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Progress Report

ELK ECOLOGY

Study IV: Factors Influencing Elk Calf Recruitment

Job No. 1: Pregnancy rates and condition of cow elk
Job No. 2: Calf mortality causes and rates
Job No. 3: Predation effects on elk calf recruitment

July 1, 2003 to June 30, 2004

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JOB NO. 1: PREGNANCY RATES AND CONDITION OF COW ELK

Abstract

As part of a larger effort to determine the factors responsible for poor or declining elk recruitment, we continue to evaluate the body condition and pregnancy status of cow elk on contrasting study areas in north-central Idaho. In March 2004, we captured and evaluated seven cow elk on the South Fork, 24 on the Lochsa, and 22 on the North Fork study areas. On average, South Fork cows continue to be younger (7.3 vs. 11.2 years old), in better condition (BCS 9.9 vs. 8.9 vs. 8.9), and exhibit higher pregnancy rates (100% vs. 79% and 77%) and blood selenium levels (0.17 vs. 0.045 and 0.120) than the Lochsa and North Fork study areas. Steroid metabolite levels derived from fecal samples collected from wintering free-ranging elk were also used to determine pregnancy rate. To be useful, this index must be adjusted for young, less productive animals and young bulls that occur with cow groups during January-March. We are currently testing a DNA-based approach to make this adjustment.

Introduction

Elk recruitment has been chronically low or has declined in many key elk management units in Idaho. This is cause for concern because recruitment replaces losses to hunting and other factors, thus allowing population stability or growth. There are a variety of factors that can influence recruitment including elk density, habitat condition, nutrition, weather, pregnancy rates, predation, breeding conditions, and calf condition. Each factor probably plays a role, but which factors are significant and how they relate to each other remains to be addressed.

We are interested in identifying ultimate factors that have a major influence on recruitment, as well as understanding the underlying mechanisms. Within the context of this project, we consider three broad categories of ultimate factors: 1) elk density and habitat, 2) predation, and 3) age structure of bulls as being potentially important to elk in Idaho. This report addresses elk density and habitat and several closely related factors. A literature review is provided in Gratson and Zager (1997) and Zager and Gratson (2001).

Study Area

We selected two contrasting study areas, the Lochsa River/North Fork of the Clearwater River and the South Fork of the Clearwater River, to investigate mechanisms potentially affecting elk recruitment. The Lochsa/North Fork study area includes portions of Game Management Units (GMU) 10 and 12 in north-central Idaho. It is bounded on the north, west, south, and east by Pierce, Orofino, Kooskia, and Castle Butte, respectively. The primary landowners are the Clearwater National Forest, Potlatch Corporation, and Idaho Department of Lands, with scattered private parcels. Topography ranges from a rolling patchwork of timbered parcels on the western private lands to large and rugged drainages on forested land in the central and eastern portions. Elevations range from 425 m at Syringa to 2,030 m at Castle Butte.

The Lochsa/North Fork is characterized by poor elk recruitment, moderate access, possibly stagnant habitats, and apparently high predator densities.

The South Fork study area (GMU 15) is also in north-central Idaho. The majority of the area is under public ownership administered by the Nez Perce National Forest. Elevations range from 1,200 m at the western end of the winter range to 2,000 m at the peaks in the eastern portion of the GMU.

More complete study area descriptions are provided in Gratson and Zager (1997) and Zager and Gratson (2001).

Methods

During late March 2004, we used a helicopter to capture seven adult cow elk on South Fork, 24 on the Lochsa, and 22 on the North Fork study area winter ranges. South Fork elk were captured with a net-gun, whereas Lochsa and North Fork animals were darted and immobilized with approximately 3 mg of carfentanil, then reversed with naltrexone.

We used a body condition score (BCS) (Gerhart et al. 1996, Cook et al. 2001) to determine physical condition of each elk. We measured chest girth and converted it to mass (Cook et al. 2003, Millspaugh and Brundige 1996). A blood sample was taken and processed according to standard protocols (Gratson and Zager 1998). The Analytical Sciences Laboratory at the University of Idaho evaluated serum trace element levels and whole blood selenium levels.

A fecal sample was collected, frozen, and submitted to Dr. Josh Millspaugh's laboratory at the University of Missouri-Columbia to determine fecal glucocorticoid levels (Millspaugh et al. 2001). In past years, Dr. Glenn DelGiudice's laboratory (Minnesota Department of Natural Resources) evaluated serum parameters related to physiological condition and status. Because of administrative problems, Dr. DelGiudice suggested that we locate another lab to evaluate the samples. We have not yet located an appropriate lab.

An I4 tooth (canine or "ivory") was collected and submitted to Matson's lab for age determination. Animals were ear-tagged, radio-collared, and released. They were located approximately monthly to monitor survival and general seasonal movements.

In cooperation with the regional wildlife management staff, we collected fresh (<2 days old) fecal samples during January through March from cow elk in accessible portions of GMUs 10, 12, and 15 to evaluate pregnancy status. Samples were sent to Dr. Steven Monfort's laboratory at the Conservation and Research Center of the Smithsonian Institute for pregnancy evaluation (Garrott et al. 1998, Stoops et al. 1999).

Department biologists routinely take blood from elk captured elsewhere in Idaho. We are attempting to coordinate collection of serum and blood samples from these animals to begin building a statewide database.

Results

Table 1 summarizes the results of the March 2004 sampling effort and compares those results with previous capture efforts.

Since 1997, on average, adult cows on the South Fork have been significantly younger, in better condition, and exhibit higher blood selenium levels and pregnancy rates than cows from the Lochsa or North Fork study areas (Table 1). Results of the evaluation of serum parameters (Table 2) and glucocorticoid levels (Table 1) in fecal samples collected from cow elk during winter 2004 are not yet available.

Using the "approximately adequate ranges" provided by the Analytical Sciences Laboratory, the Lochsa, North Fork, and South Fork elk are deficient in zinc; North Fork elk are phosphorus-deficient; and Lochsa elk are selenium-deficient (Table 3).

During February and March 2004, we collected 53 elk fecal samples from South Fork, 50 from Lochsa, and 50 from North Fork winter ranges. Based on these samples, the overall pregnancy rate was 48.0% for South Fork elk, 70.0% for Lochsa elk, and 32.0% for North Fork elk (Table 4). Samples from non-pregnant animals were submitted to Dr. Lisette Waits' lab to determine the sex of the animal using established DNA technologies. Those results are not yet available.

Discussion

Elk recruitment is inadequate in several important GMUs in Idaho. As a result, several key elk populations have declined over the past decade. Predation is often cited as the primary cause of this decline, but a variety of factors may affect recruitment. We have chosen to take a broader view of the recruitment question by considering factors in addition to predation, such as:

1. Habitat quality and structure as it affects:
    a. Cow condition
    b. Pregnancy rates
    c. Calf condition
    d. Calf vulnerability
    e. Predator efficiency

2. Bull:cow ratios

3. Bull and cow age structures

4. Road access and success rates of bear and lion hunters

Because pregnancy is such an important piece of information, we initiated an effort to assess pregnancy non-invasively by collecting fresh fecal pellets from cow elk during February and March. Fecal steroid metabolite levels were evaluated to estimate the pregnancy rate (Stoops et al. 1999). For this approach to work, one must be able to differentiate samples from male vs. non-pregnant females. Otherwise some of the "non-pregnant" samples may actually represent bulls rather than cows, skewing the results.

In collaboration with Dr. Steven Monfort's lab, we investigated the use of hormone profiles in fecal samples to determine sex. This approach is appealing because it is much less costly than DNA-based evaluations. However, using P_4, T, and the P_4/T ratio, we were unable to distinguish between samples from non-pregnant females and male elk. Pregnant animals were readily identified using the same parameters.

An alternative, though more expensive, approach is to use a DNA-based evaluation of fecal samples to determine an animal's sex. We are working with Dr. Lisette Waits' lab at the University of Idaho on such an approach.

Trace element levels and other serum parameters have proven difficult to interpret (DelGiudice et al. 1990, DelGiudice et al. 1991, Cook et al. 2001). Nevertheless, where differences occur among our study areas, the Lochsa and/or North Fork are generally "deficient". This may reflect habitat and environmental differences among the study areas. We expected marked differences in pregnancy rates and physical condition of adult cows among the study areas. The pregnancy rate was 13% higher and the BCS (Gerhart et al. 1996) was significantly greater for South Fork vs. Lochsa/North Fork animals in 1997. Furthermore, following a relatively mild winter, the pregnancy rate was slightly higher and BCS significantly greater for South Fork cows in 1998 vs. 1997. In March 2002, pregnancy was essentially 100% across all study areas, but South Fork animals continued to exhibit better BCSs. South Fork cows continued to be in better condition and exhibit higher pregnancy rates in 2004, than those on the Lochsa and North Fork study areas.

Mitchell and Brown (1974), Hamilton and Blaxter (1980), and Albon et al. (1986) reported a correlation between environmental conditions, animal condition (weight), and pregnancy rates for red deer (*Cervus elaphus*). Likewise, Gunn et al. (1969) demonstrated that domestic sheep (*Ovis aries*) in good or improving condition have a higher fertility rate than individuals in poor condition.

Over the past decade, biologists have investigated ways to measure physiological stress in wild populations. One response to such stresses is increased secretion of glucocorticoids which can be detected in fecal samples. Increased secretions are adaptive in the short-term, but chronically elevated levels can produce reproductive suppression, ulcers, muscle wasting, and immune suppression (Sapolski 1992). We suspected that three factors may differentially influence fecal glucocorticoid levels in elk on our study areas:

1. Winter 1996-1997 was particularly difficult in north-central Idaho. Snow-pack was 200% of normal, whereas the winters of 1997-1998 and 2001-2002 were near "normal" with snow-packs approximating the long-term average. We suspected these conditions would be reflected in elevated fecal glucocorticoid levels in 1996-1997 samples and lower levels in 1997-1998, 2001-2002, and 2002-2003 samples.

2. Lochsa winter ranges are characterized by decadent shrub-fields and deep snow. The primary South Fork winter range is Earthquake Basin – much of which burned in 1967. The South Fork habitat remains productive and available to elk because snow depths are markedly less than found on the Lochsa/North Fork winter ranges. We suspected that physiological stress and fecal glucocorticoid levels would be higher for Lochsa animals than for South Fork elk.

3. Wolves were infrequently found on each study area during the 1996-1997 and 1997-1998 collections. Wolves were a significant component of the Lochsa/North Fork ecosystem by 2001-2002. They continue to be infrequently present on the study area portion of GMU 15. We suspected that fecal glucocorticoid levels would be higher on the Lochsa/North Fork in 2002 and 2003 than in previous sample years because wolves had become established in the interim. We did not expect a similar change in the South Fork because wolves were not yet established on the study area portion of the GMU.

Fecal glucocorticoid levels were 2-3 times higher on the Lochsa than the South Fork, indicating a higher level of physiological stress for the Lochsa animals. The Lochsa values are well below those reported for elk in the Yellowstone ecosystem (Creel et al. 2002). Either there was no response to winter severity or presence of wolves, or they acted as confounding variables because the 1996-1997 fecal glucocorticoid level was not significantly different from the 2001-2002 level. Unexpectedly, the South Fork fecal glucocorticoid levels were significantly higher in 2001-2002 than in 1996-1997, but remained markedly lower than Lochsa values. Possible reasons for this are unclear.

Though the connection between fecal glucocorticoid levels and population performance is unclear, monitoring fecal glucocorticoid levels in conjunction with BCS, pregnancy rates, age structure, and so forth may provide a useful index of the physiological condition and status of an elk population (Millspaugh et al. 2001).

Our data from the Lochsa/North Fork and the South Fork (Gratson and Zager 1997, 1998, 1999, 2000; Zager and Gratson 2001; this report) suggest that the "recruitment problem" in north-central Idaho, and particularly the Lolo Zone, is more than a question of predation. Preliminary information suggests that Lochsa/North Fork cows exhibit generally lower than expected pregnancy rates and an apparently older age structure in addition to poor calf survival.

Lower pregnancy rates may be related to poor habitat quality, high population density, or other factors. Any changes in predator density or predation rate may simply exacerbate the recruitment problem.

Furthermore, more than 20 years of bulls-only hunting has resulted in a cow age structure skewed toward older animals on the Lochsa/North Fork. Because fecundity begins to decline at eight (Greer 1966) to 12 (Bubenik 1982) years old, this age structure may also contribute to low pregnancy rates and declining recruitment.

Recommendations

Include other GMUs in efforts to collect age-specific condition and pregnancy data. GMUs representing a broad range of conditions should be included for such data to be truly useful.

Evaluating fecal steroids in samples collected from cow elk during winter shows promise as a means to index or measure pregnancy rates. Extending this effort will provide data necessary to fully evaluate the efficacy and accuracy of the approach. We are currently attempting to develop a means to determine the sex of the animal that deposited the sample. This will allow us to readily eliminate fecal samples deposited by bull elk so we can easily remove males from the equation.

As wolves become established on these study areas, it is important to continuing monitoring adult cow survival and condition to better understand the impacts of predation on elk populations in north-central Idaho

JOB NO. 2: CALF MORTALITY CAUSES AND RATES

Abstract

There are a variety of factors that may influence calf survival. These can be summarized into three major issues (Gratson and Zager 1997): 1) the balance between elk density and habitat, 2) number and age structure of bulls, and 3) predation. Gratson and Zager (1997) provide a literature review and discussion on the details of these issues. Importantly, these factors may simultaneously influence calf survival and interactions often occur; therefore, Job 2 has been combined with Job 3 and presented under Job 3.

JOB NO. 3: PREDATION EFFECTS ON ELK CALF RECRUITMENT

Abstract

We are investigating causes of variation in calf mortality, including the effects of predation by black bear (*Ursus americanus*) and mountain lion (*Felis concolor*). During the report period, we monitored survival and determined causes of death of radio-collared elk calves captured in 2003 in parts of GMU 15 (South Fork Clearwater) and 2004 in parts of GMU 15, GMU 10 (North Fork Clearwater), and GMU 12 (Lochsa). In fall 1999, the Department increased the bag limit to two bears and two lions per year on a portion of the Lochsa study area and eliminated legal harvest of bears and lions in part of the South Fork study area. The North Fork Clearwater and a portion of the South Fork serve as control areas. Annual survival rate of calves captured in 2003 was 0.33 ± 0.10 on the South Fork. The survival rate of calves captured in 2004 to August 1 was 0.65 ± 0.10 on the South Fork, 0.83 ± 0.15 on the North Fork, and 0.82 ± 0.08 on the Lochsa.

Predation, mostly by bear and lion, continues to be the primary proximate source of mortality. We observed 0.13 bears/flying hour on the South Fork, 0.76 bears/flying hour on the North Fork, and 0.64 bears/flying hour on the Lochsa during 2004 calf capture operations. Black bear bait station surveys and a mark-recapture index indicate that the bear populations in the two treatment areas are responding to manipulation as anticipated. The bear population on the South Fork treatment area has increased to mirror the control area since the harvest season was closed and the population on the Lochsa treatment area has declined in relation to the North Fork control since we initiated efforts to increase bear harvest. During 2003-2004, we continued efforts to index mountain lion populations using mark-recapture analyses of DNA samples collected in three different ways.

Introduction

Recruitment is chronically low or has declined in many key elk populations in Idaho (Gratson and Johnson 1995, Gratson and Zager 1997). This is cause for concern because recruitment must replace losses of adults to hunting and other factors to allow population stability or growth. In Idaho, hunting losses typically account for >85% of the annual mortality of adults (Leptich and Zager 1991, Unsworth et al. 1993). However, hunting mortality can be managed by manipulating hunter numbers and success through changes in season timing and length, sex and antler point restrictions, legal hunting equipment and techniques, road densities, cover amounts and juxtaposition, and controlled-hunts (Thomas 1991, Unsworth et al. 1993, Gratson and Whitman 2000). In contrast, information pertaining to predicting and managing elk recruitment both across geographic areas and within populations is generally lacking.

There are a number of demographic parameters that may affect elk recruitment such as pregnancy rates, birth rates, and calf survival. This study addresses calf survival rates. Elsewhere, we address elk recruitment from a statewide, broad-scale perspective, investigating patterns of calf:cow ratios (Bomar et al. 2001) and questions of pregnancy, birth rates, and cow condition (Job 1, this report).

The objectives of this study are to determine:

1. Factors influencing variation in calf survival rates and causes of mortality.

2. Effects of predation by black bears and mountain lions on recruitment rates.

We are also attempting to develop methods to index black bear and mountain lion population status and trends.

Study Areas and Methods

The Lochsa/North Fork study area includes the south-central portion of GMU 10 and the north-central portion of GMU 12. Calf:cow ratios are low in GMUs 10 and 12 and have been declining since the early 1990s. Recruitment is inadequate to replace losses of adults. Further details of this area are provided in Gratson and Zager (1998).

Beginning in fall 1999, we implemented a predator reduction “treatment” on the Lochsa portion of the study area. A bag limit of two bears and two lions per year was available for hunters within the 699 km^2 treatment area. To further affect this treatment, beginning with the spring 2001 season, the Department offered non-resident reduced bear and mountain lion tags valid in the Lolo, Selway, and Middle Fork zones. Non-resident hunters could purchase up to two bear and two mountain lion tags, valid only for these zones, at a significantly reduced cost.

In contrast, a bag limit of one bear and one lion per year was maintained within the 1,333 km^2 North Fork control area. Bear seasons were further extended in Unit 10 and 12 from April 1 to June 30 and August 30 to November 3. Lion seasons extended from August 30 to March 31.

The main South Fork study area consists generally of the northern half of GMU 15. Calf:cow ratios are stable and have averaged 30-35 since the early 1990s. Recruitment is adequate to replace losses of adults. Further details of the main South Fork study area are presented in Gratson and Zager (1998).

Beginning in fall 1999, we implemented a predator increase “treatment” on the north side of the South Fork study area. Legal harvest of bear and lion was eliminated within the 574 km^2 treatment area. In contrast, the traditional bag limit of one bear and one lion per year was maintained on the south side of the South Fork (1,357 km^2 control area). Bear seasons extended from April 15 to May 15 and August 30 to October 31. Lion seasons extended from September 15 to March 31.

Elk Capture and Monitoring

Details of capture and monitoring neonate elk calves are provided in Gratson and Zager (1998). Because use of Johnson’s (1951) aging criteria alone can result in uncertain calf ages, we are developing an aging technique in collaboration with others (Montgomery et al. 2003) using known-aged calves from captive elk herds near LaGrande, Oregon, and Moscow, Idaho (Gratson and Zager 1999).

Predators

Black Bears

We continue to use harvest data, bait station surveys, a mark-recapture index, and an index based on observations during calf capture to monitor black bear population status and trend. Methods are detailed in previous reports (Gratson and Zager 1999, Zager and Gratson 2001).

We modified the mark-recapture methodology from that of Garshelis and Visser (1997). They developed a statewide bear population estimate using tetracycline-laced baits distributed throughout bear habitat in Minnesota and Michigan. Though their concepts are appealing, their approach is probably not appropriate for use on smaller study areas such as ours (Garshelis personal communication). Our analysis and interpretation focus on one-year mark-recapture periods rather than estimates that incorporate cumulative recaptures. An important assumption is that most bears (and/or an estimable proportion) are harvested and few die from natural causes and are unrecorded. That assumption may be reasonable for Idaho bears for the short-term (possibly one year), but becomes a significant problem with time (possibly beyond one year) because Idaho bear populations are not as well known as those in Minnesota and Michigan. Furthermore, extensive and difficult terrain, poor access, and relatively low hunter densities likely result in black bear harvest rates that are markedly lower than in Minnesota and Michigan. Fates are unknown for a greater, though unknown, proportion of bears in Idaho.

Mountain Lions

We initiated a mountain lion population survey in 1999 on the Lochsa/North Fork study area using network sampling methodology (Becker et al. 1998) rather than linear transects (Becker 1991, Van Sickle and Lindzey 1991). That approach and those data are presented in Gratson and Zager (1999). That effort was not repeated.

We renewed efforts to index mountain lion populations during 2001-2002. Methods and approximate cost of DNA analysis are detailed in previous reports (Zager et al. 2002, Zager and White 2003). Modifications to the rub station methods were initiated during the 2004 summer field season and are described here.

Preliminary data indicated that few lions visited and rubbed at our stations. Density of the lion population and density of the rub stations over the study area may be factors in determining visitation rate. However, the method remains untested and many variables (e.g., choice of lure, individual lion behavior, time of year) may play a role in whether a lion finds, visits, and leaves hair at a rub station. During 2004, we used a variety of lures and visual attractants and changed the density and pattern placement of rub stations. A pilot-test of these changes was conducted in March-April of 2004 and final modifications were in place by the 2004 summer field season.

During 2004, we established 8 km survey routes along existing roads and trails. Two rub stations were placed at each 1.6 km interval starting at the beginning of the route. At each 1.6 km interval, one rub station was placed close to the road or trail but it was not visible from the road or trail. The second rub station was placed 50-100 m from the first. Rub station survey routes were operated for one 14-day sampling period. A visual estimate of the forest and shrub cover within 15 m of each station was recorded.

Rub stations were constructed of a carpet pad (10.2 cm x 10.2 cm), with ten 5-cm nail-gun nails pushed through the pad. Nails with a small (8 mm) wire attached to the shaft helped snag the hairs. Carpet pads were nailed to a tree (>15 cm dbh) at a height of 63-73 cm. Trees had their lower (<1.5 m) branches removed, and shrubs and obstacles within 1.5 m were cleared. Carpet pads were baited with 4.0-9.8 ml of lure and sprinkled with dry catnip (about one teaspoon). A film canister containing cotton balls soaked with 4.0-9.8 ml of lure was nailed 2-5 m above the carpet pad to increase scent range. A visual attractant was hung from a nearby tree branch. Where possible, a hand rake was used to clear twigs and leaves and rough up the soil on the side of the tree that had the rub station so that tracks could be seen.

Lures used included a beaver castoreum liquid lure, beaver castoreum paste lure, mountain lion urine, and Canine Call (a commercial trapping lure). Visual attractants used included flattened aluminum pie pan, aluminum foil, ribbon, tinsel, and a bird wing.

Elk and Alternate Prey Numbers

In February 2002 and January and February of 2003, regional wildlife personnel conducted population surveys of elk in GMUs 10, 12, and 15 using traditional sampling and sightability methods (Unsworth et al. 1994). They also conducted "composition surveys" (using a modified, less intensive survey protocol) in these GMUs during 2004. Deer survey data have been collected on the main South Fork study area using traditional sampling and sightability methods in January 1998 and 2000.

Results and Discussion

In 2004, we captured and radio-collared 19 calves (nine male, ten female) on the South Fork treatment area, 11 calves (seven male, four female) on the South Fork control area, six calves (three male, three female) on the North Fork control area, and 27 calves (15 male, 12 female) on the Lochsa treatment area. Calves were captured from June 1-9 on the South Fork and May 31-June 11 on the North Fork and Lochsa areas.

In 2003, we captured and radio-collared 29 calves (14 male, 15 female) on the South Fork treatment area, and four calves (three male, one female) on the South Fork control area (Zager and White 2003).

Age and Condition

The precise age of wild calves at capture is unknown. A graduate student at the University of Idaho is developing and testing aging criteria for wild calves using known-aged calves from captive herds in Moscow, Idaho, and LaGrande, Oregon (Montgomery et al. 2003). Known-aged calf data include approximately 676 captures during which incisor eruption and hoof growth line were recorded, 334 captures during which leg and foot measurements were additionally recorded, and 50 captures during which navel, umbilical cord, dewclaw, hoof, stability, and stature characteristics were also recorded.

Characterizing condition of calves depends on knowing capture age of calves. Thus, we have not predicted day-old weights of calves captured during 1999-2004.

In addition to birth weight or weight adjusted to body frame size, blood constituents may provide information on overall body condition of calves. For wild calves captured in 2001, trace mineral and serum parameters are presented in Tables 5 and 6. Calves from a captive herd in Moscow, Idaho, are presented for comparison. Blood parameter values may be influenced by age at capture as well as nutrition and condition of the calves, and few standards exist for elk related to age, nutrition, or condition. To reduce handling time and resultant stress on calves, we stopped collecting blood samples in 2001.

Survival and Causes of Mortality

Survival of neonate radio-collared calves captured in 2004 between capture and August 1 was 0.65 ± 0.10 for combined South Fork treatment and control areas, 0.83 ± 0.15 for the North Fork control, and 0.82 ± 0.08 for the Lochsa treatment (Table 7). Previous years are also presented for comparison.

Annual survival of calves captured in 2003 was 0.33 ± 0.10 on the South Fork (Table 8).

Proximate causes of mortality of calves captured in 2004 through August 1 include black bears (n=2), mountain lions (n=3), unknown predators (n=3), and disease (n=2) (Table 9). Annual survival data from previous years are also presented for comparison (Table 10).

Predator Numbers

Black Bears - We saw six black bears on the combined South Fork study area during 45.7 hours of flying during calf capture operations (0.13 bears/hour) (Table 11). We saw 0.59 bears/hour on the Lochsa and 0.76 bears/hour on the North Fork study areas.

The South Fork study area is highly roaded and most of the roads are open to motorized vehicles. There are relatively few closed roads or trails on the study area. Therefore, our South Fork bait station surveys focus on routes along open roads.

At the outset, we anticipated the initial black bear population density would be roughly comparable within the South Fork control and treatment areas. However, our mark-recapture index demonstrated that the "treatment" area density was substantially less than that of the "control" area (Tables 12 and 13). Furthermore, the proportion of survey routes that had ≥1 bait taken by a black bear (hit rate) was markedly higher on the control area when compared to the treatment area before the black bear harvest manipulation was implemented (Table 14). The hit rate differential (proportion of control routes minus the proportion of treatment routes with ≥1 bait taken by black bears) for 1997-1999 was 11.7% in favor of the control area. Once the black bear population manipulation was implemented, the 2000-2004 hit rate differential declined to about 0.5%, indicating that the black bear population in the treatment area had increased to the level of the South Fork control area.

Open roads and trails provided most of the access to the Lochsa/North Fork study area, and our bait station survey effort reflects this (Table 14). Before implementation of the black bear population manipulation, the hit rate differential for trails favored the "treatment" area (avg. = -5.3%, 1997-1999). Following implementation, the differential favored the "control" area (avg. = +2.0%, 2000-2002). A similar pattern was evident from the road routes. The differential changed from avg. = -6.7 % (1997-1999) to avg. = +11.5.0% (2000-2004).

Our mark-recapture index also indicates a population decline on the treatment area between 1997 and 2003.

Efforts to increase the bear harvest in the treatment area played an important role in the black bear population decline. In addition, a portion of the decline evident in 1999 is likely related to a general huckleberry (*Vaccinium* spp.) failure the previous year. Loss of a reproductive cohort and possibly some adult bears (increased vulnerability during hunting season) often results from such a failure. The 1999 decline was also reflected in the South Fork control area data (Table 13).

The mark-recapture index for the Lochsa/North Fork control area is less useful because we had no recaptures during 1997 or 1998. However, based on bait station surveys, we do not believe the population changed markedly in the control area between 1997 and 2004.

Mountain Lions - Beginning in 1999, mountain lion populations were manipulated in the Lochsa/North Fork and South Fork study areas by increased, decreased, or stable harvest pressure from sportsmen. Also in 1999, a lion population survey was initiated on the Lochsa/North Fork study area (Gratson and Zager 1999). That effort has not been repeated. Our objective is to develop a monitoring program that would index mountain lion populations in our study areas and could potentially estimate population size.

Darting - Efforts by two hired houndsmen during the 2003-2004 lion harvest season resulted in nine attempts to tree mountain lions (Table 15). Six lions were treed and four DNA samples were collected. During the 2002-2003 lion harvest season, the two hired houndsmen attempted to tree 31 mountain lions, treed 27 lions, and collected 15 DNA samples.

The South Fork study area was surveyed by two different houndsmen between 2002-2003 and 2003-2004. Differences in hounds, activity level of wolves, and houndsmen's comfort level around wolves partly resulted in fewer chases and treeing of lions.

The hired houndsmen also provided a track/mile index. Preliminary interpretation of the data indicates that the Lochsa treatment area has a higher track index than the North Fork control area and the South Fork study areas (Table 15). Further work is needed to understand the relationship between the index and lion populations. Comparisons between years of the index should not be made until further analysis is completed.

Harvest - During the 2003-2004 harvest season, 82% of Big Game Mortality Reports (BGMR) (32 of 39) submitted by vendors for lions harvested in GMUs 10, 12, and 15 were accompanied by tissue samples. During the 2002-2003 season, vendors returned 74% of the BGMRs with a tissue sample.

Known legal harvest of mountain lions was slightly higher overall in the study areas during the 2003-2004 (n=24) season compared to 2002-2003 (n=21). Since the predator reduction was implemented in 1999-2000, the average harvest in the Lochsa treatment area has increased compared to the five years of harvest prior (Table 16). The harvest in the Lochsa/North Fork control area and the South Fork control area declined since the 1999-2000 season. The South Fork treatment area has remained closed.

Rub stations - We placed 730 rub stations and recorded 69 visits over the 14-day sampling period. Thirty-seven of the visits resulted in ≥1 hair. Preliminary results indicate that four visits were by lion, 25 visits were by bear, one visit was possibly by a lion, and four visits were possibly a bear. Total number of rub stations was increased dramatically because rub stations density and placement pattern changed. However, the total number of visits was slightly less than last year. Most importantly, the end product appears to be similar, e.g., few visits by lions were recorded. We did notice a number of the bear and lion visits were responding to the commercial lure Canine Call. Results from stations are preliminary until DNA analysis results are available. Data from the previous year are also presented for comparison (Table 17).

Our approach, using a combination of biopsy darts, rub stations, and harvest information, acknowledges the difficulties in acquiring population information about mountain lions while attempting to maintain a reasonably rigorous design that can provide a useful index and minimum population estimate.

Current results from our three-fold approach to index mountain lions magnify the difficulty in surveying them. Chasing and treeing mountain lions continues to be one of the more acceptable ways to determine lion populations, but our own efforts over three winters indicate results can fluctuate due to weather patterns, hound experience, and changing population dynamics. We should continue and intensify our efforts to collect DNA samples using houndsmen. Using biopsy darts and hounds ensures we get the DNA from the target species. Additional data (e.g. number of tracks, distribution, effort per treeing event) is also collected by houndsmen while in the field. We should continue to collect tissue from harvested lions. This data should provide us with an exploitation rate.

The rub station method is designed to balance cost, time, and logistics. If lions rarely visit rub stations, then a change in the lion population over the years will be impossible to detect. Our preliminary data indicates that very few lions visited and rubbed at our stations. Density of the lion population as well as density of the rub stations over the study area may be a factor in determining visitation rate. We increased the density of rub stations with seemingly little increase in visits, but we also operated the stations 28 fewer days. The method remains unproven and many variables (e.g. choice of lure, individual lion behavior, time of year) may play a role on whether a lion finds, visits, and leaves hair at a rub station. Rub stations have not been as successful as the other methods in collecting DNA samples.

Elk and Alternate Prey Numbers

Aerial surveys of elk were conducted in GMUs 10, 12, and 15 in January and February 2002, 2003, and 2004 (Table 18). Some of the surveys were conducted to collect trend data only and estimate age composition. Aerial surveys of deer were conducted in GUM 15 in January 1998 and 2000 (Table 19). Use of the mule deer sightability model for white-tailed deer has not been investigated, so bias and precision of the deer abundance index, although less biased and more precise than simple counts, are unknown.

Recommendations

Replicates of predator reduction and predator increase "treatments" should be pursued to avoid the confounding effects of simple geographic area differences rather than predator effects. Less intensive or intrusive methods may be necessary to achieve this and should be explored. If replicates cannot be secured, a "before-during-after control treatment" study design may have to be used. This approach requires estimates of calf survival, cause-specific mortality, calf condition, alternate prey, and predator abundance before, during, and after predator reduction and predator increase "treatments." Alternatively, a cross-over design could be used to address these concerns.

Secondly, bear and lion population indices must be established to verify substantial "treatments" are actually implemented. Work should continue toward a useful index of bear and lion population status and trend.

With the establishment of wolves in these ecosystems, it is important to continue monitoring neo-natal calves. Work in the Yellowstone Ecosystem indicates that wolves have a significant impact on elk calves and, therefore, population trajectories.

Finally, although substantial time and effort has gone into investigating condition of calves at capture as it relates to subsequent survival and cause-specific mortality, it might be argued that nutrition "*well after*" birth may better explain differences between study areas in survival of calves after most of the bear predation is over. Data regarding condition of calves during late summer/early fall are needed to address this question. Those data will be difficult and expensive to develop.

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Table 1. Body condition score (BCS), average weight, pregnancy rate, average age, blood selenium level, and fecal glucocorticoid (FG) levels for adult cow elk (>2 years old) captured on the Lochsa, North Fork, and South Fork study areas during March 1997, 1998, 2002, 2003, and 2004. Standard deviations are in parentheses.

Study area/Year	BCS[a]	Average weight[b] (kg)	Pregnancy rate (%)	Average age (years)	Se level (ug/gm)	FG[c] (ng/gm)	No. of animals
Lochsa							
1997	6.1 (1.92)	252 (20.94)	71	10.8 (4.44)	0.026 (0.017)	92.58 (40.91)	17
2002	7.2 (1.32)	220 (65.40)	100	12.1 (3.93)	0.09 (0.027)	101.02 (38.65)	10
2004	8.9 (1.72)	251 (16.95)	79	11.5 (5.94)	0.045 (0.033)	[d] [d]	24
North Fork							
2002	7.9 (0.99)	247 (8.37)	100	9.4 (2.88)	0.10 (0.029)	32.84 (4.47)	8
2004	8.9 (1.93)	259 (9.09)	77.2	11.4 (5.11)	0.12 (0.137)	[d] [d]	22
South Fork							
1997	8.9 (1.16)	250 (17.50)	89	7.6 (3.75)	0.13 (0.042)	35.12 (8.22)	18
1998	9.8 (1.20)	254 (24.82)	93	7.8 (2.77)	0.19 (0.125)	43.00 (19.34)	13
2002	9.2 (1.56)	246 (28.37)	100	5.25 (2.15)	0.12 (0.037)	55.46 (21.57)	16
2003	10.1 (1.96)	253 (17.10)	79	7.3 (3.95)	0.14 (0.14)	29.8 (13.67)	15
2004	9.9 (1.95)	265.4 (22.81)	100	7.3 (3.35)	0.17 (0.098)	[d] [d]	7

[a] After Gerhart et al. 1996.
[b] After Cook et al. 2003.
[c] After Millspaugh et al. 2001.
[d] Results not available yet.

Table 2. Serum parameters for adult cow elk captured on the Lochsa and South Fork study areas during March 1998 and 2002. Standard deviations are in parentheses. March 2003 and 2004 results are not yet available.

	Lochsa			North Fork		Lochsa & North Fork		South Fork				
	1998	2002		2002		2002		1998		2002		2003
Triglycerides (mg/dL)	63.00	36.60	(15.65)	50.89	(19.06)	43.37	(18.38)	83.07	(40.77)	55.05	(27.95)	-
Cholesterol (mg/dL)	82.00	65.40	(11.32)	70.56	(10.84)	67.84	(11.10)	75.14	(29.76)	66.60	(10.95)	-
Triiodothyronine (ng/dL)	71.00	62.20	(12.99)	54.78	(16.73)	58.68	(14.94)	51.57	(23.27)	53.85	(10.95)	-
Cortisol (ug/dL)	6.20	3.47	(0.60)	4.03	(1.32)	3.74	(1.02)	3.20	(2.19)	3.01	(0.97)	-
Urea Nitrogen (mg/dL)	8.00	10.30	(4.45)	11.89	(4.40)	11.05	(4.38)	15.93	(7.33)	15.10	(4.98)	-
Creatinine (mg/dL)	3.50	2.97	(0.44)	3.00	(0.32)	2.98	(0.38)	2.58	(0.74)	3.22	(0.40)	-
Total Protein (g/dL)	7.50	6.15	(0.46)	5.92	(0.39)	6.04	(0.43)	7.11	(2.16)	7.01	(0.48)	-
Sodium (mEq/L)	142.00	141.60	(4.38)	141.78	(3.15)	141.68	(3.74)	133.93	(3.41)	146.55	(6.17)	-
Potassium (mEq/L)	6.10	4.68	(0.69)	4.57	(0.58)	4.63	(0.63)	5.58	(1.37)	7.20	(1.19)	-
Calcium (mg/dL)	9.70	9.69	(0.35)	10.10	(0.55)	9.88	(0.49)	8.82	(2.54)	10.74	(0.90)	-
Phosphorus (mg/dL)	9.10	4.50	(0.41)	4.08	(0.77)	4.30	(0.63)	6.48	(2.45)	5.73	(0.80)	-
No. animals	1	10		9		19		14		20		15

Table 3. Trace element levels in adult (>1.5 years old) cow elk sampled during winter. Standard deviations are in parentheses.

Element[a]	GMU 12[b] (n=56)		GMU 10[f] (n=30)		GMU 15[c] (n=77)		GMU 62[d] (n=11)		GMU 67[d] (n=35)		GMU 32A[e] (n=20)	
Selenium	0.048	(0.036)	0.115	(0.115)	0.131	(0.074)	0.112	(0.038)	0.164	(0.108)	0.123	(0.117)
Calcium	102.000	(9.825)	100.700	(7.918)	107.108	(8.444)	89.860	(3.674)	87.468	(16.924)	99.800	(4.188)
Copper	0.694	(0.110)	0.720	(0.109)	0.725	(0.110)	0.801	(0.146)	0.788	(0.151)	0.743	(0.126)
Iron	1.792	(0.480)	1.510	(0.357)	1.925	(1.397)	1.373	(0.649)	1.526	(0.606)	2.070	(0.526)
Magnesium	28.500	(3.131)	28.600	(4.702)	28.405	(2.914)	20.000	(0.649)	21.625	(2.537)	28.300	(2.849)
Phosphorus	54.852	(12.950)	49.600	(8.224)	67.554	(11.767)	34.429	(10.628)	41.313	(16.912)	74.400	(10.733)
Zinc	0.652	(0.110)	0.620	(0.108)	0.607	(0.115)	0.509	(0.100)	0.480	(0.126)	0.646	(0.090)

[a] Selenium is based on whole blood, whereas all others are serum values. All units are µg/gm. Approximate adequate ranges provided by the Analytical Sciences Laboratory at the University of Idaho are as follows: Selenium 0.100-0.300 µg/gm; calcium 90-128 µg/gm; copper 0.60-1.20 µg/gm; iron 0.64-1.68 µg/gm; magnesium 18-32 µg/gm; phosphorus 55-120 µg/gm; zinc 0.70-1.50 µg/gm.

[b] GMU 12 values are based on data collected in March 1997, 2002, and 2004.

[c] GMU 15 values are based on March 1997, 1998, 2002, 2003, and 2004 data.

[d] GMUs 62 and 67 values are based on data collected in 2001 and 2002.

[e] GMU 32A values are from a March 2003 capture.

[f] GMU 10 values are based on March 2002 and 2004 captures.

Table 4. Elk pregnancy rates determined from progesterone metabolite levels in fecal samples collected during winter from three north-central Idaho study areas. Elk were considered pregnant if $P_4 \geq 1.4$. Sample sizes are in parentheses.

Year	Pregnancy rate		
	South Fork	Lochsa	North Fork
1999	79.6 (49)	76.1 (46)	- -
2000	79.7 (59)	75.0 (52)	100.0 (2)
2001	66.0 (50)	84.2 (57)	100.0 (16)
2002[a]	- -	- -	- -
2003	39.7 (58)	66.1 (62)	84.0 (50)
2004	48.0 (53)	70.0 (50)	32.0 (50)

[a] An equipment problem resulted in loss of the 2002 samples.

Table 5. Blood trace mineral levels (mean µg/g ± SD below) in elk neonates at capture (sample size in parentheses).

Year/Area	Mineral level[a] Se[b]	Zn	P	Fe[c]	Mg	Cu	Ca
1997							
Lochsa	0.006	0.47	96.8	2.9	23.1	0.61	132.3
(23)	0.006	0.24	21.6	1.9	2.5	0.23	11.9
South Fork	0.017	0.58	92.6	2.8	22.1	0.63	129.0
(28)	0.016	0.25	15.9	1.9	2.5	0.29	12.3
1998							
Lochsa	0.010	0.45	84.9	2.5	20.2	0.66	115.3
(20)	0.009	0.29	19.1	2.3	2.9	0.36	10.4
South Fork	0.022	0.41	85.0	2.3	21.2	0.63	120.3
(26)	0.009	0.23	11.6	1.9	2.6	0.33	10.0
1999							
North Fork	0.013	0.66	98.0	3.4	21.2	0.74	119.8
(15)	0.004	0.26	17.0	1.7	2.8	0.38	11.6
Lochsa	0.015	0.94	98.4	2.7	21.1	0.59	119.9
(15)	0.009	1.40	14.4	1.8	2.7	0.22	11.7
South Fork	0.039	0.72	108.1	3.5	23.8	0.83	129.6
(20)	0.012	0.31	19.5	1.9	2.8	0.36	13.3
Moscow[d]	-	0.47	99.3	2.4	20.2	0.57	119.9
(9)	-	0.25	11.2	1.4	2.5	0.32	10.4
2000							
North Fork	0.010	0.57	95.3	2.8	21.3	0.64	118.1
(15)	0.010	0.30	21.4	1.8	2.6	0.21	10.9
Lochsa	0.044	0.51	99.3	3.2	21.3	0.66	120.7
(15)	0.018	0.28	14.4	1.9	2.7	0.20	8.1
South Fork	0.038	0.66	104.9	2.9	21.6	0.75	117.7
(18)	0.034	0.23	12.6	1.7	1.6	0.19	6.5
2001							
North Fork	0.008	0.46	94.7	2.7	21.4	0.65	108.7
(9)	0.005	0.18	19.1	2.3	2.3	0.24	5.9
Lochsa	0.022	0.44	88.8	2.9	19.2	0.62	108.3
(12)	0.009	0.21	8.9	1.4	1.9	0.19	8.9
South Fork	0.028	0.46	90.1	1.3	20.3	0.50	108.4
(30)	0.013	0.23	12.2	1.4	1.7	0.18	6.6

[a] Se = selenium; Zn = zinc; P = phosphorus; Fe = iron; Mg = magnesium; Cu = copper; and Ca = calcium.

[b] Used 0.004 µg/g for individual Se values that were below estimated detection limits (0.005 µg/g) to calculate mean and SD.

[c] Used 0.021 µg/g for individual Fe values that were below estimated detection limits (0.22 µg/g) to calculate mean and SD.

[d] Calves given Se injection shortly after birth.

Table 6. Blood serum parameters (mean ± SD below) for elk neonates at capture (sample size in parentheses).

	Parameter[a]										
Year/Area	TRIG	CHOL	T3	CORT	UN	CREAT	TP	NA	K	CA	P
1997											
Lochsa	48.4	44.9	381	7.48	15.68	1.15	5.47	144.0	5.32	9.9	8.8
(25)	33.9	13.8	114	4.19	6.07	0.36	0.65	3.0	0.85	0.8	2.1
South Fork	43.5	42.3	404	5.87	13.28	0.96	5.87	147.0	5.03	10.8	8.9
(29)	15.8	9.5	109	2.33	4.56	0.35	0.65	3.8	0.53	1.0	1.5
1998											
Lochsa	46.7	40.3	342	5.67	15.40	1.66	5.67	141.0	4.76	10.5	9.2
(20)	21.1	15.9	71	2.53	5.27	0.90	1.08	3.1	0.48	0.8	2.1
South Fork	41.2	41.8	371	3.96	13.36	1.23	6.07	141.0	4.46	10.4	8.9
(28)	26.4	13.1	120	1.58	3.93	0.30	0.72	4.5	0.38	0.7	1.2
1999											
North Fork	54.8	43.1	384	4.59	14.07	1.16	5.61	144.0	4.71	10.7	9.5
(15)	34.1	13.8	126	2.42	5.52	0.57	1.21	4.0	0.32	0.9	1.6
Lochsa	41.1	44.4	392	5.33	13.73	1.13	5.99	144.0	4.63	10.8	9.6
(15)	16.0	93.9	136	2.26	4.76	0.39	0.63	3.1	0.38	0.9	1.0
South Fork	37.2	40.6	348	4.31	14.30	1.17	6.02	148.0	4.77	10.8	10.1
(20)	20.5	8.7	114	1.47	3.06	0.31	0.41	3.5	0.38	0.6	1.9
Moscow	41.6	44.7	333	4.90	18.65	1.31	5.98	146.0	4.63	10.1	9.6
(17)	21.7	13.8	101	3.25	10.85	0.42	1.16	10.2	0.73	1.2	1.7
2000											
North Fork	57.6	39.0	334	3.66	15.80	1.31	5.94	148.0	4.68	11.2	8.9
(15)	32.9	11.0	52	1.73	4.61	0.61	1.01	3.3	0.42	1.1	2.0
Lochsa	51.3	43.0	380	4.40	17.60	1.14	6.21	147.0	4.91	11.3	9.2
(15)	29.8	10.0	99	2.93	4.63	0.37	0.71	3.3	0.59	0.8	1.5
South Fork	33.2	43.0	281	1.99	17.70	1.09	5.98	145.0	4.57	11.0	10.6
(18)	11.0	13.0	103	1.18	9.23	0.17	0.52	3.7	0.43	0.9	1.4

[a] TRIG = triglycerides (mg/dl); CHOL = cholesterol (mg/dl); T3 = triiodothyronine (µg/ml); CORT = cortisol (mg/dl); UN = urea nitrogen (mg/dl); CREAT = creatinine (mg/dl); TP = total protein (g/dl); NA = sodium (meq/l); K = potassium (meq/l); CA = calcium (mg/dl); P = phosphorus (mg/dl).

Table 7. Survival rates (SE in parentheses) of radio-collared elk neonates from capture to August 1.

Year	Survival rate[a]					
	North Fork		Lochsa		South Fork	
1997	-		0.27	(0.09)	0.73	(0.08)
N[b]	-		27		31	
1998	-		0.27	(0.10)	0.58	(0.10)
N[b]	-		20		28	
1999	0.31	(0.11)	0.45	(0.13)	0.84	(0.08)
N[b]	16		15		22	
2000	0.59	(0.13)	0.53	(0.13)	0.75	(0.10)
N[b]	15		15		18	
2001	0.67	(0.16)	0.40	(0.16)	0.21	(0.07)
N[b]	9		11		30	
2002	-		-		0.38	(0.09)
N[b]	-		-		29	
2003	-		-		0.46	(0.09)
N[b]	-		-		33	
2004	0.83	(0.15)	0.82	(0.08)	0.65	(0.10)
N[b]	6		25		30	

[a] Excludes deaths associated with abandonment by cow presumably related to capture.
[b] Total number of radio-collared calves.

Table 8. Annual survival rates (SE in parentheses) of radio-collared elk calves.

Year	Survival rate[a]		
	North Fork	Lochsa	South Fork
1997	-	0.06 (0.06)	0.56 (0.14)
N[b]	-	27	31
1998	-	0.16 (0.11)	0.43 (0.33)
N[b]	-	20	28
1999	0.08 (0.08)	0.21 (0.11)	0.72 (0.11)
N[b]	16	15	22
2000	0.13 (0.12)	0.27 (0.13)	0.29 (0.11)
N[b]	15	15	18
2001	0.42 (0.18)	0.40 (0.18)	0.14 (0.06)
N[b]	9	11	30
2002	-	-	0.28 (0.09)
N[b]			29
2003	-	-	0.33 (0.10)
N[b]			33

[a] Excludes deaths associated with abandonment by cow presumably related to capture.
[b] Total number of radio-collared calves.

Table 9. Proximate cause of death of radio-collared elk neonates (%) from capture to August 1, 2004.

Cause of death[b]	Percent[a]		
	North Fork	Lochsa	South Fork
Bear	0	0	8.7
Lion	16.7	0	8.7
Unknown predator	0	4.2	8.7
Unknown[c]	0	4.2	8.7
Non-predation	0	8.3	0

[a] Total number of calf mortalities = 13.
[b] Tentative identification of causes of death; excludes deaths related to abandonment by cow presumably related to capture.
[c] Unknown whether predation or not.

Table 10. Proximate cause of death of radio-collared elk calves (%) from capture to June 1 of the following year. Reported numbers may differ slightly from previous progress report numbers.

	North Fork			Lochsa					South Fork						
Cause of death[a]	1999	2000	2001	1997	1998	1999	2000	2001	1997	1998	1999	2000	2001	2002	2003
Accident	0	0	0	10.0	0	0	0	0	0	8.3	0	0	0	0	0
Disease/starvation	0	0	0	0	0	0	0	0	7.7	0	33.3	0	4.5	5.6	5.6
Unknown[b]	14.3	0	33.3	0	0	9.1	10.0	14.3	7.7	8.3	16.7	8.3	0	11.1	5.6
Predation															
Bear	50.0	10.0	50.0	50.0	53.3	54.5	40.0	57.1	46.2	25.0	16.7	16.7	72.7	27.8	22.2
Lion	35.7	90.0	16.7	40.0	46.7	27.3	40.0	14.3	30.7	41.7	33.3	41.7	22.7	33.3	38.9
Wolf	0	0	0	0	0	0	0	14.3	0	0	0	0	0	0	0
Bobcat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.6
Unknown[c]	0	0	0	0	0	9.1	10.0	0	0	8.3	0	16.7	0	22.2	16.7
Gunshot	0	0	0	0	0	0	0	0	7.7	8.3	0	16.7	0	0	5.6
N[d]	14	10	6	20	15	11	10	7	13	12	6	12	22	18	18

[a] Tentative identification of causes of death; excludes deaths related to abandonment by cow presumably related to capture.
[b] Cause of death unknown.
[c] Predation but unknown species.
[d] Total number of calf mortalities.

Table 11. Black bear observations on combined Lochsa/North Fork and South Fork study areas during aerial calf capture operations.

Year	Lochsa/North Fork (combined)	Lochsa (treatment)	North Fork (control)	South Fork
1997				
Bears/flying hour	1.68	-	-	0.09
Bear observations	94	-	-	7
1998				
Bears/flying hour	1.84	-	-	0.11
Bear observations	107	-	-	6
1999				
Bears/flying hour	1.15	-	-	0.12
Bear observations	60	-	-	7
2000				
Bears/flying hour	0.94	-	-	0.24
Bear observations	40	-	-	12
2001				
Bears/flying hour	0.85	0.62	1.14	0.09
Bear observations	46	16	30	4
2002				
Bears/flying hour	-	-	-	0.13
Bear observations	-	-	-	9
2003				
Bears/flying hour	-	-	-	0.05
Bear observations	-	-	-	3
2004				
Bears/flying hour	0.64	0.59	0.76	0.13
Bear observations	36	25	11	6

Table 12. Black bear population index (bears/square km) based upon a mark-recapture analysis of the proportion of tetracycline-laced baits taken at stations distributed across each north-central Idaho study area, 1997-2004. Values should be interpreted as a population index rather than a density. Adapted from Garshelis and Visser (1997).

	South Fork		Lochsa/North Fork	
Year	Control	Treatment	Control	Treatment
1997-1998	0.26	0.61	[a]	0.55
1998-1999	0.53	0.29	[a]	0.55
1999-2000[b]	0.20	[c]	1.18	0.23
2000-2001	0.34	[c]	0.48	0.28
2001-2002	0.44	[c]	1.07	0.22
2002-2003	0.17	[c]	0.35	0.36
2003-2004	.	.	.	.

[a] There were no recaptures; therefore, a calculated index is meaningless.
[b] Fall 1999 was the first hunting season under the population manipulation.
[c] Very few bears were in the reported harvest (three in 1999-2000, two in 2000-2001, and zero in 2001-2002) because the season was closed.

Table 13. Data used to calculate a black bear population index based upon a mark-recapture evaluation of the proportion of tetracycline-laced baits taken at stations distributed across each north-central Idaho study area, 1997-2004. Adapted from Garshelis and Visser (1997).

Year	Harvest season	Potential marks	Total harvest	Number of recaptures	Percent recaptures	Population index
South Fork control area						
1997	F97-S98	94	15	4	26.7	0.26
1998	F98-S99	65	11	1	9.1	0.53
1999[a]	F99-S00	72	15	4	26.7	0.20
2000	F00-S01	65	7	1	14.3	0.34
2001	F01-S02	50	12	1	9.1	0.44
2002	F02-S03	56	12	3	25.0	0.17
2003	F03-S04	70	-	-	-	-
South Fork treatment area						
1997	F97-S98	51	12	4	33.3	0.27
1998	F98-S99	29	12	5	41.7	0.12
1999[a]	F99-S00	27	3	2	66.7	[b]
2000	F00-S01	32	2	1	50.0	[b]
2001	F01-S02	35	1	0	0.0	[b]
2002	F02-S03	46	1	0	0.0	
2003	F03-S04	58	-	-	-	-
Lochsa/North Fork control area						
1997	F97-S98	51	66	0	0.0	[c]
1998	F98-S99	85	70	0	0.0	[c]
1999[a]	F99-S00	63	50	2	4.0	1.18
2000[d]	F00-S01	50	38	3	7.9	0.48
2001	F01-S02	54	53	2	3.8	1.07
2002	F02-S03	64	87	12	13.8	0.35
2003	F03-S04	60	-	-	-	-
Lochsa/North Fork treatment area						
1997	F97-S98	43	27	3	11.1	0.55
1998	F98-S99	35	44	4	9.1	0.55
1999[a]	F99-S00	22	29	4	13.8	0.23

Table 13. Continued.

Year	Harvest season	Potential marks	Total harvest	Number of recaptures	Percent recaptures	Population index
2000[d]	F00-S01	20	69	7	10.1	0.28
2001	F01-S02	18	61	7	11.5	0.22

[a] Fall 1999 was the first hunting season under the population manipulation.
[b] Very few bears were in the reported harvest (three in 1999-2000 and two in 2000-2001) because the season was closed.
[c] There were no recaptures, therefore a calculated index is meaningless.
[d] Spring 2001 included reduced non-resident tag fees and increased outfitter assistance.

Table 14. Percent visitation (sample size in parentheses) of tetracycline-laced bait routes by black bears in portions of GMUs 10, 12, and 15 during 1997-2003.

	Lochsa/North Fork Routes					South Fork Routes				
Year	Control		Treatment		Difference	Control		Treatment		Difference
1997										
Trails	75	(12)	89	(9)	-14	67	(6)	100	(2)	-
Closed roads	0	(0)	0	(0)	-	100	(6)	100	(4)	0
Open roads	53	(15)	78	(9)	-25	80	(35)	76	(21)	4
1998										
Trails	81	(21)	83	(6)	-2	100	(5)	0	(0)	-
Closed roads	100	(2)	0	(0)	-	80	(5)	100	(1)	-20
Open roads	63	(16)	80	(15)	-17	70	(33)	54	(28)	16
1999										
Trails	86	(14)	86	(7)	0	80	(5)	0	(0)	-
Closed roads	0	(0)	0	(0)	-	100	(5)	75	(4)	25
Open roads	72	(18)	50	(8)	22	69	(29)	54	(22)	15
2000										
Trails	76	(21)	71	(7)	5	67	(3)	100	(1)	-
Closed roads	0	(0)	0	(0)	-	100	(7)	67	(3)	33
Open roads	53	(18)	46	(13)	7	66	(32)	57	(23)	9
2001										
Trails	75	(20)	63	(8)	12	100	(2)	0	(0)	-
Closed roads	0	(0)	0	(0)	-	100	(5)	100	(5)	0
Open roads	57	(21)	41	(17)	16	52	(31)	57	(21)	-5
2002										
Trails	85	(15)	80	(5)	5	0	(1)	0	(0)	-
Closed roads	0	(0)	0	(0)	-	100	(1)	100	(4)	0
Open roads	78	(18)	60	(15)	18	82	(34)	84	(19)	-2
2003										
Trails	72	(18)	86	(7)	-14	100	(2)	0	(0)	100
Closed roads	100	(1)	0	(0)	100	75	(4)	100	(5)	-25
Open roads	68	(22)	37	(19)	31	74	(31)	77	(22)	-3
2004										
Trails	86	(14)	100	(6)	-14	100	(1)	0	(0)	-
Closed roads	0	(0)	0	(0)	-	83	(6)	100	(3)	-17
Open roads	60	(20)	63	(16)	-3	68	(31)	56	(25)	12

Table 15. Mountain lion tracking and treeing results across each north-central Idaho study area during the 2002-2003 and 2003-2004 winter seasons.

Year	Tracks[a]	Miles Searched	Track/Mile	Chases	Treeing Occurrences[b]	Lions Treed[c]	Males Treed	Females Treed	Sex Unidentified	Kittens Treed	DNA Samples Obtained
South Fork Control											
2002-2003	23	1,586	0.015	10	8	9	1	5	3	0	5
2003-2004	26	890	0.029	5	2	2	0	1	0	1	1
South Fork Treatment											
2002-2003	26	1,627	0.016	7	5	5	0	5	0	0	4
2003-2004	19	957	0.020	1	1	1	0	0	0	1	0
North Fork Control											
2002-2003	15	544	0.028	4	3	5	1	1	1	2	2
2003-2004	6	563	0.011	3	3	3	1	2	0	0	3
Lochsa Treatment											
2002-2003	22	219	0.100	10	7	9	3	2	1	3	4
2003-2004	6	67	0.089	0	0	0	0	0	0	0	0

[a] Tracks were only counted if <3 days old.

[b] A treeing occurrence is defined as an event in which the hounds treed ∃1 lion after a chase.

[c] Includes lions that were possible captured twice.

Table 16. Average harvest of mountain lions five years prior and five years after the 1999 regulation increased the bag limit from one to two lions in the Lochsa treatment portion of the north-central Idaho study areas, 1994-2003.

	South Fork		Lochsa/North Fork	
Seasons averaged	Control	Treatment	Control	Treatment
1994-1998	22	13	10	6
1999-2003	13	0[a]	8	9
Percent Change	-41	-100	-20	50

[a] Area has remained closed to harvest.

Table 17. Visits to rub stations in the Lochsa/North Fork and South Fork study areas during 2002-2004. The data for the 2004 rub stations are reported here but readers should be aware that rub station density and pattern placement was spatially different from previous years.

	Lochsa/North Fork rub stations			South Fork rub stations		
	2002 (N=25)	2003 (N=52)	2004 (N=350)[a]	2002 (N=27)	2003 (N=45)	2004 (N=380)[b]
Rub stations visited	15	25	55	11	29	12
Total visits[c]	28	35	56	12	42	13
Lion	2	0	0	1	1	4
Bear	5	8	22	2	9	3
Possible Lion	2	5	1	2	2	0
Possible Bear	0	1	0	2	3	4
Possible Lion or bear	0	1	0	0	4	0
Unknown	19	18	32	4	23	2
Other	0	1	2	1	0	0
Total DNA samples	10	19	30	5	17	7

[a] The rub stations reported here were distributed on 35 routes, with each route having ten rub stations paired in two's.

[b] The rub stations reported here were distributed on 38 routes, with each route having ten rub stations paired in two's.

[c] Presented here are all visits at rub stations over multiple sampling periods; 2004 had only one sampling period.

Table 18. Elk calf:cow ratios for GMUs 10, 12, and 15 during February 2002, January and February 2003, and 2004.

GMU	Year	Calves:100 cows (estimate)
10	2002[a]	14.9
	2003	20.3
	2004[a]	25.7
12	2002	26.8
	2003[a]	30.4
	2004[a]	28.1
15	2002[a]	34.8
	2003[a]	27.4
	2004[a]	29.5

[a] During these years, trend surveys were completed to estimate age composition only.

Table 19. Deer index for South Fork study area (GMU 15) in January 1998 and 2000.

Deer index	Estimate	90% confidence interval
1998	1,554	229
2000	1,223	359

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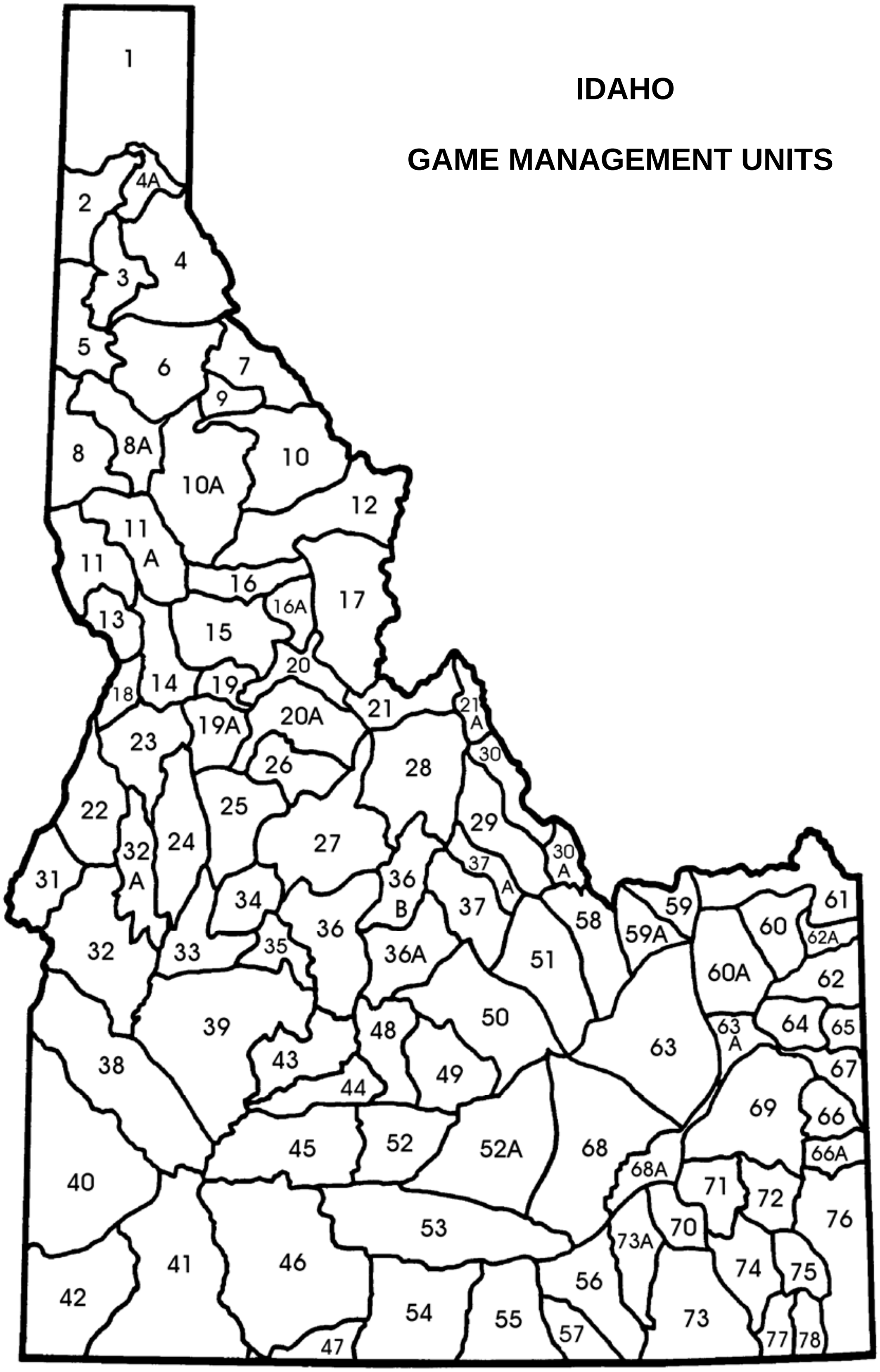
GAME MANAGEMENT UNITS



FEDERAL AID IN WILDLIFE RESTORATION

The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sale of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program then allots the funds back to states through a formula based on each state's geographic area and the number of paid hunting license holders in the state. The Idaho Department of Fish and Game uses the funds to help restore, conserve, manage, and enhance wild birds and mammals for the public benefit. These funds are also used to educate hunters to develop the skills, knowledge, and attitudes necessary to be responsible, ethical hunters. Seventy-five percent of the funds for this project are from Federal Aid. The other 25% comes from license-generated funds.