# NORTHERN SPOTTED OWL MONITORING
# ANNUAL REPORT, FY 2015

## 1. Title:

Demographic characteristics of northern spotted owls (*Strix occidentalis caurina*) in the Klamath Mountain Province of Oregon, 1990-2015.

## 2. Principal Investigators and Organizations:

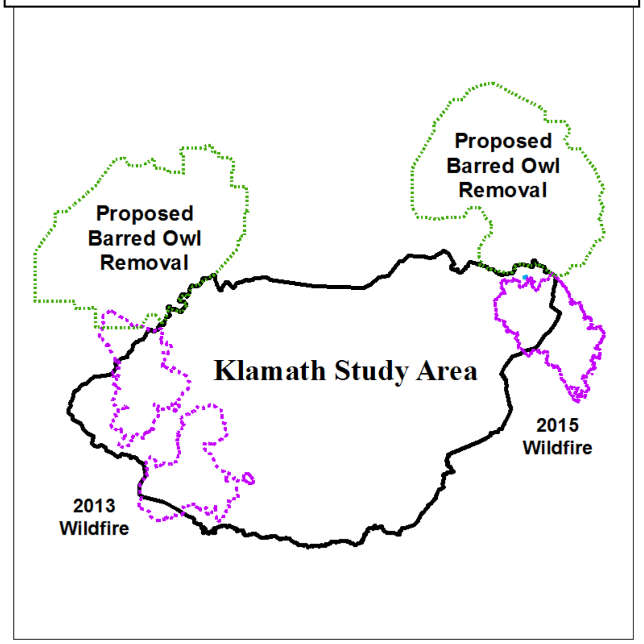
Bruce Hollen (Principal Investigator); R. Horn (Lead Biologist); Biologists: R. Crutchley, K. Fukuda, T. Kaufmann, C. Larson, A. Price, H. Wise.

## 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:

*Figure 1. Klamath Study Area boundary. Approximate boundaries of the 2013, 2015 wildfires and the proposed experimental removal of barred owls.*



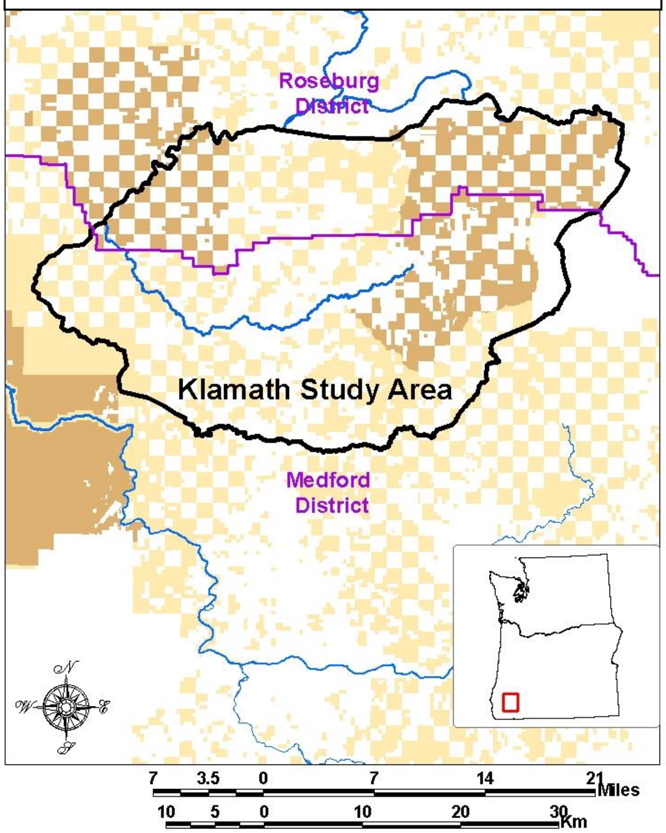

The KSA is one of eight long-term northern spotted owl study areas designed to assess the status and trends in northern spotted owl populations and habitat as directed under the Northwest Forest Plan (USDA and USDI 1994). The data from these studies are analyzed every 5 years as part of a range-wide meta-analysis workshop, and were most recently analyzed using data through 2013 (Dugger et al, 2016). 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).

An Environmental Impact Statement (EIS) has proposed experimental removal of barred owls in four areas (USDI, 2013). The Union Myrtle Study Area (UMSA) is one of the four proposed long-term northern spotted owl study areas designed to assess the effects of barred owl removal on the status and trends in northern spotted owl populations as directed under Recovery Action 29 in the Revised Recovery Plan (USDI 2011) (Figure 1). The KSA is considered the control area for this proposal.

## 5. **Study Area Description and Survey Design**:

The KSA was located within the Klamath Mountains Physiographic Province in Southwestern Oregon and was approximately 1422 km$^2$ (351,334 ac) in size (Figure 2).

*Figure 2. Klamath Study Area boundary. Yellow and brown represent federally administered lands, brown represents Late Successional Reserves.*




This province was characterized by mixed conifer forests dominated by Douglas-fir (*Pseudotsuga menziesii*) and incense cedar (*Calocedrus decurrens*). Other common species included pine (*Pinus* spp.), grand fir (*Abies grandis*), pacific madrone (*Arbutus menziesii*), golden chinquapin (*Castanopsis chrysophylla*), and oak (*Quercus* spp.) (Franklin and Dyrness 1973). Owl sites within the current boundaries of the KSA were systematically surveyed from 1997 to the present, with many opportunistic surveys done previous to that time. 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 two BLM Districts in Western Oregon (Medford and Roseburg) and much of the intervening areas of private and state lands (Figure 2). The federal lands were primarily in an alternating "checkerboard" pattern of ownership with private lands. Of the eight long-term studies, two (Klamath and Tyee) were composed almost entirely of this checkerboard pattern of ownership. Two types of study areas were included in the eight 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 two LSR's designated under the NWFP.

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 boundary was drawn around each of the two 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.

During July 2015, a wildfire of more than 10,000 ha (25,000 ac) impacted the eastern edge of the study area. In addition, during July 2013 another large wildfire of more than 16,000 ha (40,000 ac) impacted the western edge of the study area (Figure 1).

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 all newly detected owls and 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. <u>Results for FY 2015</u>:

### Survey Effort

There are currently 158 known spotted owl sites within the KSA (Appendix A). During the period of study, it was determined that four sites previously considered separate sites, were different use areas of another site and have since been combined with other sites. Of the 158 sites surveyed during 2015; 33 were occupied by a pair, 10 by a single, and 16 were occupied by one or two owls with unknown status (Appendix A). At least one spotted owl was detected at 59 (37.3 %) of the sites (Appendix A).

### Spotted Owl Occupancy

We identified 92 individual, non-juvenile, spotted owls (53 males and 39 females) in 2015, resulting in a male:female ratio of 1.36:1. Of the 77 non-juvenile owls where age was determined, 83 (94.8%) were adults and 4 (5.2%) were subadults (Appendix B). A total of 16 owls were newly banded during 2015; 14 (87.5%) were fledglings, one (6.3%) was an adult, and one (6.3%) was a subadult.

The July 2015 wildfire was about half within the study area boundary. Eight demographic site centers were within the perimeter, approximately 4 of the sites had a substantial amount of suitable habitat burned. In addition, the July 2013 wildfire was mostly within the study area boundary. Twenty seven demographic site centers were within the perimeter, approximately 5 of the sites had a substantial amount of suitable habitat severely burned. The small number of occupied sites with major impacts and the short time frame means any conclusions regarding occupancy or reproduction would be inappropriate.

**Spotted Owl Reproduction**

Yearly reproductive data (Appendix C, D) 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 four female age classes; 1-year old, 2-year old, adult, and unknown age. The reproductive data were summarized two ways: (1) the entire KSA and (2) by LUA (LSR and non-LSR) (Appendix E).

There were a total of 30 sites where nesting status was determined in 2015, 13 territories nested (43.3%) and 17 territories did not nest (56.7%). Nine nesting attempts resulted in successfully fledged young and four failed, resulting in a nesting success rate of 69.2% (Appendix D).

The fecundity rate for all age classes in the KSA during 2015 was 0.219 (Appendix C). The fecundity rate for all sites during the years 1990-2015 was split into four female age classes. The rate for 1-year olds (0.063) was much lower than 2-year olds (0.304), adults (0.328), and unknown age class (0.271) (Table 1).

In 2015, the mean brood size was 1.56. The mean brood size for the years 1990-2015 was split into four 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 (1990-2015).* [a]

| Age class | Mean fecundity (N), 1990-2015 | 95% CI for fecundity | Mean brood size (N), 1990-2015 | 95% CI for brood size |
|---|---|---|---|---|
| 1-yr | 0.063 (95) | 0.016-0.110 | 1.71 (7) | 1.35-2.08 |
| 2-yr | 0.304 (138) | 0.237-0.372 | 1.50 (56) | 1.37-1.63 |
| Adult | 0.328 (1500) | 0.307-0.350 | 1.58 (619) | 1.54-1.62 |
| Unk | 0.271 (49) | 0.171-0.371 | 1.30 (20) | 1.09-1.51 |
| Total | 0.311 | | 1.57 | |

[a] Preliminary data, values may change.

## Spotted Owl Dispersal

Three owls originally banded as juveniles within the KSA were recaptured for the first time during 2015, two were internal dispersals and one emigrated off the study area. In addition, one juvenile immigrated onto the study area (Appendix F).

*Figure 3. The annual average distance of non-juvenile movements within the KSA (1990-2015). All types of movements are included; immigration, emigration, and internal. A polynomial trend line is plotted ($r^2$ = 0.522).*

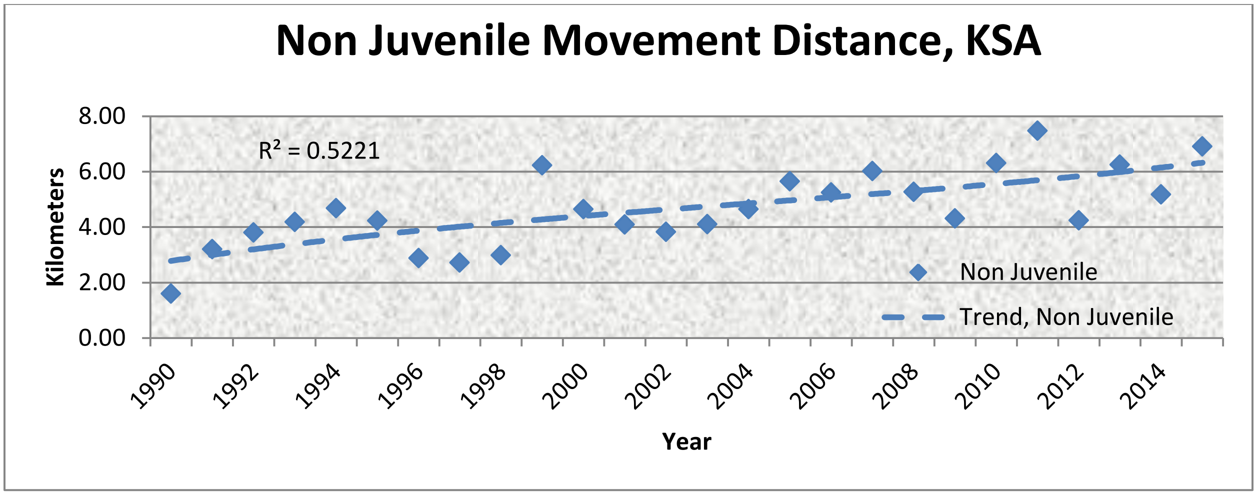
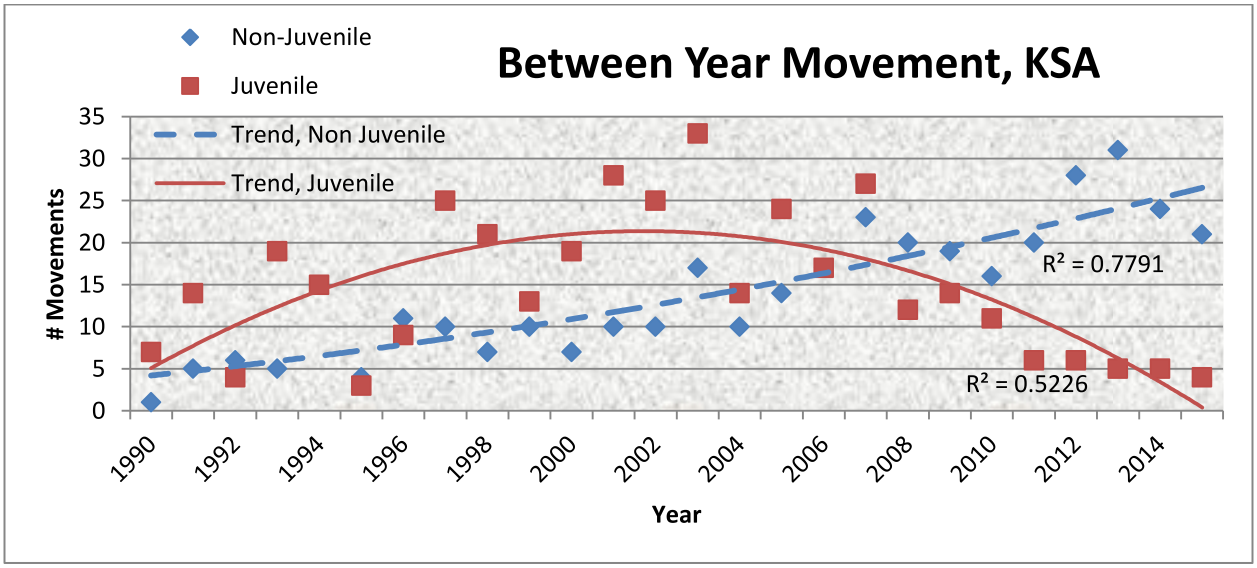


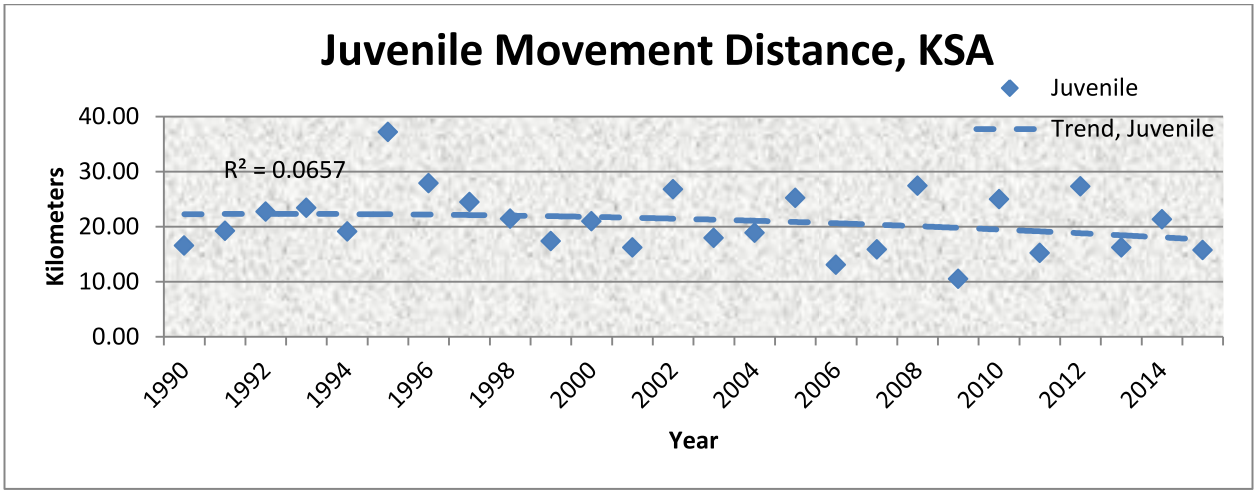

*Figure 4. The annual number of movements within the KSA (1990-2015). All types of movements are included; immigration, emigration, and internal. A polynomial trend line is plotted for non-juvenile ($r^2$ = 0.779) and juvenile ($r^2$ = 0.523).*




The average distance of between year movements for non-juveniles within the KSA, during

2015, was 6.9 km (4.3 mi); 8.0 km (5.0 mi) (N=12) for males and 5.8 km (3.6 mi) (N=8) for females (Figure 3). The number of between year movements has been steadily increasing and the trend line fits the data quite well ($r^2$ = 0.779) (Figure 4). The number of between year dispersal movements rose steadily through the mid 2000's, and then has begun to decrease dramatically (Figure 4). The average distance of dispersal movements for juveniles within the KSA, during 2015, was 15.7 km (9.8 mi); 15.7 km (9.8 mi) (N=4) for males and no females were recaptured (Figure 5).

*Figure 5. The annual average distance of juvenile movements within the KSA (1990-2015). All movements including immigration, emigration, and internal are included. A polynomial trend line is plotted ($r^2$ = 0.066).*




## Barred Owl

There were at least 143 non-juvenile barred owls (*Strix varia*) detected at 82 sites on the KSA during 2015. We detected a pair of barred owls at 45 sites and a single at 37 sites. Fledglings were detected at 14 of the sites during 2015. One male hybrid was detected in 2015. 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 6). 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 steadily increasing, from less than 10% in all years previous to 2003, to greater than 10% in all years beginning with 2003 (Appendix A).

We compared the fecundity rate of spotted owls at sites with barred owl detections and sites without known barred owl detections (Figure 7). The fecundity rate during 2015 was 0.214 (N=7) at sites with barred owl presence, and 0.220 (N=26) at sites without known barred owl presence. The average spotted owl fecundity rate from 1999-2015 was 0.182 (N=95) at sites with barred owl presence, and 0.283 (N=1154) at sites without known barred owl presence. The beginning year of 1999 was chosen since it was the first year any barred owls were detected at a site where spotted owl reproductive status was determined. Before barred owl detections at all the sites within the study area exceeded 10% (1990-2002), the fecundity rate for all sites was 0.393. The fecundity rate was 0.227 after barred owl detections at all the sites within the study area exceeded 10% (2003-2015). The 10% threshold was chosen to estimate a low level of barred owl presence, below which there would be limited effect on spotted owl territories and population.

*Figure 6. Percentage of sites surveyed with at least one spotted owl detection versus sites with at least one barred owl detection. Klamath Study Area (KSA) and proposed experimental barred owl removal area (UMSA), 1990-2015.*

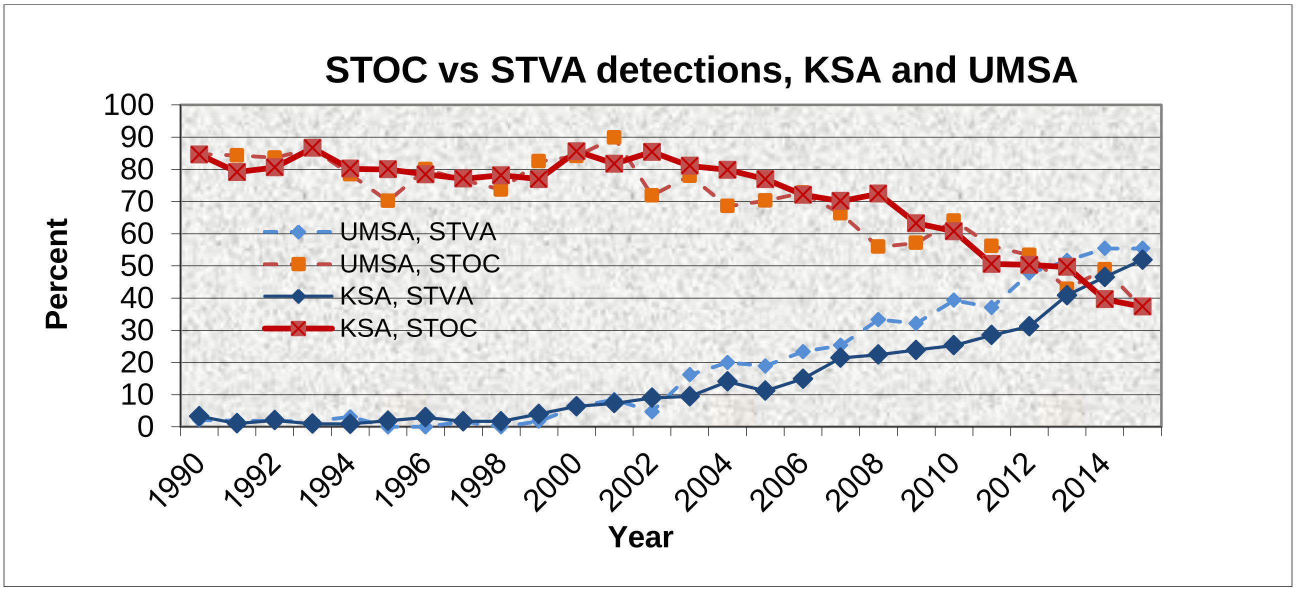
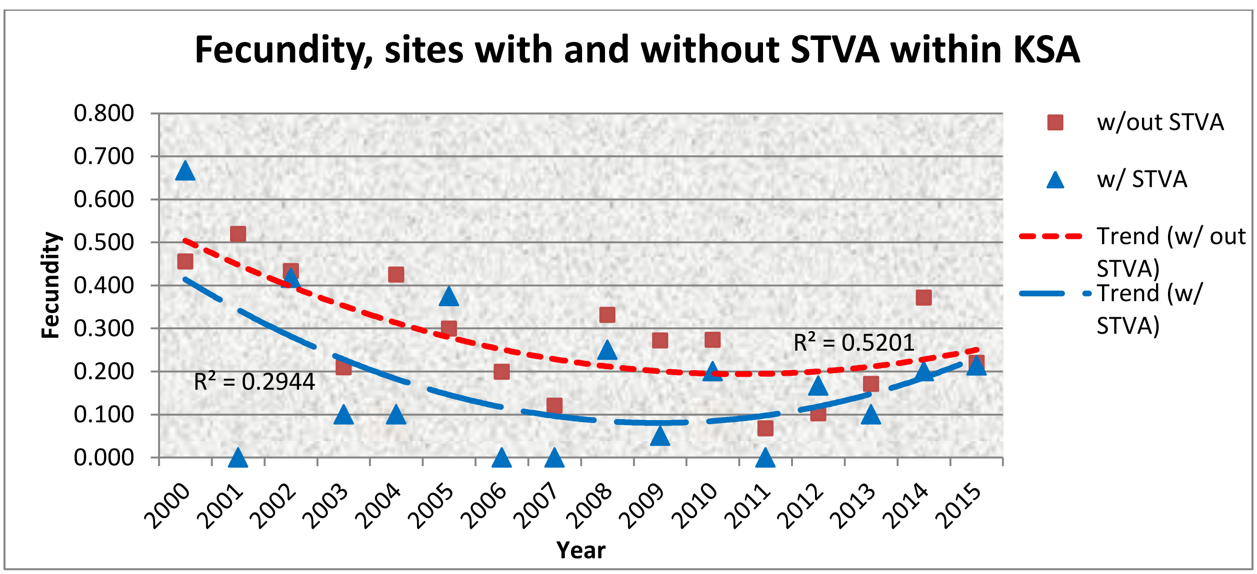



*Figure 7. Spotted owl fecundity rate at sites with and without known STVA detections (1999-2015). Polynomial trend lines are plotted.*



## 7. <u>Discussion for FY 2015</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 survey effort began in 1990 with the effort increasing until about 2003, and has remained relatively steady since. Although most of the area within this boundary is covered by territorial surveys, it is not a density study and some area may not be surveyed.

### Spotted Owl Occupancy

The sex ratio of male:female 1.36:1 was highly skewed towards males during 2015. While the sex ratio has always favored males (Appendix B) and may be related to differential detection rates, 3 of the past 5 years exhibit the highly skewed results.

In recent years there has been a steady decline in the number of non-juveniles detected (Appendix B), a decrease in the number of pairs detected, and an increase in the number of unoccupied sites (Appendix A). The number of non-juveniles detected in 2015 (92) was the lowest ever documented on the study area (Appendix B). The number of individual spotted owls during 2015 was 58.7% fewer than the high of 223 during 2002. The decline in the number of pairs was even more sizeable than the decline of individuals, with 66.3% fewer detected in 2015 than the high of 98 during 2005. The number of pairs detected on the study area has declined every year since 2005. The 33 pairs detected during 2015 was the lowest number documented during the study period. The most recent data regarding individual and pair occupancy has shown a steady and rapid decline, which suggests the stability of the population may be in question. The recent meta-analysis (Dugger et al, 2016) indicated that the estimates of realized population change on the KSA was a 34% decline through 2011, the numbers above may indicate this trend is continuing.

The decrease in the number of subadults is even more pronounced than the decrease within all non-juvenile age classes. The highest proportion of subadults ever documented in the KSA (25.1%) occurred during 2003 and the lowest proportion (0.0%) occurred during 2014. The proportion has been decreasing in recent years with subadults averaging 15.2% from 1990-2006, since 2006 they have accounted for just 6.0%. Some of this decline may be explained by an extended period of very low fecundity, resulting in fewer subadults recruited into the population in subsequent years. Another indicator of recruitment is the number of juveniles that successfully disperse and are recruited into the population. Four juveniles were initially banded within the KSA or immigrated into the KSA during 2015, one of the lowest numbers ever documented (Appendix F).

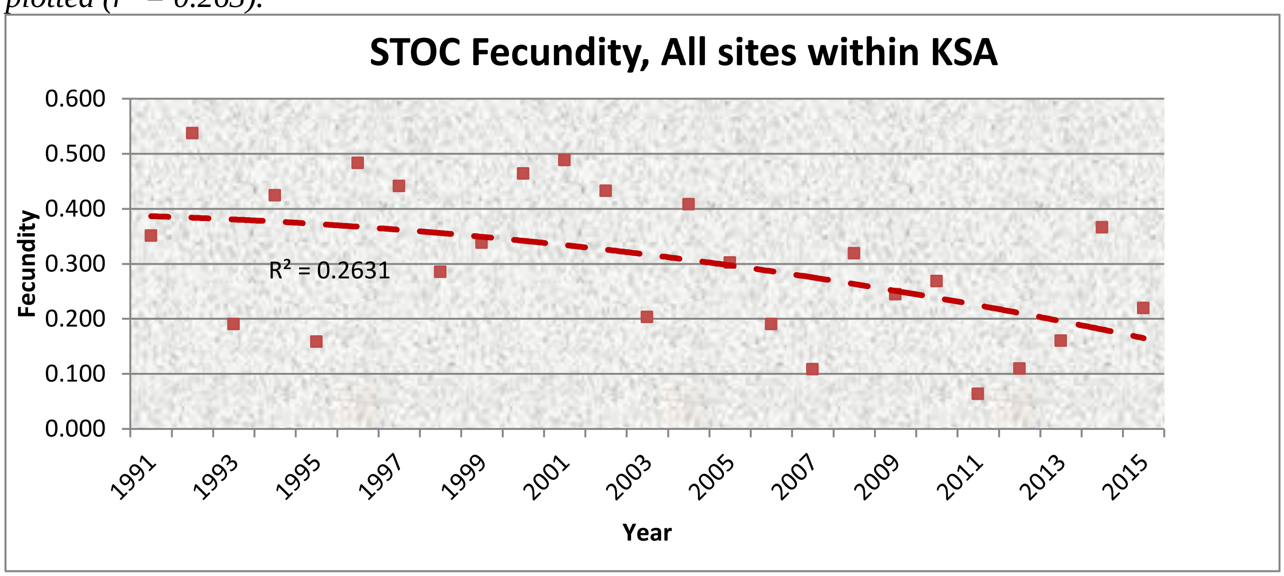
### Spotted Owl Reproduction

Nesting status was determined at 30 sites during 2015, the lowest number ever documented. The number of sites where nest status was determined has decreased every year since 2005 (N-90), and appears directly related to the decrease in pair occupancy. The nest success rate for 2015 (69.2%) was lower than the 1990-2014 average of 74.2%. Nesting success has fluctuated above and below the 24 year average with no obvious trend (Appendix D), however the declining number of pairs available for reproductive output during those years has resulted reduced total production. Mean brood size was 1.56 in 2015, equal to the average for all years (1.56, Appendix C). Although the nest attempt rate, nest success rate and mean brood size during 2015 were all near the average, the continuing decline in pair occupancy results in fewer fledglings produced than during earlier years when reproductive rates were lower but pair occupancy was much higher (Appendix B, C, D).

Fecundity increases from 1-year old to adult age classes on the KSA. Our most recent analysis shows a very low fecundity rate of 0.063 for 1-year olds, while the rate for 2-year olds was very similar to the adult rate (0.304 and 0.328, respectively) (Table 1). This is somewhat different than the most recent meta-analysis (Dugger et al, 2016), where the 2-year old fecundity rate (0.175) was midway between 1-year old (0.065) and adults (0.309). However, several study areas had a similar pattern to the KSA where the 2-year old rate was similar to the adult rate. The mean brood size within the KSA varied by age class, with the 1-year old age class actually having the highest rate (1.71), however the sample size was very small.

The fecundity rate for 2015 was 0.219, which was slightly lower than the average for the years 1990-2015 (0.310) (Appendix C). While the fecundity rate for spotted owls is known to fluctuate, we documented only 2 years during the most recent 10 years where the fecundity rate was above the overall average, and the rate appears to be in a downward trend (Figure 8). Dugger et al. (2016) noted that the fecundity rate on the KSA was declining and the most recent data agrees with this conclusion. The number of fledglings detected within the KSA during 2015 (14) was lower than the overall mean (42.5) and the most recent 7 years all had a lower number of fledglings detected on the study area than the overall mean (Appendix B). A combination of the downward trend in fecundity rates, the downward trend in number of pairs, and the declining number of non-juveniles may indicate problems with maintaining a stable population.

*Figure 8. Spotted owl fecundity at all sites surveyed, KSA 1990-2015. A polynomial trend line is plotted ($r^2$ = 0.263).*



The yearly fecundity rates for sites within an LSR compared to sites outside the LSR boundary are given in Appendix E. 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 average fecundity rates after the NWFP implementation for both LSR (0.411 versus 0.290) and non-LSR (0.399 versus 0.287) sites. The fecundity rate during 1990-2015 was virtually identical for LSR sites and for non-LSR sites. After the NWFP implementation, the timber harvest level on federal land decreased significantly. This resulted in less difference in habitat loss between LSR and non-LSR, which may partially explain the similar fecundity rates. In addition, as mentioned below the influence of the barred owl on both survival and reproduction may have swamped any effect of land use.

**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. There is strong evidence that barred owls are having a negative effect on spotted owl populations (Dugger et al. 2016). The most recent meta-analysis (Dugger et al., 2016) indicates that the spotted owl populations have declined across most of the range and that the annual rates of decline were accelerating in many areas. The most significant declines have occurred in Washington where the barred owl has been present the longest. Forsman et al (2011a) indicated an annual rate of population change ($\lambda$) of 0.990, (95% CI: 0.962-1.017) within the KSA during the 1992-2006 study period, the more recent analysis by Dugger et al. (2016) indicated an annual rate of population change ($\lambda$) of 0.972, (95% CI: 0.940-1.005)) within the KSA during the 1992-2011 study period. Dugger et al. (2016) suggested that declines in apparent annual survival rates were strongly associated with barred owls in 7 of 11 study areas. Since the most recent meta-analysis, the KSA data continues to show these trends where the numbers of barred owls continue to increase, while spotted owl occupancy and fecundity continue to decrease.

The number of individual barred owl detections was increasing during recent years and 2015 was the highest number ever detected. In addition, many of these detections appear to comprise more than one pair of barred owls within a single spotted owl site. Multiple detections at a site are estimated using a home range distance separating detections during a season or simultaneous responses. There were at least 143 non-juvenile barred owls detected on the KSA during 2015 compared to 128 during 2014. The numbers may be underestimated since barred owl detections were incidental during surveys where spotted owl calls were used, 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). However, as the numbers of spotted owl pairs decline, any underestimation may become lower since Bailey et al. (2009) noted that barred owls are often twice as likely to be detected if spotted owls are not present.

Using simple presence of at least one owl at a site, there has been an increase in the number of sites with barred owl detections during the past 10 years (Appendix A). This increase agrees with the increase in the number of individual detections noted above. Beginning in 2004, the number of barred owls detected has increased in each subsequent year (Figure 6).

On the KSA, the number of sites where barred owls were detected exceeded the number of sites where spotted owls were detected for the first time in 2014 (Figure 6). Barred owls were detected on the highest percentage of sites during 2015, and the percentage of sites where spotted owls were detected was the lowest of any year.

Olson et al. (2005) determined 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. Dugger et al. (2016) reported that the presence of barred owls resulted in an increase in local extinction rates for all 11 study areas analyzed, the KSA is included. The steady decline in the number of pairs and the number of non-juveniles on the KSA since 2002 (Appendix A, B) indicates that the KSA population may be experiencing these effects. It is probable that barred owls will continue their expansion south affecting spotted owl detections and population trends (Kelly 2001).

It has been postulated that the spotted owl population will experience internal movements in reaction to barred owl disruption of territories. Data on the distance of non-juvenile movements indicated a slight upward trend in distance moved since 2003 as well as an increase in the numbers of movements (Figure 3, Figure 4). Forsman et al (2011b) noted an increase of non-juvenile movements as well as an increase in the number of individuals located at multiple sites during the same year on the Tyee Density study area. There appears to be a trend of increasing numbers of between year movements of non-juvenile spotted owls within the KSA that seems to agree with Forsman et al. (2011b). Since fewer sites were surveyed in the earlier years, the numbers are not directly comparable but the trend is towards increasing numbers of movements. These data indicate that a disruption of territorial fidelity within the KSA may be occurring.

**Barred Owl Influence on Spotted Owl Reproduction**

We compared fecundity rates at sites with and without barred owl influences using two methods. The first method was a site specific rate that compares fecundity at sites with barred owl presence to sites where barred owls have not been detected. The second method is a coarse scale rate that compares the study wide fecundity during years with low barred owl presence (1990-2002) to years with higher barred owl presence (detections at >10% of sites) (2003-2015). Because barred owl detections were incidental, the results from sites where spotted owl reproduction was determined may be biased low. However, any survey bias comparing reproductive versus non reproductive sites should be somewhat similar since most visits to occupied sites occur diurnally. The site specific fecundity rate from 1999-2015 at sites with known barred owl presence was 0.182 compared to 0.283 at sites where barred owls were not detected. The average fecundity at a coarse scale was 0.393 (1990-2002) compared to 0.227 (2003-2015) (Figure 8). The site specific analysis and coarse scale analysis give similar results. In both cases, barred owl presence appears to reduce spotted owl fecundity rates. These individual and cumulative year data indicate barred owl presence may be 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. Dugger et al. (2016) noted only a weak negative effect of barred owl presence on fecundity. 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 may be negatively impacting the spotted owl population within the KSA. This is illustrated by several apparent population trends: (1) spotted owl detections have been steadily decreasing (Figure 6) and reached the lowest point in 2015, when barred owl detections reached their highest level; (2) fecundity rates appear to be declining (Figure 8) and in only 2 of the previous 11 years was the rate above the 26 year average; and (3) the fecundity rate for sites with known barred owl presence was lower than at other sites and is continuing to decline. 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 more recent meta-analysis (Dugger et al. 2016) was even more emphatic in stating that competition with barred owls may be the primary cause of spotted owl population declines. The recent KSA data, with the combination of decreasing occupancy and reduced fecundity, appears 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. Funding for range wide demographic studies comes from BLM, USDA Forest Service, and the National Park Service.

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Appendix A. Territories surveyed and occupancy results by year within the KSA (1990-2015). [a]

| Year | Total Sites[b] | Sites w/ STVA[c] | Total STVA ind[d] | Sites w/ Pair[e] | Sites w/ single | Sites w/ undetermined status[f] | Total occupied sites | Sites w/ no occ[g] | Sites w/ incomplete survey[h] |
|---|---|---|---|---|---|---|---|---|---|
| 1990 | 91 | 3 | 4 | 58 | 10 | 9 | 77 | 14 | 7 |
| 1991 | 96 | 1 | 1 | 59 | 11 | 6 | 76 | 18 | 9 |
| 1992* | 98 | 2 | 2 | 58 | 12 | 9 | 79 | 17 | 9 |
| 1993* | 105 | 1 | 1 | 64 | 14 | 13 | 91 | 13 | 9 |
| 1994* | 111 | 1 | 1 | 73 | 4 | 12 | 89 | 21 | 9 |
| 1995* | 105 | 2 | 2 | 61 | 11 | 12 | 84 | 17 | 16 |
| 1996 | 102 | 3 | 4 | 60 | 7 | 13 | 80 | 20 | 19 |
| 1997 | 118 | 2 | 2 | 61 | 13 | 17 | 91 | 25 | 8 |
| 1998* | 119 | 2 | 3 | 76 | 9 | 8 | 93 | 22 | 10 |
| 1999* | 126 | 5 | 6 | 74 | 9 | 14 | 97 | 26 | 5 |
| 2000* | 125 | 8 | 10 | 71 | 16 | 20 | 107 | 14 | 7 |
| 2001* | 137 | 10 | 15 | 86 | 12 | 14 | 112 | 20 | 1 |
| 2002 | 144 | 13 | 16 | 96 | 10 | 17 | 123 | 17 | 1 |
| 2003 | 148 | 14 | 23 | 96 | 11 | 13 | 120 | 20 | 0 |
| 2004 | 149 | 21 | 28 | 97 | 10 | 12 | 119 | 26 | 0 |
| 2005 | 152 | 17 | 27 | 98 | 12 | 7 | 117 | 31 | 1 |
| 2006 | 154 | 23 | 31 | 90 | 11 | 10 | 111 | 33 | 1 |
| 2007 | 154 | 33 | 52 | 82 | 15 | 11 | 108 | 37 | 1 |
| 2008 | 156 | 35 | 52 | 80 | 12 | 21 | 113 | 35 | 0 |
| 2009 | 155 | 37 | 60 | 76 | 8 | 14 | 98 | 51 | 2 |
| 2010 | 158 | 40 | 63 | 69 | 12 | 15 | 96 | 51 | 0 |
| 2011 | 158 | 45 | 62 | 52 | 13 | 15 | 80 | 57 | 1 |
| 2012 | 157 | 49 | 86 | 51 | 11 | 17 | 79 | 70 | 2 |
| 2013 | 159 | 65 | 104 | 48 | 14 | 17 | 79 | 69 | 0 |
| 2014 | 159 | 74 | 128 | 38 | 10 | 15 | 63 | 80 | 0 |
| 2015 | 158 | 82 | 143 | 33 | 10 | 16 | 59 | 82 | 0 |

[a] Preliminary data, values may change.
[b] Sites surveyed to protocol.
[c] STVA occupancy is opportunistic and is defined as any detection at the site.
[d] Total STVA individuals is an estimate based biologist opinion if multiples occupy the same site.
[e] Pair as defined in Lint et al 1999.
[f] Undetermined status may include one or 2 owls, does not qualify as a pair or resident single.
[g] No occupancy determined with at least 3 survey visits. The sum of this column and the total occupied sites column may not equal the total sites number since sites with the same individual located at 2 sites during the same year are not considered as occupied at one of the sites.
[h] 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 (1990-2015). 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 | 102 (58,44) | 16 (10,6) | 13.6 | 22 (11,11) | 140 (79,61) | 52 |
| 1991 | 111 (60,51) | 18 (9,9) | 14.0 | 13 (6,7) | 142 (75,67) | 40 |
| 1992 | 106 (61,45) | 18 (8,10) | 14.5 | 18 (11,7) | 142 (80,62) | 59 |
| 1993 | 113 (61,52) | 24 (13,11) | 17.5 | 28 (17,11) | 165 (91,74) | 22 |
| 1994 | 122 (67,55) | 27 (12,15) | 18.1 | 18 (9,9) | 167 (88,79) | 55 |
| 1995 | 118 (66,52) | 9 (1,8) | 7.1 | 19 (14,5) | 146 (81,65) | 18 |
| 1996 | 110 (60,50) | 8 (4,4) | 6.8 | 29 (15,14) | 147 (79,68) | 56 |
| 1997 | 112 (57,55) | 22 (15,7) | 16.4 | 26 (11,15) | 160 (83,77) | 52 |
| 1998 | 127 (69,58) | 28 (15,13) | 18.1 | 20 (9,11) | 175 (93,82) | 41 |
| 1999 | 133 (74,59) | 17 (6,11) | 11.3 | 29 (14,15) | 179 (94,85) | 44 |
| 2000 | 136 (74,62) | 19 (10,9) | 12.3 | 28 (18,10) | 183 (102,81) | 65 |
| 2001 | 151 (80,71) | 35 (20,15) | 18.8 | 19 (14,5) | 205 (114,91) | 82 |
| 2002 | 154 (85,69) | 48 (21,27) | 23.8 | 21 (14,7) | 223 (120,103) | 83 |
| 2003 | 152 (85,67) | 51 (23,28) | 25.1 | 14 (10,4) | 217 (118,99) | 38 |
| 2004 | 171 (93,78) | 29 (11,18) | 14.5 | 19 (14,5) | 219 (118,101) | 75 |
| 2005 | 191 (106,85) | 19 (3,16) | 9.0 | 8 (7,1) | 218 (116,102) | 61 |
| 2006 | 170 (91,79) | 19 (5,14) | 10.1 | 14 (11,3) | 203 (107,96) | 35 |
| 2007 | 162 (85,77) | 16 (7,9) | 9.0 | 12 (8,4) | 190 (100,90) | 19 |
| 2008 | 161 (82,79) | 9 (4,5) | 6.3 | 21 (13,8) | 191 (99,92) | 53 |
| 2009 | 150 (76,74) | 10 (5,5) | 5.2 | 15 (12,3) | 175 (93,82) | 38 |
| 2010 | 137 (71,66) | 12 (7,5) | 8.1 | 20 (12,8) | 169 (90,79) | 38 |
| 2011 | 111 (58,53) | 8 (5,3) | 6.7 | 17 (14,3) | 136 (77,59) | 7 |
| 2012 | 110 (54,56) | 9 (7,2) | 7.6 | 15 (10,5) | 134 (71,63) | 12 |
| 2013 | 105 (58,47) | 2 (0,2) | 1.9 | 26 (21,5) | 133 (79,54) | 15 |
| 2014 | 87 (44,43) | 0 (0,0) | 0.0 | 15 (10,5) | 102 (54,48) | 31 |
| 2015 | 73 (40,33) | 4 (3,1) | 5.2 | 15 (10,5) | 92 (53,39) | 14 |

[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. Fecundity rate and mean brood size by year within the KSA (1990-2015). 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* | 0.521 (48) | 0.397-0.644 | 1.61 (31) | 1.44-1.79 |
| 1991* | 0.351 (57) | 0.233-0.468 | 1.67 (24) | 1.44-1.89 |
| 1992* | 0.537 (53) | 0.425-0.650 | 1.49 (39) | 1.30-1.68 |
| 1993 | 0.190 (58) | 0.100-0.279 | 1.47 (15) | 1.21-1.73 |
| 1994 | 0.424 (66) | 0.308-0.541 | 1.81 (31) | 1.64-1.97 |
| 1995 | 0.158 (57) | 0.076-0.240 | 1.38 (13) | 1.11-1.66 |
| 1996 | 0.483 (58) | 0.378-0.588 | 1.47 (38) | 1.34-1.61 |
| 1997 | 0.441 (59) | 0.322-0.559 | 1.73 (30) | 1.57-1.89 |
| 1998 | 0.285 (72) | 0.198-0.371 | 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 | 0.408 (92) | 0.319-0.496 | 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 | 0.319 (83) | 0.234-0.404 | 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 | 0.063 (56) | 0.006-0.119 | 1.40 (5) | 0.92-1.88 |
| 2012 | 0.109 (57) | 0.035-0.183 | 1.50 (8) | 1.13-1.87 |
| 2013 | 0.160 (49) | 0.067-0.252 | 1.50 (10) | 1.17-1.83 |
| 2014 | 0.366 (41) | 0.229-0.503 | 1.67 (18) | 1.44-1.89 |
| 2015 | 0.219 (33) | 0.089-0.348 | 1.56 (9) | 1.21-1.90 |
| **1990-2015** | **0.310** | | **1.56** | |

[a] Preliminary data, values may change.

Appendix D. Proportion of nesting attempts at sites with nest status determined, and proportion of nest success by year within the KSA (1990-2015). 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* | 0.696 (46) | 0.561-0.830 | 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 | 0.579 (57) | 0.450-0.708 | 0.818 (33) | 0.685-0.952 |
| 1995 | 0.462 (39) | 0.303-0.620 | 0.667 (18) | 0.443-0.891 |
| 1996 | 0.872 (39) | 0.765-0.978 | 0.853 (34) | 0.732-0.974 |
| 1997 | 0.540 (50) | 0.400-0.680 | 0.963 (27) | 0.890-1.036 |
| 1998 | 0.660 (53) | 0.532-0.789 | 0.618 (34) | 0.452-0.783 |
| 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 | 0.716 (74) | 0.613-0.820 | 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 | 0.600 (90) | 0.498-0.702 | 0.611 (54) | 0.480-0.742 |
| 2006 | 0.375 (88) | 0.273-0.477 | 0.606 (33) | 0.437-0.775 |
| 2007 | 0.224 (76) | 0.129-0.318 | 0.647 (17) | 0.413-0.881 |
| 2008 | 0.613 (75) | 0.502-0.724 | 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 | 0.208 (48) | 0.092-0.324 | 0.500 (10) | 0.173-0.827 |
| 2012 | 0.208 (48) | 0.092-0.324 | 0.800 (10) | 0.539-1.061 |
| 2013 | 0.267 (45) | 0.136-0.397 | 0.833 (12) | 0.613-1.054 |
| 2014 | 0.571 (35) | 0.405-0.738 | 0.800 (20) | 0.620-0.980 |
| 2015 | 0.433 (30) | 0.253-0.614 | 0.692 (13) | 0.431-0.953 |
| **1990-2015** | **0.550** | | **0.742** | |

[a] Preliminary data, values may change.

Appendix E. 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* | 0.500 (26) | 0.328-0.672 | 0.545 (22) | 0.364-0.727 |
| 1991* | 0.397 (29) | 0.232-0.561 | 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 | 0.167 (30) | 0.048-0.285 |
| 1994 | 0.357 (35) | 0.194-0.521 | 0.500 (31) | 0.336-0.664 |
| 1995 | 0.145 (31) | 0.032-0.258 | 0.173 (26) | 0.052-0.294 |
| 1996 | 0.485 (33) | 0.347-0.623 | 0.480 (25) | 0.315-0.645 |
| 1997 | 0.533 (30) | 0.371-0.696 | 0.345 (29) | 0.176-0.514 |
| 1998 | 0.294 (34) | 0.176-0.412 | 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 | 0.406 (48) | 0.291-0.522 |
| 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 | 0.319 (47) | 0.202-0.436 |
| 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 | 0.056 (36) | 0.000-0.131 |
| 2012 | 0.158 (19) | 0.007-0.309 | 0.083 (38) | 0.003-0.164 |
| 2013 | 0.029 (17) | 0.000-0.087 | 0.233 (32) | 0.099-0.368 |
| 2014 | 0.467 (15) | 0.223-0.710 | 0.309 (26) | 0.144-0.471 |
| 2015 | 0.357 (14) | 0.118-0.596 | 0.118 (18) | 0.000-0.248 |
| **1990-1994** | **0.411** | | **0.399** | |
| **1995-2015** | **0.290** | | **0.287** | |
| **1990-2015** | **0.313** | | **0.308** | |

[a] Preliminary data, values may change.

Appendix F. Count and distance traveled between year movement within the KSA (1990-2015). All juvenile and non-juvenile movements including immigration, emigration, and internal are included. [a]

| Year | Count of juv move | Juv KmTravel | Count of non-juv move | Non-juv KmTravel |
|---|---|---|---|---|
| 1990 | 7 | 16.57 | 1 | 1.60 |
| 1991 | 14 | 19.21 | 5 | 3.20 |
| 1992 | 4 | 22.68 | 6 | 3.80 |
| 1993 | 19 | 23.43 | 5 | 4.18 |
| 1994 | 15 | 19.11 | 15 | 4.68 |
| 1995 | 3 | 37.17 | 4 | 4.23 |
| 1996 | 9 | 27.89 | 11 | 2.88 |
| 1997 | 25 | 24.46 | 10 | 2.72 |
| 1998 | 21 | 21.43 | 7 | 2.99 |
| 1999 | 13 | 17.36 | 10 | 6.22 |
| 2000 | 19 | 20.94 | 7 | 4.64 |
| 2001 | 28 | 16.18 | 10 | 4.09 |
| 2002 | 25 | 26.79 | 10 | 3.82 |
| 2003 | 33 | 17.91 | 17 | 4.11 |
| 2004 | 14 | 18.88 | 10 | 4.64 |
| 2005 | 24 | 25.18 | 14 | 5.65 |
| 2006 | 17 | 13.05 | 17 | 5.25 |
| 2007 | 27 | 15.86 | 23 | 6.02 |
| 2008 | 12 | 27.40 | 20 | 5.27 |
| 2009 | 14 | 10.49 | 19 | 4.31 |
| 2010 | 11 | 24.95 | 16 | 6.31 |
| 2011 | 6 | 15.18 | 20 | 7.47 |
| 2012 | 6 | 27.27 | 28 | 4.24 |
| 2013 | 5 | 16.22 | 31 | 6.25 |
| 2014 | 5 | 21.30 | 24 | 5.18 |
| 2015 | 4 | 15.73 | 21 | 6.90 |

[a] Preliminary data, values may change.