NORTHERN SPOTTED OWL MONITORING
ANNUAL REPORT, FY 2011 30 January 2012

1. Title:

Demographic characteristics of northern spotted owls (*Strix occidentalis caurina*) in the Klamath Mountain Province of Oregon, 1990-2011.

2. Principal Investigators and Organizations:

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3. Study Objectives:

The study objectives are to estimate the population parameters of northern spotted owls on the Klamath Study Area (KSA) within the Klamath Mountain Province. These parameters include occupancy, survival and reproductive success. The lands are administered by the USDI Bureau of Land Management (BLM), Glendale Field Office of the Medford District and South River Field Office of the Roseburg District.

4. Potential Benefit or Utility of the Study:

The KSA is one of 8 long-term northern spotted owl study areas designed to assess status and trends in northern spotted owl populations and habitat as directed under the Northwest Forest Plan (USDA and USDI 1994). The data from these studies were recently analyzed as part of a rangewide meta-analysis workshop (Forsman et al. 2011a). The survival and reproductive data has and will be used in population modeling to assess the long-term stability of the population (Franklin et al. 1999). Data from several study areas has also been used in the development of habitat suitability models and maps for the spotted owl (Lint et al. 1999, Anthony et al. 2000, Lint 2005, Davis et al. 2011, USFWS 2011).

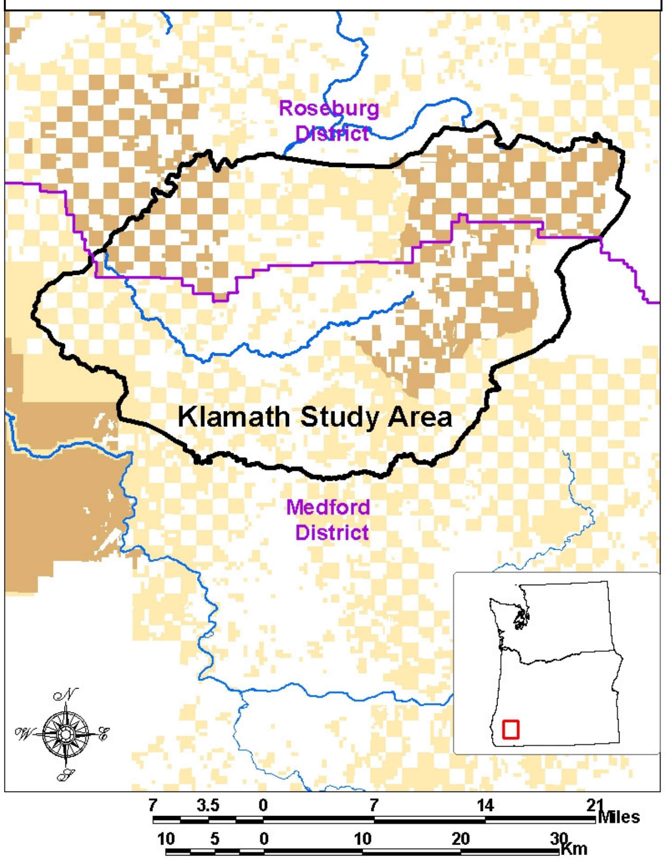
5. Study Area Description and Survey Design:

The KSA was located within the Klamath Mountains Physiographic Province in SW Oregon and was approximately 1422 km^2 (351,334 ac) in size (Figure 1). This province was characterized by mixed conifer forests dominated by Douglas-fir (*Pseudotsuga menziesii*) and incense cedar (*Calocedrus decurrens*). Other species common included pine (*Pinus* spp.), grand fir (*Abies grandis*), pacific madrone (*Arbutus menziesii*), golden chinquapin (*Castanopsis chrysophylla*), and oak (*Quercus* spp.) (Franklin and Dyrness 1973). Sites within the current boundaries of the KSA were systematically surveyed from 1997-present. A smaller study area (about 466 km^2; 115,138 ac) was systematically surveyed from 1990-1994 and was within the current study area boundary.

The KSA included portions of 2 BLM Districts in Western Oregon (Medford and Roseburg), and much of the intervening areas of private and state lands. The federal lands were primarily in an alternating "checkerboard" pattern of ownership with private lands. Of the 8 long-term studies, 2 (Klamath and Tyee) were composed almost entirely of this checkerboard pattern of ownership. Two types of study areas were included in the 8 long-term studies; (1) density study areas, where all of the area within the boundary was surveyed each year, and (2) territorial study areas, where all known past and present owl territories were surveyed each year. The KSA was a territory based study area.

The Northwest Forest Plan (NWFP) designated forestland into several Land Use Allocations (LUA's). One such LUA, Late Successional Reserves (LSR), were designed to maintain a functional, interacting, late-successional and old growth forest ecosystem across the range of the northern spotted owl (USDA and USDI, 1994). The KSA includes part or all of 2 LSR's designated under the NWFP.

Figure 1. Klamath Study Area boundary. Yellow and brown represent federally administered lands, brown represents LSR.



The checkerboard pattern made analysis by ownership or LUA difficult since virtually all sites within an LSR designation also encompass non-LSR within their home range. For the purpose of this analysis, a line was drawn around each of the 2 LSR's in the study. If sites were located within these boundaries they were considered in LSR, even though the private land within these boundaries was not actually designated as LSR.

The study monitored demographic parameters including survival rates, reproductive rates, and annual rate of population change. The protocol used to determine site occupancy, nesting, and reproductive status for this study follows the guidelines specified by the Northern Spotted Owl Effectiveness Monitoring Plan for the Northwest Forest Plan (Lint et al. 1999). An attempt was made to uniquely color band or re-observe all previously banded individuals within the study. The re-observation of banded owls was used for the calculation of survival rates and population trends (Franklin et al. 1999, Burnham et al. 1996, Anthony et al. 2006, Forsman et al. 2011a).

6. Results for FY 2011:

Survey Effort

There are currently 158 known spotted owl sites within the KSA. During the period of study, it was determined that 4 sites that were considered separate sites were different use areas of another site and have since been combined. Of the 158 sites surveyed during 2011; 53 were occupied by a pair, 12 by a single, and 14 were occupied by 1 or 2 owls with unknown status (Appendix A). At least one spotted owl was detected at 79 (50.0 %) of the sites. Two new sites were documented within the study during 2011. Consistent occupancy by a territorial single or a pair is the usual criteria for designating a new site.

Spotted Owl Occupancy

In 2011, we identified 136 individual, non-juvenile, spotted owls (76 males and 60 females), resulting in a male:female sex ratio of 1.27:1. Of the 119 non-juvenile owls where age was determined, 111 (93.3%) were adults and 8 (6.7%) were subadults (Appendix B). The oldest known owl within the KSA was a male at least 18 years old. The oldest known female was at least 16 years old. A total of 11 owls were newly banded during 2011. Of these, 7 (63.6%) were fledglings, 1 (9.1%) was an adult, and 3 (27.3%) were subadults.

Spotted Owl Reproduction

Yearly reproductive data (1990-2011) (Appendix D, E) includes nesting attempts, nesting success, fecundity rate, and mean brood size. The proportion of nesting attempts is defined as the number of females that attempted to nest versus the number where nesting status was determined. Nesting success is defined as the proportion of nesting females that fledged young. The fecundity rate is defined as the number of female young produced per female versus the number of sites where the number of young produced was determined. The mean brood size is defined as the average number of young produced per successfully reproducing pair. Where appropriate, the data were split into 4 female age classes; 1-year old, 2-year old, adult, and unknown age. The reproductive data were summarized 2 ways: (1) the entire KSA, and (2) divided into 2 groups (LSR and non-LSR) (Appendix F).

During 2011, there were a total of 50 sites where nesting status was determined, 10 nested (20.0%) and 40 did not nest (80.0%). Of the sites where nesting occurred, 5 pairs successfully fledged young and 5 pairs nested and failed, resulting in a nesting success rate of 50.0% (Appendix E).

The fecundity rate for the entire KSA during 2011 was calculated at 0.061 (Appendix D). The fecundity rate for all sites during the years 1990-2011 was split into 4 female age classes. The rate for 1-year olds (0.061) was much lower than 2-year olds (0.299), adults (0.344), and unknown age class (0.250) (Table 1). Neither of the 2 pairs with a 1-year old female attempted to nest.

In 2011, the mean brood size (1.40) was lower than the average for the years 1990-2011

(1.56). The mean brood size for the years 1990-2011 was split into 4 female age classes, all known age classes resulted in similar values (Table 1).

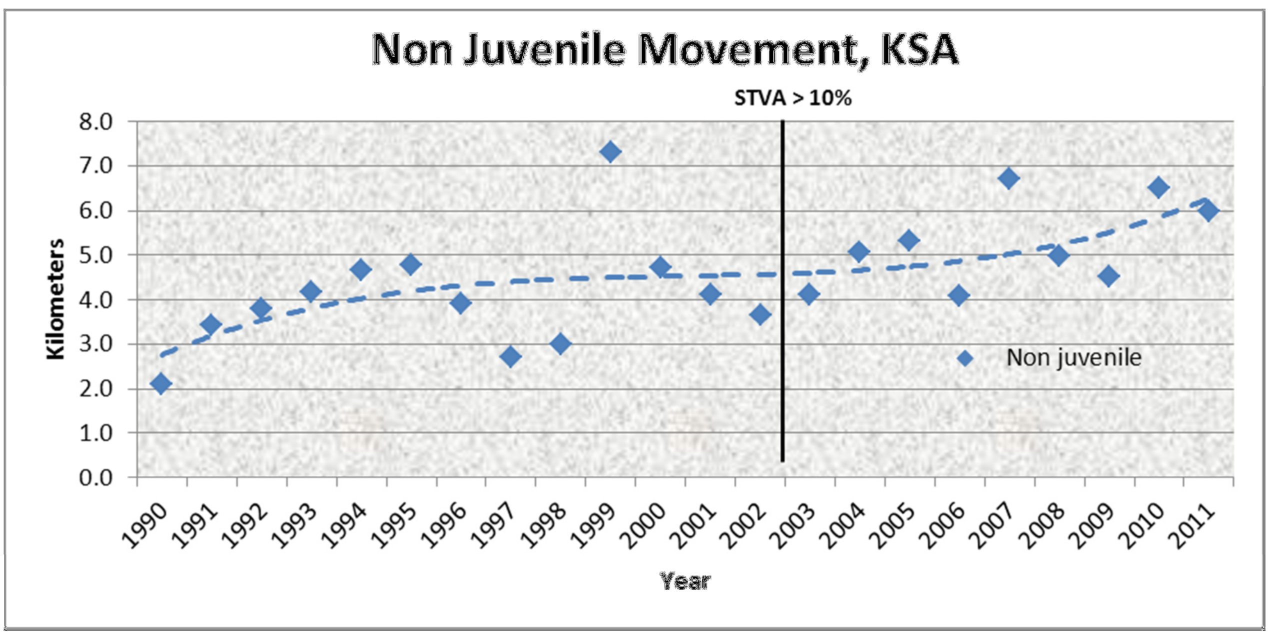
Table 1. Fecundity rate and mean brood size by age class of female within the KSA (1990-2011). (a)

Age class	**Mean fecundity (N), 1990-2011**	**95% CI for fecundity**	**Mean brood size (N), 1990-2011**	**95% CI for brood size**
1-yr	0.061 (98)	0.016-0.107	1.71 (7)	1.35-2.08
2-yr	0.299 (139)	0.232-0.365	1.51 (55)	1.38-1.64
Adult	0.344 (1329)	0.321-0.367	1.58 (577)	1.54-1.63
Unk	0.250 (44)	0.147-0.353	1.29 (17)	1.07-1.52
Total	0.326		1.56	

(a) Preliminary data, values may change.

Spotted Owl Dispersal

Figure 2. The annual average distance of non-juvenile movements within the KSA (1990-2011). All movements are included; internal, immigration, and emigration. A polynomial trend line is plotted ($r^2 = 0.389$). The vertical line represents the first year STVA detections exceeded 10% of the sites surveyed.



During 2011, of the 9 owls encountered for the first time as non-juveniles on the study, the ages of 8 (88.9%) were known exactly or within 1 year. On the KSA during 2011, 2 non-juveniles were known immigrants and 1 non-juvenile was a known emigrant. A total of 7 owls originally banded as juveniles within the KSA were recaptured for the first time during

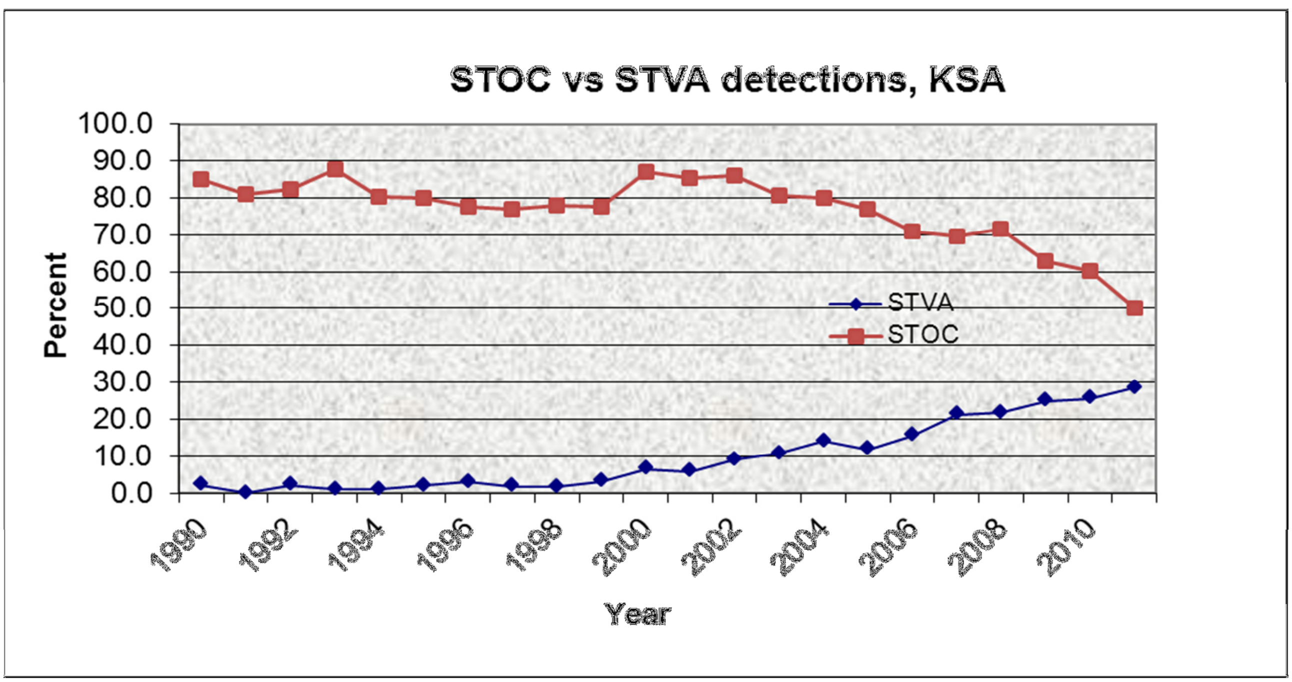
2011, 5 were recaptured within the KSA (Appendix C).

The longest distance moved, for a juvenile banded within the study and relocated during 2011, was 31.6 km (19.6 mi) from the point of original banding, and the longest distance moved for a non-juvenile banded within the study and relocated during 2011 was 25.7 km (16.0 mi) from the point of previous confirmation. The average distance for recoveries of dispersing males during 2011 was 17.7 km (11.0 mi) (N=6) and for females was 16.2 km (10.1 mi) (N=1). These distances are similar to Forsman et al. (2002). The average distance for movements of non-juveniles during 2011 was 6.0 km (3.7 mi); 4.0 km (2.5 mi) (N=7) for males and 7.2 km (4.5 mi) (N=11) for females (Figure 2).

Barred Owl

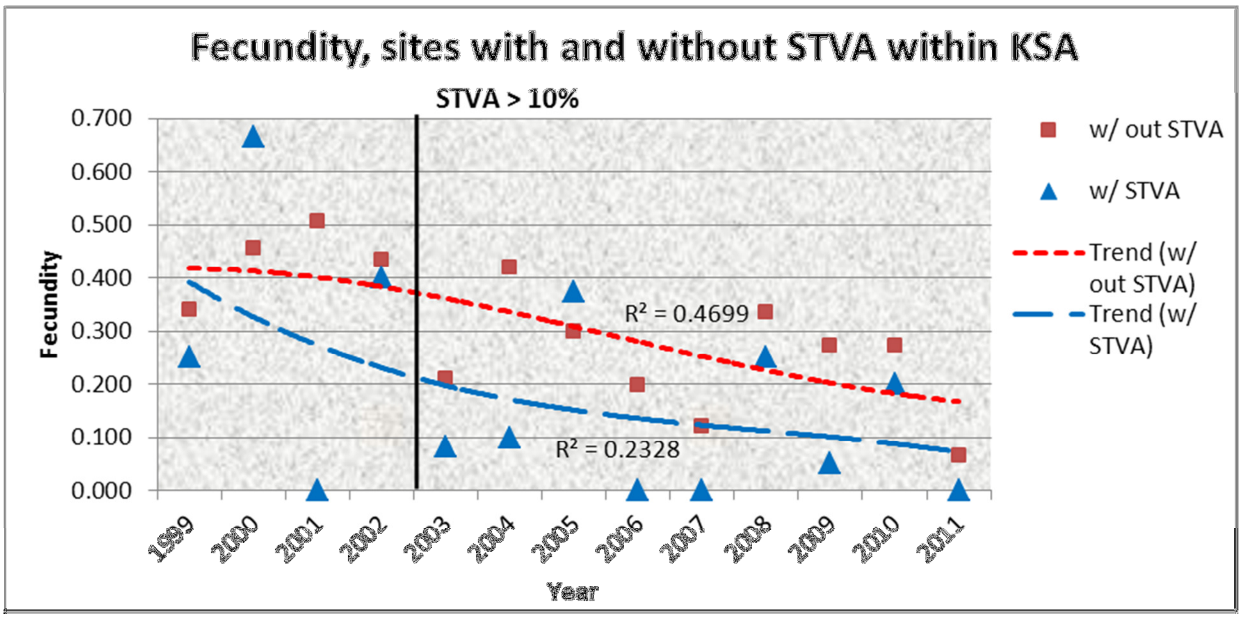
There were at least 62 non-juvenile barred owls (*Strix varia*) detected at 45 sites on the KSA during 2011. We detected a pair of barred owls at 14 sites, a single at 31 sites and at least one additional male at 3 of these sites. No fledglings were detected at any sites during 2011. There have been several hybrids detected in previous years, but no hybrids were detected in 2011. We compared the percentage of sites that were surveyed where at least one spotted owl was detected versus at least one barred owl detected (Figure 3). The barred owl detections were incidental to spotted owl surveys, therefore the number of sites with at least one barred owl detection is probably underestimated. The percentage of spotted owl sites with barred owl detections is increasing from a relatively low 1.7% in 1998, to 10.7% in 2003, 21.8% in 2008, and 28.5% in 2011 (Appendix A). The percentage of sites with a barred owl detection exceeded 10% for the first time during 2003, and has remained above 10% since.

Figure 3. Percentage of sites surveyed with at least one spotted owl detection versus sites with at least one barred owl detection. Klamath Study Area, 1990-2011.



We compared the fecundity rate of spotted owls at sites with barred owl detections and sites without known barred owl detections (Figure 4). Nineteen ninety nine was the first year any barred owls were detected at a site where spotted owl reproductive status was determined. From 1999-2011, the average fecundity rate was 0.183 (N=70) at sites with barred owl presence, and 0.303 (N=1002) at sites without known barred owl presence. The fecundity rate during 2011 was 0.000 (N=4) for sites with barred owl presence, and 0.066 (N=53) for sites without known barred owl presence. Before barred owl detections exceeded 10% of the sites within the study area (1990-2002), the fecundity rate for all sites was 0.390 and the fecundity rate was 0.210 after the barred owl detections exceeded 10% of the sites (2003-2011).

Figure 4. Spotted owl fecundity rate at sites with and without known STVA detections (1999-2011). Polynomial trend lines are plotted. The vertical line represents the first year STVA detections exceeded 10% of the sites surveyed.



7. <u>Discussion for FY 2011</u>:

Survey Effort

The survey effort within the KSA has varied over time, however the general trend has been an increase in the number of sites located and surveyed (Appendix A). The KSA boundaries were established in 1997 and the survey effort increased significantly at that time. The number of sites located and surveyed within the KSA has remained relatively stable since 2003. Although most of the area within this boundary is covered by territorial surveys, it is not a density study and some area may still not be surveyed.

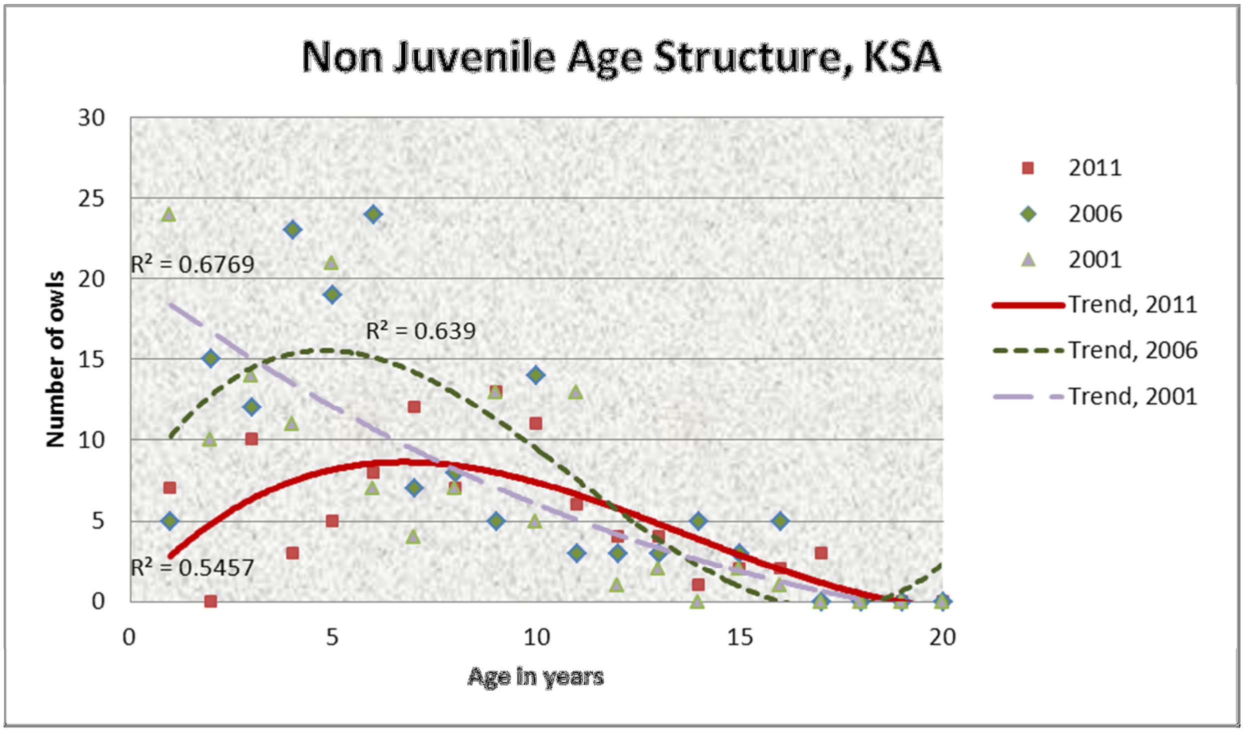
Spotted Owl Occupancy

In recent years there has been a steady decline in the number of non-juveniles detected (Appendix B) and an even larger decrease in the number of pairs detected (Appendix A). The number of non-juveniles detected in 2011 (136) was the lowest since 1990, and the decline from 2010 (31 fewer) was the largest one year decline during the study period. The number of individual spotted owls during 2011 was 38.7% fewer than the high of 222 during 2002. The decline in the number of pairs was even more sizeable, with 44.8% fewer detected in 2011 than the high of 96 during 2002. The 53 pairs detected during 2011 was the lowest number documented during the study period. Although the number of sites surveyed during this period has remained relatively constant, the number of pairs detected at sites has declined and the number of unoccupied sites has increased. While the recent meta-analysis (Forsman et al, 2011a) indicated that survival on the KSA was stable through 2006, the most recent data regarding occupancy has shown a rapid decline, which suggests the stability of the survival rate may no longer be valid.

The decrease in the number within the subadult age class is even more pronounced than the decrease within all non-juvenile age classes. The highest proportion of subadults ever documented in the KSA (25.9% in 2003) occurred early in this decade and has declined to under 10% during each of the past 7 years (Appendix B). Some of this decline may be explained by multiple years of low fecundity corresponding to subsequent years of fewer subadults recruited into the population. However the recent decline is an extended period of low recruitment, with 2008 and 2009 being the lowest during the entire study period. Another indicator of recruitment is the number of juveniles banded on the KSA that survive and are subsequently recaptured. The highest number of internal recruits was 20 in 2003 which was preceded by 3 consecutive years of very high fecundity rates. During 2011 there were 4 juveniles previously banded within the KSA that were recaptured within the KSA, and 5 were recaptured in 2010. The only previous year with fewer juveniles recruited than 2011 or 2010 was during 1995 (2) (Appendix C).

A majority of the non-juvenile owls identified on the study area during 2011 (82.2%) were of known age or known within 1 year. Known age owls were a result of banding juveniles while an age known within 1 year was a result of banding owls while they were still in the subadult age class. Knowing the age structure of the population allows flexibility for current and future analysis. Figure 5 illustrates the age structure during 3 years (2001, 2006, and 2011), using only known or approximate age individuals. Using 2001 as the first year of age structure comparison should reduce the bias associated with excluding minimum age individuals. Banding was initiated in the late 1980's, therefore most known or approximate ages of the older age cohort during 2001 have be documented, while few minimum age individuals are remaining in the population. During 2006, most of the population was comprised of individuals aged 4-8 years, which agrees with the results from Loschl (2008) whose data for an Oregon study showed that the average life span was 7-9 years. However, the age structure for 2011 is showing a shift towards an older age structure. This apparent age structure shift further illustrates a potential problem with recruitment.

Figure 5. Age structure within the KSA, during 3 years (2001, 2006, and 2011). Only spotted owls with ages known within 1 year are included. Polynomial trend lines are plotted.



Spotted Owl Reproduction

During 2011, the nesting status was determined at 50 of the sites (87.7%) where reproductive status was eventually determined during the season. In previous years, nest status determination was consistently high (88.5% in 2009, 84.5% in 2010). Locating nesting pairs before 1 June is not required to determine reproductive status, but it has several benefits. One benefit is a more accurate determination of nest success, which is the number of pairs that attempted to nest and actually fledged young. Another benefit is a more accurate count of the number of young fledged. If the nest tree location is known, reproductive visits can be timed soon after fledging occurs to avoid the effects of early juvenile mortality which would lead to the undercounting of nesting success.

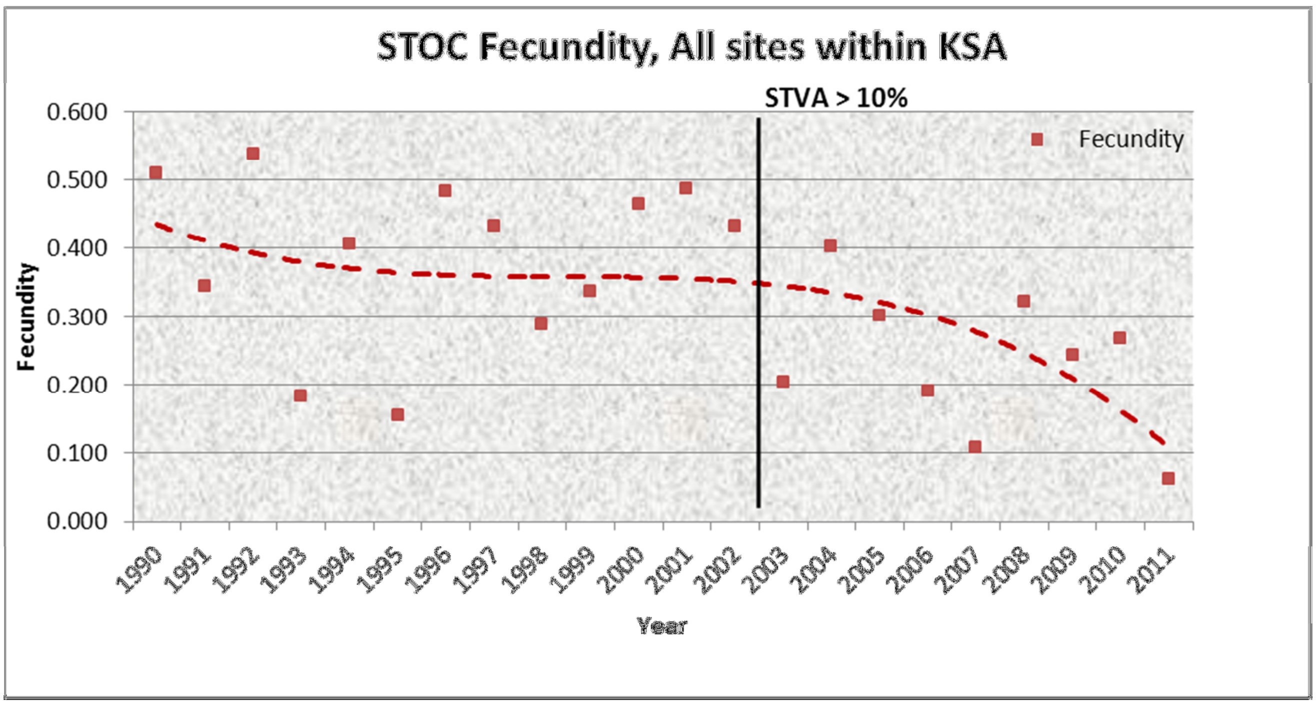
The 2 years with the lowest nest success rate were in 2011 and 2010 (50.0%). This compares to an average of 73.5% from 1990-2011 (Appendix E). Nesting success during 7 of the previous 9 years (2003-2011) were below the 22 year average, indicating a downward trend. The 2011 mean brood size was 1.40 and was lower than the average for all years (1.56, Appendix D). The combination of very low nest success and low brood size in 2010 and 2011 may be cause for concern.

The low nest success rate may be partially explained by the cool and wet spring. Rainfall within the KSA during the combined months of March through May 2011 was 32.5 cm (12.81 inches), the second highest amount during 22 years of the study and well above the 19.7 cm (7.76 inch) average. The average temperature during May 2011 was 13.1° C (55.5°

F), slightly below the average for the study period (Appendix C). When the KSA data are plotted, there is a negative correlation between precipitation during March through May and nest success, but it is only moderately strong (r^2 0.407). Forsman et al. (2011a) noted that there was evidence that high precipitation during the early nesting season had a negative effect on fecundity. In addition, Glenn (2009) noted that there were negative associations with nest season precipitation during the early nesting season within the Tyee Density study just north of the KSA. This may help explain the extremely low nest success rate during 2010 and 2011, but does not fully account for the recent trend of lower nest success.

There is an increasing fecundity rate from 1-year old to adult age classes on the KSA. Our most recent analysis shows a very low fecundity rate for 1-year olds, while the rate for 2-year olds was similar to, but slightly lower than the adult rate (Table 1). This follows the trend that Loschl (2008) reported for data from the Oregon Coast Range, where the mean annual number of young fledged increased at a constant rate from 1-year old through 4-year olds, then remained constant. Although fecundity rates varied by age class, the mean brood sizes did not appear to differ greatly among age classes.

Figure 6. Spotted owl fecundity at all sites surveyed, KSA 1990-2011. A polynomial trend line is plotted ($r^2 = 0.339$). The vertical line represents the first year STVA detections exceeded 10% of the sites surveyed.



The fecundity rate for 2011 was 0.061, which is the lowest ever documented during the study and is considerably lower than the next lowest rate of 0.108 during 2007. The 2011 rate was much lower than the average for the years 1990-2011 (0.326) (Appendix D). While the fecundity rate for spotted owls is known to fluctuate, we documented only 1 year during the most recent 9 years where the fecundity rate was above the overall average, indicating a downward trend (Figure 6). It was noted in Forsman et al. (2011a), that the fecundity rate on the KSA was declining and the most recent data agrees with this conclusion. The number of juveniles detected within the KSA during 2011 (7) was much lower than the overall median (Appendix B). None of the previous 21 years documented fewer juveniles, and the highest numbers ever documented were during 2001 and 2002, even though there were fewer sites surveyed during those years. This 2011 combination of the lowest fecundity rate ever documented and the lowest number of pair ever documented indicates potentially serious problems with maintaining a stable population. This is even more alarming since both of these results are following a long term downward trend.

The yearly fecundity rates for sites within an LSR compared to sites outside the LSR boundary are given in Appendix F. The NWFP became effective in the spring of 1994. Data presented here are for the combined years before and after the effective date. Fecundity rates for LSR sites compared to non-LSR sites, both before and after the NWFP implementation, indicate similar trends. There was a decrease in fecundity rates after the NWFP implementation for both LSR (0.405 versus 0.299) and non-LSR (0.388 versus 0.309) sites. The fecundity rate during 1990-2011 was virtually identical for LSR sites and for non-LSR sites. It is quite possible that any effect on the population due to habitat changes is masked by a much more important stressor, the presence of the barred owl as discussed below.

Barred Owl Influence on Spotted Owl Occupancy

It is clear that the barred owl population is increasing across the range of the northern spotted owl. The most recent meta-analysis (Forsman et al., 2011a) indicates that the spotted owl populations have declined across most of the range, with the most significant declines occurring in Washington where the barred owl has been present the longest. Analysis of all 3 of the study areas in Washington indicated declining populations. Although analysis within the KSA indicated a stable spotted owl population during the study period (1992-2006), the recent data may indicate the beginning of a trend towards a declining population. The numbers of barred owls continued to increase, while spotted owl occupancy and fecundity continued to decrease.

There were at least 62 non-juvenile barred owls detected on the KSA. The number of sites with at least one barred owl detection probably underestimates the actual number of barred owls present. The numbers were probably underestimated since detections were incidental while using spotted owl calls, and Wiens (2011) noted that barred owls were more likely to respond to a conspecific call versus a spotted owl call (0.66/visit vs. 0.48/visit). In addition, Bailey et al. (2009) noted that barred owls are often twice as likely to be detected if spotted owls are not present. The number of barred owl detections was trending upward during recent years (2008, 44; 2009, 58; and 2010, 61), and was the highest number detected during any previous year. In addition, many of these detections appear to comprise more than one pair of barred owls within a single spotted owl site. Using simple presence at a site, there was a proportional increase in the number of sites with barred owl detections during the last few years, agreeing with the number of individual detections noted above. Beginning in 2003, barred owls were detected at more than 10% of the sites surveyed in each subsequent year (Figure 3). During 2011, the percent of sites where barred owls were detected was the highest of any year, and the percent of sites where spotted owls were detected was the lowest of any year. The 45 sites where barred owls were detected in 2011 is a more than tenfold increase from the 4 sites with detections in 1999, and a more than 10% increase from the previous year.

There has been a rapid increase in barred owl detections on the Tyee Density study area north of the KSA (Forsman et al. 2011b). On the Tyee Density study, the number of sites where barred owls were detected exceeded the number of sites where spotted owls were detected for the first time in 2009. The percent of sites where barred owls were detected exceeded 50% during the past 4 years and never exceeded 50% previous to that time. The graph in Figure 3 appears similar to the Tyee data through 2003, the barred owls will continue to increase in the KSA as well if a similar growth occurs. It is probable that barred owls will continue their expansion south affecting spotted owl detections and population trends (Kelly 2001).

It has been shown (Bailey et al. 2009, Crozier et al. 2006) that the presence of barred owls negatively affects the detection probabilities of spotted owls. While this may account for some of the decrease in spotted owl detections, it is quite likely the barred owl is actually having an impact on the spotted owl population. The decrease in spotted owl detections since 2002 corresponds to an increase in barred owl presence (Figure 3). It has been shown (Olson et al. 2005) that barred owl presence positively affected local-extinction probabilities or negatively affected colonization probabilities of spotted owls. They concluded that a further decline in the proportion of sites occupied by spotted owls is expected. The steady decline in the number of non-juveniles since 2002 (Appendix B) seems to indicate that the KSA population is experiencing these effects.

Data on the number of non-juvenile movements within the study were fairly consistent over recent time (Appendix C) while the years previous to large numbers of barred owl detections tended to result in fewer movements. Since about 32% fewer sites were surveyed in the earlier years, the numbers are not directly comparable. In addition, data on the distance of non-juvenile movements (Figure 2) indicated an upward trend in recent years. It has been postulated that the spotted owl population will experience internal movements in reaction to barred owl disruption of territories. Forsman et al (2011b) noted an increase on the Tyee Density study area of non-juvenile movements as well as an increase in the number of individuals located at multiple sites during the same year. These data indicate that a disruption of territorial fidelity on the KSA may have begun.

Barred Owl Influence on Spotted Owl Reproduction

We compared fecundity rates at sites with and without barred owl detections from 1999-2011. Because barred owl detections were incidental, the results from sites where spotted owl reproduction was determined may be biased low regarding barred owl detections. However, any survey bias comparing reproductive versus non reproductive sites should be somewhat similar since most visits to occupied sites occur diurnally. The site by site fecundity rate from 1999-2011 at sites with known barred owl presence was 0.183 compared to 0.303 at sites where barred owls were not detected. The average fecundity at a coarse scale for all sites before and after major barred owl presence (detections at >10% of sites) on the study area was 0.210 (2003-2011) compared to 0.390 (1990-2002). The highest number of juveniles produced on the KSA was during 2001 and 2002, the time period just before barred owl detections exceeded 10%. The site by site analysis and coarse scale study wide analysis give similar results. These individual and cumulative year data indicate barred owl presence is having a negative impact on spotted owl reproduction and is consistent with findings from Forsman et al. (2011a) which included analysis of the KSA through 2008. Glenn (2009) and Olson et al. (2004) also noted that there was a negative association with barred owl presence and reproduction in their respective analysis.

There is mounting evidence that barred owls are negatively impacting the spotted owl population within the KSA. This is illustrated by several population trends beginning in 2003, when barred owl detections within the KSA exceed 10% of the sites. Spotted owl detections have been steadily decreasing since 2002 (Figure 3) and reached the lowest point in 2011, when barred owl detections reached their highest level. Fecundity rates appear to be declining (Figure 6) during the past 9 years and in only 1 of those 9 years was the rate above average. In addition, the fecundity rate for sites with known barred owl presence was lower than at other sites. Forsman et al. (2011a) noted that the consistency of the negative associations between spotted owl demographic rates and the presence of barred owls supports the conclusion that barred owls are having a negative effect on spotted owl populations. The recent KSA data, with the combination of decreasing occupancy and reduced fecundity, seems to reinforce this conclusion.

8. Acknowledgments:

Many people and organizations contributed to the success of this project. Without the dozens of dedicated people collecting the field data, none of this could have been accomplished. In addition, biologists from surrounding areas have contributed information regarding owl movements. Several private timber companies have been gracious enough to allow access to sites on their property. The primary government agencies with land owned or administered within the Klamath Study Area are the BLM and the State of Oregon. Funding for range wide demographic studies comes from BLM, USDA Forest Service, and the National Park Service.

9. Literature Cited:

Anthony, R., G. Olson, E. Forsman, J. Reid, P. Loschl, W. Ripple, E. Glenn, and K. Harkins. 2000. Predicting Abundance and Demographic Performance of Northern Spotted Owls from Vegetative Characteristics. Report on Phase I: Evaluation of Different Methods for Habitat Mapping. 100pp.

Anthony, R., E. Forsman, A. Franklin, D. Anderson, K. Burnham, G. White, C. Schwartz, J. Nichols, J. Hines, G. Olson, S. Ackers, S. Andrews, B. Biswell, P. Carlson, L. Diller, K. Dugger, K. Fehring, T. Fleming, R. Gerhardt, S. Gremel, R. Gutierrez, P. Happe, D. Herter, J. Higley, R. Horn, L. Irwin, P. Loschl, J. Reid, and S. Sovern. 2006. Status and Trends in Demography of Northern Spotted Owls, 1985-2003. Wildlife Monograph No. 163.

Bailey, L.L., J.A. Reid, E.D. Forsman, and J.D. Nichols. 2009. Modeling co-occurrence of northern spotted and barred owls: Accounting for detection probability differences. Biological

Conservation. 142:2983-2989.

Burnham, K.P., D.R. Anderson, and G.C. White. 1996. Meta-Analysis of vital rates of the northern spotted owl. Studies in Avian Biology 17:92-101.

Crozier, M.L., M.E. Seamans, R.J. Gutierrez, P.J. Loschl, R.B. Horn, S.G. Sovern, and E.D. Forsman. 2006. Does the presence of barred owls suppress the calling behavior of spotted owls? The Condor. 108:760-769.

Davis, R.J., K.M. Dugger, S. Mohoric, L. Evers, W.C.Aney. 2011. Northwest Forest Plan - the first 15 years (1994–2008): status and trends of northern spotted owl populations and habitats. Gen. Tech. Rep. PNW-GTR-850. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 147 p.

Forsman, E.D., R.G. Anthony, J.A. Reid, P.J. Loschl, S.G. Sovern, M. Taylor, B.L. Biswell, A. Ellingson, E.C. Meslow, G.S. Miller, K.A. Swindle, J.A. Thrailkill, F.F. Wagner, and D.E. Seaman. 2002. Natal and Breeding Dispersal of Northern Spotted Owls. Wildlife Monograph No.149.

Forsman, E. D., Anthony, R., K. Dugger, E. Glenn, A. Franklin, G. White, C. Schwartz, K. Burnham, D. Anderson, J. Nichols, J. Hines, J. Lint, R. Davis, S. Ackers, S. Andrews, B. Biswell, P. Carlson, L. Diller, S. Gremel, Herter, J. Higley, R. Horn, J. Reid, J. Rockweit, J. Schaberl, T. Snetsinger, and S. Sovern. 2011a. Population Demography of Northern Spotted Owls. Studies in Avian Biology. 106p.

Forsman, E. D., J.A. Reid, S. M. Flannagan, J. S. Mowdy, and A.L. Price. 2011b. Demographic characteristics of northern spotted owls (*Strix occidentalis*) on the Tyee Density Study Area, Roseburg, Oregon: 1985-2011. Annual Report. 18p.

Franklin, A.B., K.P. Burnham, G.C. White, R.G. Anthony, E.D. Forsman, C. Schwarz, J.D. Nichols, and J. Hines. 1999. Range-wide status and trends in northern spotted owl populations. Colorado Cooperative Wildlife Research Unit, Colorado State University, Fort Collins, Colorado, USA and Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, Corvallis, Oregon, USA. 71pp.

Franklin, J.F., and C.T. Dyrness. 1973. Natural Vegetation of Oregon and Washington. U.S. Department of Agriculture - Forest Service. Gen. Tech. Rpt. PNW-GTR-8.

Glenn, E. M. 2009. Local Weather, Regional Climate and Population Dynamics of Northern Spotted Owls in Washington and Oregon [dissertation]. Corvallis, OR: Oregon State University. 299p.

Kelly, E. G. 2001. The Range Expansion of the Northern Barred Owl: An Evaluation of the Impact on Spotted Owls [thesis]. Corvallis, OR: Oregon State University. 78p.

Lint, J.B., tech. coord. 2005. Northwest Forest Plan - the first 10 years (1994–2003): status and trends of northern spotted owl populations and habitat. Gen. Tech. Rep. PNW-GTR-648.

Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 176 p.

Lint, J.B., B.R. Noon, R.G. Anthony, E.D. Forsman, M.G. Raphael, M. I. Collopy and E.E. Starkey. 1999. Northern spotted owl effectiveness monitoring plan for the Northwest Forest Plan. U.S. Department of Agriculture - Forest Service. Gen. Tech. Rpt. PNW-GTR-440. 43pp.

Loschl, P.J. 2008. Age-specific and Lifetime Reproductive Success of Known Age Northern Spotted Owls on Four Study Areas in Oregon and Washington [thesis]. Corvallis, OR: Oregon State University. 141p.

Olson, G. S., E.M. Glenn, R.G. Anthony, E.D. Forsman, J.A. Reid, P.J. Loschl, and W.L. Ripple. 2004. Modeling Demographic Performance of Northern Spotted Owls Relative to Forest Habitat in Oregon. Journal of Wildlife Management 68:1039-1053.

Olson, G. S., R.G. Anthony, E.D. Forsman, S.H. Ackers, P.J. Loschl, J.A. Reid, K.M. Dugger, and W.J. Ripple. 2005. Modeling of Site Occupancy of Northern Spotted Owls, with Emphasis on the Effects of Barred Owls. Journal of Wildlife Management 69:918-932.

USDA and USDI. 1994. Final supplemental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. 2 volumes. U. S. Department of Agriculture - Forest Service and U.S. Department of Interior - Bureau of Land Management, Portland, Oregon, USA.

USDI [U.S. Fish and Wildlife Service]. 2011. Revised recovery plan for the Northern Spotted Owl (Strix occidentalis caurina). USFWS, Region 1, Portland, Oregon.

Wiens, D. J., R. G. Anthony, E. D. Forsman. 2011. Barred Owl Occupancy Surveys Within the Range of the Northern Spotted Owl. Journal of Wildlife Management 75:531-538.

Appendix A. Territories surveyed and occupancy results by year within the KSA (1990-2011). (a)

Year	Total Sites (b)	Sites w/ STVA (c)	Sites w/ Pair (d)	Sites w/ single	Sites w/ undetermined status (e)	Total occupied sites	Sites w/ no occupation (f)	Sites w/ incomplete survey (g)
1990	93	2	58	10	11	79	14	7
1991	95	0	61	11	5	77	18	11
1992*	97	2	58	13	9	80	17	11
1993*	107	1	66	15	13	94	13	9
1994*	112	1	73	4	13	90	22	9
1995*	105	2	60	11	13	84	18	17
1996	103	3	58	7	15	80	21	19
1997	117	2	61	12	17	90	25	9
1998*	119	2	74	9	10	93	22	11
1999*	125	4	74	9	14	97	25	7
2000*	124	8	71	16	21	108	12	9
2001*	138	8	86	12	16	118	20	1
2002	144	13	96	10	18	124	16	1
2003	149	16	95	11	14	120	21	0
2004	150	21	96	10	14	120	26	0
2005	153	18	91	13	14	118	31	1
2006	155	24	89	10	11	110	36	1
2007	155	33	81	16	11	108	38	1
2008	156	34	79	13	20	112	36	0
2009	156	39	75	9	14	98	52	0
2010	156	40	67	12	15	94	51	0
2011	158	45	53	12	14	79	58	0

(a) Preliminary data, values may change.
(b) Sites surveyed to protocol. The sum of the last 3 columns may not equal the total sites since sites with the same individual located at 2 sites are not considered as occupied at one site.
(c) STVA occupancy is opportunistic and is defined as any detection at the site.
(d) Pair as defined in Lint et al 1999.
(e) Undetermined status may include one or 2 owls, does not qualify as a pair or single.
(f) No occupancy determined with at least 3 survey visits.
(g) Incomplete survey is 2 visits or less (usually no visits, only includes sites surveyed in previous years).
* represents years with a site where the pair was comprised of a spotted owl and a barred owl which was included as a “site with single”.

Appendix B. Sex and age composition of spotted owls located within the KSA (1990-2011). Non-juvenile owls where the sex could not be determined are not included. (a)

Year	Adult (M,F)	Subadult (M,F)	Percent Subadult	Age unk (M,F) (b)	Total non-juvenile (M,F)	Juvenile
1990	100 (56,44)	14 (8,6)	12.3	22 (12,10)	136 (76,60)	52
1991	112 (61,51)	16 (7,9)	12.5	14 (8,6)	142 (76,66)	40
1992	106 (61,45)	16 (6,10)	13.1	18 (11,7)	140 (78,62)	59
1993	117 (63,54)	23 (12,11)	16.4	23 (16,7)	163 (91,72)	22
1994	125 (67,58)	28 (13,15)	18.3	15 (8,7)	168 (88,80)	55
1995	118 (65,53)	9 (1,8)	7.1	20 (15,5)	147 (81,66)	18
1996	112 (61,51)	8 (4,4)	6.7	26 (14,12)	146 (79,67)	56
1997	114 (59,55)	22 (15,7)	16.2	26 (12,14)	162 (86,76)	52
1998	124 (67,57)	27 (14,13)	17.9	19 (9,10)	170 (90,80)	41
1999	131 (72,59)	16 (5,11)	10.9	31 (16,15)	178 (93,85)	44
2000	135 (74,61)	18 (9,9)	11.8	32 (19,13)	185 (102,83)	65
2001	148 (77,71)	34 (19,15)	18.7	18 (13,5)	200 (109,91)	82
2002	154 (84,70)	49 (21,28)	24.1	19 (13,6)	222 (118,104)	83
2003	152 (84,68)	53 (25,28)	25.9	12 (8,4)	217 (117,100)	38
2004	173 (93,80)	28 (11,17)	13.9	18 (13,5)	216 (115,101)	75
2005	192 (105,87)	17 (3,14)	8.2	6 (6,0)	215 (114,101)	61
2006	168 (91,77)	18 (3,15)	9.7	14 (10,4)	200 (104,96)	35
2007	159 (82,77)	16 (7,9)	9.1	14 (9,5)	189 (98,91)	19
2008	163 (83,80)	11 (4,7)	6.3	19 (12,7)	193 (99,94)	53
2009	147 (75,72)	8 (5,3)	5.2	14 (12,2)	169 (92,77)	38
2010	135 (69,66)	12 (7,5)	8.2	20 (12,8)	167 (88,79)	38
2011	111 (58,53)	8 (4,4)	6.7	17 (14,3)	136 (76,60)	7

(a) Preliminary data, values may change.
(b) It is possible some of the unknown are auditory responses and the same individuals as included in another category.

Appendix C. Internal recruitment and movement within the KSA (1990-2011). Average precipitation and temperature at Western Regional Climate Center weather station #357169, Riddle, Oregon. (a)

Year	Juvenile recruit	Subadult movement	Adult movement	Total non-juv movement	Mar-May precip	May ave temp, F
1990	5	0	2	2	3.63	55.6
1991	8	2	4	6	10.55	53.9
1992	7	0	6	6	5.40	63.0
1993	9	3	2	5	9.32	59.6
1994	6	3	11	14	4.66	59.4
1995	2	0	4	4	9.95	58.3
1996	6	3	8	11	11.00	56.3
1997	11	3	7	10	7.48	61.6
1998	10	1	6	7	14.92	54.2
1999	7	4	8	12	5.03	54.3
2000	12	2	4	6	6.57	58.6
2001	18	2	8	10	4.53	60.6
2002	15	4	7	11	4.21	55.5
2003	20	5	11	16	8.48	56.7
2004	9	6	3	9	4.23	59.0
2005	11	6	7	13	12.27	59.7
2006	9	3	10	13	8.53	59.4
2007	17	2	13	15	4.28	58.4
2008	6	0	14	14	5.54	58.8
2009	9	4	14	18	5.32	59.2
2010	5	3	12	15	12.10	55.5
2011	4	0	18	18	12.81	55.5
1990-2011					**7.76**	**57.9**

(a) Preliminary data, values may change.

Appendix D. Fecundity rate and mean brood size by year within the KSA (1990-2011). Years with an * represent years when backpack transmitters were attached to females during the nesting season, these sites are excluded from the calculation. (a)

Year	Mean fecundity (N)	95% CI for fecundity	Mean brood size (N)	95% CI for brood size
1990*	0.510 (49)	0.387-0.633	1.61 (31)	1.44-1.79
1991*	0.345 (58)	0.229-0.461	1.67 (24)	1.44-1.89
1992*	0.538 (53)	0.423-0.652	1.50 (38)	1.31-1.69
1993	0.183 (60)	0.096-0.270	1.47 (15)	1.21-1.73
1994	0.406 (69)	0.293-0.519	1.81 (31)	1.64-1.97
1995	0.155 (58)	0.074-0.236	1.38 (13)	1.11-1.66
1996	0.483 (58)	0.378-0.588	1.47 (38)	1.34-1.61
1997	0.433 (60)	0.316-0.551	1.73 (30)	1.57-1.89
1998	0.289 (71)	0.202-0.376	1.37 (30)	1.19-1.54
1999	0.338 (65)	0.231-0.446	1.69 (26)	1.51-1.87
2000	0.464 (70)	0.366-0.563	1.51 (43)	1.36-1.66
2001	0.488 (84)	0.387-0.589	1.78 (46)	1.66-1.90
2002	0.432 (96)	0.344-0.520	1.60 (52)	1.49-1.70
2003	0.203 (96)	0.136-0.271	1.34 (29)	1.17-1.52
2004	0.403 (93)	0.316-0.491	1.56 (48)	1.42-1.70
2005	0.302 (101)	0.220-0.384	1.61 (38)	1.45-1.76
2006	0.190 (92)	0.116-0.264	1.59 (22)	1.38-1.80
2007	0.108 (88)	0.046-0.170	1.73 (11)	1.45-2.00
2008	0.323 (82)	0.238-0.409	1.43 (37)	1.27-1.59
2009	0.244 (78)	0.153-0.334	1.73 (22)	1.54-1.92
2010	0.268 (72)	0.181-0.355	1.41 (27)	1.22-1.60
2011	0.061 (57)	0.006-0.117	1.40 (5)	0.92-1.88
1990-2011	**0.326**		**1.56**	

(a) Preliminary data, values may change.

Appendix E. Proportion of nesting attempts at sites with nest status determined, and proportion of nest success by year within the KSA (1990-2011). Years with an * represent years when backpack transmitters were attached to females during the nesting season, these sites are excluded from the calculation. (a)

Year	Nest Attempt Proportion (N)	95% CI for Nest Attempts	Nest Success Proportion (N)	95% CI for Nest Success
1990*	0.821 (39)	0.698-0.943	0.750 (32)	0.598-0.902
1991*	0.681 (47)	0.546-0.816	0.688 (32)	0.524-0.851
1992*	0.783 (46)	0.662-0.903	0.889 (36)	0.785-0.993
1993	0.391 (46)	0.249-0.534	0.722 (18)	0.509-0.935
1994	0.569 (58)	0.440-0.698	0.818 (33)	0.685-0.952
1995	0.439 (41)	0.285-0.593	0.667 (18)	0.443-0.891
1996	0.825 (40)	0.706-0.944	0.848 (33)	0.724-0.973
1997	0.540 (50)	0.400-0.680	0.963 (27)	0.890-1.036
1998	0.660 (53)	0.532-0.789	0.636 (33)	0.470-0.803
1999	0.472 (53)	0.336-0.607	0.880 (25)	0.750-1.010
2000	0.776 (58)	0.668-0.884	0.844 (45)	0.737-0.952
2001	0.707 (75)	0.603-0.810	0.849 (53)	0.752-0.946
2002	0.667 (90)	0.569-0.765	0.850 (60)	0.759-0.941
2003	0.506 (83)	0.398-0.614	0.595 (42)	0.445-0.745
2004	0.614 (88)	0.511-0.716	0.852 (54)	0.756-0.947
2005	0.593 (91)	0.492-0.695	0.611 (54)	0.480-0.742
2006	0.375 (88)	0.273-0.477	0.606 (33)	0.437-0.775
2007	0.208 (77)	0.117-0.299	0.647 (17)	0.413-0.881
2008	0.622 (74)	0.510-0.733	0.783 (46)	0.662-0.903
2009	0.449 (69)	0.331-0.568	0.677 (31)	0.510-0.845
2010	0.787 (61)	0.683-0.891	0.500 (48)	0.357-0.643
2011	0.200 (50)	0.088-0.312	0.500 (10)	0.173-0.827
1990-2011	**0.577**		**0.735**	

(a) Preliminary data, values may change.

Appendix F. Fecundity rate and mean brood size by Land Use Allocation and year within the KSA. Years with an * represent years when backpack transmitters were attached to females during the nesting season, these sites are excluded from the calculation. (a)

Year	LSR, Mean fecundity (N)	LSR, 95% CI for fecundity	Non-LSR, Mean fecundity (N)	Non-LSR, 95% CI for fecundity
1990*	0.481 (27)	0.312-0.651	0.545 (22)	0.364-0.727
1991*	0.383 (30)	0.223-0.544	0.304 (28)	0.134-0.473
1992*	0.589 (28)	0.422-0.757	0.480 (25)	0.325-0.635
1993	0.214 (28)	0.077-0.352	0.156 (32)	0.045-0.268
1994	0.357 (35)	0.194-0.521	0.456 (34)	0.299-0.613
1995	0.145 (31)	0.032-0.258	0.167 (27)	0.050-0.284
1996	0.485 (33)	0.347-0.623	0.480 (25)	0.315-0.645
1997	0.533 (30)	0.371-0.696	0.333 (30)	0.168-0.498
1998	0.303 (33)	0.183-0.423	0.276 (38)	0.150-0.403
1999	0.333 (33)	0.176-0.491	0.344 (32)	0.195-0.493
2000	0.444 (36)	0.305-0.584	0.485 (34)	0.345-0.626
2001	0.500 (43)	0.362-0.638	0.476 (41)	0.327-0.625
2002	0.489 (46)	0.358-0.620	0.380 (50)	0.263-0.497
2003	0.191 (47)	0.090-0.293	0.214 (49)	0.124-0.305
2004	0.409 (44)	0.273-0.545	0.398 (49)	0.284-0.512
2005	0.202 (47)	0.100-0.304	0.389 (54)	0.268-0.509
2006	0.113 (40)	0.023-0.202	0.250 (52)	0.141-0.359
2007	0.051 (39)	0.000-0.121	0.153 (49)	0.057-0.249
2008	0.319(36)	0.195-0.444	0.326 (46)	0.207-0.445
2009	0.181 (36)	0.056-0.305	0.298 (42)	0.168-0.427
2010	0.317 (30)	0.165-0.469	0.232 (42)	0.130-0.334
2011	0.075 (20)	0.000-0.155	0.054 (37)	0.000-0.128
1990-1994	**0.405**		**0.388**	
1995-2011	**0.299**		**0.309**	
1990-2011	**0.323**		**0.327**	

(a) Preliminary data, values may change.