotted owl population will likely continue to experience declines.

7. Publications and Presentations:

a) We provided information to Ron Gaines, Environmental Services Northwest, and biological consultant for Lone Rock Timber Company.

b) We provided survey information to Eugene, Roseburg, and Coos Bay Districts of the BLM for the sites that we surveyed in their districts.

c) We provided spotted owl survey information to Oregon Department of Forestry.

d) We provided survey information to several landowners including Weyerhaeuser Company, Roseburg Resources, Rockin C Ranch, Elkton Reserve, Seneca Jones Timber Company, and several other smaller landowners that granted us access to conduct surveys.

e) We provided feather samples for genetic analysis and datasets for pedigree analysis to the USGS genetics lab in Corvallis.

f) Charles Brandon Yackulic, Janice Reid, James D. Nichols, James E. Hines, Raymond Davis, and Eric Forsman In press. The roles of competition and habitat in the dynamics of populations and species distributions. Ecology.

g) We led a field outing for the Oregon Youth Conservation Corps to demonstrate the field techniques associated with spotted owl demography studies.

h) Paul Bannick, photographer, was provided with a field outing to a spotted owl nest site.

i) A meta-analysis workshop was conducted in January of 2014. Results from that publication (Dugger et al.) are in review.

8. Acknowledgments

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Appendix 1. Number of previously unbanded spotted owls banded, Tyee Density Study Area, Roseburg, Oregon: 1990–2014.

	Adults		Subadults		Fledglings
Year	Male	Female	Male	Female	
<1990[1]	67	49	12	13	58
1990	14	7	4	7	31
1991	4	5	5	3	23
1992	3	6	2	3	44
1993	1	2	0	1	11
1994	0	2	2	2	28
1995	1	1	0	0	16
1996	1	0	0	0	53
1997	0	0	2	0	26
1998	1	0	1	2	34
1999	0	2	2	1	26
2000	1	1	1	0	28
2001	2	0	0	2	67
2002	2	1	1	4	40
2003	0	1	1	2	18
2004	1	2	0	1	37
2005	0	1	0	1	45
2006	2	0	2	0	10
2007	1	0	1	2	20
2008	1	1	2	2	27
2009	0	0	3	3	11
2010	0	0	1	1	15
2011	1	0	1	1	2
2012	0	0	0	1	4
2013	0	0	0	0	7
2014	0	0	0	1	5
Total	103	81	43	53	686

[1]Includes those owls banded 1983-1989. The analysis for the DSA focuses on 1990-2014.

Appendix 2. Number of spotted owls detected within the Tyee Density Study Area (DSA), Roseburg, Oregon: 1990–2014.

		Adults		1– 2-year-old		Age Unknown		Non-
Year	Pairs	Male	Female	Male	Female	Male	Female	Juveniles
1990	*58*	*61*	*49*	*7*	*10*	*7*	*8*	*142*
1991	*55*	*60*	*51*	*12*	*6*	*7*	*6*	*142*
1992	*57*	*60*	*52*	*10*	*8*	*4*	*5*	*139*
1993	*54*	*56*	*44*	*8*	*9*	*4*	*4*	*125*
1994	*59*	*60*	*51*	*10*	*9*	*1*	*2*	*133*
1995	*55*	*63*	*54*	*1*	*3*	*2*	*6*	*129*
1996	*53*	*56*	*51*	*5*	*5*	*4*	*2*	*123*
1997	*53*	*57*	*49*	*14*	*6*	*4*	*1*	*131*
1998	*60*	*53*	*46*	*18*	*14*	*5*	*4*	*140*
1999	*51*	*58*	*50*	*8*	*4*	*9*	*3*	*132*
2000	*52*	*57*	*53*	*5*	*2*	*5*	*3*	*125*
2001	*58*	*61*	*51*	*9*	*8*	*1*	*3*	*133*
2002	*64*	*60*	*48*	*17*	*17*	*3*	*1*	*146*
2003	*62*	*64*	*46*	*15*	*17*	*1*	*2*	*145*
2004	*66*	*73*	*60*	*4*	*5*	*1*	*2*	*145*
2005	*66*	*71*	*59*	*8*	*7*	*1*	*0*	*146*
2006	*52*	*58*	*50*	*10*	*9*	*2*	*0*	*129*
2007	*46*	*59*	*42*	*4*	*7*	*5*	*2*	*119*
2008	*47*	*63*	*43*	*9*	*8*	*2*	*2*	*127*
2009	*44*	*56*	*35*	*9*	*9*	*3*	*4*	*116*
2010	*48*	*51*	*42*	*13*	*6*	*1*	*0*	*113*
2011	*32*	*43*	*35*	*5*	*2*	*5*	*1*	*91*
2012	*29*	*43*	*31*	*0*	*1*	*1*	*3*	*79*
2013	*29*	*37*	*31*	*0*	*0*	*4*	*1*	*73*
2014	*27*	*34*	*27*	*0*	*2*	*2*	*0*	*65*
AVG	*51.1*	*56.6*	*46.0*	*8.0*	*7.0*	*3.4*	*2.6*	*123.5*

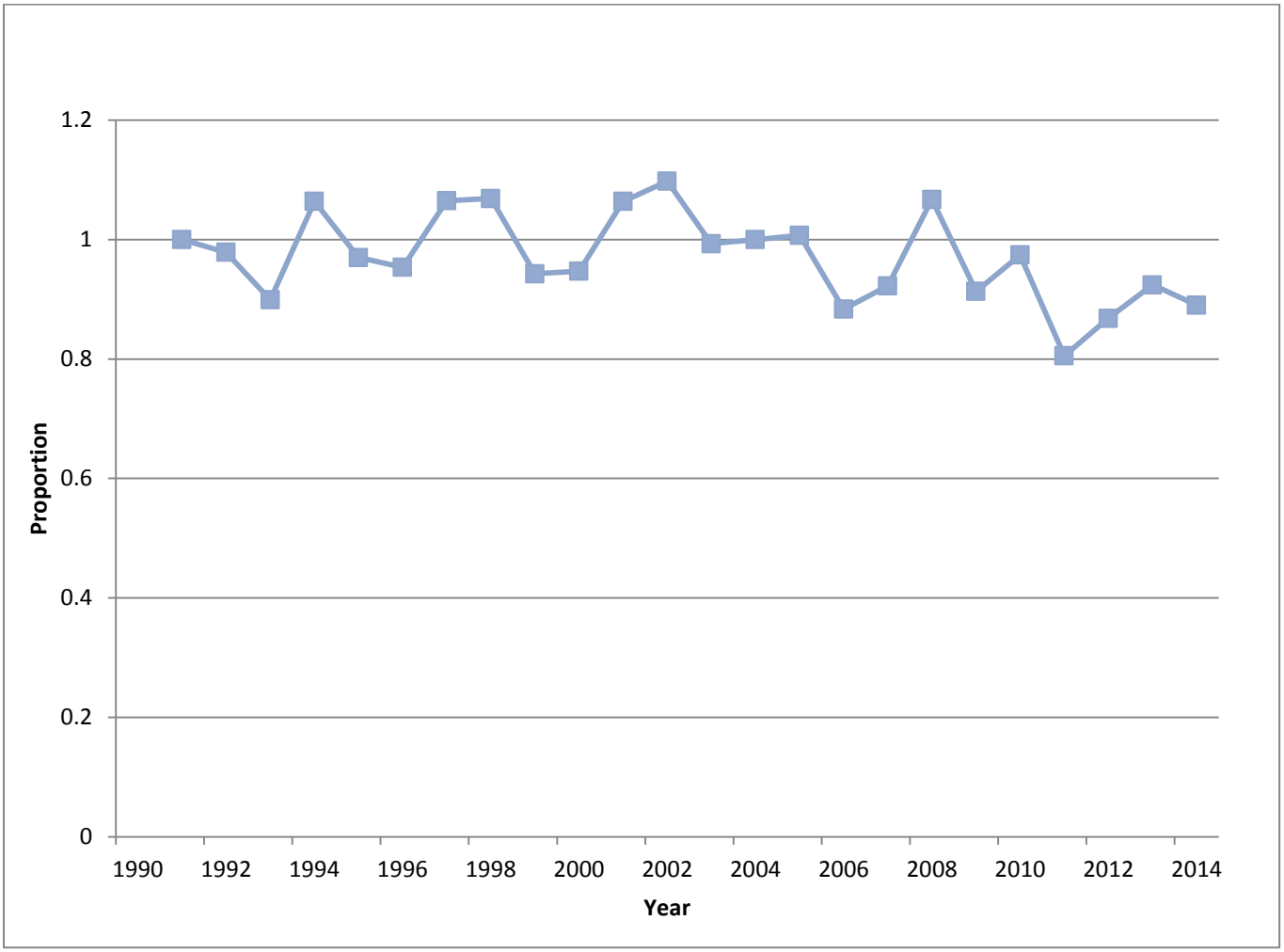
Appendix 3. Estimated number of young fledged and mean brood size of female spotted owls on the Tyee Density Study Area: 1990–2014.

	Number of young fledged[1]			Brood size[2]		
Year	Females	Young	Mean	Female	Mean	SE
1990	61	35	0.574	29	1.207	0.077
1991	59	24	0.407	14	1.714	0.125
1992	62	48	0.774	30	1.600	0.091
1993	54	11	0.204	7	1.571	0.202
1994	60	33	0.550	23	1.435	0.106
1995	60	18	0.300	12	1.500	0.151
1996	56	60	1.071	34	1.765	0.074
1997	55	29	0.527	18	1.611	0.118
1998	63	38	0.603	27	1.444	0.097
1999	55	26	0.473	18	1.444	0.121
2000	54	28	0.519	17	1.647	0.119
2001	61	70	1.148	39	1.795	0.075
2002	65	41	0.631	25	1.640	0.098
2003	66	17	0.258	13	1.308	0.133
2004	66	44	0.667	28	1.571	0.095
2005	65	47	0.723	29	1.621	0.092
2006	57	11	0.193	8	1.375	0.183
2007	48	20	0.417	14	1.429	0.137
2008	50	26	0.520	16	1.625	0.125
2009	45	13	0.289	8	1.625	0.183
2010	46	18	0.391	12	1.500	0.151
2011	37	2	0.054	1	2.000	N/A
2012	31	4	0.129	3	1.333	0.333
2013	29	6	0.207	4	1.500	0.289
2014	29	5	0.172	3	1.667	0.272
Mean	**25**	26.96	0.506	**25**	**1.539**	0.029

[1] Documented by 31 August

[2] Both number of young fledged and brood size were based on the number of young seen outside the nest tree, regardless of whether they were dead or alive.

Appendix 4. Change in population relative to the previous year, Tyee DSA, Roseburg, OR, 1990-2014.



Appendix 5. Habitat change for Tyee DSA From 1990 to 2013, Tyee DSA underwent a 10% reduction in the suitable habitat (37% to 27%).