WILDLIFE HABITAT RELATIONSHIPS
IN WASHINGTON AND OREGON
FY2015
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1. Title: Annual Report: Demographic characteristics of northern spotted owls (*Strix occidentalis*) on the Tyee Density Study Area, Roseburg, Oregon: 1985–2015.

2. Principal Investigator(s) and Organization(s): Dr. D. Lesmeister (PI), J. A. Reid (Assistant PI), U. S. Forest Service, Pacific Northwest Research Station. Biologists: J. Burgher, J. Dewar, B. Betterly, 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 the 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).

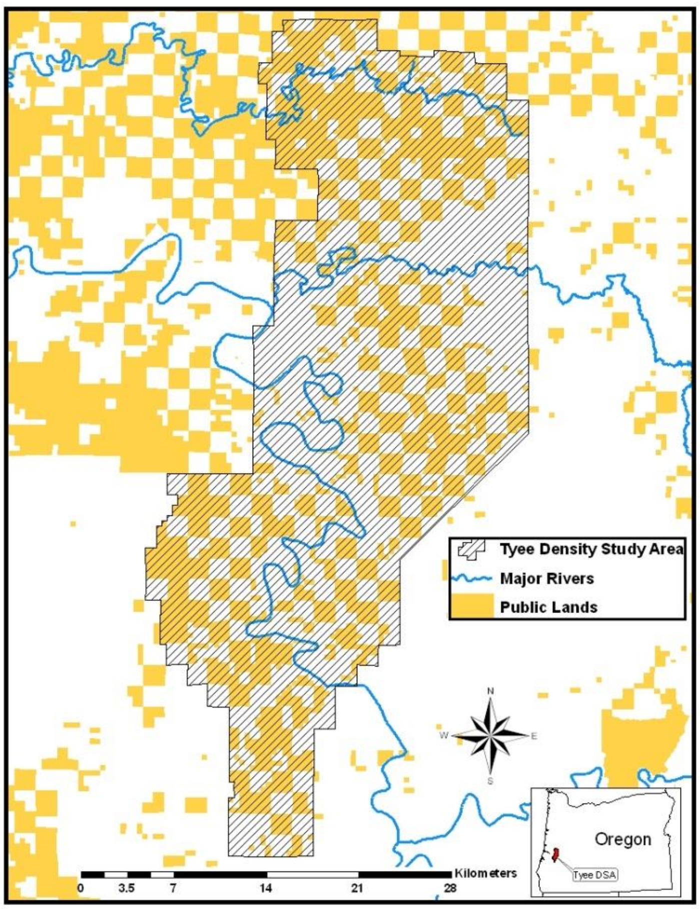


Figure 1. The hatched area represents the Tyee Density Study Area (DSA), Roseburg, Oregon.

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 survey method by which we sample 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 2015, we banded 960 spotted owls on the DSA, including 706 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 2015, we documented 60 non-juvenile spotted owls in the DSA, including 23 pairs and 14 unpaired individuals (Appendix 2). This represents approximately 42% 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 second consecutive year that the population of spotted owls has dipped below 50% of the original 1990 population level.

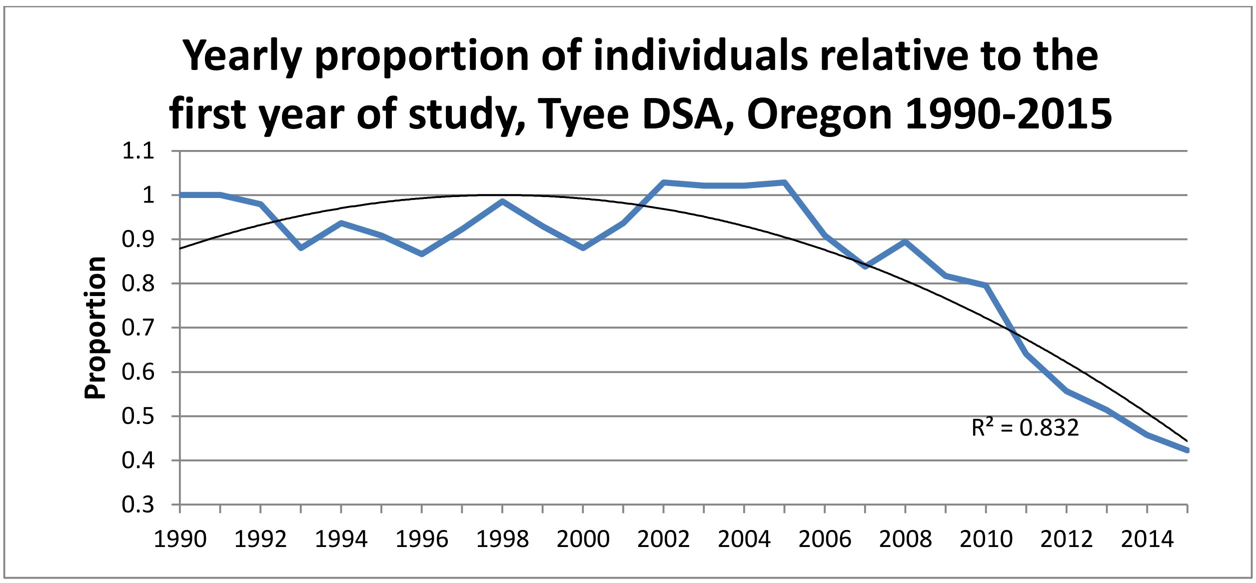


Figure 2. Yearly proportion of non-juvenile spotted owls detected relative to the first year of study, Tyee Density Study Area (DSA), Roseburg, Oregon, 1990-2015.

Age Distribution

Population age structure can be an indication of the future trends in population numbers. The non-juvenile spotted owl population in the Tyee DSA has completely turned over since 1996 (Fig. 3). None of the individuals that were preent in 1996 were present in 2015. The typical population age structure of higher numbers of younger owls in the population is not the case for the Tyee DSA. This could be useful in predicting future reproductive output. As the older owls die off and there are fewer owls in the high reproductive age classes, the population could be experiencing a population collapse.

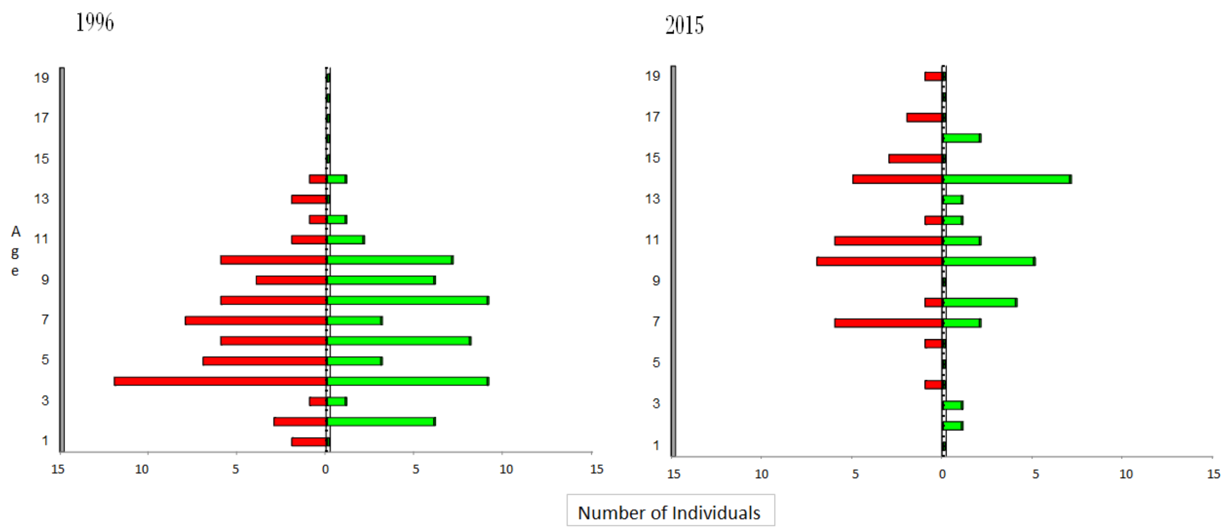


Figure 3. Age structure of non-juvenile spotted owls, Tyee DSA, Roseburg, Oregon 1996 and 2015.

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 2015 (Appendix 2). In 2015, the number of pairs and the total number of non-juvenile spotted owls detected was the lowest recorded for the 26 year survey period (Fig. 4). In 2015, approximately 78% of the pairs (N=23) and 73% of the nesting pairs (N=15) in the DSA were located on federal land and 27% were on private land.

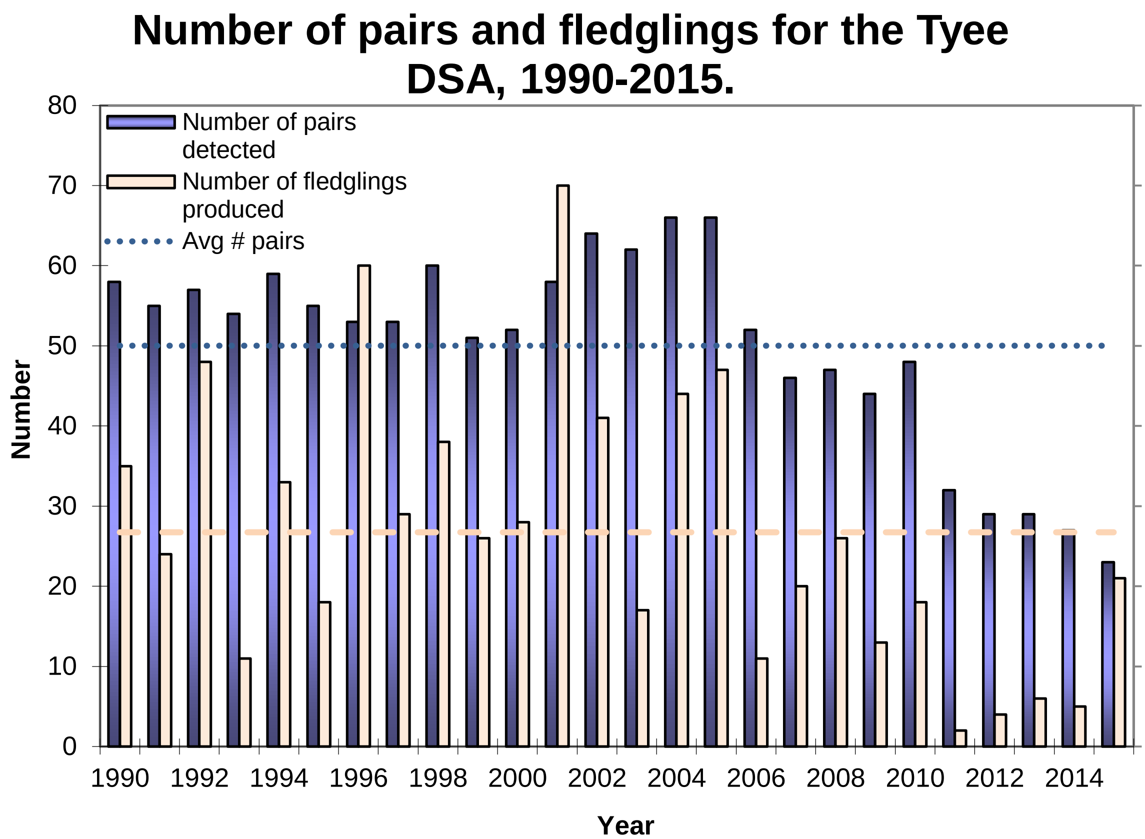


Figure 4. Annual number of spotted owl pairs detected and fledglings produced, Tyee DSA, Roseburg, Oregon: 1990-2015. Horizontal lines indicate means for the entire period.

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 2015, 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).

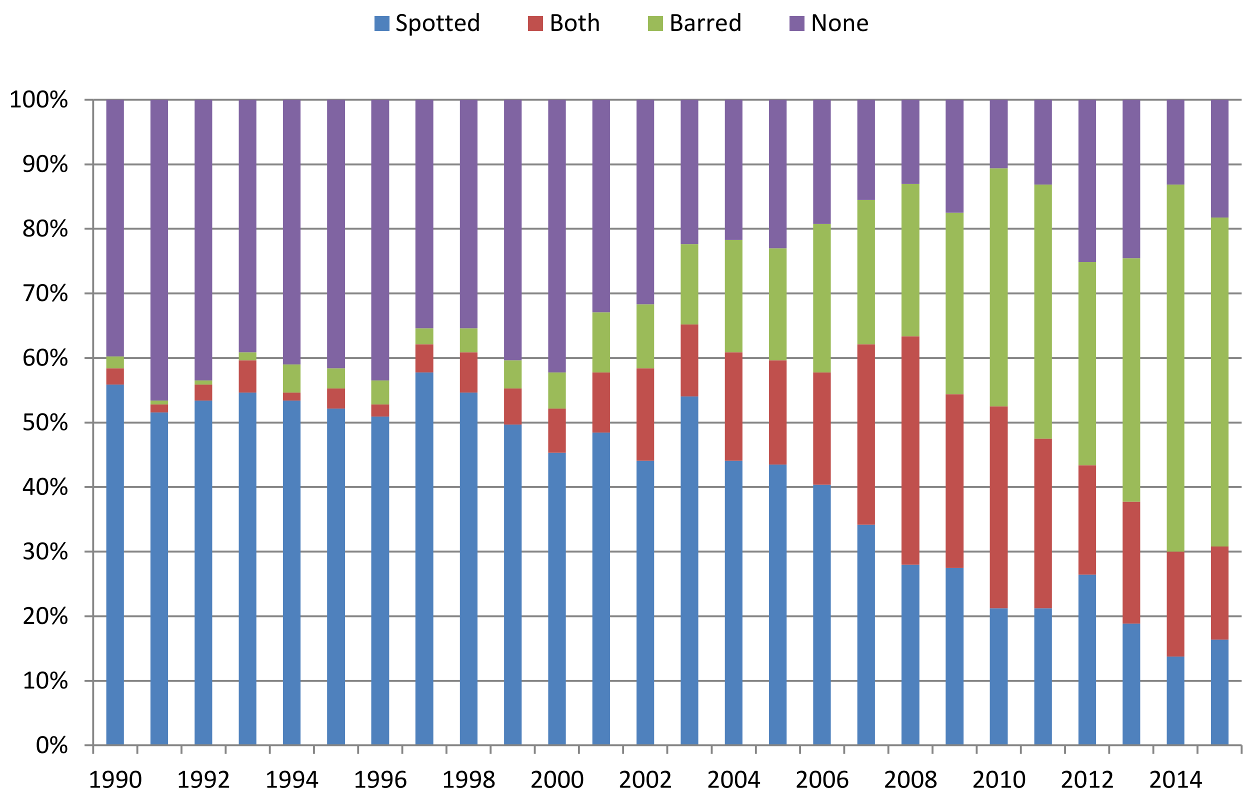


Figure 5. Percent of sites occupied by spotted owls and/or barred owls, Tyee DSA, Roseburg, Oregon: 1990-2015.

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).

In 2015, we identified a male spotted owl that had gone undetected for 9 years. These longer periods in resighting contribute to the lower resighting rates. 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. Our ability to detect spotted owls is dependent on spotted owls responding or reacting to our vocal imitations. Short term disturbances are unlikely to have much impact on detection rates, but continuous disturbances, such as the presence of barred owls, could change spotted owl behavior to the point that they are no longer reacting to our vocalizations, especially if the owl is not paired. When spotted owls are excluded from their traditional core areas they may be relegated to the margins of the sites or forced to join the nomadic (floater) population (Fig. 6), making them even more difficult to locate and driving the detection rates down.

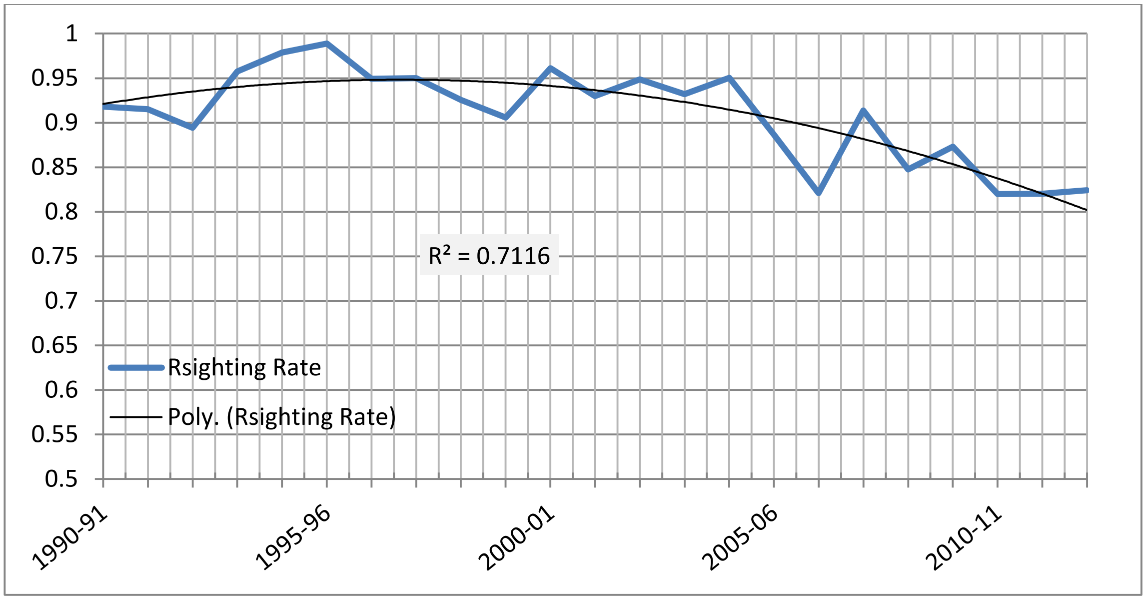


Figure 6. Resighting probabilities of spotted owls {Phi (.), p(t) }, Tyee Density Study Area, 1990-2013.

Reproduction

The proportion of females nesting in 2015 was higher than the previous year, (0.40, 95% CI = 0.20-0.60), and the proportion of those that actually were successful (13 out of 14) was well above 63.9% average. The number of pairs has severely declined in the last 5 years, yet the number of young produced was the highest since 2008 (Fig. 4). For all years combined, the annual percentage of females that nested averaged 49% (N= 26 years, Table 1).

The average number of young produced per female in 2015 was 0.417, which was considerably higher than the average of 0.242 for all years (N=26) (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. 7). In 2015, we documented an increasing proportion of spotted owls nesting and a higher reproductive output. However, the number of pairs continued to decline. Unless we continue to have the reproductive success from the few pairs remaining, the spotted owl population may not be able to stabilize. A decline in the number of spotted owl pairs that successfully reproduced has been evident in 8 of the last 9 years (Fig. 7).

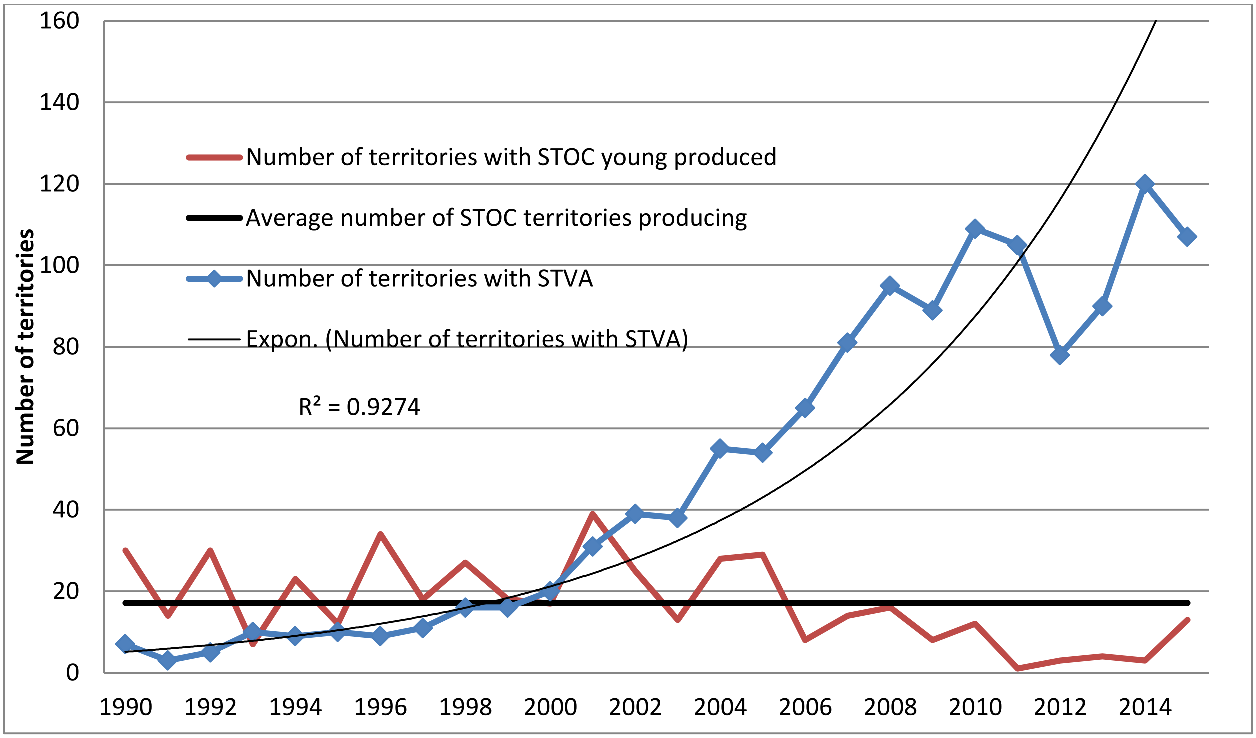


Figure 7. Yearly number of survey polygons (maximum of 160) on the Tyee DSA where barred owls were detected and where spotted owl reproduction was documented, Tyee DSA, Roseburg, Oregon: 1990-2015.

Table 1. Annual reproductive statistics for female northern spotted owls on the Tyee Density Study Area, Roseburg, Oregon: 1990–2015.

	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
2015	24	0.583	0.39-0.78	24	0.542	0.34-0.74	14	0.929	0.79-1.00
Mean	N=26 years	0.490		N=26 years	0.312		N=26 years	0.639	

[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: 1990–2015.

	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		70	0.029	0.00–0.07		7	0.286	0.00–0.65
2 year old	89	0.449	0.34–0.55		103	0.243	0.16–0.33		41	0.610	0.46–0.76
Adult	1073	0.536	0.51–0.57		1164	0.355	0.33–0.38		595	0.694	0.66–0.73
Unknown	11	0.545	0.20–0.85		21	0.238	0.05–0.42		10	0.500	0.17–0.83

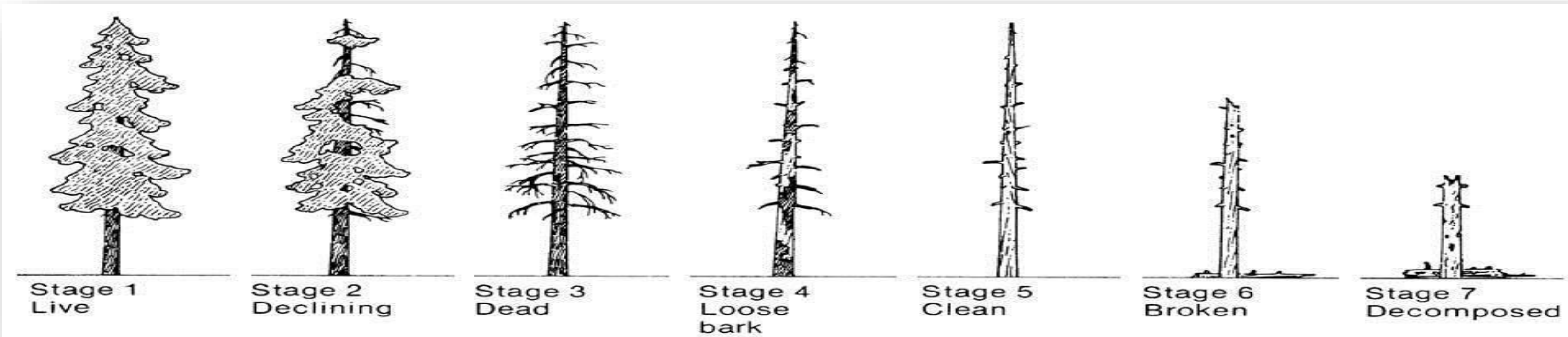
[1] Estimates were calculated for females whose nesting status was determined to protocol.
[2] Estimates were calculated for females whose reproductive status was determined by 31 August.
[3] Estimates were calculated for females whose reproductive status was determined to protocol and reproductive status 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: 1990–2015.

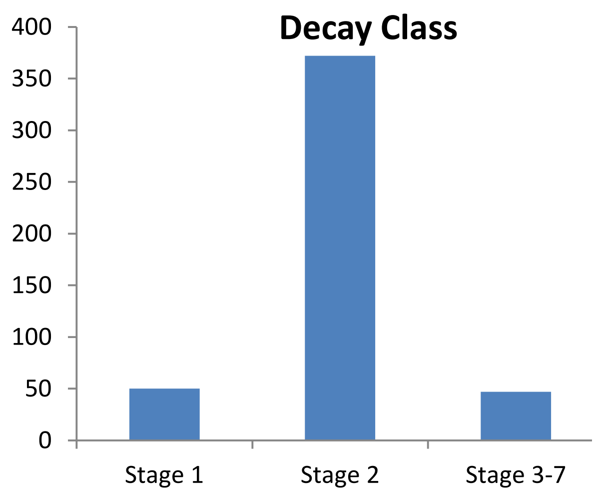
					Brood size[2]		
	N	No. Young Fledged	Mean		N	Mean	SE
1 year old	70	0.029	0.020		2	2.000	0.000
2 years old	103	0.204	0.037		25	1.680	0.095
Adults	1164	0.276	0.012		411	1.557	0.025
Unknown	21	0.167	0.072		5	1.400	0.245

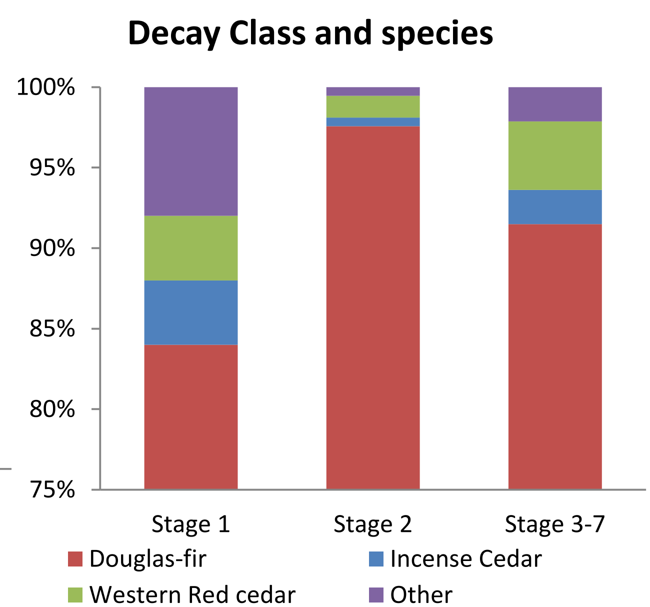
[1] Number of young fledged was defined as number produced per female.
[2] Brood size was based on the number of young seen outside the nest tree, regardless of whether they were dead or alive.

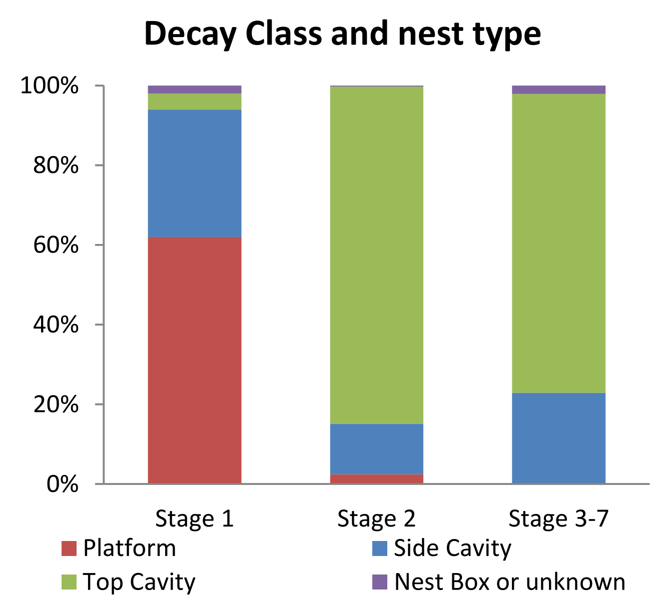
Nest tree characterization on the Tyee DSA 1990-2015.

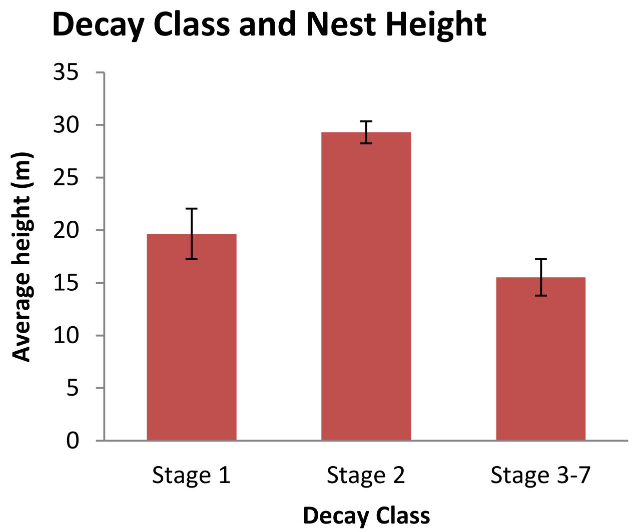


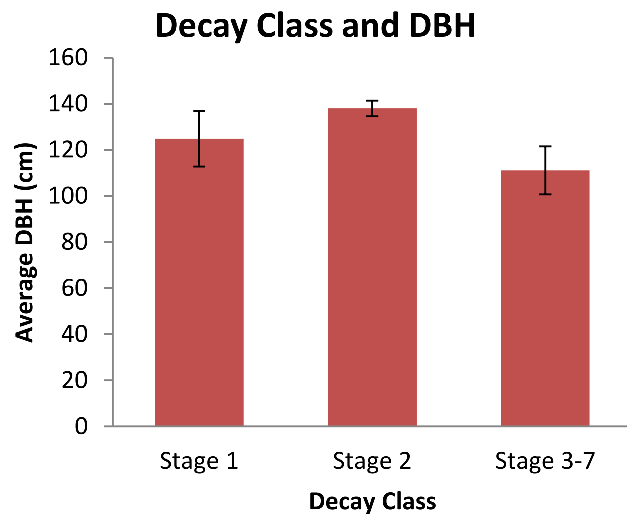
The following graphs characterize 468 nest trees on the Tyee DSA from 1990-2015. Nest trees on the Tyee DSA tend to be live, broken topped Douglas-fir trees, 120 to 140cm DBH, between 40-45m in height and on the lower to middle third of steep slopes (greater than 60 degree slope). They also occur more frequently on the south and westerly aspect. Nests are generally top cavities between 30-40m from the ground.

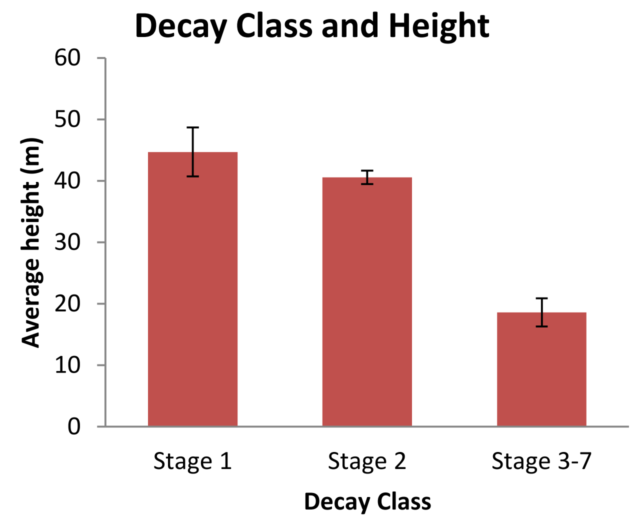


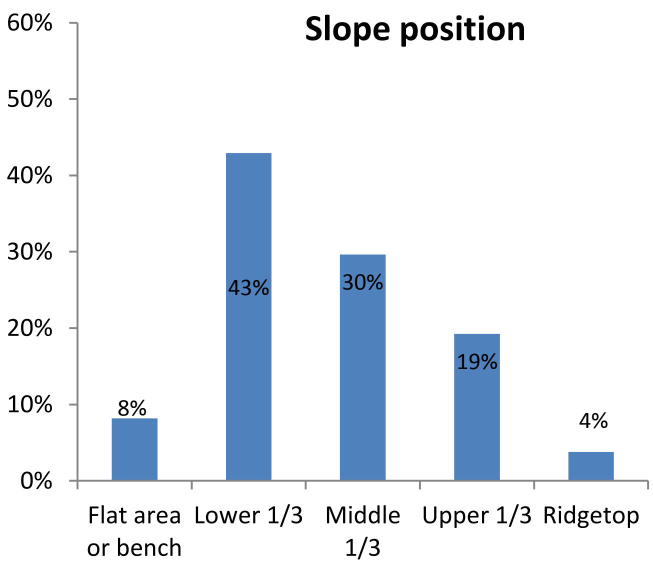


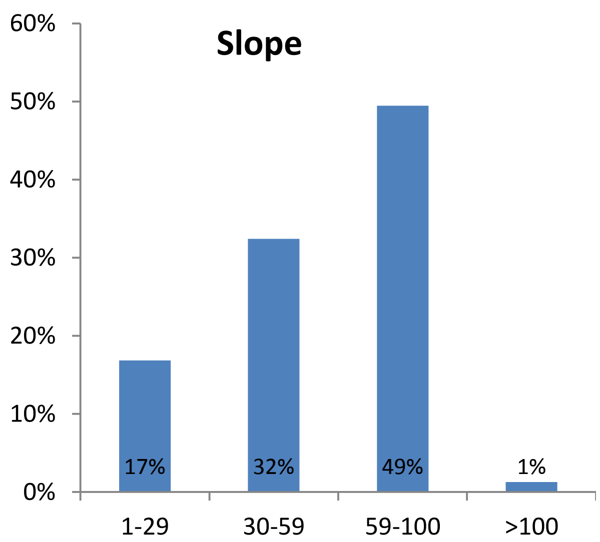


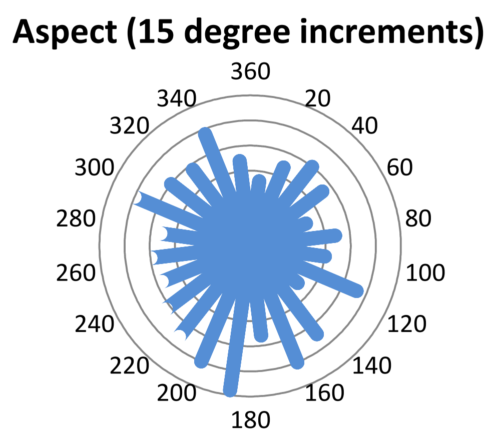

Decay Class and Nest Height
Average height (m)
35
30
25
20
15
10
5
0
Stage 1
Stage 2
Stage 3-7
Decay Class


Decay Class and DBH
Average DBH (cm)
160
140
120
100
80
60
40
20
0
Stage 1
Stage 2
Stage 3-7
Decay Class


Decay Class and Height
Average height (m)
60
50
40
30
20
10
0
Stage 1
Stage 2
Stage 3-7
Decay Class


Slope position
60%
50%
40%
30%
20%
10%
0%
8%
43%
30%
19%
4%
Flat area or bench
Lower 1/3
Middle 1/3
Upper 1/3
Ridgetop


Slope
60%
50%
40%
30%
20%
10%
0%
17%
32%
49%
1%
1-29
30-59
59-100
>100


Aspect (15 degree increments)
360
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340

Nest Tree Location Error

Our procedure for documenting nest trees includes recording the location in UTM (Universal Transverse Mercator) coordinates and marking the tree with a metal tag. Within the Tyee Density Study Area, we have consistently gathered nest tree information since 1989 and have nest tree records as early as 1983. Nest tree locations prior to 1999 were spatially estimated from topographical and aerial photographic maps, whereas nest tree locations recorded after 1999 were documented with Global Positioning System (GPS) devices. Since 1999, we visually re-located nest trees that were first located before our use of GPS technology in order to record updated location information. We recorded the error differences from 87 re-measured nest trees which allowed us to assess the potential location errors of all nest trees measured prior to the use of GPS. We calculated the average error for all years and all observers (previous to 1999).

Federal management guidelines for NSO critical habitat (USFWS 2012) include multiple levels of protection based upon distance from activity centers, each with its own level of importance and corresponding restrictions for management. The smallest and most restrictive of these areas is the nest patch which is contained in the core area of activity. These nest patch areas are 300m buffer zones around known or suspected active nest trees (USDI and USDA 2008, Medford BLM, 2010). The integrity of these buffer zones is important to the continuing reproductive success of the spotted owl. As has been previously documented, thinning or logging operations within the core areas can have detrimental effects to owl occupancy and the continued use of these forests by spotted owls (Forsman et al. 1984, Meiman et al. 2003, and Wilson and Forsman 2013). While the specific tree is important, it is also important to maintain the old forest characteristics of the stand surrounding the nest tree. Spotted owl sites usually contain more than one nest tree and increased reproductive success is related to the amount of mature and older forests (Swindle et al. 1999, USFSW, 2012,). The accuracy of the spatial placement of the nest tree that is used to derive these management areas and subsequent assessment of the area is central to maintaining the integrity of the nest patch.

Nest tree locations pre-GPS technology were, on average, 82m (N=87, SE=7.86) in error from the GPS location estimate (Figure 8). Error estimates ranged from 2m-363m (Fig. 8). The median error was 58m. We used this average error to create error buffer zones around all pre-GPS nest tree locations in GIS (Geographical Information System) mapping software. We also used the BLM's Forest Operations Inventory (FOI) GIS information that to assess how errors in nest tree placement could impact the classification of "nest patch" stand characterization. The FOI information has been widely used in the past for determination of stand age and for placement of proposed projects of stand manipulation and is available on the BLM GIS website (http://www.blm.gov/or/gis/data-details.php?id=15304). Using these buffer zones and the FOI coverage we were able to identify 173 nest tree locations on BLM and adjoining private land measured prior to 1999. Of these 173 nest tree locations, 27.1% (N = 47) fell within 80m of stands characterized within the BLM GIS shapefiles as less than 100 years old (Figure 9). Because older nest trees may not be spatially accurate, we feel that there is potential for the actual nest patch to be vulnerable to habitat alterations that threaten the integrity of the nest site habitat.

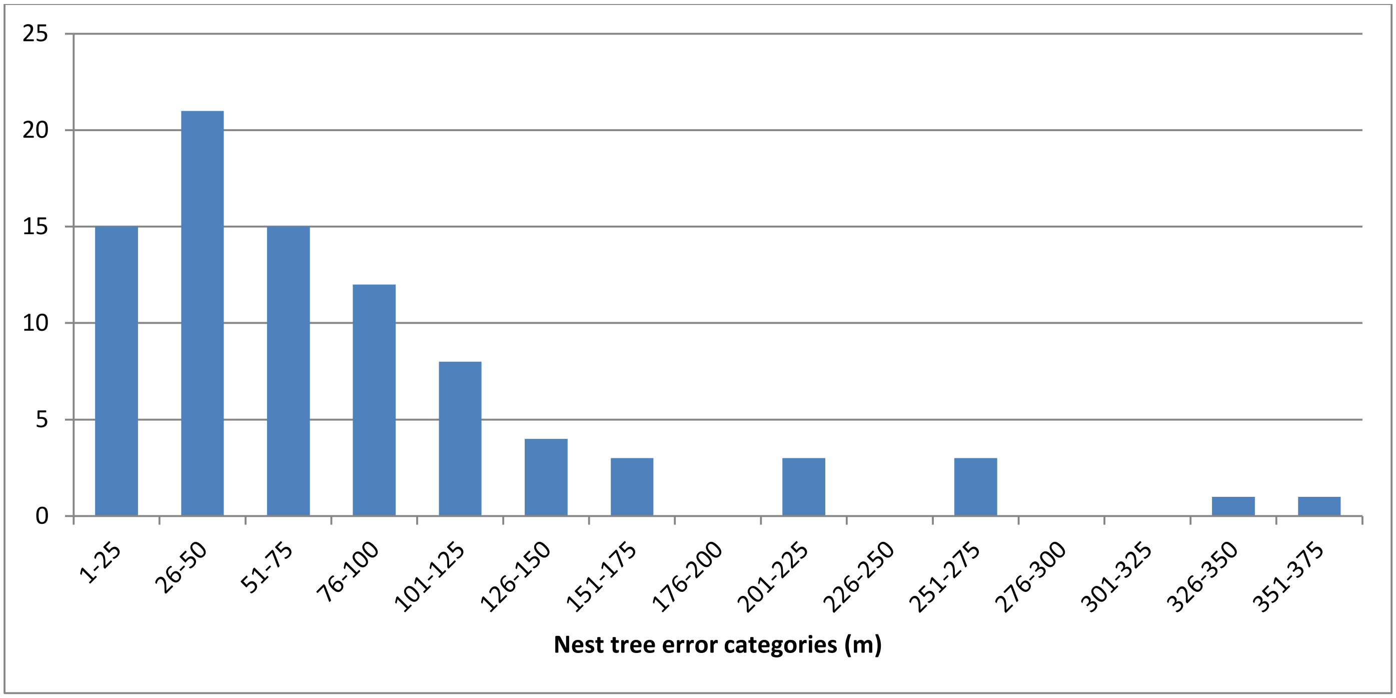


Figure 8. Number of pre-GPS nest tree locations and error categories, Tyee DSA 1990-2015.

The “nest patch” designation is such a crucial and yet small part of the NSO habitat requirements. It is also relatively new to management analysis (USDA and USDA 2008) such that we feel that it is worthwhile to visually relocate and verify the location of older nest trees, especially if the older nest trees are included in assessment of upcoming projects that will subject the area to stand manipulation. BLM stand age data available in the FOI and used in our analysis sometimes misclassified stand age as younger than our recorded information from on-the-ground observations verified with aerial photography. Updating the nest tree location will more accurately reflect the true location and could avoid erroneous nest patch assessment and stand analysis. Our average error of 82m could exclude approximately 27% of the actual 300m nest patch from protection under current forest management analysis. Our information indicated that many of the spatial errors were below 200m (Figure 8). Even so, nest tree location data gathered with pre-GPS technology could result in the erroneous or partial destruction of some nest patch areas. If this older and more inaccurate information is still currently used for project planning, we recommend that field verification of the nest tree be performed in order to avoid conducting analysis on the incorrect area and erroneously affecting the integrity of nest patches.

Thistleburn Creek Remeasured Nest Tree Error
FOI Misclassification

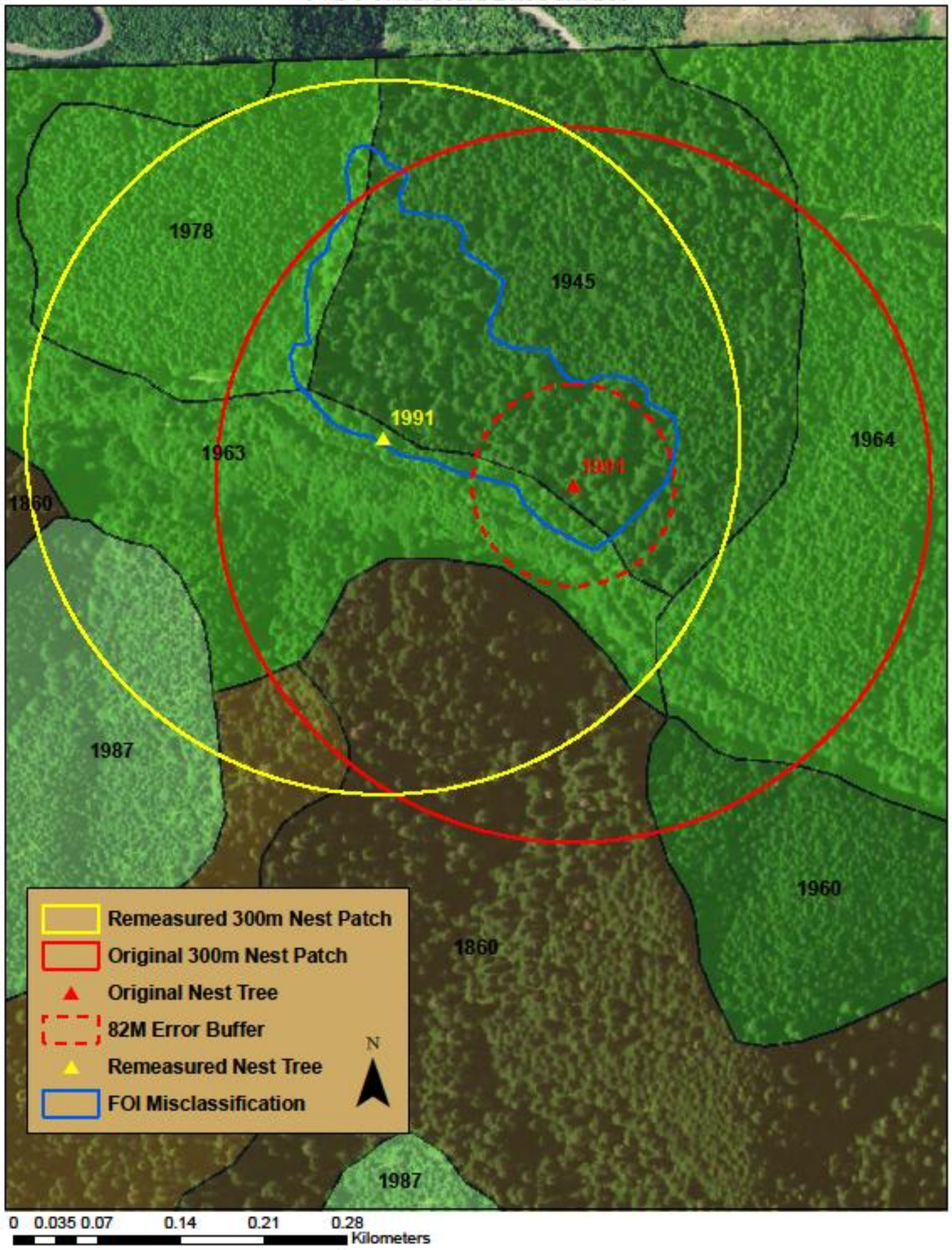


Figure 9. Example of nest tree spatial error, stand age missclassification, and potential error in nest patch analysis and protection.

Interesting observations and unusual events documented in 2015:

We located a spotted owl nest in a hole in a small cliff in 2014, which was only the 3rd case of cliff nesting that we have documented on the Tyee DSA in 25 years (Fig. 10). Potential nest sites in steep cliffs are not widely available on the study area, which probably explains why they are rarely used. In 2015, the pair again used the hole in the cliff to nest. They produced 2 young for the second consecutive year.

Figure 10. Spotted owl nest in a hole in a cliff on the Tyee Density Study Area, 2014 and 2015.

We encountered a single male that showed signs of imbalance. Each time the male landed on a branch, he displayed difficulty balancing and would lean against the trunk of the tree. This was atypical behavior and could be a reaction caused by a virus, ingested substance, or an external force. We will likely not be able to determine what caused the abnormality since it was the only time we encountered the owl all season. The site location is near several houses and a busy highway.

We typically do not document mortalities except when we have owls fitted with radio transmitters that enable us to locate the owl when it has been killed or dies of natural causes. Therefore, it was unusual to receive 3 confirmations of mortalities within a single year. We documented mortality for 3 owls that were missing (one for 3 weeks, one for 1 year and one for 2 years) during the 2015 survey season. All of the owls succumbed to either predation or some other natural cause of mortality. All were found well away from roads and 2 of the 3 were within forested areas. One was found on a decommissioned and overgrown road.

During a nighttime walk into a nest site to determine the number of young fledged, the pair of spotted owls and their single young was observed. The pair was very vocal and when a barred owl pair arrived and vocalized the adult spotted owls sounded an alarm call signifying that there was danger. The young spotted owl did not cease vocalizing and the spotted owl pair remained stationary. The barred owl pair did not attack the vocalizing young or the adults and after a short period of time could be heard in the distance. We know that barred owls can be very physically aggressive in their territorial defense.

Apparently, they can also be more passive as well, choosing to be acoustically territorial rather than physically territorial.

Problems encountered:

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. One small woodland owner in the study area has refused access to the site on his land to verify identification of the owls on his property. Extra effort and thought have gone into formulating ways to continue to gather the necessary information on identification, nesting and reproductive output for this site.

Noise from logging traffic has also increased in recent years and results in extra effort to reschedule visits to avoid the problem. All of this leads to decreased survey efficiency and a greater workload.

6. Summary

Although the number of spotted owls detected on the DSA continued to decline in 2015 (Appendix 2), the proportion of females that attempted to nest was above average and the total number of young produced was the most since 2008 (Appendix 3). All of the non-juvenile spotted owls in the study area in 2015 were previously banded indicating that recruitment of younger owls into the territorial population continues to remain very low (Appendix 1). The spotted owl population is aging and with low recruitment of young owls in recent years, the prospect for a stable or increasing population of spotted owls is doubtful. For several years previous to 2015, the reproductive output was nearly non-existent, giving little hope that the vacancies from mortality and emigration could be replaced. Evidence from the most recent meta-analysis (Dugger et al, 2015) indicates that populations across the range are still in decline. The reproductive output in 2015 is promising and may provide the necessary boost to recruitment that the aging population needs.

The higher reproductive output in 2015 could be related to the favorable weather conditions (Franklin et al. 2000). We continued to document fewer pairs of spotted owls in the study area which could be related to the much larger population of barred owls and habitat degradation that continues to occur. Habitat within spotted owl sites on the Tyee DSA was still being degraded as state forest practices regulations applied to private land still greatly impact federal land. The most common harvest method on private land is still predominantly clearcut and has occurred immediately adjacent to and within nest patches of spotted owls. Harvest of forest adjacent to federal land with known nest trees, and seemingly protected by federal critical habitat designations, continued to be degraded through intrusion by adjacent private landowners who used the very large trees on federal land to anchor their harvest cables. On federal land, roosting and foraging habitat (young, mature, and mixed age stands) on BLM lands were degraded by thinning activities. Older forests on federal lands are currently being selected for future clearcutting (regeneration harvest) which will further decrease the available high quality habitat for the remaining spotted owls in the population. With a declining population, every spotted owl nest site may prove vital to the recovery of the species and further intrusions and habitat degradation of the nest sites could compound the impact that the barred owl has on the spotted owl population within the study area.

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.

Our study area entered the 26th year of consistent data collection. Locating and characterizing some basic features of nest trees throughout the study period can help determine the most favorable spatial locations for spotted owls to nest. We have over 450 nest trees that we have measured. Our nest tree information indicates that spotted owls favor certain conditions on the landscape. This information can be helpful for identifying potential high priority spotted owl nest sites. Various state, private and federal agencies use the nest tree location information to assess management options. When a study such as ours spans such a length of time, changes in technology are incorporated into the process. Although our primary focus is identification of the individuals spotted owls in the study area, additional information that we collect, such as the nest tree location,can also be important for a variety of other analysis. Our accuracy of the spatial location that we collect has improved with technology. Correcting all older spatial information is not possible but correcting older spatial information used in any analysis may be worthwhile as we discovered that older spatial information could misplace nest area protection and leave spotted owl core areas open for inadvertent stand manipulation.

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 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, 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. 2015. The roles of competition and habitat in the dynamics of populations and species distributions. Ecology.

g) We gave a presentation to the wildlife biology class at Umpqua Community College on the study area materials, methods and information gathered.We led a field outing for the Oregon Youth Conservation Corps to demonstrate the field techniques associated with spotted owl demography studies.

h) We led a field outing for the Oregon Birders Association to demonstrate our field techniques and discuss the history and purpose of the study.

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

8. Acknowledgments

This study was funded by the USDI Bureau of Land Management Oregon State Office and the USDA Forest Service, Pacific Northwest Region. The Roseburg District of the BLM provided invaluable support in all phases of the research. We would like to thank the Weyerhaeuser Company, Roseburg Resources, Lone Rock and Juniper Properties, Seneca Timber Company, Giustina Resources, and Bear Creek Timber for allowing us access to their lands. Several small private landowners provided invaluable access through and to their property.

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Appendix 1. Number of previously unbanded spotted owls banded, Tyee Density Study Area, Roseburg, Oregon: 1990–2015.

	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
2015	0	0	0	0	20
Total	103	81	43	53	686

[1]Includes those owls banded 1983-1989. The analysis for the DSA focuses on 1990-2015.

Appendix 2. Number of spotted owls detected within the Tyee Density Study Area (DSA), Roseburg, Oregon: 1990–2015.

		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*
2015	*23*	*31*	*23*	*0*	*1*	*4*	*1*	*59*
AVG	50.0	55.6	45.1	7.7	6.7	3.4	2.5	*121.1*

Appendix 3. Estimated number of young fledged and mean brood size of female spotted owls on the Tyee Density Study Area: 1990–2015.

	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
2015	24	20	0.417	12	1.667	0.136
Mean	**26**	**694**	**0.242**	**26**	**1.544**	**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.