WYOMING GAME AND FISH DEPARTMENT

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FY15 FINAL PROJECT REPORT

July 1, 2014 – June 30, 2015

Project Title: Large Carnivore-Livestock Depredation Prevention and Control

Brief Synopsis of the Project: This project is in cooperation with the Wyoming Animal Damage Management Board (ADMB) to fund the Wyoming Game and Fish Department (WGFD) contract with United States Department of Agriculture-Animal Plant Health Inspection Service-Wildlife Services (WS) up to a maximum of $25,000.00 annually for services to investigate and control damage caused by black bears, grizzly bears, mountain lions, and gray wolves. Work to control damage by these species to livestock, bees, and beehives qualify for reimbursement as per W.S 23-1-901 and Wyoming Game and Fish Commission Chapter 28 Regulation Governing Big or Trophy Game Animal or Game Bird Damage Claims.

Project Details:

From July 1, 2014 through June 30, 2015, the WGFD/WS investigated 90 trophy game damage claims, totaling $938,516.12 being claimed with the WGFD paying $890,008.60 for confirmed losses. Gray wolves accounted for 21 claims ($333,786.22 claimed/$330,667.58 paid), grizzly bears accounted for 34 claims ($523,358.83 claimed/$486,842.58 paid), mountain lions accounted for 18 claims ($45,887.57 claimed/$38,051.86 paid) and black bears accounted for 17 claims ($35,483.50 claimed/$34,446.58 paid). Many of these damage claim investigations were conducted with the assistance of WS personnel. The assistance of WS personnel with trophy game damage claim investigations and conflicts allow the WGFD to be effective and efficient is dealing with damage/conflict situations, meet their legal obligations pertaining to damage, and is a win-win for the WGFD, WS, livestock producers and the public.

During FY15, WS conducted the following damage investigation and control activities:

- Spent 56.5 hours on mountain lion incidents.
- Spent 58 hours on black bears incidents.
- Spent 23 hours, including 4.5 hours of aerial removal work, on gray wolves incidents.
- Spent 2.5 hours on grizzly bear incidents.

During FY15, WS spent 140 hours dealing with trophy game damage/conflicts for a total monetary obligation of $10,808.59.

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An Assessment of Greater Sage-grouse (*Centrocercus urophasianus*) Population Demographics in the Bighorn Basin, Wyoming, 2011-2014

Report to the Wyoming Wildlife and Natural Resources Trust

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An Assessment of Greater Sage-grouse (*Centrocercus urophasianus*) Population Demographics in the Bighorn Basin, Wyoming, 2011-2014.

Executive Summary

Greater sage-grouse (hereafter sage-grouse) populations have declined across their range since European settlement of the Great Plains. The observed population declines have led to concern for the persistence of populations throughout the currently occupied range. The U. S. Fish and Wildlife Service has determined that listing the range-wide sage-grouse population is warranted but precluded. Given the process and timeline under which other species have been listed as threatened or endangered, this finding could indicate that listing of sage-grouse is imminent.

Sage-grouse are a landscape species requiring large expanses of native sagebrush rangelands to persist. Wyoming is one of 11 western states and 2 Canadian provinces where sage-grouse currently occupy. Wyoming contains a large contiguous expanse of native sagebrush rangelands and 37% of the overall sage-grouse population representing 64% of the eastern sage-grouse population. Therefore, understanding sage-grouse population dynamics and population growth rates in Wyoming is important for the conservation of the species and to avoid the need to list the species by the federal government.

We conducted a demographic study of sage-grouse populations on 5 sites within the Bighorn Basin in northwestern Wyoming between 2011 and 2014. We captured and marked 202 breeding female sage-grouse with either VHF radio or GPS transmitters. We used standard statistical analysis techniques to estimate demographic parameters including annual breeding female survival, nest survival, and chick survival. We used motion-capture cameras at nests to identify specific nest predators and estimated cause-specific mortality rates of breeding females. We used the estimated demographic parameters to develop vital rates and build Population

Viability Analysis (PVA) models to estimate population growth rates (λ). We estimated the risk of extinction of sage-grouse across the Bighorn Basin within 50 years based on estimated λ values.

We estimated that survival differed between the nesting and brood rearing period (1 March-31 October; hereafter breeding season) and over-winter (1 November-last day of February) but did not differ across study site, across year, or by bird age. Breeding season survival was 0.62 (SE = 0.03) and over-winter survival was 0.92 (SE = 0.03). Cause-specific mortality rates for breeding females did not significantly differ by cause during the breeding season. We observed a greater rate of cause-specific mortality of breeding females due to unidentifiable causes during the over-winter. This is likely an artifact of difficulty navigating to the mortality location in a timely manner during severe winter weather common to northwestern Wyoming.

We estimated that nest survival differed across study sites but did not differ across years or by bird age. Site-specific nest survival rates were, from highest to lowest, 0.56 (SE = 0.05) at Fifteen Mile, 0.45 (SE = 0.03) at Oregon Basin, 0.35 (SE = 0.05) at Bud Kimball, 0.33 (SE = 0.03) at Major Basin, and 0.20 (SE = 0.01) at Polecat Bench. The greatest cause of nest failures at Fifteen Mile, Oregon Basin, and Polecat Bench was due to coyote depredation. The greatest cause of nest failure at Major Basin was due to badger depredation. The greatest cause of nest failure at Bud Kimball was due to abandonment. Even though the leading cause of nest failure at Polecat Bench was coyote depredation we observed much greater depredation of sage-grouse nests by ravens on this site than on any other. In fact, the number of observed sage-grouse nests lost to raven depredation on Polecat Bench was twice as many as the next highest site and the

overall proportion of nest located lost to raven depredation was approximately twice what we observed on the next highest site.

We used bi-weekly brood flush counts between hatch and 56 days post-hatch to estimate sage-grouse chick survival. We estimated chick survival for this interval to be 0.54 (SE = 0.03).

We used the demographic parameter estimates above to estimate site-specific λ values. Values of 1 represents a stable population, < 1 represent a declining population, and > 1 represent an increasing population. We excluded the Bud Kimball site from these analyses because we had only 1 year of data for this site. We estimated $\lambda > 1$ at 3 sites (Fifteen Mile, Oregon Basin, and Major Basin). We estimated $\lambda < 1$ at Polecat Bench. Under these circumstances the mean time until extinction (given 10,000 simulations) was greater than 50 years at Fifteen Mile, Oregon Basin, and Major Basin and 20 years (SE = 0.10) at Polecat Bench.

Since we observed disproportionate nest loss due to raven depredation at Polecat Bench we conducted exploratory analyses to determine the effect of reducing sage-grouse nest loss to ravens by 50% and 75%. If raven depredation of sage-grouse nests is additive rather than compensatory, estimates of λ increased to 0.90 (SE = 0.0001) and 0.97 (SE = 0.0002) when sage-grouse nest loss to ravens was reduced by 50% and 75%, respectively. Mean time until extinction under these hypothetical conditions increased to 33 years (SE = 0.43) and 50 years (SE = 0.07) when sage-grouse nest loss to ravens was reduced by 50% and 75%, respectively.

We compared our demographic parameter estimates to other documented estimates from across the sage-grouse range. We found that, in general, our estimates were within the average reported range for specific demographic parameter. Our estimates were often near the upper reported average estimate and sometimes exceeded documented estimates from other studies.

The nest survival estimate at Polecat Bench was very low when compared to other sites within this study and nest survival estimates documented from other parts of the sage-grouse range.

In the most general terms it appears that the sage-grouse population across the Bighorn Basin is secure with the exception of the Polecat Bench site. These findings reflect the on-the-ground management activities (predator management, grazing practices, mining activities, etc…) that occurred over the course of our study. Current land-use practices appear to not have a negative impact on sage-grouse populations across most of the Bighorn Basin. While the sage-grouse population at Polecat Bench appears to be in jeopardy, our exploratory analyses for this site suggest management effective at controlling the raven population could result in a turnaround for this population.

This research study was conducted by the USDA, APHIS, Wildlife Services, National Wildlife Research in cooperation with the Meeteetse Conservation District. The synthesis of the data included in this report was made possible by a grant from the Wyoming Wildlife and Natural Resources Trust. Support for the project was provided by Wildlife Services personnel of the Northwest Wyoming District, the Bighorn Basin Conservation Districts, the Bighorn Basin Predator Management Districts, WYO-BEN, BreitBurn Operating LP, Marathon Oil Company, Fidelity Oil Company, Wyoming Animal Damage Management Board, V Ranch, Belden Ranch, Park County Farm Bureau, Wyoming Game and Fish Department, U. S. Bureau of Land Management, and the Shoshone National Forest. We thank each and every person, company, and agency that have made this project the success that it is.

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INTRODUCTION

Greater sage-grouse (*Centrocercus urophasianus*; hereafter, sage-grouse) populations have declined across their range since the early 1900's (Connelly and Braun 1997). It is estimated that current sage-grouse populations occupy 56% of their historic range that existed prior to settlement of the Great Plains (Schroeder et al. 2004). Their range includes portions of 11 western states and 2 Canadian provinces (Schroeder et al. 2004); however, individual populations have become increasingly geographically isolated (Knick et al. 2003) throughout these areas. The causes of this decline have been attributed to the loss and fragmentation of native sagebrush (*Artemisia* spp.) rangeland (Knick et al. 2003) from conversion of native rangeland for agricultural purposes (Braun 1998), altered fire regimes, mineral exploration and extraction (Noss et al. 1995), poor grazing practices (Connelly et al. 2000), and invasion of exotic and invasive grass species (Miller et al. 2011).

The U. S. Fish and Wildlife Service (USFWS) received 3 petitions in 2002 and 2003 requesting sage-grouse be listed as threatened or endangered across the entire range in accordance with section 4(f)(1) of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 *et seq*.), and announced a not-warranted 12-month finding in 2005 (USFWS 2010). The U. S. District Court of Idaho ruled against USFWS finding and remanded the decision to USFWS for further consideration in 2007 (USFWS 2010). Listing of sage-grouse was determined to be warranted, but precluded by higher priority listing actions in 2010 (USFWS 2010) and assigned a listing priority number of 8 (USFWS 2014, Table 1).

Approximately 37% of the current occupied range occurs within the state boundary of Wyoming, representing 64% of the eastern population of sage-grouse (Doherty 2011). Recognizing this distribution, Wyoming sage-grouse populations are predicted to remain a stronghold for the greater population (Knick et al. 2003). Understanding regional-specific population parameters would improve development of relevant management activities. Yet, reports of vital rates vary across sage-grouse populations (Taylor et al. 2012), accentuating the importance of understanding populations dynamics throughout their range. Secure populations could provide insight into management that could be effective in other parts of the range.

Our objectives for this study were to examine population parameters gathered from marked female sage-grouse across 5 study sites over 4 years in the Bighorn Basin, Wyoming and use these data to estimate population growth rates and risk of extinction. We accomplished these objectives by 1) estimating demographic parameters (breeding female seasonal survival, nest survival, and chick survival) based on data returned from marked individuals, 2) using estimates of demographic parameters to build population viability analysis (PVA) models and estimate population growth rates, and 3) using PVA model results to estimate the risk of extinction of local sage-grouse populations within 50 years.

STUDY AREA

We conducted our study at 5 sites throughout the Bighorn Basin (Figure 1). This basin is intermontane and includes Bighorn, Hot Springs, Park, and Washakie counties. The Bighorn Basin is 32,000 km^2 with study sites representing 1,094 km^2: 1 site in Hot Springs County (Major Basin = 257 km^2), 3 sites in Park County (Fifteen Mile = 262 km^2, Oregon Basin = 130 km^2, and Polecat Bench = 341 km^2), and 1 site in Washakie County (Bud Kimball = 104 km^2). Elevation at the sites ranges from 1,230 to 1750 m above sea level. Average annual temperatures range from -4 to 12 ºC with the maximum and minimum temperatures recorded in the months of July and December, respectively (U. S. Climate Data 2015). Average annual rainfall is 345 mm with the greatest rainfall in May and average annual snowfall is 180 cm with the greatest snowfall in March (U. S. Climate Data 2015).

Vegetative cover is characterized by large expanses of sagebrush including basin big sagebrush (*Artemesia tridentate* ssp. *tridentate*), Wyoming big sagebrush (*A. tridentate* ssp. *wyomingensis*), mountain big sagebrush (*A. tridentate* ssp. *vaseyana*), and low sagebrush (*A. arbuscula*; Hess and Beck 2012). Predominant land-use across the Bighorn Basin is livestock grazing. Other land-uses include crop production, and mineral exploration and extraction. Active predator control is implemented to protect livestock and game species other than sage-grouse throughout the study area.

METHODS

Capture and Handling

We captured female sage-grouse with rocket nets on leks in the spring of each year (Schemnitz 1994). We captured additional females with spotlights and hoop nets during fall 2011 (Connelly et al. 2003). Captured males were assessed for trapping related injuries and immediately released. Females were removed from nets and placed in cloth bags for holding until processing. We classified females as juvenile (first breeding season post-hatch) or adult (> first breeding season post-hatch) based on the shape and condition of outer primary feathers (Crunden 1963). Females were fitted with either a VHF radio transmitter equipped with a 12-hour mortality sensing switch or GPS transmitter, and released at the capture site. All study methods were approved by the Institutional Animal Use and Care Committee of the United States Department of Agriculture, Animal and Plant Inspection Service, Wildlife Services, National Wildlife Research Center (Protocol QA-1860), and the Wyoming Game and Fish Department Chapter 33 Permits No. 802 and 892.

Monitoring Survival and Locating Nests

We monitored birds with VHF transmitters ≥ 3 days/week during the nesting and brood rearing season (1 March-31 October) and at least once/week during the over-winter period (1 November-last day of February). Individuals were located using the homing technique to within 100-200 m or tracked from the air using fixed-wing aircraft (Samuel and Fuller 1994). We received location data for birds marked with GPS transmitters from ARGOS satellites every 3 days. We defined 3 seasons (Coates et al. 2013) to determine if seasonal behavior or weather affected survival. Breeding and nesting season was characterized by attendance at leks and nesting activities 1 March-30 June. Brood rearing season was characterized by attending to broods and natal dispersal and ended with brood break-up and formation of winter flocks 1 July-31 October. Over-winter was characterized by the lack of breeding or brood rearing activities 1 November-last day of February.

Upon receiving a mortality signal from VHF transmitters, we identified the last known transmitter location to inspect any carcass remains and estimate a cause of mortality (Dumke and Pils 1973, Small et al. 1991). We assumed birds marked with GPS transmitters were dead if their location remained stationary for >2 days and identified the last know location to estimate cause of mortality following the same procedures used for VHF marked birds (Dumke and Pils 1973, Small et al. 1991) We classified mortalities as avian predation, mammalian predation, other sources of mortality, or unidentified cause. We estimated cause-specific mortality (Schaub and Pradel 2004, Heisey and Patterson 2006) using Package *wild1* (Sargeant 2011) in Program R (R Development Core Team 2012).

When we estimated a bird marked with a VHF transmitter to be stationary for >3 locations without receiving a mortality signal, we assumed the bird was incubating a nest and verified this with a field visit. If GPS marked birds were stationary for >3 days during the nesting season we inspected the site to determine if a nest was present. Because accurate assignment of specific causes of nest failure can be difficult due to scavenging (Coates et al. 2008), we placed motion sensing cameras at nests to accurately determine the predator species if the nest failed (Cox et al. 2012). We camouflaged cameras within live vegetation to avoid detection by nest predators. We counted clutch size if the incubating bird flushed while we were locating the nest.

We classified nest fate (succeeded or failed) after we field verified an incubating sage-grouse had left the nest. The motion sensor camera was retrieved at this point. We classified nests as successful if ≥1 whole egg cap or detached shell membrane was present. We reviewed camera images to determine if the camera functioned properly during the time it was deployed and to assess the date the incubating bird left the nest. When a nest failed, we examined images to determine the cause of nest failure. For successful nests, we recorded the date of hatch and determined initial brood size based on the number of whole egg caps present. We conducted bi-weekly brood flushes between 14 and 56 days post-hatch.

Statistical Analysis

We assumed there was no long-term negative effect of marking on survival. We assessed the need for and appropriate duration of an adjustment period following capture, handling, and marking to control for any negative impact associated with stress as a result of our trapping methods (Holt et al. 2009). Birds that experienced mortality within the appropriate adjustment period were not used in survival analysis.

We estimated daily survival rates for marked females using the logit-link function in the nest model (Dinsmore et al. 2002) in Program MARK (White and Burnham 1999). The use of the nest model in Program MARK is appropriate for ragged telemetry data if monitoring intervals are irregular (Hartke et al. 2006) or exact date of loss is unknown (Hagen et al. 2007). We transformed daily survival estimates to interval survival estimates and approximated interval survival variances using the delta method (Powell 2007). We developed 12 *a priori* models to describe survival of marked female sage-grouse (Table 2). We used multimodel inference based on Akaike's Information Criterion (AIC; Akaike 1973, Burnham and Anderson 1998) corrected for small sample size (Anderson et al. 2000) to determine which of our *a priori* models best described survival of marked female sage-grouse across the Bighorn Basin from 2011-2014.

We estimated daily nest survival using the logit-link function in the nest model (Dinsmore et al. 2002, Rotella et al. 2004) in Program MARK (White and Burnham 1999). We converted daily nest survival estimates to nest survival estimates and approximated nest survival variances using the delta method (Powell 2007). We assumed an incubation period of 28 days (Schroeder et al. 1999) when transforming daily nest survival rates to nest survival rates. We developed 6 *a priori* models to describe nest survival of marked sage-grouse (Table 3). We used multimodel inference based on AIC (Akaike 1973, Burnham and Anderson 1998) corrected for small sample size (Anderson et al. 2000) to determine which of our *a priori* models best described nest survival of marked sage-grouse across the Bighorn Basin from 2011-2014.

We estimated survival of individual chicks using the young survival from marked adults model (Lukacs 2004) in Program MARK (White and Burnham 1999). This approach is a likelihood-based extension of the Cormack-Jolly-Seber model (Cormack 1964, Jolly 1965, Seber 1965) and relaxes the assumption of an accurate count of surviving chicks in a brood required by other methods (Flint et al. 1995, Manly and Schmutz 2001). We assumed detection probability = 1 in our chick survival models because broods were flushed based on our ability to located brood hens marked with VHF transmitters. We pooled all broods by year and study site to estimate brood survival across the Bighorn Basin. This provided a pragmatic solution to retaining statistical power to detect differences due to limited sample size per site each year.

Vital rates calculated from field data were used to develop a stochastic, matrix-based PVA model (Wisdom and Mills 1997, Wisdom et al. 2000, Hagen et al. 2009; Figure 2). The PVA model was female only and based on a pre-breeding census. Vital rates were recruitment and hen survival. Recruitment was the product of ½ mean clutch size assuming a female to male ratio of 1:1 (Atamian and Sedinger 2010, Swenson 1986), nest survival, brood survival, and over-winter survival. Vital rates contributing to recruitment were assumed to be equal for all classes. Hen survival was the product of breeding season survival and over-winter survival. We used 4 stages in the model (Figure 3). Survival rates were drawn from β-distributions and clutch size was drawn from a normal distribution and multiplied by 0.5 to represent number of females in a clutch under a 1:1 gender ratio assumption. We used β-distributions for survival data because the data collected and associated standard errors were used to determine the shape of the curve from which random values for vital rates were drawn. In this manner, the simulations were more appropriately based on the real data collected in the field.

We estimated study site-specific population growth rates (λ) using the PVA model. Models for each study site were run 10,000 times and values for each vital rate were selected from a distribution during each simulation. We excluded the Bud Kimball study site from the PVA modelling because the study site was only active during 2014 and lacked sufficient multi-year data to conduct meaningful analysis.

We used the results of the PVA models to estimate the probability of quasi-extinction (hereafter, extinction) using a simulation approach in which populations were followed through time. For the probability of extinction models, we used the λ's estimated in PVA models and assumed a starting population of 300 females (120 1st-breeding year females, 90 2nd-breeding year females, 60 3rd-breeding year females, and 30 4th-breeding year females). We estimated the starting population size based on the number of females captured and marked and the number of unmarked females observed during lek observations and while conducting data collection activities. We estimated risk of extinction over 50 years for each of the 10,000 iterations. The probability of extinction was the proportion of 10,000 iterations that reached $\leq$ 10 females within 50 years.

RESULTS

We captured female sage-grouse on the Polecat Bench and Oregon Basin study sites from 2011 to 2014, the Major Basin and Fifteen Mile study sites from 2012 to 2014, and the Bud Kimball study site in 2014. We captured and marked 202 individual female sage-grouse across all study sites from 2011-2014 (Table 3).

Acute negative effects of capture, handling, and marking were best described by a model including an effect of transmitter type. Survival functions of newly captured birds were similar to those of previously captured birds after 8 days when marked with GPS transmitters and after 14 days when marked with VHF transmitters. Therefore, we did not include birds in the risk set until 9 or 15 days following initial capture when marked with GPS or VHF transmitters, respectively.

There were 3 competitive models describing breeding bird survival (Table 4). The top model included over-winter survival and survival during the remainder of the year pooled. The second competitive model included over-winter survival, survival during the remainder of the year pooled, and an effect of year. The 95% confidence interval on the b-parameter estimate for year in the second competitive model overlapped zero. The third competitive model contained effect of over-winter, nesting season, and brood-rearing season. The 95% confidence interval on the b-parameter estimates for nesting and brood rearing seasons overlapped. Because there was no significant statistical evidence to support a difference in year or nesting and brood rearing seasons, we estimated survival pooled for nesting seasons, brood rearing seasons, and years, and separately for over-winter pooled by years. We estimated survival during the overall breeding season (nesting and brood rearing seasons pooled) to be 0.62 (SE = 0.03) and during over-winter to be 0.92 (SE = 0.03).

We recovered the remains of 84 birds during the breeding season and 7 birds during over-winter. We classified causes of mortality as avian predator, mammalian predator, other, or unidentifiable cause. Primary avian predators of full-grown sage-grouse are most likely to be golden eagles (*Aquila chrysaetos*) and primary mammalian predators are likely to be coyote (*Canis latrans*). Other predators are present and sometimes capable of killing sage-grouse. It is difficult to accurately assess causes of predation to species because there are several predatory species of each suite present across the Bighorn Basin and within-suite predators leave behind similar signs. We classified the cause as unidentifiable if there was limited evidence present at the site of mortality. The other causes category included handling based mortality from changing the transmitter, vehicle collision, and recovery of remains in a mowed hayfield.

We estimated cumulative incidence functions for each class of cause of mortality (Table 5). We reported cause-specific mortality estimates for the breeding season and over-winter based on the results of models to assess survival of marked sage grouse at our sites. There was no evidence to suggest that any cause of mortality was impacting the sage grouse population at a significantly higher rate as we classified them.

Nest survival was best described by a model that included differences across study sites (Table 6). Estimated nest survival rates were high on 2 study sites, average on 2 study sites, and very low on 1 study site (Table 7). The greatest cause of nest failure for the Bud Kimball site was abandonment (Table 8). The greatest cause of nest failure for the Major Basin site was depredation by badgers (*Taxidea taxus*), which were classified with other causes of nest failure due to the low proportion of nest loss due to this factor across the other sites (Table 8). In fact, badger depredation of sage-grouse nests was only observed on one other site (Polecat Bench). The greatest cause of nest failure for the Fifteen Mile, Oregon Basin, and Polecat Bench sites was depredation by coyotes (Table 8). We observed a disproportionate failure of nests from depredation by ravens on the Polecat Bench site (Table 8). Mean clutch size was 7 eggs (SE = 2).

We conducted 36 bi-weekly brood flush counts between 14 to 56 days post-hatch from 2011-2014 on all sites combined. Based on these flush counts we estimated chick survival between hatch and 56 days-post hatch to be 0.54 (SE = 0.03).

Based on estimates of demographic parameters and model results, we estimated study site-specific population growth rates (λ) for 4 study sites (Fifteen Mile, Major Basin, Oregon Basin, and Polecat Bench). Based on 10,000 simulations for each site, we estimated average $\lambda > 1$ (increasing population) for Fifteen Mile ($\lambda = 1.52$, SE = 0.0006), Major Basin ($\lambda = 1.10$, SE = 0.0002), and Oregon Basin ($\lambda = 1.32$, SE = 0.0004). We estimated average $\lambda < 1$ (decreasing population) for Polecat Bench ($\lambda = 0.84$, SE = 0.0001).

We used the results of the PVA models for each study site to estimate study site-specific risk of extinction of sage-grouse within 50 years. The risk of sage-grouse extinction was > 50 years for Fifteen Mile, Major Basin, and Oregon Basin. The risk of sage-grouse extinction on Polecat Bench was 20 years (SE = 0.10) based on the results of our models.

Because we observed disproportionate sage-grouse nest loss as a result of raven depredation on Polecat Bench, we conducted further exploratory analyses. We hypothesized that raven depredation of sage-grouse nests was additive rather than compensatory and that if sage-grouse nest losses due to raven depredation could be reduced, we might observe greater population growth. If sage-grouse nest loss due to raven depredation was additive and was reduced by 50% the resulting λ was 0.90 (SE = 0.0001) and the risk of sage grouse extinction was 33 years (SE = 0.43). If sage-grouse nest loss due to raven depredation was additive and was reduced by 75% the resulting λ was 0.97 (SE = 0.0002) and the risk of sage grouse extinction was 50 years (SE = 0.07).

DISCUSSION

Taylor et al. (2012) documented vital rates across the range of sage-grouse. Breeding hen survival was reported as annual survival instead of seasonal survival and by age, and was 0.65 for juvenile females and 0.58 for adult females (Taylor et al. 2012). Our survival models indicated there was no differential survival between marked juvenile and adult females, but there was a seasonal difference. If we combined breeding season and over-winter survival, apparent annual survival was 0.57, which is far lower than young female survival reported for other studies and similar to older female survival estimates from across the range.

A review of our capture data indicated a low number of juvenile females were captured and marked. Our capture efforts were focused on obtaining an adequate sample size for each study site and typically occurred early following the observation of female attendance on leks. Variable lek attendance throughout the season has been observed (Dunn and Braun 1985). It is possible that we conducted capture activities before peak juvenile female lek attendance. The low number of juveniles in our sample would diminish power to detect age-specific survival.

Nest success estimates reported across the sage-grouse range were between 0.38 for juvenile first nests and 0.53 for adult re-nest attempts (Taylor et al. 2012). We did not have enough statistical power to detect differential nest survival by nest attempt. We used the nest survival model in Program MARK to model and estimate nest survival where other published studies sometimes used alternative methods to assess nest success. Other methods assessing nest success could overestimate this vital rate (Dinsmore et al. 2002).

Our estimates of nest survival ranged from 0.20-0.56. Presuming previous estimates of nest success reported across the sage-grouse range could be overestimated, our estimates are similar to others with one exception. We estimated extremely low nest survival on the Polecat Bench site throughout 2011 to 2014. Recruitment is a key element of population persistence and nest survival is a driving influence for recruitment. Therefore, the extremely low nest survival observed on the Polecat Bench study site should be cause for concern.

Overall, coyotes were the leading cause of sage-grouse nest failure across the Bighorn Basin. We observed a greater proportion of nest abandonment on the Bud Kimball site, but these observations were based on only one year of data collection and will require additional monitoring to determine if this is an anomaly or normal for this site. We observed the greatest proportion of sage-grouse nest failures for the Major Basin site as a result of badger depredation. This could be the result of more suitable badger habitat at this location compared to the others. Yet, other causes of sage-grouse nest failure for the Major Basin site were lower than observed elsewhere indicating that badger depredation of sage-grouse nests is likely compensatory on this site and should not be a cause for concern.

We observed a notably high proportion of sage-grouse nest failure on the Polecat Bench site to be the result of raven depredation. In fact, the proportion of sage-grouse nest failures on this site due to raven depredation was nearly twice that of the next highest site. The Polecat Bench study area is closer to extensive oil and gas extraction sites. While the actual drilling and extraction activities might not be the direct cause of sage-grouse nest failure, the associated infrastructure may be providing increased raven nesting and foraging habitat when compared to our other study sites.

Mean chick survival reported across the sage-grouse range was 0.41 (Taylor 2012). Our estimates of chick survival were higher (0.54, SE = 0.03) than other reported estimates. The chick survival interval used in the metadata analysis from across the range was from hatch to 35 days post-hatch (Taylor 2012) while we estimated chick survival between hatch and 56 days post-hatch. Our estimates of chick survival were similar to mean chick survival (0.50, SE = 0.05) reported for a Utah study that assessed chick survival between hatch and 42 days post-hatch (Dahlgren et al. 2010).

Results of PVA models indicate that mean λ was > 1 and extinction of sage-grouse would not occur within 50 years on 3 of the 4 study sites (Fifteen Mile, Oregon Basin, and Major Basin) we used for these analyses. Mean λ was < 1 for the Polecat Bench study site and the estimated time until extinction on this site was possible in 20 years.

Polecat Bench contained the highest proportion of sage-grouse nest failure due to raven depredation. Low sage-grouse nest survival has been observed in other areas with high raven abundance (Coates and Delehanty 2010). While this should be cause for concern, we estimate that if raven depredation of sage-grouse nests is additive and can be reduced by management, the sage-grouse population persistence at Polecat Bench might be improved by reducing raven-caused sage-grouse nest loss by 50-75%. Reduction of raven depredation of sage-grouse nests by 50% and 75% increased the time until extinction to 33 years and 50 years, respectively.

MANAGEMENT IMPLICATIONS

It is important to remember that the PVA models were based on 4 years for 2 study sites (Oregon Basin and Polecat Bench) and 3 years for 2 study sites (Fifteen Mile and Major Basin). Therefore, our estimates reflect the conditions during a relatively short period from 2011 to 2014. This includes overall management (grazing, predator management for other species, etc…) and prevailing weather during that time. If these years are representative of long-term management and weather patterns, there is little cause for concern over the persistence of sage-grouse populations across most of the Bighorn Basin.

Overall, landscape conditions appear to have been beneficial for sage-grouse in the Bighorn Basin throughout 2011 to 2014. A review of land-use practices could provide insight into appropriate management for sage-grouse populations in other landscapes. Land cover is as important as land-use to sage-grouse persistence and assessment, and measurements of land cover in the Bighorn Basin could provide a model for desired conditions in other areas.

FUTURE RESEARCH NEEDS

While the results of this study are promising, additional research is warranted to increase the accuracy of our estimates.

1. We were unable to assess age-specific female survival due to the ratio of juveniles to adults in our sample. It is unclear if this is an artifact of few juveniles in the population or of our capture methods.
2. We are limited by the capacity of our data collection equipment to follow dispersing broods over the relatively long period that we elected to use (56 days vs. 35 days). We

felt that chick survival was not equal to that of adult survival until at least 56 days post-hatch. There is a need to determine if chick survival to 56 days post-hatch is appropriate. Additional brood flush counts will be needed to model this aspect of the population.

3. Based on our models, it is possible that ravens had a severe negative impact on the Polecat Bench sage-grouse population during this study despite the uncertainty of the mechanism behind this impact. Several issues should be addressed to inform better management with respect this issue including:
   a. *The additive or compensatory nature of raven depredation of sage-grouse nests*
      We need to understand what happens to sage-grouse nests if raven depredation is reduced. It is unclear if reducing ravens as a source of sage-grouse nest depredation will succeed or fail due to another cause (i.e. coyote depredation).
   b. *Space-use of ravens on Polecat Bench*
      We need to understand how ravens use the landscape on the Polecat Bench site and what cues are associated with a settling response in the area. We need to understand which groups of ravens, specifically resident and/or transient individuals, are negatively impacting the sage-grouse population.
   c. *Effective management activities to control raven depredation of sage-grouse nests*
      We need to understand if depredation of sage-grouse nests by ravens can be mitigated by passive control measures or if active control is necessary. It is possible that cost-effective deterrence measures (raven nesting exclusion devices on oilfield structures, noise harassment, etc…) could be preferable over costly, routine removal activities. If active removal is called for, we need to understand

the duration between active removal events necessary for these efforts to be effective.

ACKNOWLEDGMENTS

The synthesis of the 4 years of data included in this report was made possible by a grant from the Wyoming Wildlife and Natural Resources Trust. This project would have been impossible without the cooperation of private landowners throughout the Bighorn Basin that allowed field and research staff access to conduct monitoring activities. The long days with early morning starts associated with the data collection was carried out by the professional staff of the USDA Wildlife Services Northwest Wyoming District. Each specialist in the region has greatly contributed their time and effort over the course of this project. Field and office assistance also was provided by staff of the Meeteetse Conservation District. Many cooperators have contributed financially or provided logistical support for the project and include Bighorn Basin Conservation Districts, Bighorn Basin Predator Management Districts, WYO-BEN, BreitBurn Operating LP, Marathon Oil Company, Fidelity Oil Company, Wyoming Animal Damage Management Board, V Ranch, Belden Ranch, Park County Farm Bureau, Wyoming Game and Fish Department, U. S. Bureau of Land Management, and the Shoshone National Forest. We thank each and every person, company, and agency that have made this project the success that it is.

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FIGURES AND TABLES (In order as they appear in text)

Table 1. Priority ranking matrix used to determine listing priority number for species considered for protection under the Endangered Species Act by the U. S. Fish and Wildlife Service (adapted from U. S. Fish and Wildlife Service 1983).

Threat			
Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies	6
Moderate to low	Imminent	Monotypic genus	7
		Species	8
		Subspecies	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies	12

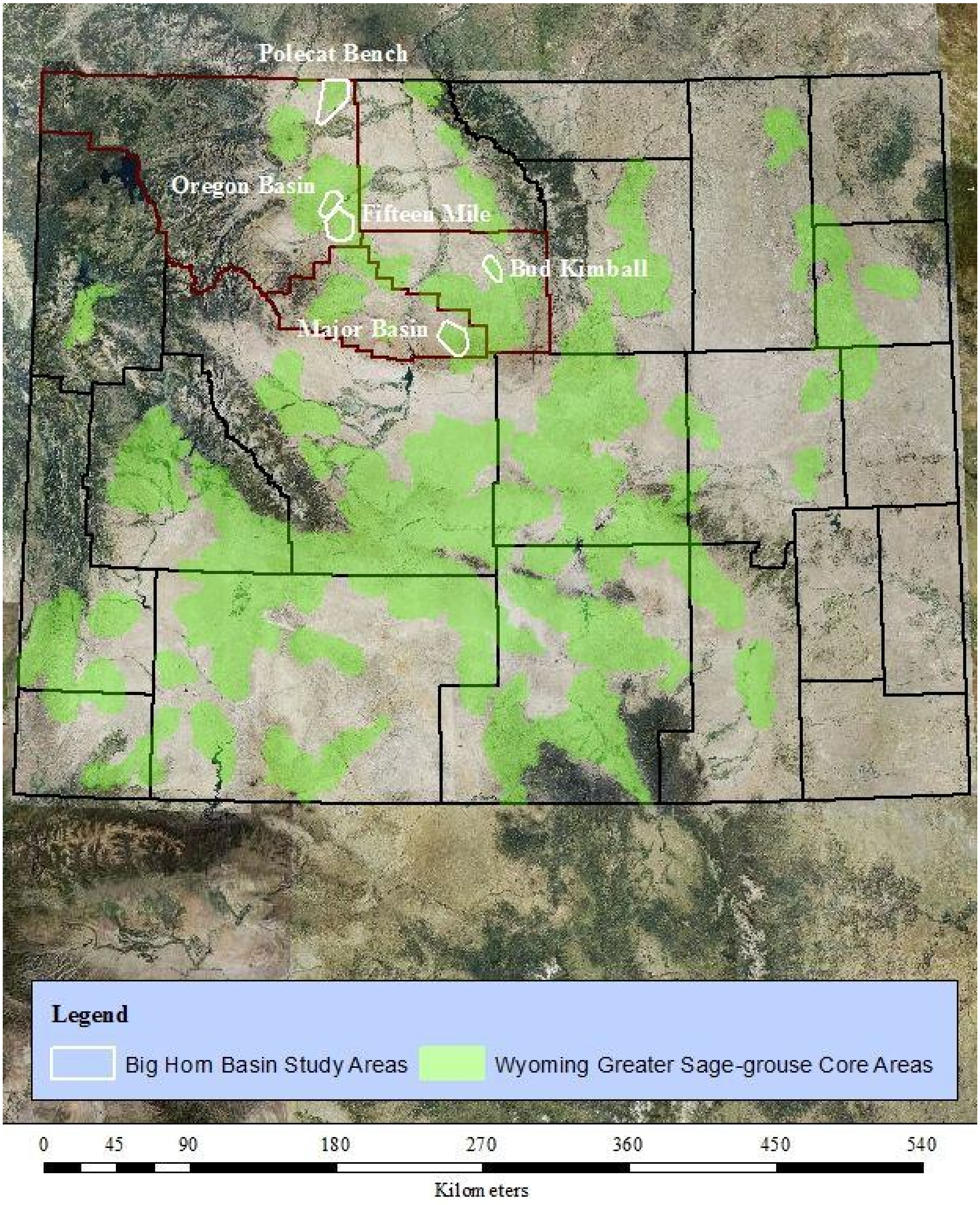


Figure 1. Sage-grouse study sites in the Bighorn Basin, Wyoming where demographic data were collected from marked females, 2011-2014.

Table 2. Description of *a priori* models used to describe survival of marked female sage-grouse across the Bighorn Basin, Wyoming, USA, 2011-2014.

Model	Description
$S_{intercept\ only}$	No difference in survival due to study site, age of bird, year, season, or type of transmitter (VHF of GPS).
$S_{study\ site}$	Survival differs across study sites
S_{age}	Survival differs between juvenile and adult birds.
S_{year}	Survival differs across years.
S_{season}	Survival differs across breeding/nesting season (1 March-30 June), brood rearing season (1 July-31 October), and over-winter (1 November-last day of February)
S_{winter}	Over-winter (1 November-last day of February) survival differs from rest of the year.
$S_{transmitter\ type}$	Survival differs between transmitter types.
$S_{year\ +\ study\ site}$	Survival differs by study site and year.
$S_{study\ site\ +\ season}$	Survival differs by study site and season.
$S_{year\ +\ season}$	Survival differs by year and season.
$S_{study\ site\ +\ winter}$	Survival differs by study site and over-winter and the rest of the year
$S_{year\ +\ winter}$	Survival differs by year and over-winter and the rest of the year.

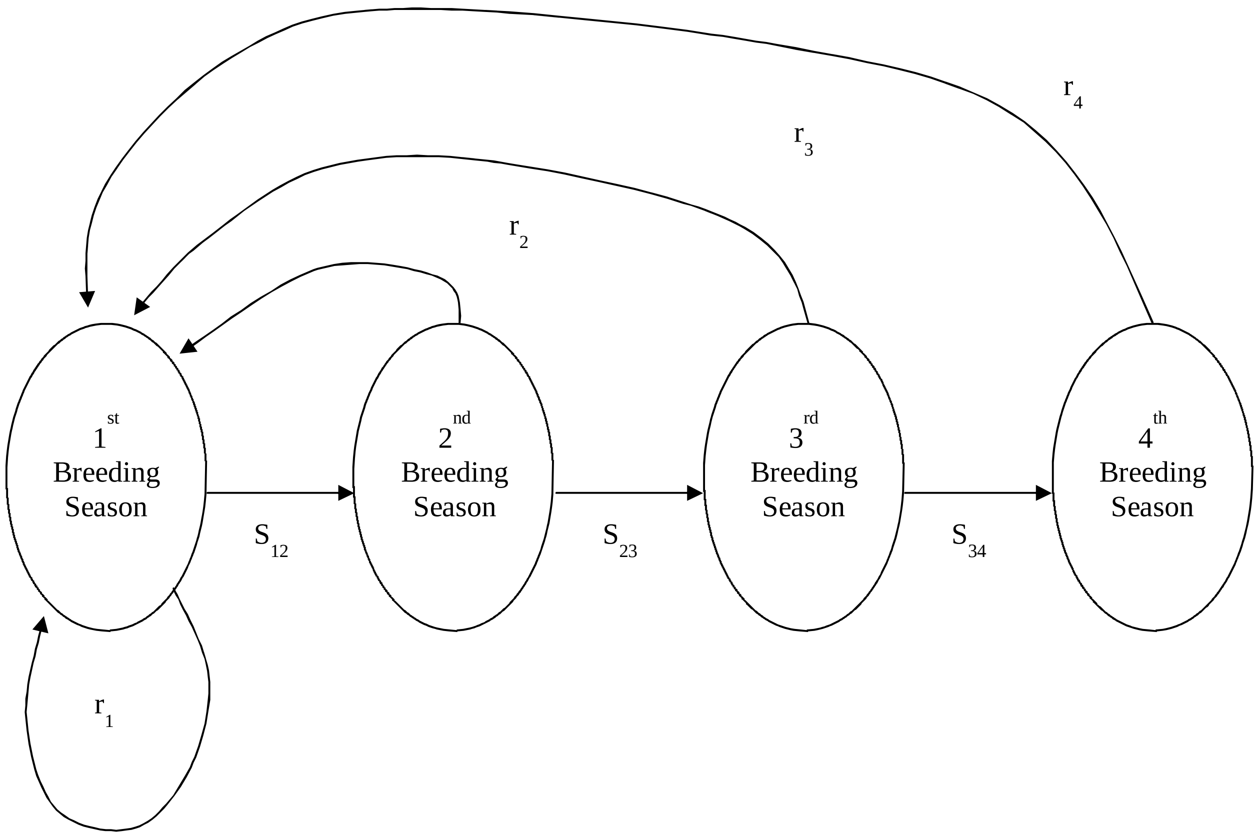
Table 3. Description of *a priori* models used to describe nest survival of marked sage-grouse across the Bighorn Basin, Wyoming, USA, 2011-2014.

Model	Description
$S_{intercept\ only}$	No difference in nest survival due to study site, year, or seasonal trend.
$S_{study\ site}$	Nest survival differs across study sites
S_{year}	Nest survival differs across years.
$S_{year\ +\ study\ site}$	Nest survival differs by study site and year.
$S_{within\ year\ linear\ trend}$	Nest survival varies linearly within year and does not differ across years.
$S_{within\ year\ quadratic\ trend}$	Nest survival varies quadratically within year and does not differ across years.

$$\lambda = \begin{bmatrix} r_1 & r_2 & r_3 & r_3 \\ s_{12} & 0 & 0 & 0 \\ 0 & s_{23} & 0 & 0 \\ 0 & 0 & s_{34} & 0 \end{bmatrix}$$

r_1 = recruitment from 1st breeding year birds
r_2 = recruitment from 2nd breeding year birds
r_3 = recruitment from 3rd breeding year birds
r_4 = recruitment from 4th breeding year birds
s_{12} = survival of birds from the beginning of the 1st breeding year to the beginning of the 2nd breeding year
s_{23} = survival of birds from the beginning of the 2nd breeding year to the beginning of the 3rd breeding year
s_{34} = survival of birds from the beginning of the 3rd breeding year to the beginning of the 4th breeding year

Figure 2. Population viability analysis model matrix for radiomarked female greater sage-grouse on 5 study sites across the Bighorn Basin, Wyoming.



r_1 = recruitment from 1st breeding year birds, r_2 = recruitment from 2nd breeding year birds, r_3 = recruitment from 3rd breeding year birds, r_4 = recruitment from 4th breeding year birds, s_{12} = survival of birds from the beginning of the 1st breeding year to the beginning of the 2nd breeding year, s_{23} = survival of birds from the beginning of the 2nd breeding year to the beginning of the 3rd breeding year, s_{34} = survival of birds from the beginning of the 3rd breeding year to the beginning of the 4th breeding year

Figure 3. 4-stage model used to develop population viability analysis for radiomarked female greater sage-grouse across the Bighorn Basin, Wyoming.

Table 3. Number of individual female sage-grouse captured on study sites across the Bighorn Basin, Wyoming by study site and year 2011-2014.

Study Site	Year				TOTAL
	2011	2012	2013	2014	
Polecat Bench	14	14	12	10	50
Oregon Basin	19	13	18	6	56
Major Basin	N/A	13	15	12	40
Fifteen Mile	N/A	17	14	10	41
Bud Kimball	N/A	N/A	N/A	15	15
TOTAL	33	57	59	53	202

Table 4. Marked female sage-grouse survival models for the Bighorn Basin, Wyoming 2011-2014.

Model	AIC_c	ΔAIC_c	ω	Model Likelihood	# Parameters	Deviance
S_{winter}	1099.58	0.00	0.36	1.00	2	1095.58
$S_{year + winter}$	1099.58	0.00	0.36	1.00	7	1085.58
S_{season}	1101.54	1.96	0.13	0.37	3	1095.54
S_{year}	1103.20	3.63	0.06	0.16	4	1095.20
$S_{transmitter\ type}$	1104.51	4.93	0.03	0.08	2	1100.51
S_{age}	1104.76	5.19	0.03	0.07	2	1100.76
$S_{year + season}$	1106.63	7.05	0.01	0.03	11	1084.62
$S_{intercept\ only}$	1106.79	7.21	0.01	0.03	1	1104.79
$S_{year + study\ site}$	1108.75	9.17	0.00	0.01	15	1078.74
$S_{study\ site + winter}$	1108.92	9.34	0.00	0.01	9	1090.92
$S_{study\ site}$	1110.90	11.32	0.00	< 0.01	5	1100.90
$S_{study\ site + season}$	1115.75	16.17	0.00	< 0.01	14	1087.74

Table 5. Cause specific mortality of marked female sage-grouse on 5 study sites across the Bighorn Basin, Wyoming 2011-2014.

Mortality Factor	Breeding Season			Over-winter		
	n	CIF[a]	SE	n	CIF[a]	SE
Mammalian Predator	28	0.12	0.02	1	0.01	0.01
Avian Predator	30	0.14	0.03	1	0.01	0.01
Unidentifiable Cause	23	0.10	0.02	5	0.06	0.02
Other	3	0.02	0.01	0	-	-

[a]Cumulative Incidnece Function (Cause Specific Mortality Rate)

Table 6. Nest survival models for nests of marked sage-grouse on 5 study sites across the Bighorn Basin, Wyoming 2011-2014.

Model	AIC_c	Δ AIC_c	AIC_c Weights	Model Likelihood	# Parameters	Deviance
$S_{study\ site}$	941.70	0.00	0.96	1.00	5	931.68
$S_{study\ site\ +\ year}$	949.46	7.76	0.02	0.02	15	919.31
$S_{intercept\ only}$	951.11	9.42	0.01	0.01	1	949.11
$S_{within\ year\ quadratic\ trend\ (tt)}$	953.01	11.31	0.00	< 0.01	2	949.00
$S_{within\ year\ linear\ trend\ (t)}$	953.06	11.37	0.00	< 0.01	2	949.06
S_{year}	953.60	11.90	0.00	< 0.01	4	945.58

Table 7. Nest survival estimates for nests of marked sage-grouse on 5 study sites across the Bighorn Basin, Wyoming 2011-2014.

Study Site	Daily Nest Survival Rate	SE	Lower 95% Confidence Interval	Upper 95% Confidence Interval	Nest Survival Rate	SE	Lower 95% Confidence Interval	Upper 95% Confidence Interval
Bud Kimball	0.96	0.02	0.92	0.98	0.35	0.05	0.24	0.45
Fifteen Mile	0.98	0.01	0.97	0.99	0.56	0.05	0.47	0.65
Major Basin	0.96	0.01	0.94	0.98	0.33	0.03	0.27	0.39
Oregon Basin	0.97	0.01	0.96	0.98	0.45	0.03	0.39	0.51
Polecat Bench	0.94	0.01	0.93	0.96	0.20	0.01	0.18	0.21

Table 8. Causes of failure of nests of marked sage-grouse on 5 study sites across the Bighorn Basin, Wyoming 2011-2014 reported as a proportion of all nests located by study site.

Study Site	Total # Nests Located	# Failed Nests	Abandoned		Hen Mortality		Raven		Coyote		Unidentified		Other [a]	
			n	proportion	n	proportion	n	proportion	n	proportion	n	proportion	n	proportion
Bud Kimball	10	6	3	0.30	1	0.10	1	0.10	1	0.10	0	-	0	-
Fifteen Mile	40	16	2	0.05	2	0.05	1	0.03	8	0.20	3	0.08	0	-
Major Basin	32	18	3	0.09	1	0.03	1	0.03	3	0.09	2	0.06	8	0.25
Oregon Basin	59	31	2	0.03	5	0.08	6	0.10	8	0.13	8	0.13	2	0.03
Polecat Bench	62	48	6	0.10	4	0.06	12	0.19	13	0.21	11	0.18	2	0.03
TOTAL	203	119	16		13		21		33		24		12	

[a] Major Basin: 6 badger, 1 snake, 1 pronghorn; Oregon Basin: 1 fox, 1 skunk; Polecat Bench: 2 badger

HAUB SCHOOL OF ENVIRONMENT AND NATURAL RESOURCES

Wyoming Range Mule Deer Project

Summer 2017 Update

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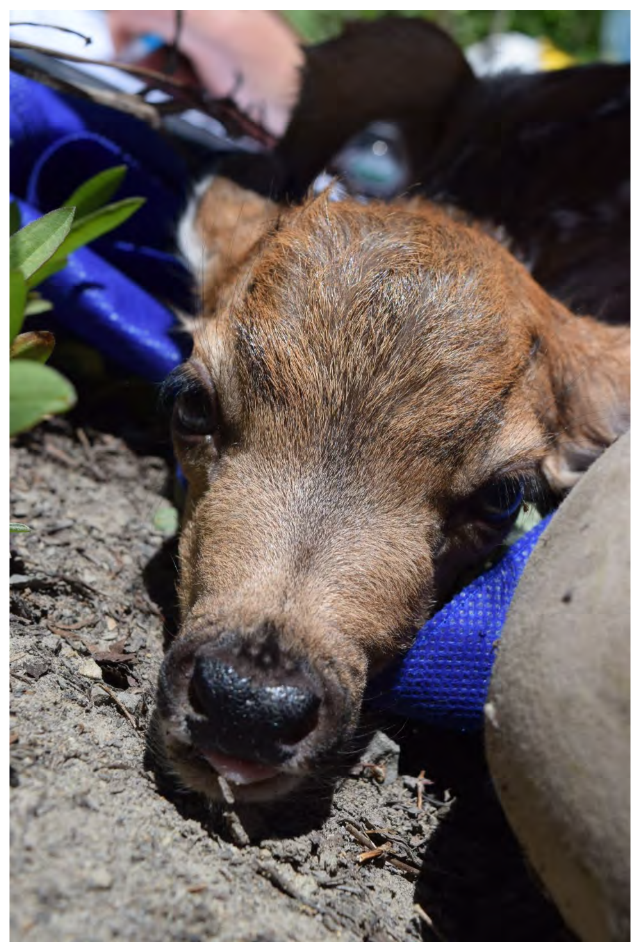
PROJECT BACKGROUND

The Wyoming Range Mule Deer Project was initiated in March 2013. The overarching goal of the project is to investigate the nutritional relationships among habitat conditions, climate, and behavior to understand how these factors interact to regulate population performance. Since the initiation of the project, we have tracked and monitored the survival, behaviors, reproduction, and habitat conditions of 164 female, adult mule deer of the Wyoming Range. In March 2015, we expanded our research efforts to include evaluation of survival and cause-specific mortality of fawns belonging to our collared mule deer. This component of the project is aimed at unraveling the relative contributions of habitat, maternal nutrition, and predation on survival of young mule deer—a study that is the first of it's kind in Wyoming. This update will report on some of our accomplishments and preliminary findings of adult survival and reproduction and will highlight the breadth of factors that contribute to fawn mortality in western Wyoming. So far, our research has gleaned invaluable insight into what regulates population performance of this iconic population, and we aim to further refine our understanding of the factors that affect the population with continued, robust data collection on various aspects of mule deer ecology, including nutrition and habitat contributions, predation, migration, reproduction, and survival.



WINTER 2016/2017

Adult Survival

This last winter of 2016/2017 proved to be a tough one for mule deer. Conditions on winter ranges for Wyoming Range mule deer were severe with snowpack levels exceeding 200% and numerous days of sub-zero weather. These harsh winter conditions strongly affected winter survival and only 63% of our collared adults survived from November until summer 2017 (compared with >90% in years past). Older animals and animals that entered winter in poor condition were more susceptible to succumbing to winter exposure (Figure 1).

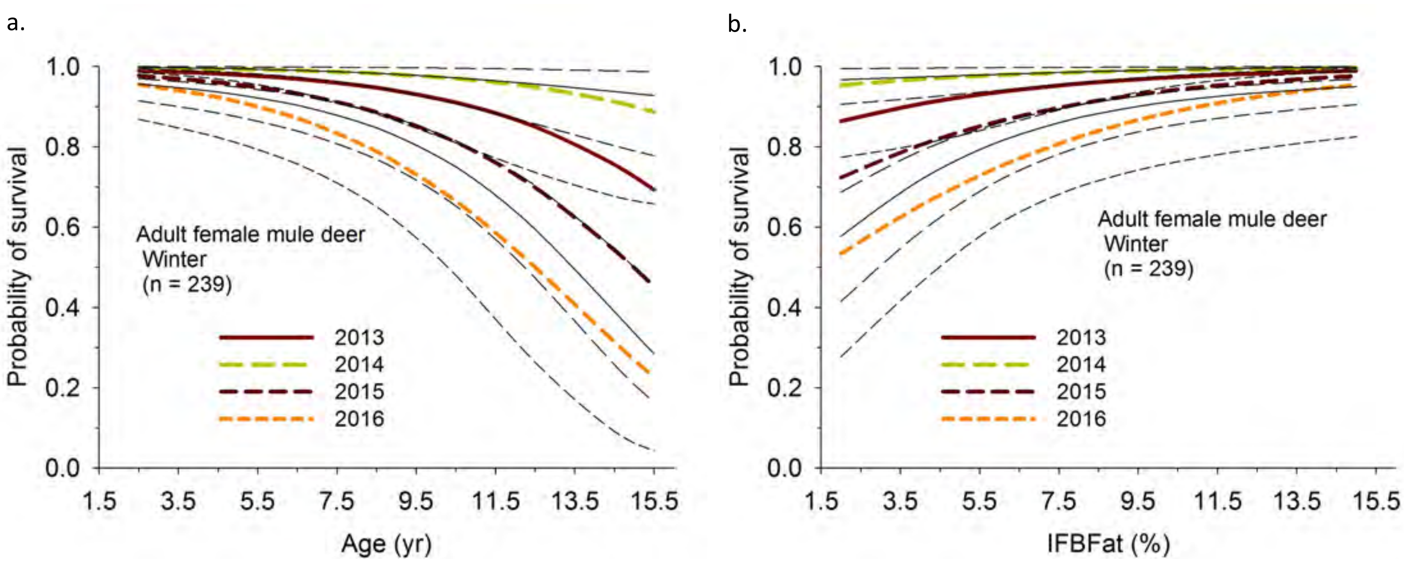


Figure 1. The effects of age (a) and December body fat (IFBFat %; b) on the probability of survival overwinter. Probability of survival decreases as animals get older and as the % body fat (IFBFat %) in December decreases.

Fawn Survival

Winter conditions tend to have the greatest effect on survival of fawns and this winter was no exception. We observed 100% mortality of the fawns we collared in summer 2016 and had survived to the beginning of winter. Mortality rates of that caliber can have substantial repercussions on population dynamics because the majority of an entire cohort of deer is gone. Although these numbers are staggering, winter die-offs like the one observed this winter do occasionally occur and populations do eventually rebound. We have now found ourselves with a unique opportunity to evaluate how mule deer populations rebound from harsh winters.

We retrieved all remains of mortalities of collared fawns. Whole carcasses were submitted to the Wyoming State Veterinary Lab and WGFD Wildlife Health Laboratory for necropsy.

MARCH 2017 ADULT CAPTURES

Since March 2013, we have recaptured collared mule deer as they enter winter ranges in December and before they leave winter ranges in March. This has allowed us to track changes in nutritional condition and reproductive status of animals.

We use ultrasonography to measure % body fat and evaluate pregnancy of collared mule deer.

Nutritional Condition

Nutritional condition in March 2017, measured as % body fat, was the lowest we have observed in our research (averaging 1.8% ± 0.25; Figure 2). Although it is rare to see animals in this poor of condition, it was expected given the severity of the winter.

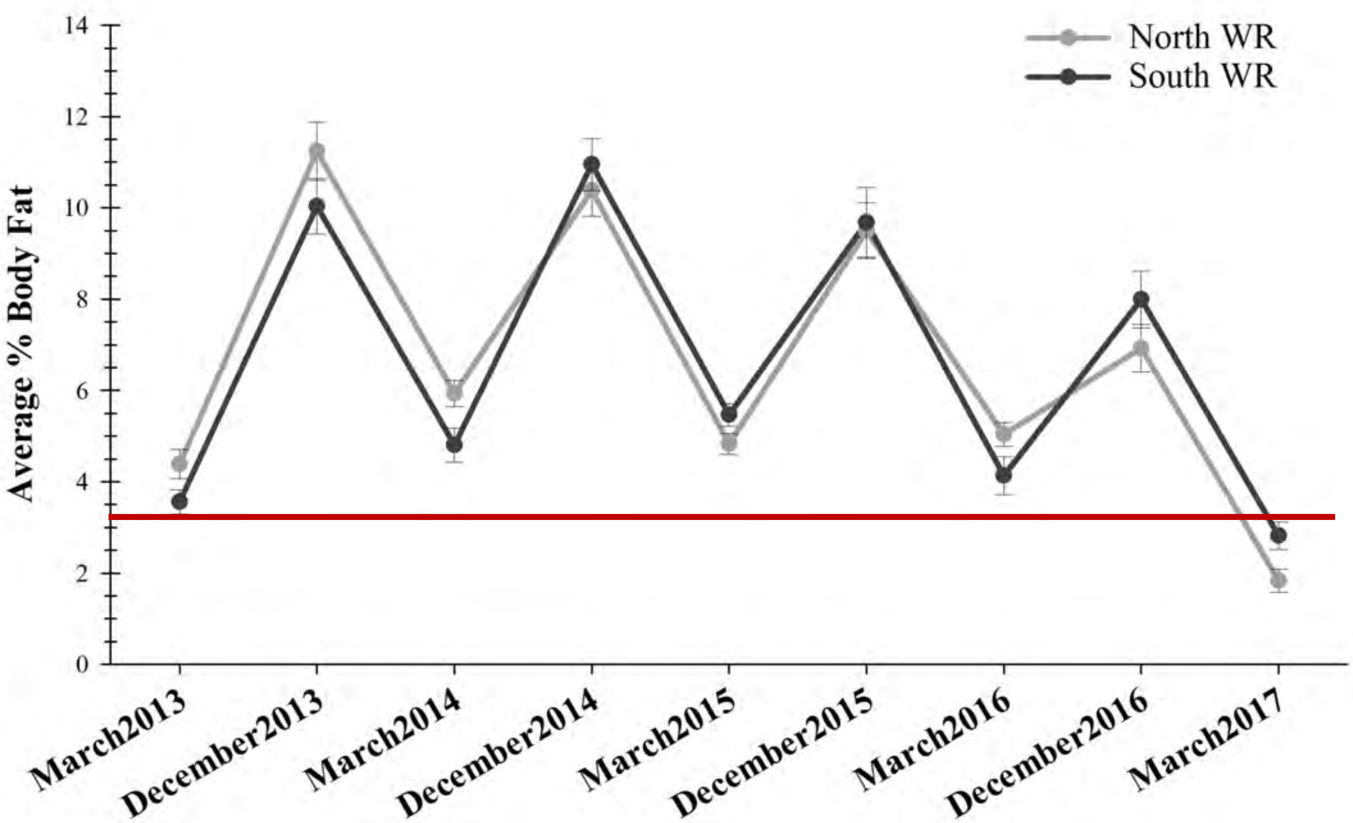


Figure 2. Average % body fat of adult, female mule deer on North (near Big Piney,WY) and South (near Cokeville and Evanston, WY) winter ranges for Wyoming Range mule deer. Deer were in significantly poorer shape in March 2017 than any other year.

Pregnancy

Despite extremely poor nutritional condition of animals this March, fetal rates among winter ranges were comparable to the preceding 4 years (Figure 3) and pregnancy rates remained high. Interestingly, average eye diameter of fetuses was lower in March 2017 (14.0 ± 0.18) than in previous years (15.3 ± 0.11; Figure 4). Fetal eye diameter is a measure of fetal development and is often used to estimate the timing of birth.

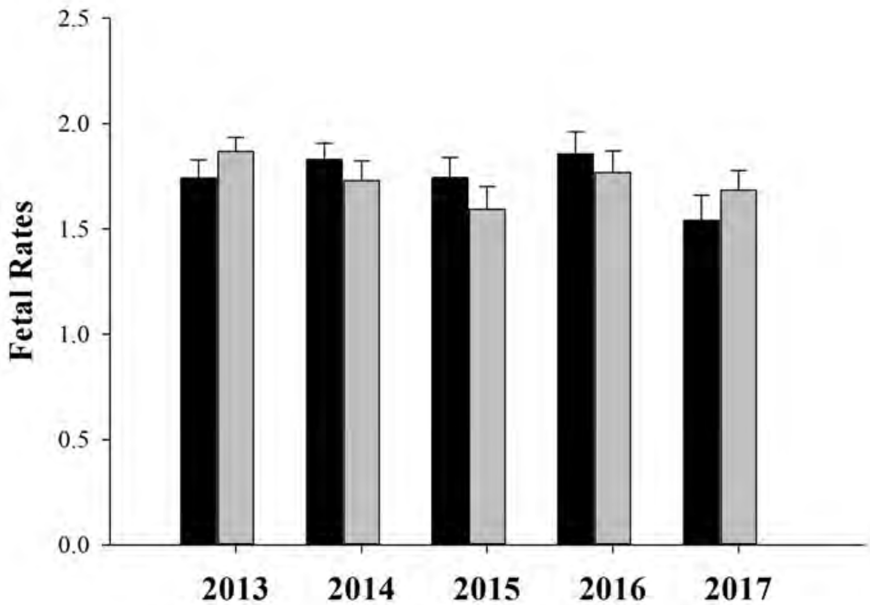


Figure 3. Fetal rates (average number of fetuses per pregnant animal) did not differ among years—despite severe winter conditions.

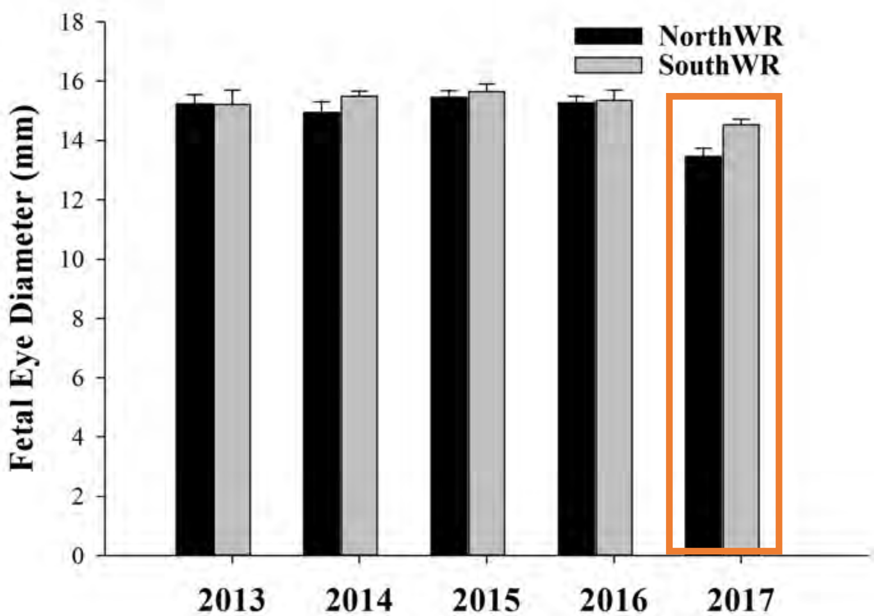
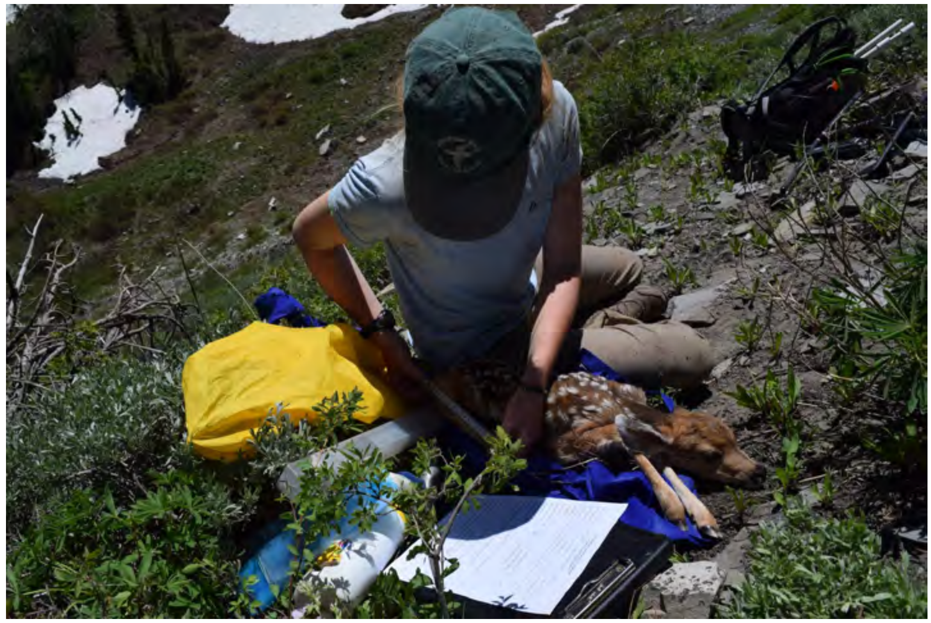


Figure 4. Average fetal eye diameter measured in March of each year. Fetal eye diameter was significantly smaller in March 2017 compared with any other year.

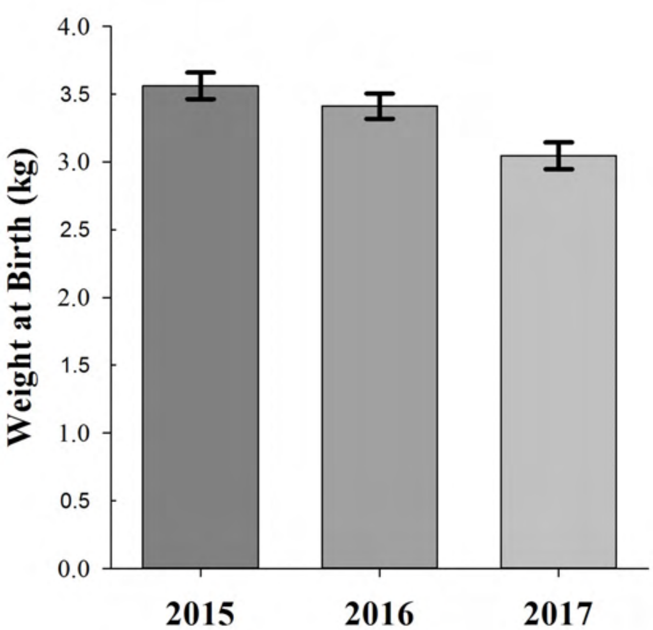
FAWN SURVIVAL



Fawn Capture and Collaring

Since March 2015, we have been capturing and collaring fawns of our collared adults to evaluate what factor most influence fawn survival. Fawns are located using a vaginal implanted transmitter (VIT) deployed in pregnant females that is expelled at birth. Once fawns are located, we then capture, radio-collare, and collecte a suite physical data (e.g., body weight). We then monitored daily survival of collared fawns. Over the three summers, we have tracked the survival of 194 mule deer fawns throughout the Wyoming Range.

	2015	2016	2017 - So Far
Number of Fawns Tracked	58	70	66
Summer Mortality	45%	56%	44%
Median Birthdate	June 10	June 13	June 16
Average Weight at Birth	3.56 (± 0.098)	3.41 (±0.093)	3.04 (±0.099)



Newborn fawns caught in 2017 were significantly lighter than newborn fawns caught in previous years (Figure 5). This was of little surprise because of the overall poor nutritional condition of pregnant females and the smaller eye diameter of fetuses measured in March 2017. With this information, we are now in a position to better evaluate the influence of birth weight and maternal condition on summer survival of fawns.

Figure 5. Average weight of fawns captured <48hours from birth. Fawns were significantly lighter in 2017 compared with the previous two years.

Cause-Specific Mortality of Fawns

To evaluate cause-specific mortality of fawns, we track daily survival of all fawns captured over the course of the summer. When a mortality is detected, we immediately investigate the event to ensure an accurate assessment of the cause of mortality. There is a breadth of various causes for fawn mortality including predation, disease, malnutrition, drowning, hypothermia, vehicle-collision, and just getting caught up in vegetation. The proportion of fawns that die because of the aforementioned causes varies from year to year (Figure 6).

So far, in summer 2017, 30% of mortalities were because fawns were stillborn. Currently, this is leading cause of death for fawns in 2017, but that will inevitably change as the summer progresses and more fawns die of other causes such as disease and predation.

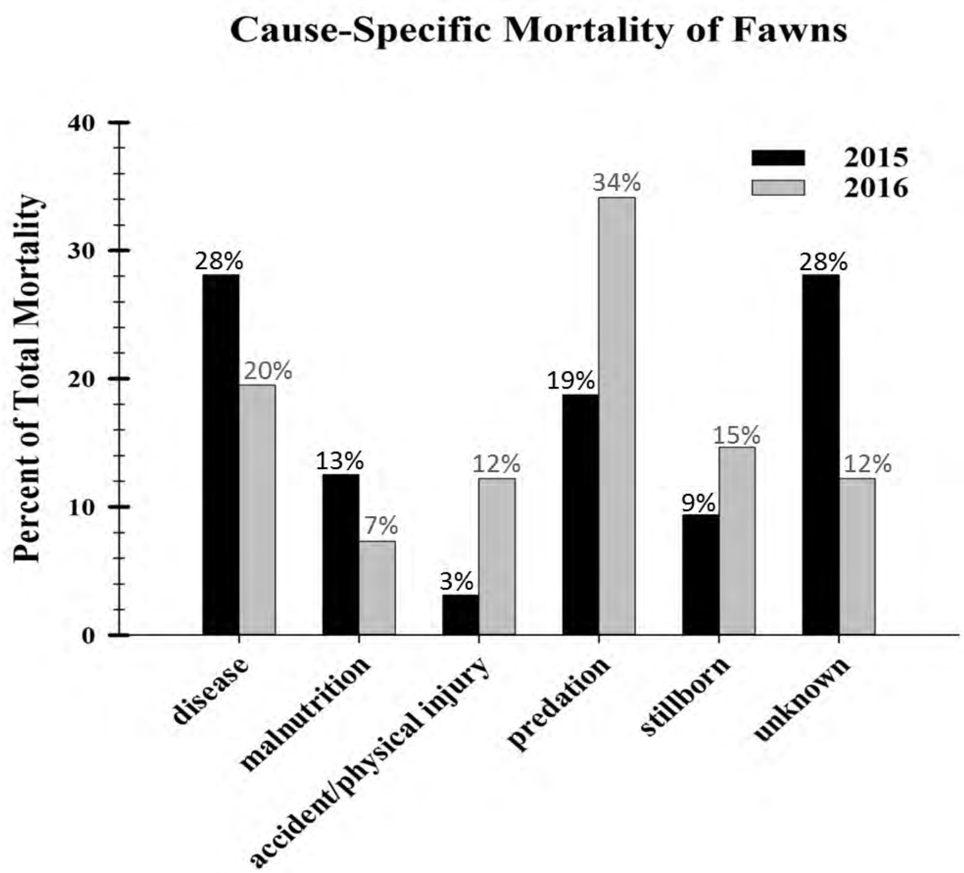


Figure 6. The relative occurrences of various causes of mortality for mule deer fawns.

Cause of Mortality: Malnutrition

Cause of Mortality: Predation

Habitat and Maternal Conditions

The condition of a female and the habitat conditions she experiences in the summer may be very important in predicting and understanding fawn survival – especially in understanding the influence of malnutrition and disease on fawn survival. Therefore, we are evaluating forage and habitat conditions within summer home ranges of collared deer. Specifically, we are measuring habitat structure and forage availability of known locations of use by collared adults that gave birth to fawns. We will then couple these data with information on maternal condition (i.e., nutritional condition) and evaluate the influence on fawn survival.

FUTURE RESEARCH EFFORTS

Throughout summer and winter of 2017, we will continue our research efforts aimed at elucidating the relative influence of predation, climate, and habitat conditions on fawn survival in the Wyoming Range. The severe winter conditions of 2017 will provide us with a unique opportunity to evaluate how severe winter weather may influence the ability of females to subsequently rear young, and thus, provide valuable insight into the factors that regulate population growth and examine the prospects for recovery of this cherished herd.

Project Partners and Funders

The Wyoming Range Deer Project is a collaborative partnership in inception, development, operations, and funding. Without all the active partners, this work would not be possible. Funds have been provided by the Wyoming Game and Fish Department, Wyoming Game and Fish Commission, Wyoming Wildlife and Natural Resource Trust, Muley Fanatic Foundation, Bureau of Land Management, Knobloch Family Foundation, U.S. Geological Survey, National Science Foundation, Wyoming Governor's Big Game License Coalition, Boone and Crockett Club, Animal Damage Management Board, Ridgeline Energy Atlantic Power, Bowhunters of Wyoming, and the Wyoming Outfitters and Guides Association. Special thanks to the Wyoming Game and Fish Department, Bureau of Land Management, and Wyoming State Veterinary Lab for assistance with logistics, lab analyses, and fieldwork. Also, thanks to the Cokeville Meadows National Wildlife Refuge and U.S. Forest Service for providing field housing.

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Wyoming Livestock Predation Trends and Mitigation Survey

FINAL PROJECT REPORT

Photo source: www.aphis.usda.gov

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Funded by: Wyoming Animal Damage Management Board

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Executive Summary

Predation of livestock in Wyoming is a major concern for agriculture and conservation, but federal surveys only extrapolate limited information at a very coarse scale (i.e., loss data at the state scale). Ranchers in Wyoming, USA were jointly administered a survey through the University of Wyoming, Wyoming Stock Growers Association (WSGA), Wyoming Wool Growers Association (WWGA), and the Wyoming Department of Agriculture's Animal Damage Management Board. A total of 274 ranchers from all 23 Wyoming counties responded and results from 273 were analyzed in time for this report.

The following key conclusions were discovered:

- Wolves are the greatest predator of bulls and cows and coyotes are the greatest predator of calves.
- Coyotes are the greatest predator of rams, ewes, and lambs.
- For cattle operations peak parturition periods correlate with peak predation periods but for sheep operations predation is a problem for the majority of the year.
- As the period of parturition is extended, the period of predation is extended, so shortening the parturition period should theoretically shorten the 'bad' predation period.
- Half of the participants indicated that rough country and severe winters were both associated with an increase of predation.
- More than two-thirds of participants noted an increase of livestock nervousness and change in distribution and grazing patterns associated with the presence of predators.
- Coyote predation of sheep is a major problem state-wide.
- Foxes and bobcats are generally not a problem predator for cattle.
- Bear predation is generally confined to the western part of the state.
- Bird predation (eagles, buzzards, ravens) of sheep are a major problem state-wide.
- Non-lethal mitigation strategies are generally considered to be non-effective with the exception of guard animals for certain predator species with a few exceptions noted for herding and fencing.
- Emerging themes included (1) concern about predatory birds (eagles, buzzards, ravens), (2) the effects of predators on sage-grouse, and (3) concern about funding in the future.

Future work includes additional modeling and the finalizing of manuscripts to be published in peer-review journals. We are grateful for the funding and will provide final manuscripts to ADMB as they become available in the future.

Problem Overview

Predation of livestock in Wyoming is a major concern for agriculture and conservation, but federal surveys only extrapolate limited information at a very coarse scale (i.e., loss data at the state scale). Limitations of these federal surveys include only a limited-subsample of Wyoming ranchers, limited county-level extrapolation, no annual trend information, no seasonal or production stage trend information, no effectiveness information of mitigation strategies, and no assessment of non-death losses such as behavioral changes. Given that the combined financial losses to livestock predation are estimated at more than $4 Million dollars annually in the state of Wyoming, more information will help ranchers more effectively mitigate predation. Given the shortfall of federal surveys, the economic impact of livestock predation, and the changing political and social perceptions of predatory species, we propose a Wyoming survey to expand on what we know about livestock predation in our state.

Economic Impact

The 2010 estimates of cattle losses from predators were estimated at $1.8 Million for cattle and calves combined. In this report on cattle losses, 20% of losses were attributed to coyotes, 19% to wolves, 16% to bears, and 12% to mountain lions and bobcats. Out of the 49 states reporting (excluding Alaska), only 7 states reported values for wolves, and 15 reported values for bears (Cattle Death Loss 2011). The 2013 survey of sheep and lamb losses reported 17,300 head lost to predators with coyotes accounting for 61%, bears accounting for 17%, and wolves accounting for 7%. The 2013 estimates of sheep and lamb losses from predators was $2.7 Million (Wyoming Sheep & Lamb Losses 2013). Combined the value of annual losses of cattle and sheep in Wyoming are around $4.5 Million. While the NASS reports are useful for understanding the total losses for a state annually, they have a number of issues and gaps that our proposal will address and move beyond. The primary issues are the inability to understand predation trends through time, a lack of information relative to livestock production cycles and ranch locations, and the lack of information on the effective use of mitigation strategies.

Original Research Proposal

Given the number of limitations of interpreting and extrapolating the data in the only livestock predation surveys available, the USDA NASS surveys, I propose conducting a Wyoming-specific survey on livestock predation. This survey will be jointly administered through the University of Wyoming, Wyoming Stock Growers Association, and Wyoming Wool Growers Association. By identifying the issues and knowledge gaps in the federal survey, I propose survey questions that will generate data to inform predator management. The type of data that will be generated in my survey, that is not generated in the federal surveys, includes: surveying all Wyoming ranchers, quantifying trends through time, quantifying efficacy of different mitigation tactics, stratifying results by county and ranch size, determining periods of high-susceptibility to predation, quantifying livestock behavioral changes, and further explaining perceptions of ‘trophy’ versus ‘predator’ designations. If this proposal is funded, the Wyoming Animal Damage Management Board (WADMB) will become a partner with the University of Wyoming, Wyoming Stock Growers Association, and Wyoming Wool Growers Association in developing and conveying this new information that will have utility for ranchers and wildlife managers alike. Furthermore, we would welcome input from WADMB on the content of the survey and the format of the questions.

Proposal Implementation

Survey delivery

Ranchers in Wyoming, USA were jointly administered a survey through the University of Wyoming, Wyoming Stock Growers Association (WSGA), Wyoming Wool Growers Association (WWGA), and the Wyoming Department of Agriculture's Animal Damage Management Board. The survey was approved by the University of Wyoming Institutional Review Board as exempt under protocol #20150922DS00903. A total of 816 surveys were mailed to WSGA and WWGA members and an additional 230 were mailed to Extension offices. The survey was offered in paper or electronic form. Ranchers were asked: primary months for calving/lambing; worst predation months; problems with large carnivores relative to livestock species; landscape, weather, and livestock features that were associated with an increase in predation; and livestock behavior and non-lethal losses associated with the presence of predators. The survey was administered from April to October 2016. We calculated the percent of ranchers reporting for each question and used linear least squares regression to compare percentage of ranchers calving/lambing each month to percentage of ranchers reporting worst predation month.

Analyses

Survey responses were first summarized with descriptive statistics by county, ranch size, main livestock species raised, and exposure to large carnivores. Additional co-variates were then generated for each survey and included geographical covariates (longitude and latitude based on the geographic center of the county indicated or the center point between geographic centers of counties if more than one county was indicated) and operational covariates (main livestock species raised, main parturition month, worst predation month, ranch size, number of counties ranching in). We also used a digital elevation model (DEM) to develop an assumed elevation for each survey participant. For livestock behavior change/non-lethal losses and landscape/weather/livestock features we calculated the percent of respondents indicating each. Then to further quantify the complex co-variates and reported behavior, non-lethal losses, landscape features, weather features, and livestock features influencing predation we conducted a constrained ordination using the complex suite of co-variates to explain the reported behavior change/non-lethal losses and the landscape/weather/livestock features influencing predation (CANOCO 5). To further understand the relationship between parturition timing and predation, we stratified survey responses by type of livestock raised (sheep, sheep + cattle, and cattle) and summarized the main parturition month of the year, the worst predation month of the year, and then using linear least squares regression analyzed the relationship between the two. We similarly compared the number of months for parturition to the number of 'bad' predation months. To quantify the efficacy of lethal and non-lethal predation mitigation strategies, we calculated the average efficacy ranking for each mitigation strategy (guard animals, fencing, herding, stalling at night, shooting, trapping/snaring, private trapper, government trapper) by predator species (grizzly bear, black bear, mountain lion, bobcat, wolf, coyote, stray dog, fox, birds). Finally, we have also searched the open ended question responses for general and emerging themes.

Results

Rancher response to survey

A total of 273 ranchers responded to the survey (26.1% response rate) and represented all 23 counties in the state of Wyoming with 3 to 32 ranchers from each individual county (Table 1). Albany County had the most participants while Lincoln and Weston counties had the least (Table 1). In late May 2017 an additional survey was received and has not been included in the analysis presented in this final project report but will be incorporated into analyses for future journal articles. Because it represents less than 0.5% of the total data, we do not expect much change in the results once it is included.

Table 1. Number of participants by county.

Answer Choices	Responses	
Albany	11.68%	32
Johnson	10.58%	29
Fremont	9.85%	27
Niobrara	9.49%	26
Campbell	9.49%	26
Carbon	8.76%	24
Sheridan	8.76%	24
Sublette	8.03%	22
Sweetwater	6.93%	19
Converse	6.93%	19
Platte	6.20%	17
Natrona	5.84%	16
Park	5.47%	15
Laramie	5.11%	14
Goshen	4.38%	12
Washakie	4.38%	12
Hot Springs	2.92%	8
Crook	2.92%	8
Teton	2.55%	7
Big Horn	2.19%	6
Uinta	1.46%	4
Weston	1.09%	3
Lincoln	1.09%	3
Total Respondents: 274		

Ranches tended to be large with 100 ranches (or 36.6% of participants) from 1,001 to 10,000 acres (405 to 4,047 ha) in size and 107 ranches (or 38.8% of participants) from 10,001 to 100,000 acres (4,047 to 40,469 ha) in size. Ranches larger than 100,000 acres (40,469 ha) were represented by 24 different rancher respondents (or 8.8% of participants) (Table 2). The majority of ranchers raised cattle (252 or 92.3% of participants) and more than a quarter raised sheep (75 or 27.4% of participants).

Table 2. Size of participant ranches.

Answer Choices	Responses	
1-10 acres	0.00%	0
11-100 acres	2.21%	6
101-1,000 acres	12.55%	34
1,001-10,000 acres	36.90%	100
10,001- 100,000 acres	39.48%	107
>100,000 acres	8.86%	24
Total		271

When asked if large carnivores were ever a problem for cattle (major, sporadic, rarely, or never), 25% of ranchers reported exposure to black bears, 22% reported exposure to grizzly bears, 38% reported exposure to wolves, and 56% reported exposure to lions. When asked if large carnivores were ever a problem for sheep (major, sporadic, rarely, or never), 40% of ranchers reported exposure to black bears, 30% reported exposure to grizzly bears, 41% reported exposure to wolves, and 65% reported exposure to lions.

When asked how many head of livestock, by livestock class, were lost to each predator species, the proportion of rancher reported losses were calculated (Figure 1). For mature cattle (bulls and cows), the greatest proportion of losses were to wolves (39%), followed by unknown predators (38%), and then grizzly bears (11%). For calves, the greatest proportion of losses were to coyotes (33%), followed by unknown predators (22%), followed by 17% for wolves, and 16% for grizzly bears. The high proportion of confirmed predator species is a problem for managing the livestock-predator conflict. For mature sheep (rams and ewes) and for lambs, coyotes represented the greatest proportion of losses at 33% and 50% respectively. For mature sheep, the next greatest proportion of losses were attributed to wolves (18%), then grizzly bears (19%), then unknown predators (11%). For lambs, predatory birds were the next leading cause of mortality at 22% (Figure 1).

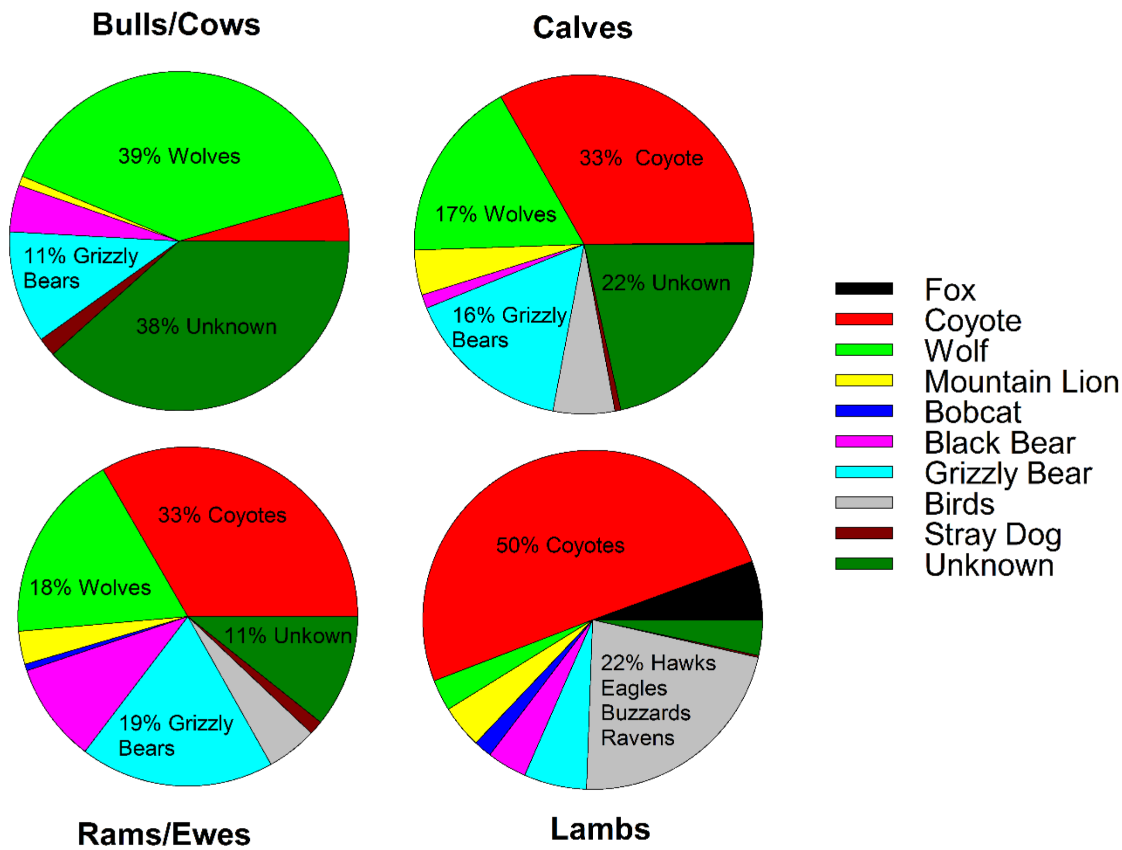


Figure 1. Proportion of rancher reported losses by livestock class and predator species in Wyoming.

Parturition and Predation

Ranchers in Wyoming primarily calve and lamb in the spring of the year as the majority of respondents reported March (58.6%), April (83.7%), and May (68.9%) as a month they calve and/or lamb (Figure 2 demonstrates these averages but is stratified by sheep, sheep + cattle, and cattle operations). A low proportion start calving in late-winter (February – 19.9%) or calve in early-summer (June – 22.7%). Fall calving/lambing was uncommon with response rates of less than 1% for September, October, November, and December respectively. The worst predation months for sheep were May through October and the worst predation months for cattle were March through May. The relationship between calving/lambing period and reported predation months was positively and significantly correlated for cattle only operations ($r^2 = 0.91$; $p < 0.001$) but was not correlated for sheep or sheep + cattle operations likely because predation continues through the year. For cattle though, the more likely a month was to be the main calving month, the more likely that month was to be one of the worst predation months. As the parturition interval got longer, so did the number of ‘bad’ predation months (Figure 3).

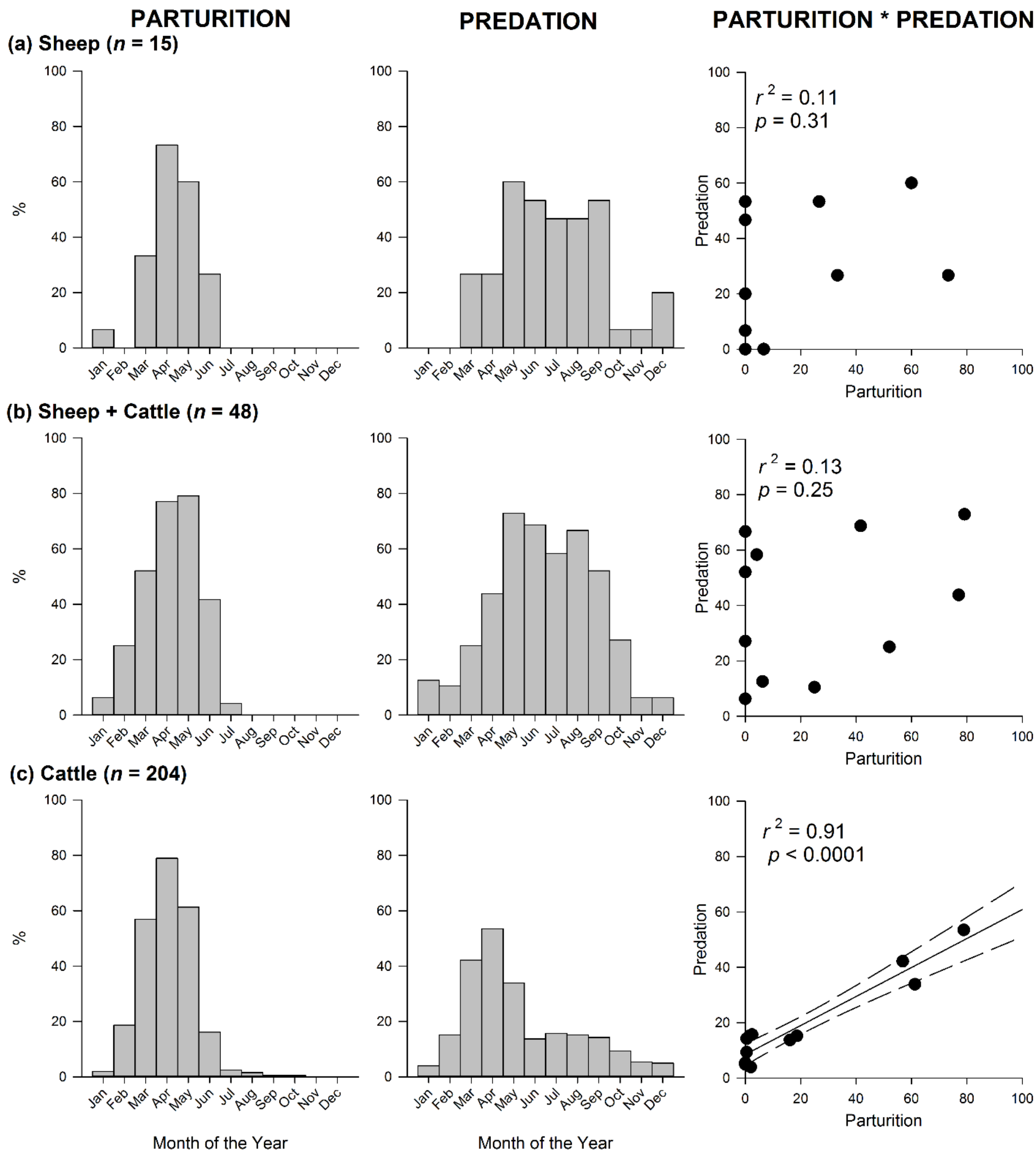


Figure 2. Parturition timing, worst predation months, and the correlation between parturition and predation stratified by livestock species raised in Wyoming.

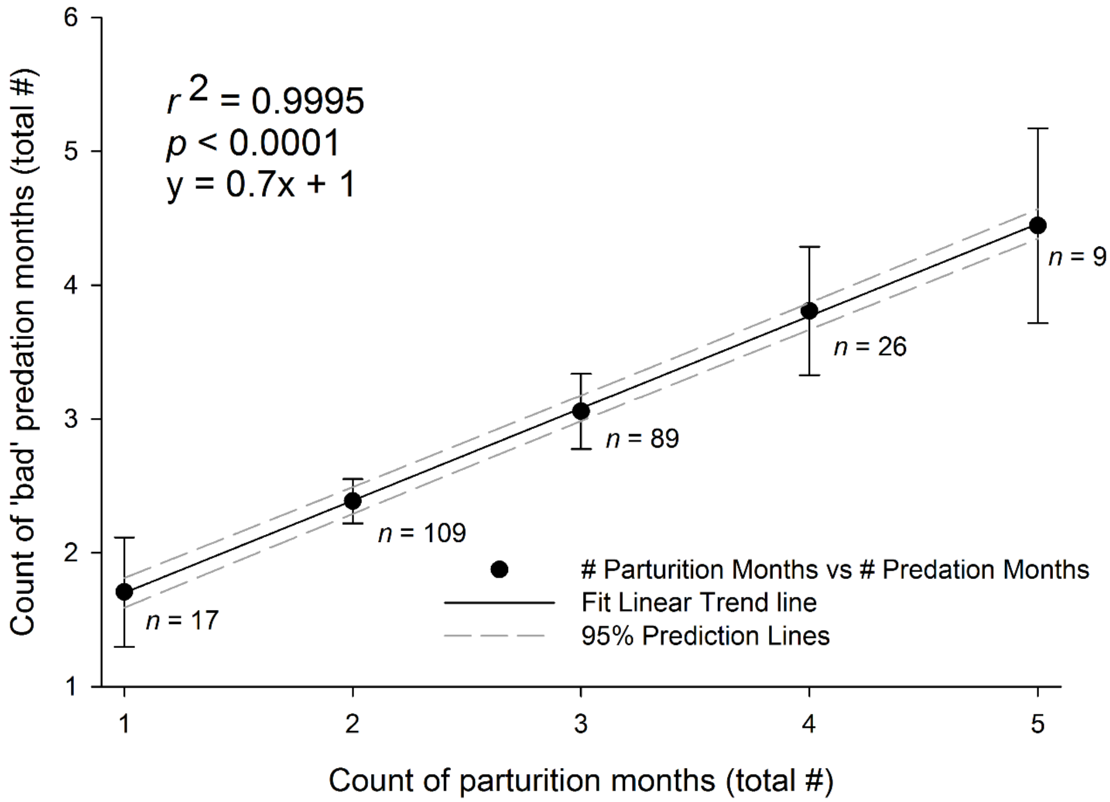


Figure 3. Correlation of length of parturition period and number of 'bad' predation months in Wyoming.

Landscape/weather/livestock and Predation

When asked about landscape features, the greatest proportion of ranchers (37%) reported that rough country was associated with an increase in livestock predation, more than any other landscape feature (Figure 4). When the landscape was forested or shrubby, approximately 20-21% of ranchers reported it was associated with an increase in livestock predation respectively. A similar proportion of ranchers reported that when they went on to a public grazing allotment they experienced more livestock predation (Figure 4). When asked about weather features, one-third of the ranchers indicated that severe winter weather characterized by snow, ice, and cold was associated with greater livestock predation, but only 9% of ranchers indicated this was the case with severe summers characterized by drought (Figure 4). When asked about livestock features, 14% of ranchers indicated that sick animals were associated with greater predation while 8% of ranchers indicated that old animals were associated with greater predation (Figure 4).

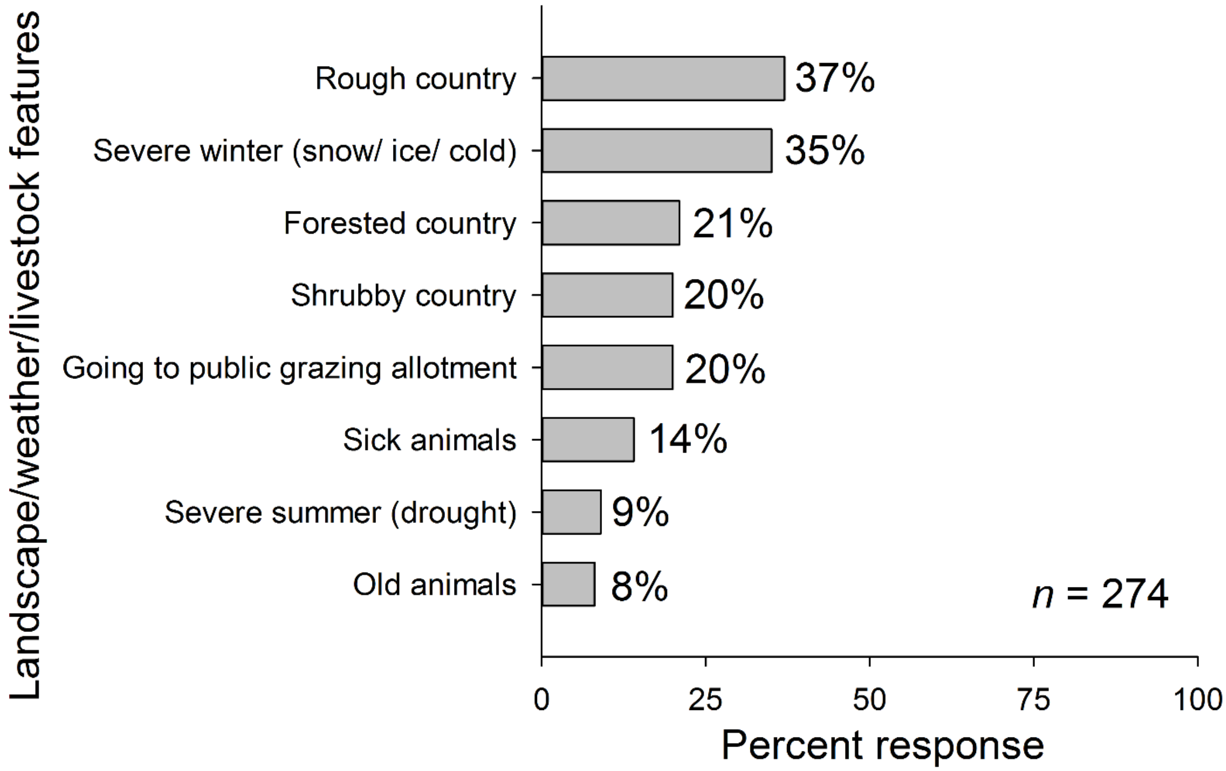


Figure 4. Rancher reported landscape, weather, and livestock features associated with an increase of predation in Wyoming.

Livestock behavioral changes/non-lethal losses and predation

When asked about livestock behavior changes associated with the presence of predators (i.e., when predators are known to be in the area), 68% of ranchers indicated they could detect a greater level of nervousness in livestock (Figure 5). Similarly, approximately a quarter of ranchers reported that livestock were harder to work (24%) and harder to gather (22%). However, only 3% reported an increased exit rate out of the chute. More than half of ranchers reported that livestock changed their distribution and grazing patterns when predators were present with a quarter of ranchers reporting an associated reduction in livestock grazing time (Figure 5). When asked about indirect production losses associated with the aforementioned behavioral changes due to the presence of predators, 27% reported lower weight gains. From a reproductive standpoint, 19% reported lower conception rates, 12% reported lower birth rates, and 11% reported a delay in birth season (Figure 5).

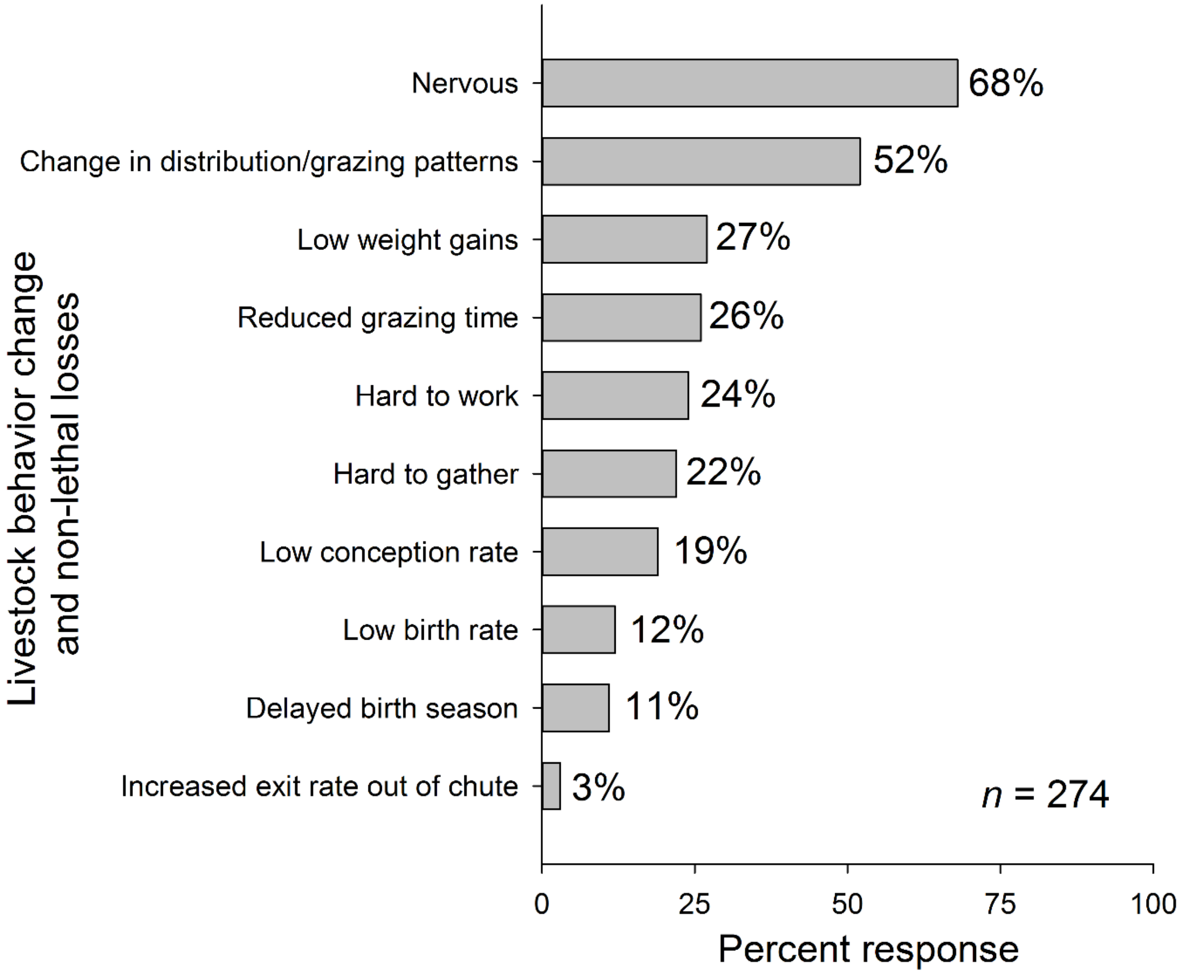


Figure 5. Rancher reported livestock behavior change and non-lethal losses associated with an increase of predation in Wyoming.

Constrained ordination indicates that going to public grazing allotments and elevation are correlated and that the severe winters and forest/shrubby/rough country tend to explain the dominant landscape features affecting predation (Figure 6). Constrained ordination also indicates that livestock behavioral responses beget livestock non-lethal losses, that non-lethal losses tend to compound, and that livestock species of an operation explain the dominant behavioral and non-lethal loss issues with predation in Wyoming (Figure 7).

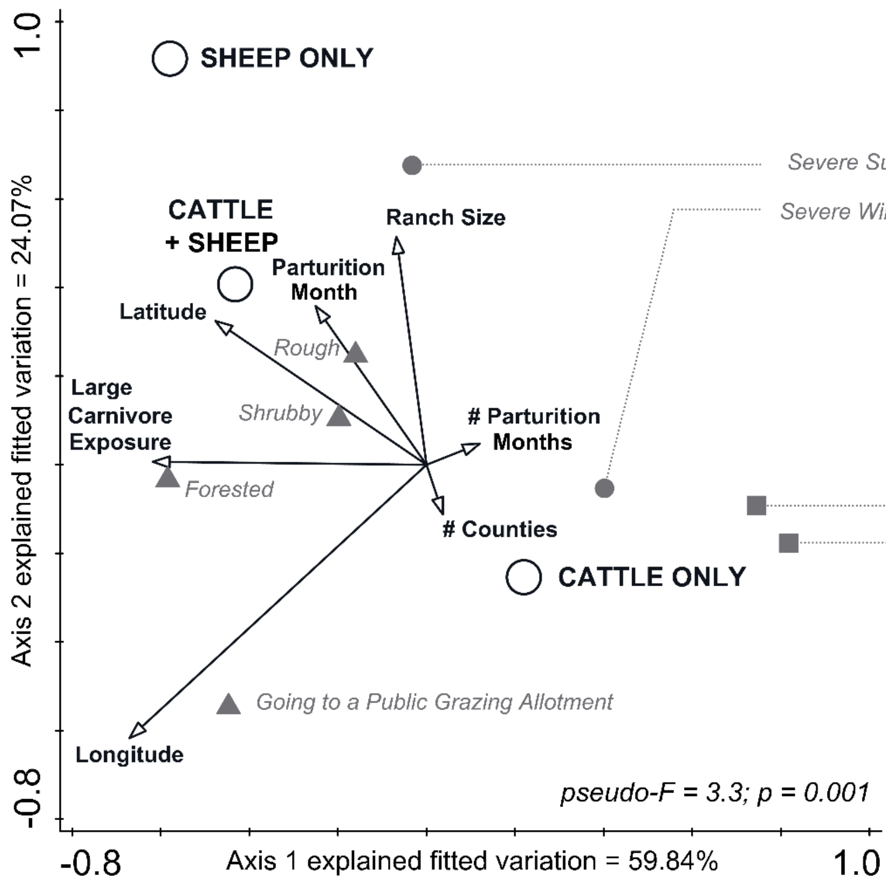


Figure 6. Constrained ordination using canonical correspondence analysis (CCA) of rancher reported landscape, weather, and livestock features relative to geographical and operational covariates associated with predation in Wyoming.

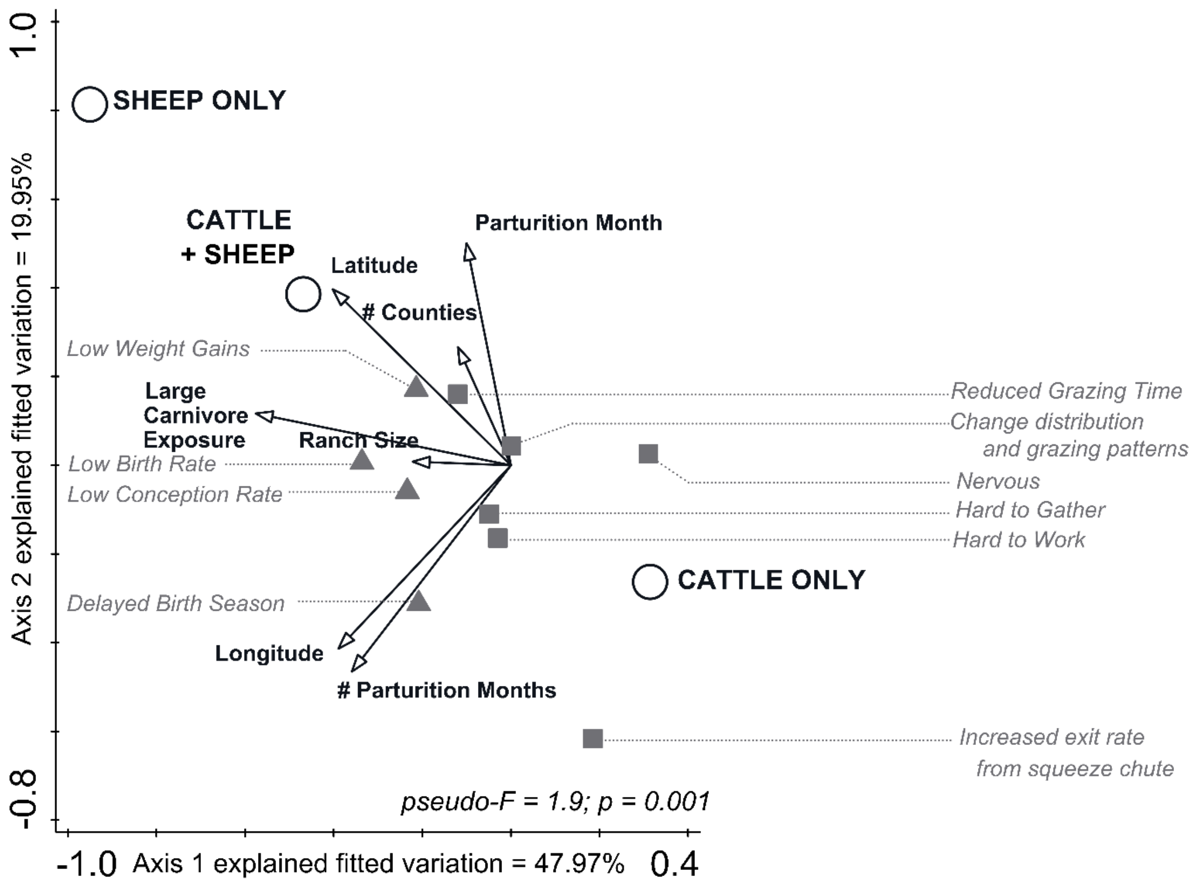


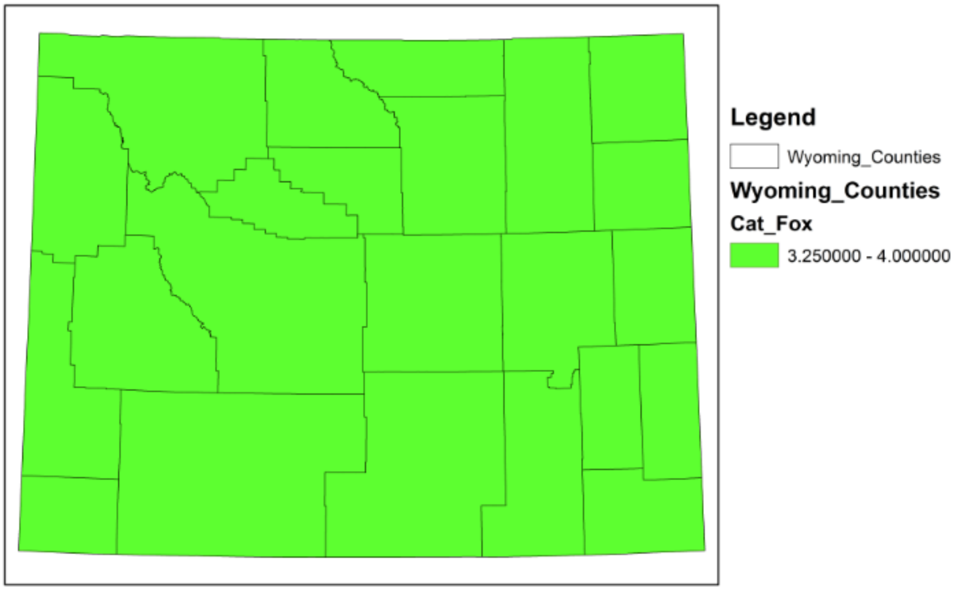
Figure 7. Constrained ordination using canonical correspondence analysis (CCA) of rancher reported livestock behavior change and non-lethal losses relative to geographical and operational covariates associated with predation in Wyoming.

Distribution of the problem

Foxes are generally not a problem for cattle (Figure 8a) but are generally a problem for sheep statewide (Figure 8b). Coyotes are more of a concern for sheep than cattle but still represent an issue for cattle particularly in the southwestern part of the state in Uinta and Sweetwater counties (Figure 9a). Wolves tend to be a problem for both cattle and sheep in the western part of the state (Figure 10a and 10b). Mountain lions are an intermediate concern for cattle with areas of concern in the northeast, northwest, and southwest (Figure 11a). Mountain lions are a concern for sheep in the Big Horn Basin area, northwest, and the southwest portions of the state (Figure 11a and 11b). Bobcats are generally not a problem for cattle (Figure 12a) and in a lot of the state are not a problem for sheep with the exception in Crook, Converse, and Laramie counties (Figure 12b). Black bears are generally not a problem for cattle (note the color scheme in Figure 13a is misleading and should be compared within this figure only) with a higher report of problems in the western half of the state (Figure 13a). Black bears are a greater problem for sheep in the west and in particular in Hot Springs and Lincoln counties (Figure 13b). Grizzly bears tend to be a greater problem for cattle in the northwest corner of the state (Figure 14a) and a greater problem for sheep in the southwestern part of the state (Figure 15b). Predatory birds are a concern mostly statewide with a higher reported problem in Uinta and Sweetwater counties (Figure 15a). Predatory birds are a concern for sheep statewide (Figure 15b). Stray dogs are a concern for cattle on the western border of the state (Figure 16a) and variably for sheep across the state (Figure 16b).

Figure 8. Fox

(a) Cattle



(b) Sheep

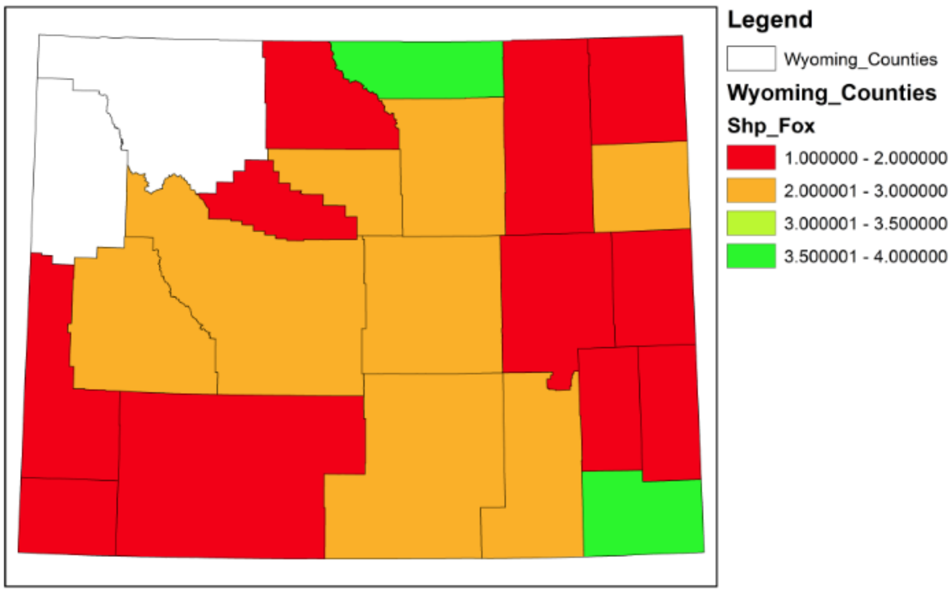
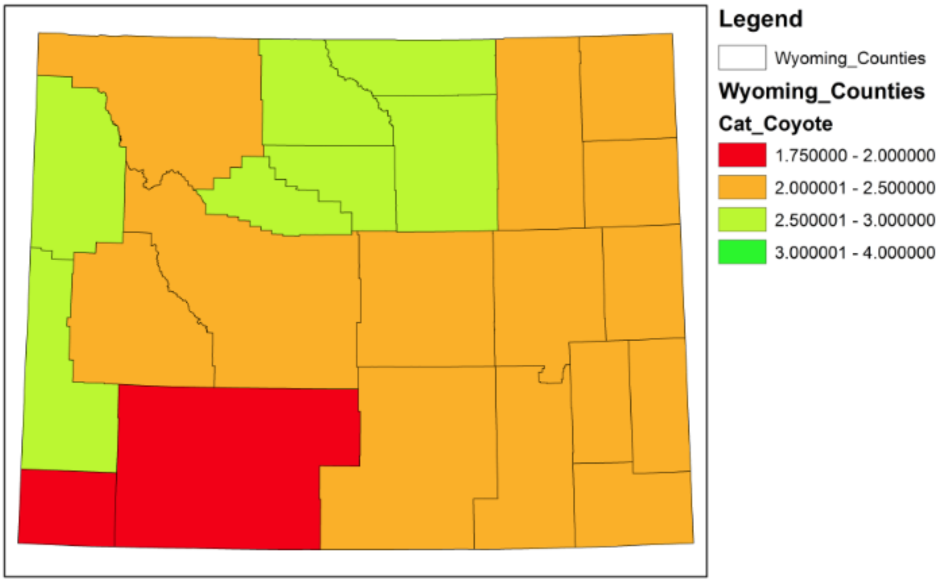


Figure 9. Coyote

(a) Cattle



(b) Sheep

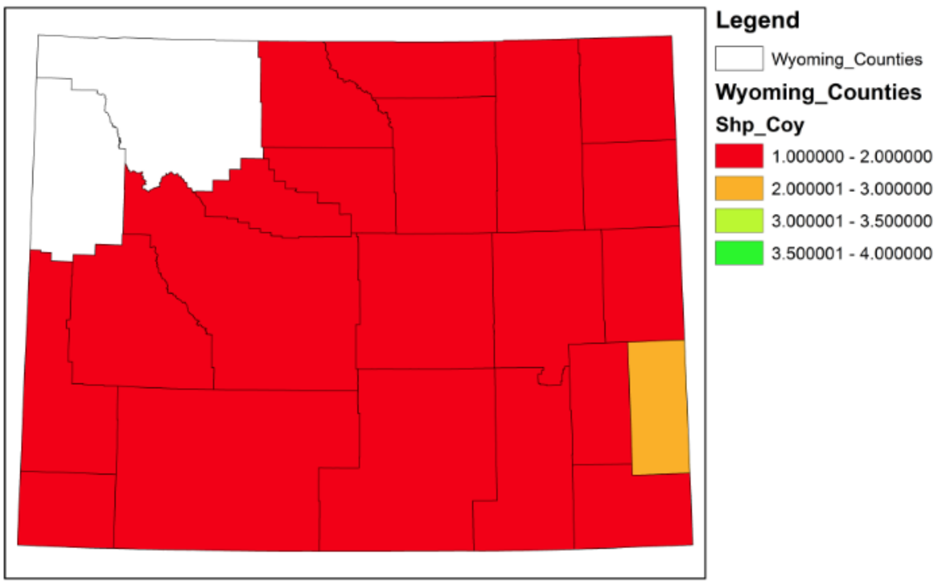
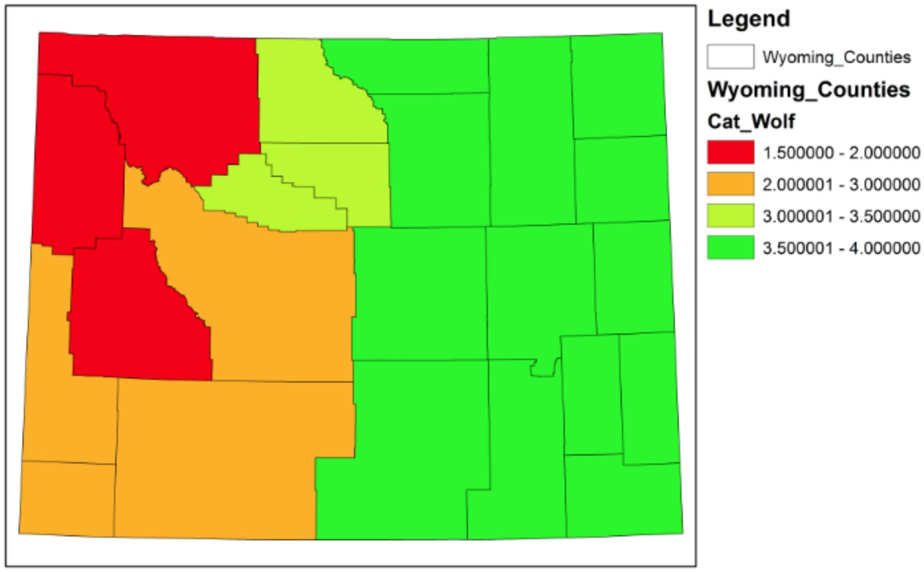


Figure 10. Wolf

(a) Cattle



(b) Sheep

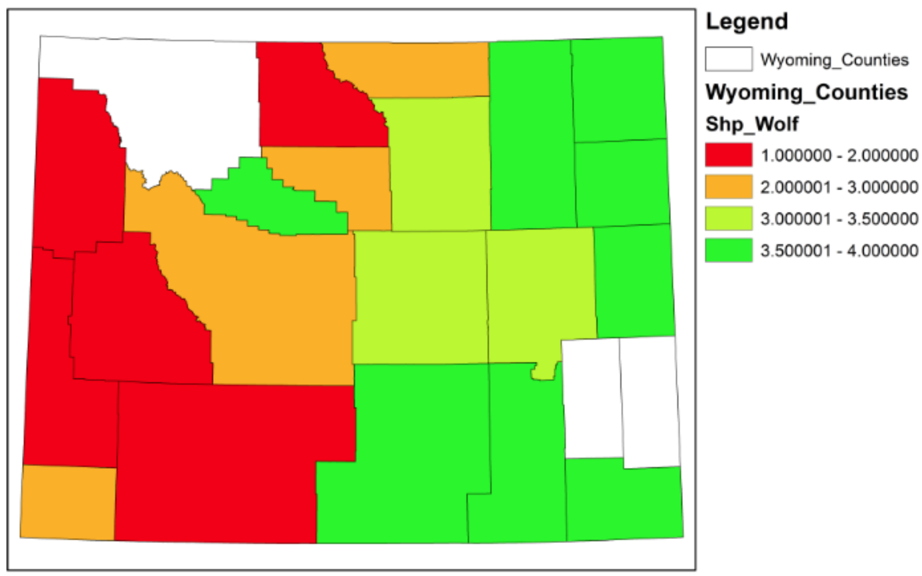
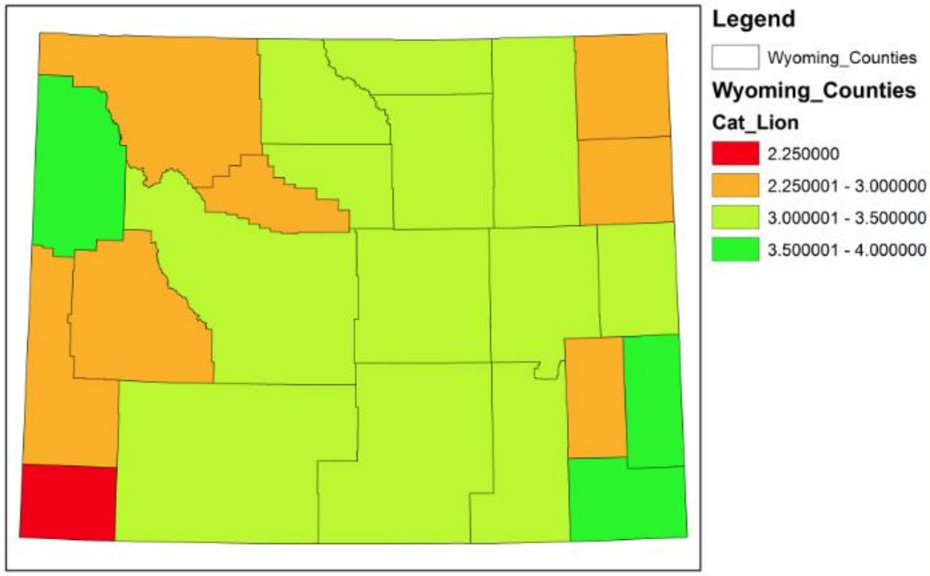


Figure 11. Mountain Lion

(a) Cattle



(b) Sheep

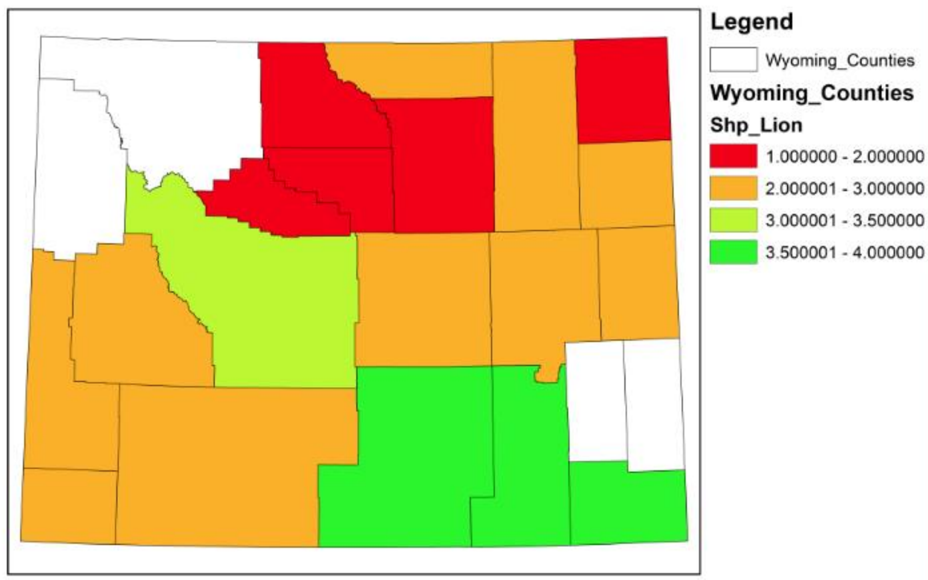
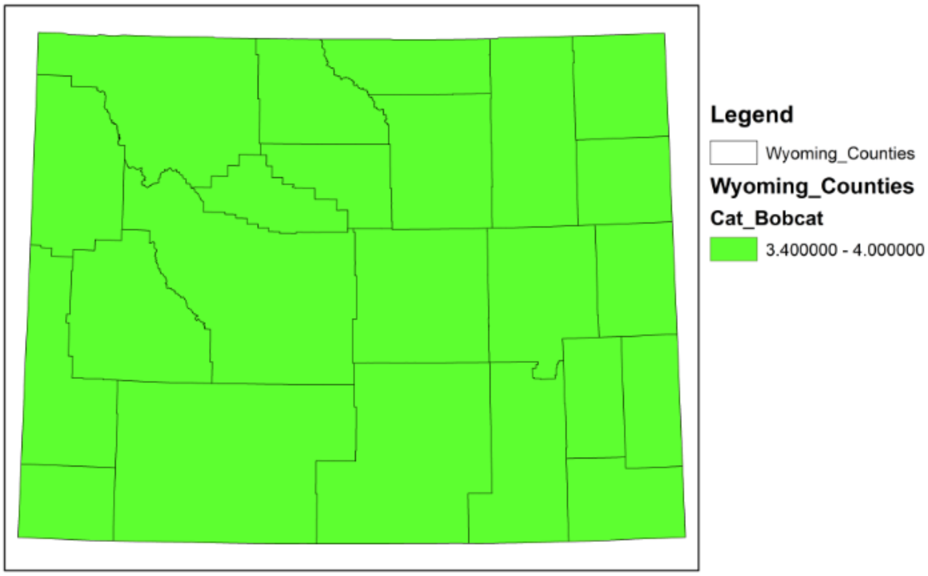


Figure 12.
Bobcat

(a) Cattle



(b) Sheep

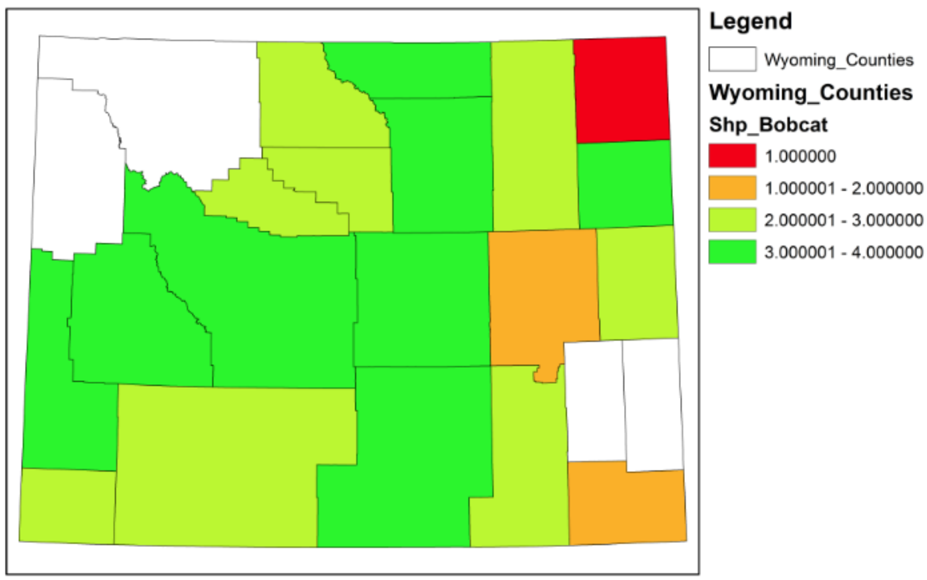
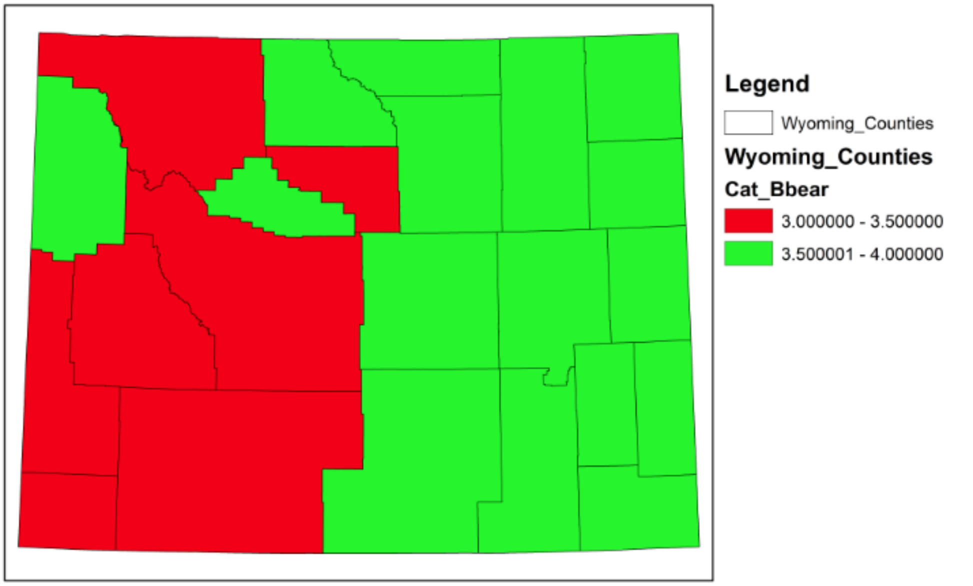


Figure 13.
Black Bear

(a) Cattle



(b) *Sheep*

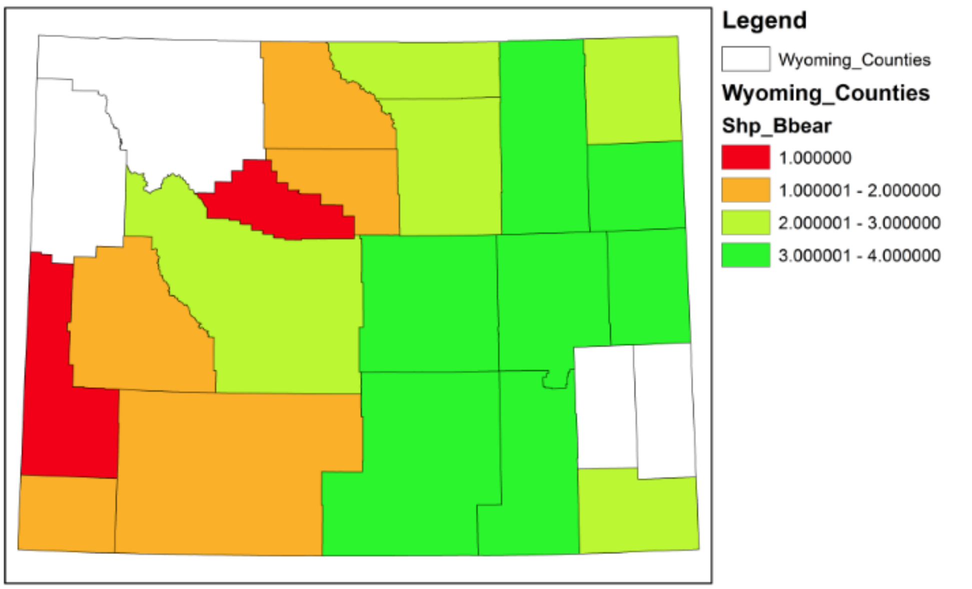
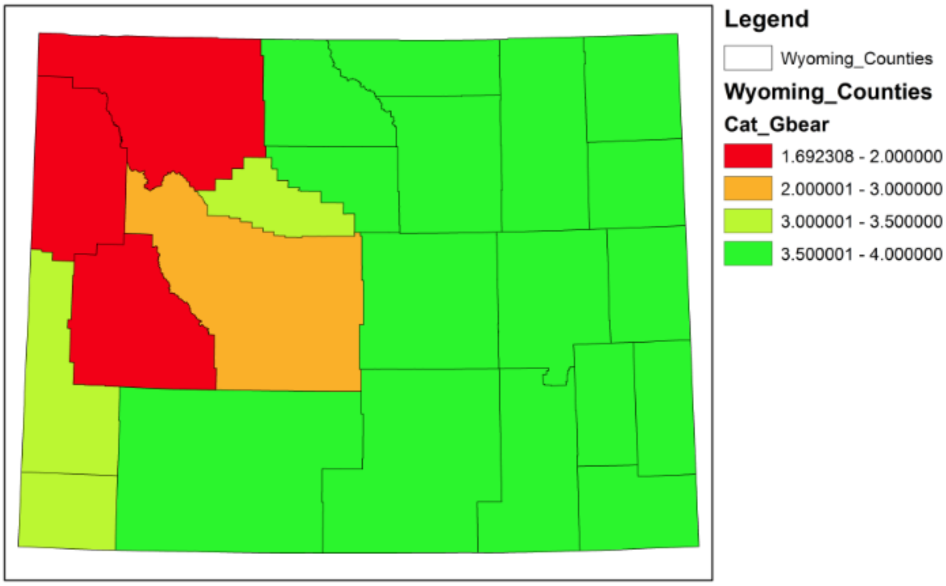


Figure 14.
Grizzly Bear

(a) Cattle



(b) *Sheep*

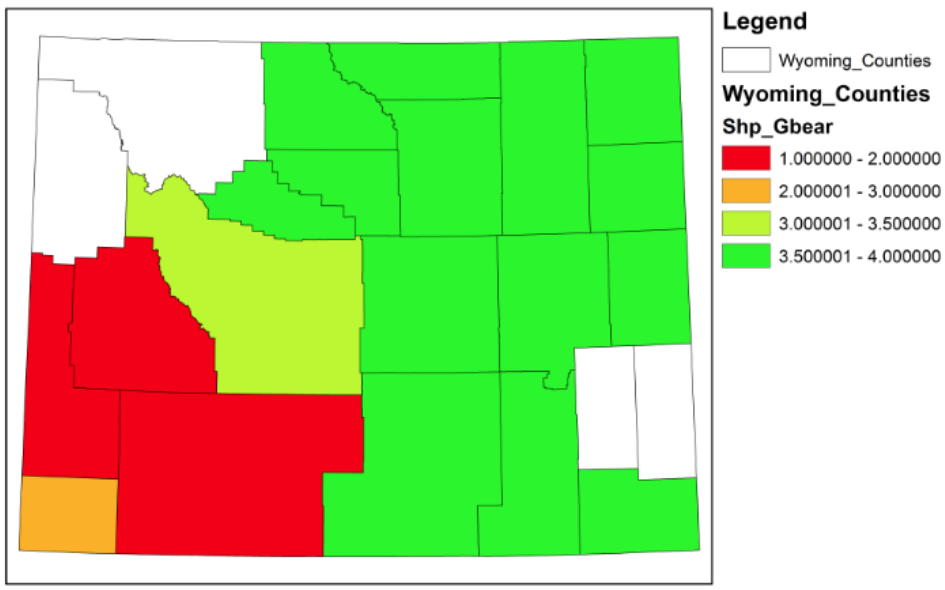
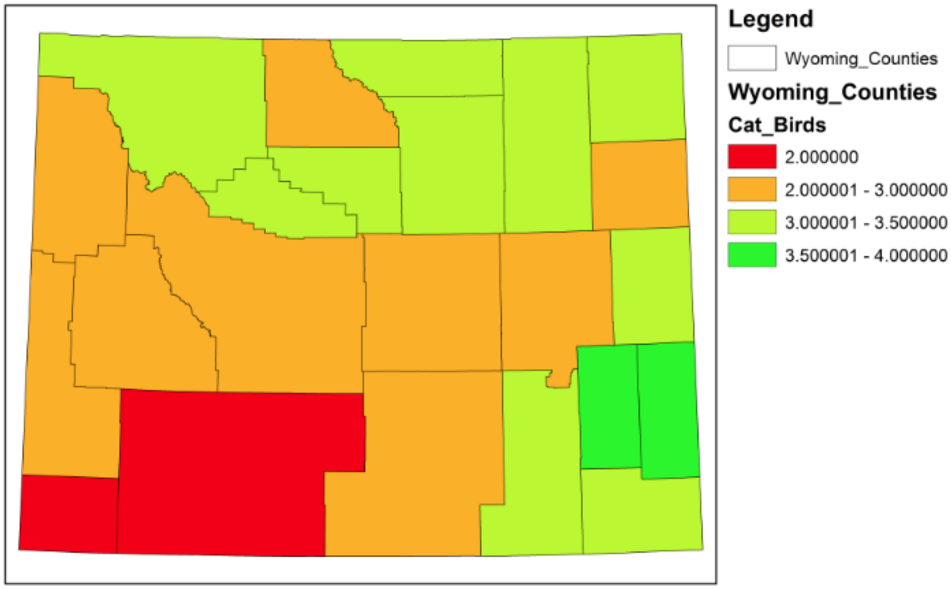


Figure 15.
Birds

(a) Cattle



(b) *Sheep*

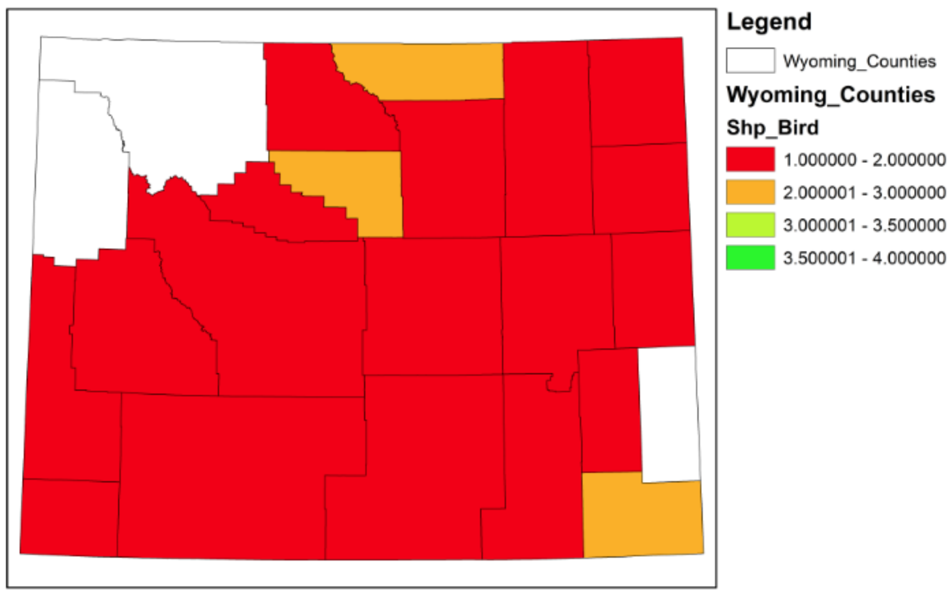
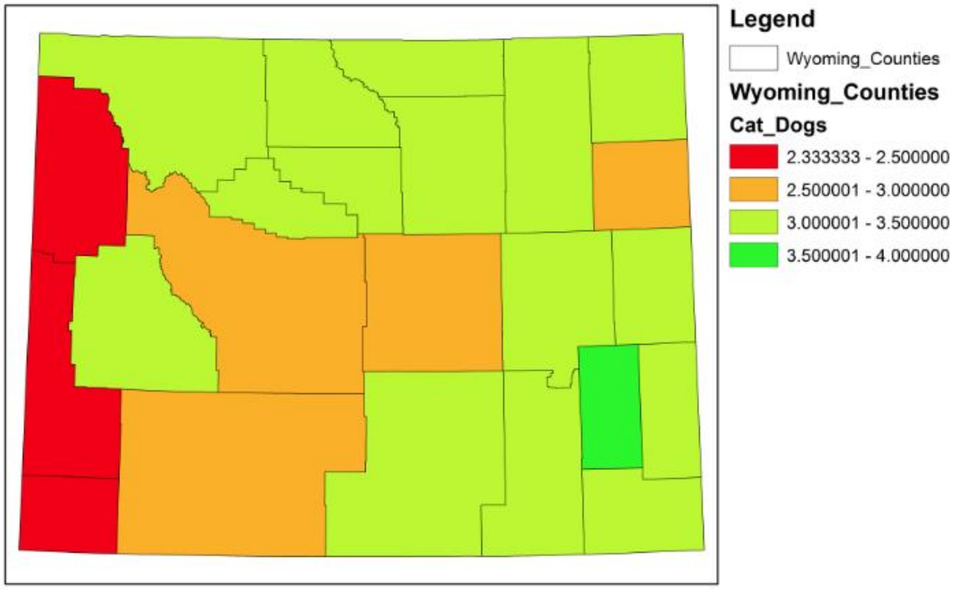
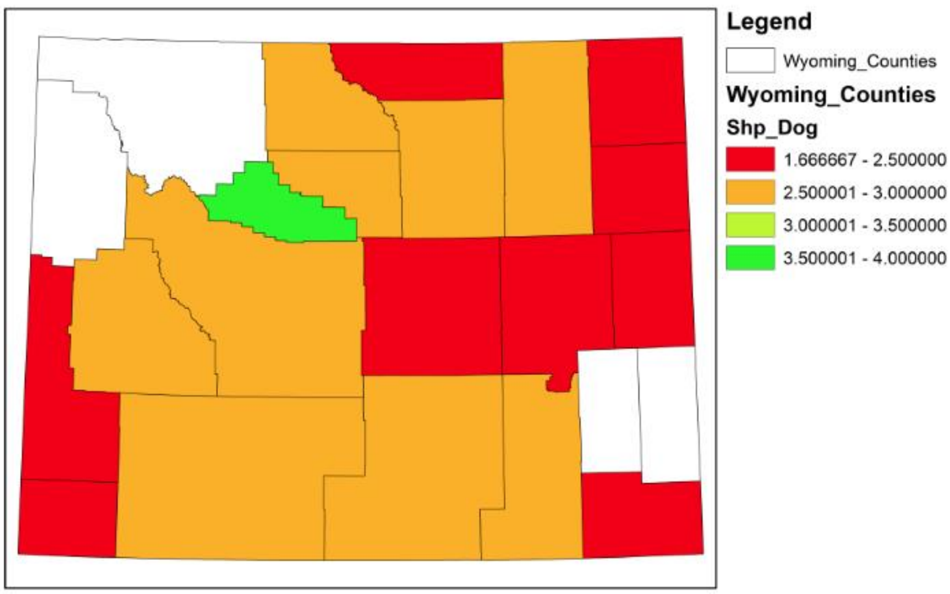


Figure 16. Dog

(a) Cattle



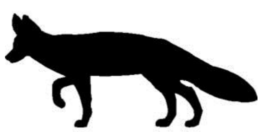
(b) *Sheep*



Efficacy of Mitigation Strategies

Lethal mitigation strategies tend to generally be more effective than non-lethal strategies for all predator species (Figures 17-25). Guard animals seem to be moderately effective for foxes (Figure 17) and a bit less so for coyotes (Figure 18). None of the non-lethal methods were generally considered effective for mitigating wolf predation (Figure 19) or mountain lion predation (Figure 20). Guard animals was between moderately and slightly effective for bobcat predation (Figure 21). None of the non-lethal methods were generally considered effective for mitigating black bear (Figure 22) or grizzly bear predation (Figure 23). For predatory birds, participants unanimously indicated that fencing was not effective (note the lack of error bars around the data point), an indication that participants were paying very close attention to the questions! None of the methods ranked between very effective or moderately effective for predatory bird mitigation (Figure 24). Shooting was the most effective mitigation strategy for dog predation (Figure 25).

Figure 17. Fox Mitigation



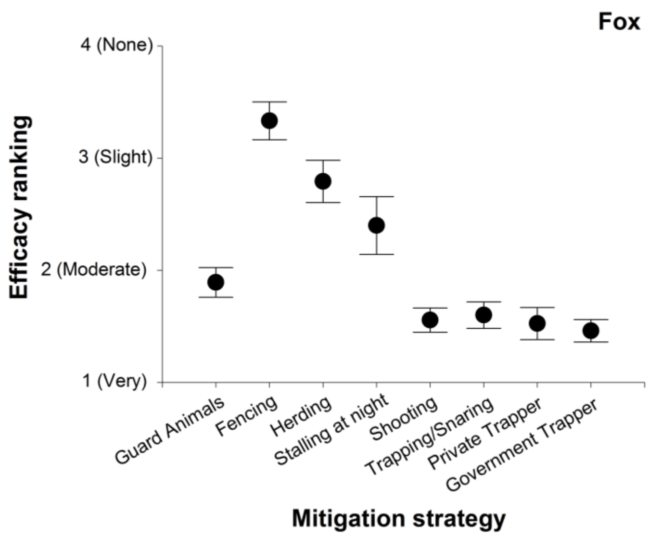


Figure 18. Coyote Mitigation

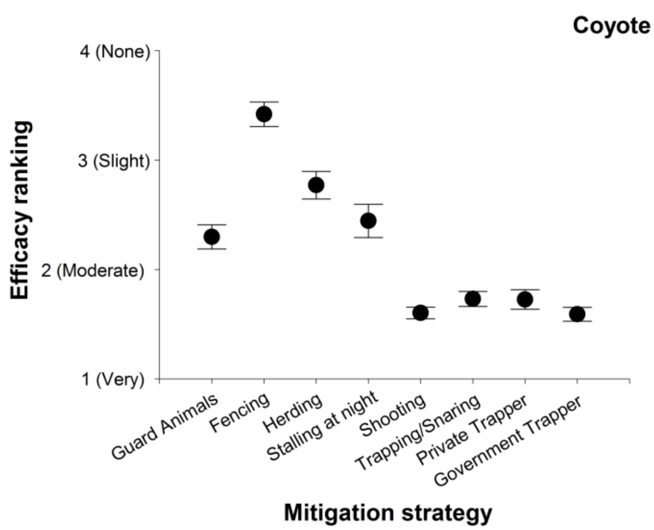


Figure 19. Wolf Mitigation

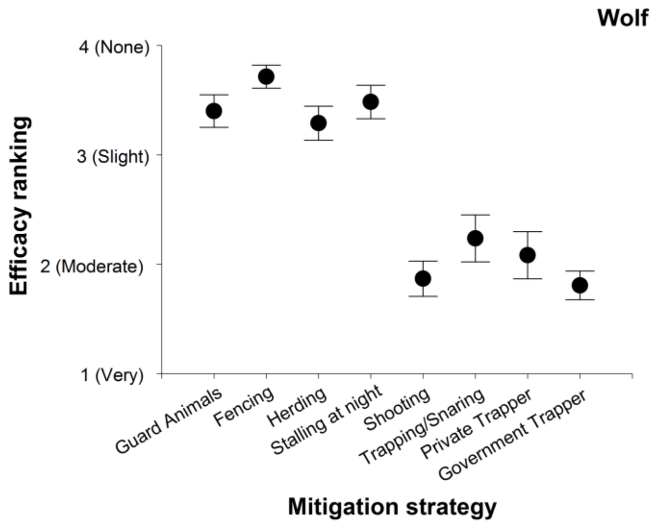
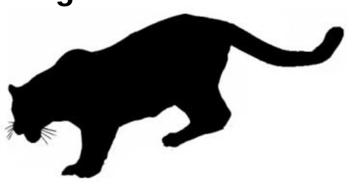


Figure 20. Mountain Lion Mitigation



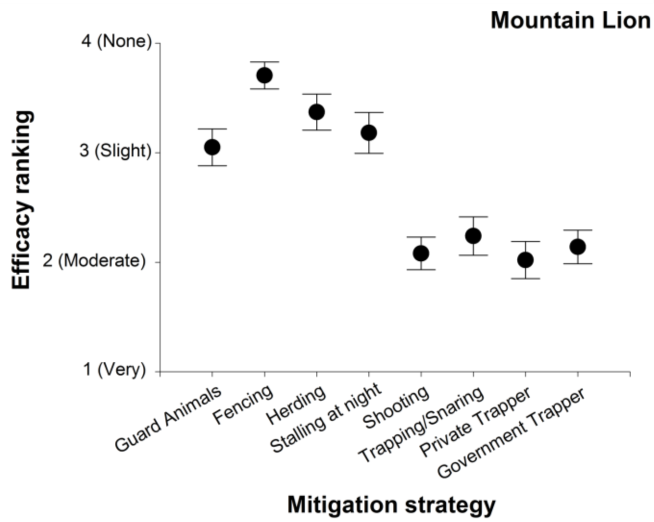
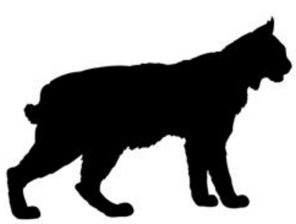


Figure 21. Bobcat Mitigation



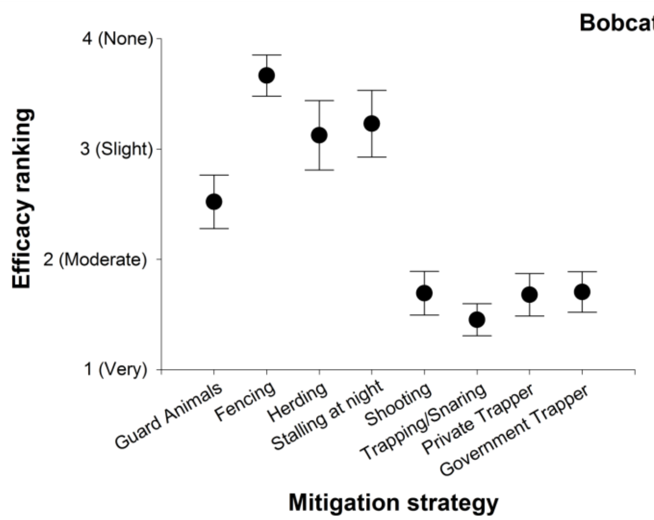


Figure 22. Black Bear Mitigation

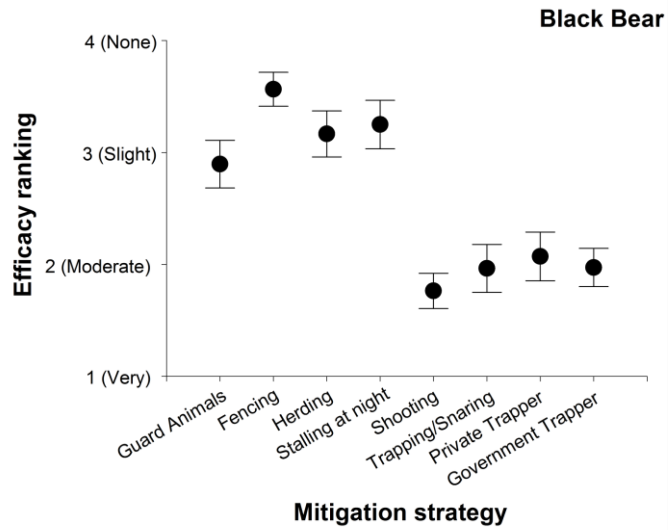
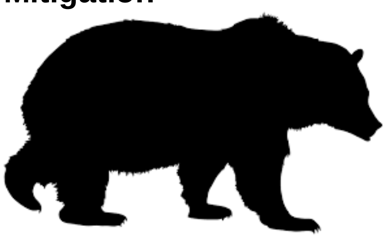


Figure 23. Grizzly Bear Mitigation



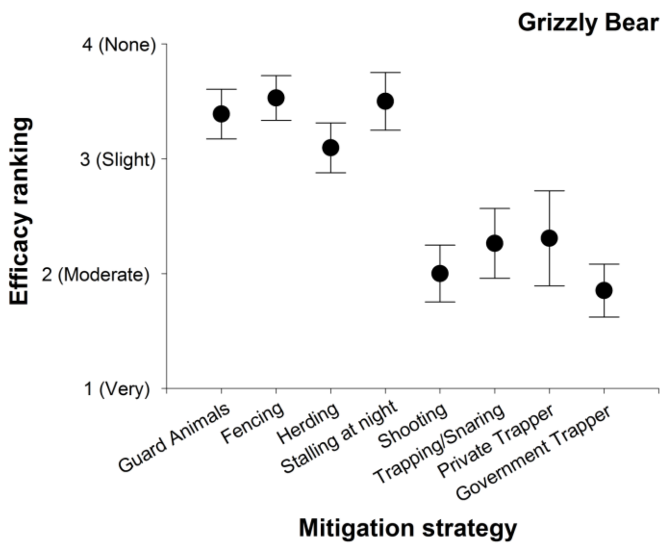
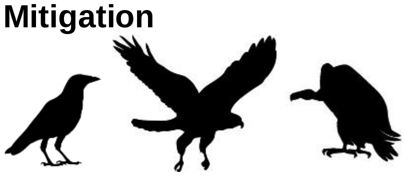


Figure 24. Predatory Bird Mitigation



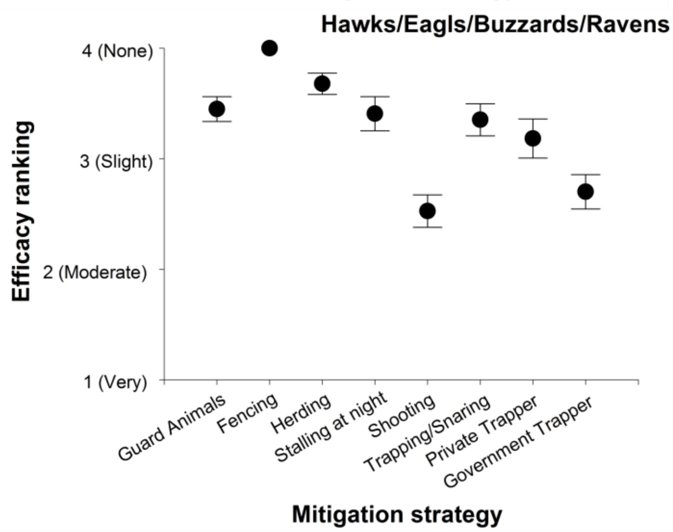
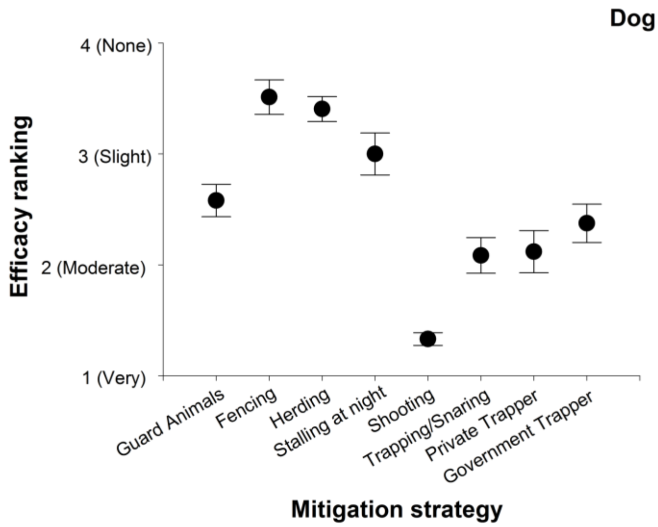


Figure 25. Dog Mitigation



Emerging Themes

Three themes emerged from the open ended responses. Verbatim responses for each theme are presented below with slight modifications to protect the identity of participants.

1. **Predatory bird concerns**

“The migratory designation of some birds (ravens) leads to increased losses of livestock. Golden Eagles are a huge factor to lamb losses. The designation of migratory or protected leads to more livestock loss.”

“Eagles are a huge problem during lambing. It would be nice to find a way to relocate or remove them from our sheep herd.”

“Eagles and ravens pick the eyes out of calves and blind them or kill them.”

2. **Sage-grouse concerns**

“Ravens eat sage grouse eggs and chicks.”

“Ravens are one of the fastest growing problems for livestock and wildlife, especially sage grouse.”

“Not controlling predators that are protected by laws has a great affect of desirable wildlife populations. i.e. 1) wolves & bears on elk. 2) badgers, ravens, buzzards, eagles, etc on "sage chickens".”

3. **Funding concerns**

“Funding is a major problem. Expenses are increasing and there is less money available for the local boards. Wildlife Services used to share more expense but it is now on the local boards and producers. With regulations regarding control it is

becoming more difficult for producers. Predators not only affect livestock but also wildlife. It is critical to maintain healthy balances."

"Funding for losses must be reinstated from the feds who have knowingly removed it when they took back the management of wolves. We will not survive without something. Wyoming must have the lead. Maybe now the Wyo govt has realized that agriculture is an enduring part of our natural resource based economy and our culture."

"I worry that further cuts in funding to the County Predator programs by the ADMB will severely limit these programs from controlling the predator numbers in my county as well as the rest of the state."

Conclusions

Our rancher reported results provide insight about the interaction between livestock and predators in Wyoming. Our results demonstrate a correlation between calving periods and predator pressure, with greater predation in the spring. This relationship corresponds with wolf diet studies in Alberta, Canada where wolf diets shifted seasonally from wild prey in the winter to cattle in the spring and summer. This indicates that ranchers should anticipate ramping up predation mitigation tactics during calving/lambing if they are not already. Moreover, for cattle operations peak parturition periods correlate with peak predation periods but for sheep operations predation is a problem for the majority of the year. As the period of parturition is extended, the period of predation is extended, so shortening the parturition period should theoretically shorten the 'bad' predation period. This also indicates that the seasonal deployment of wildlife technicians during peak predation months might be a more effective use of human resources. The rancher reports that sick or old animals are also associated with an increase in predation, albeit relatively low, also indicates that ranchers should increase vigilance if retaining these types of animals. Finally, because Wyoming is a high elevation state with cold and severe winters that can extend into April and May, ranchers and wildlife technicians should be aware that when severe winter weather overlaps with calving and lambing, the risk of predation is likely to increase.

However, when interpreting our results, it is impossible to separate calving/lambing periods, peak predation months, and moderate predation through the summer from the movement of livestock that is typical in Wyoming and the western USA. In other words, Wyoming ranchers likely deal with predators at the home ranch where they typically calve and lamb (i.e., attract predators) and then when they move to the summer allotments may be moving towards areas with more predators. We hypothesize that the moderate predator response rate for the summer months could also be attributed to the moving of livestock to public grazing allotments in Wyoming that are often rough topographically or are characterized by greater shrubs or forest vegetation at higher elevations.

Our study documented most of our rancher participants reporting an increase in nervous livestock behaviors when predators are present and corroborates other studies and rancher reports from other western US states. We postulate that this cascades into a host of additional behavior changes and non-lethal indirect losses that our participants reported. For example, the consequence of nervous livestock behavior is a change in animal distribution and grazing patterns, a decline in grazing time, and a reduction in body condition, reproduction, and animal performance.

Ranchers in Wyoming USA, where the Great Plains meet the Rocky Mountains, reported substantial predator problems that coincide with livestock production seasonality, landscape features, and losses that extend beyond mortalities. The reported seasonal shift of predator diets from wildlife sources to livestock sources, relative to calving and lambing, is important to document for informing policy and for ranchers to increase mitigation tactics during particularly difficult times. The escalation of predation risk reported to be associated with rough, shrubby, and forested country is also important for policy makers and compensation decision-makers to realize that grazing livestock in these areas often comes with a greater risk and potential loss.

Our survey also indicates that bird predation (eagles, buzzards, ravens) of sheep are a major problem state-wide. Ranchers have very few options in dealing with predatory birds and are also expressing concerns about the effects on wildlife. Our survey also indicates that non-lethal mitigation strategies are generally considered to be non-effective with the exception of guard animals for certain predator species with a few exceptions noted for herding and fencing. Finally, the merging themes we have identified ((1) concern for predatory birds (eagles, buzzards, and ravens), (2) the effects of predators on sage-grouse, and (3) concern about funding in the future) reflect the contemporary state of the issue and necessitate additional attention.

Budget Details

We have spent 63% of the budget that has gone to three items: (1) wages for the student worker (Jessica Windh), supplies for the survey (printing, postage, etc.), and lodging for presentation at the Wyoming Stock Growers Association winter conference in Casper, WY. The remaining funds ($5,632.14) will support the publication fees of anticipated journal articles and Extension bulletins and the student worker to facilitate the finalizing of such publications as originally budgeted. We have had one manuscript come back from a journal requesting more sophisticated modeling which we have completed and are preparing to return to the journal.

Table 3. Expenditures and balance of granted funds (as of 6-5-2017).

		RESP PERSON		SCASTA								
		PROJ TITLE		WYOMING LIVESTOCK PREDATION TRENDS AND MITIGATION SURVEY								
		AGENCY		WY ANIMAL DAMAGE MANAGEMENT BOARD								
		BUDGET ID		4211-11263-1002916								
		START DATE		8.20.15								
		END DATE		7.31.17								
								BAL	**0.00**			
TYPE	DATE	DOC NO.	INV #	VENDOR	DESCRIPTION	ACCT	BUDGET AMT	OBLIGATED	OBL REM	EXPENSE	BALANCE	
	8.20.15		SP	SPONSORED PROGRAMS	INITIAL AWARD	B0000	15,266.00				15,266.00	4
PAY	11.30.15			WINDH, JESSICA	NOV 15 WAGES	1200				39.00	15,227.00	5
PAY	11.30.15			WINDH, JESSICA	NOV 15 WAGES	1903				0.10	15,226.90	5
PAY	12.15.15			WINDH, JESSICA	NOV 15 WAGES	1200				65.00	15,161.90	6
PAY	12.15.15			WINDH, JESSICA	NOV 15 WAGES	1903				0.16	15,161.74	6
PR	12.21.15		REIMB	WINDH, JESSICA	PRINTING	9035				19.92	15,141.82	7
PR	12.21.15		REIMB	WINDH, JESSICA	COPIES	2203				13.78	15,128.04	7
PR	12.21.15		REIMB	WINDH, JESSICA	POSTAGE	2047				6.70	15,121.34	7
PAY	3.15.16			WINDH, JESSICA	FEB 16 WAGES	1200				71.50	15,049.84	9
PAY	3.15.16			WINDH, JESSICA	FEB 16 WAGES	1903				0.18	15,049.66	9
PAY	3.31.16			WINDH, JESSICA	MARCH 16 WAGES	1200				84.50	14,965.16	9
PAY	3.31.16			WINDH, JESSICA	MARCH 16 WAGES	1903				0.21	14,964.95	9
IDR	3.17.16	918239	918239	COPY CENTER	SURVEY PRINTING	9035				3,668.00	11,296.95	10
PAY	4.29.16			WINDH, JESSICA	APRIL 16 WAGES	1200				78.00	11,218.95	10
PAY	4.29.16			WINDH, JESSICA	APRIL 16 WAGES	1903				0.20	11,218.75	10
IDR	4.18.16	919236	919236	COPY CENTER	PRINTING	9035				21.00	11,197.75	11
PC	5.2.16	SCASTA	80212678	ULINE	OFFICE SUPPLIES	2205				412.79	10,784.96	11
PC	5.2.16	SCASTA	273	USPS	POSTAGE	2047				2,720.00	8,064.96	11
PAY	5.13.16			WINDH, JESSICA	APRIL 16 WAGES	1200				221.00	7,843.96	11
PAY	5.13.16			WINDH, JESSICA	APRIL 16 WAGES	1903				0.55	7,843.41	11
PAY	5.31.16			WINDH, JESSICA	MAY 16 WAGES	1200				39.00	7,804.41	11
PAY	5.31.16			WINDH, JESSICA	MAY 16 WAGES	1903				0.10	7,804.31	11
IDR	6.21.16	921010	921010	COPY CENTER	COPIES	9035				8.00	7,796.31	12
IDR	6.30.16	919241	919241	COPY CENTER	COPIES	9035				124.00	7,672.31	12
PC	6.1.16	SHAVER	5753960489	USPS	POSTAGE	2047				272.00	7,400.31	12
PC	7.1.16	SCASTA	136	USPS	POSTAGE	2047				168.50	7,231.81	12
PAY	6.15.16			WINDH, JESSICA	MAY 16 WAGES	1200				97.50	7,134.31	12
PAY	6.15.16			WINDH, JESSICA	MAY 16 WAGES	1903				0.24	7,134.07	12
PAY	6.30.16			WINDH, JESSICA	JUNE 16 WAGES	1200				110.50	7,023.57	12
PAY	6.30.16			WINDH, JESSICA	JUNE 16 WAGES	1903				0.28	7,023.29	12
PC	7.1.16	SCASTA	21955	USPS	POSTAGE	2047				7.75	7,015.54	1
PAY	7.15.16			WINDH, JESSICA	JUNE 16 WAGES	1200				214.50	6,801.04	1
PAY	7.15.16			WINDH, JESSICA	JUNE 16 WAGES	1903				0.47	6,800.57	1
PAY	7.29.16			WINDH, JESSICA	JULY 16 WAGES	1200				52.00	6,748.57	1
PAY	7.29.16			WINDH, JESSICA	JULY 16 WAGES	1903				0.11	6,748.46	1
PR	7.15.16		308	WYOMING STOCK GROWERS /	POSTAGE	2255				136.54	6,611.92	2
PAY	8.15.16			WINDH, JESSICA	JULY 16 WAGES	1200				136.50	6,475.42	2
PAY	8.15.16			WINDH, JESSICA	JULY 16 WAGES	1903				0.30	6,475.12	2
PAY	9.30.16			WINDH, JESSICA	SEP 16 WAGES	1200				130.00	6,345.12	3
PAY	9.30.16			WINDH, JESSICA	SEP 16 WAGES	1903				0.29	6,344.83	3
PAY	12.15.16			WINDH, JESSICA	NOV 16 WAGES	1200				91.00	6,253.83	6
PAY	12.15.16			WINDH, JESSICA	NOV 16 WAGES	1903				0.20	6,253.63	6
PAY	12.22.16			WINDH, JESSICA	DEC 16 WAGES	1200				234.00	6,019.63	6
PAY	12.22.16			WINDH, JESSICA	DEC 16 WAGES	1903				0.51	6,019.12	6
PC	1.2.17	SCASTA	5196	WYOMING STOCK GROWERS /	REGISTRATION	2074				165.00	5,854.12	7
PC	1.2.17	SCASTA	659734	PARKWAY PLAZA	WINDH LODGING	3007				110.99	5,743.13	7
PC	1.2.17	SCASTA	659733	PARKWAY PLAZA	SCASTA LODGING	3007				110.99	5,632.14	7

Appendix A. Survey format.

#	Question	Answer Options
1	What Wyoming county is the majority of your ranching operation located in?	__Albany __Big Horn __Campbell __Carbon __Converse __Crook __Fremont __Goshen __Hot Springs __Johnson __Laramie __Lincoln __Natrona __Niobrara __Park __Platte __Sheridan __Sublette __Sweetwater __Teton __Uinta __Washakie __Weston
2	What is the total size of your ranching operation (select one)?	__1-10 acres __11-100 acres __101-1,000acres __1,000 -10,000acres __10,000-100,000 acres __>100,000 acres
3	What are the most problematic predatory wildlife species for your cattle (rank them from 1 to 7; 1 is the most problematic and 7 is the least problematic)?	__N/A – I don't raise cattle __Foxes __Coyotes __Wolves __Mountain lions __Bobcats __Black bears __Grizzly bears __Hawks/Eagles/Buzzards/Ravens __Stray Dogs
4	What are the most problematic predatory wildlife species for your sheep (rank them from 1 to 7; 1 is the most problematic and 7 is the least problematic)?	__N/A – I don't raise sheep __Foxes __Coyotes __Wolves __Mountain lions __Bobcats __Black bears __Grizzly bears __Hawks/Eagles/Buzzards/Ravens __Stray Dogs
5	What age/stage of livestock are most frequently attacked by foxes (select all that apply)?	__Does not apply to my ranch __Cows/Ewes birthing __Newborn calves/lambs __1-7 days of age __7-21 days of age __3 weeks – 8 weeks of age __Older than 2 months __Old/Geriatric/Sick Stock
6	What age/stage of livestock are most frequently attacked by coyotes (select all that apply)?	__Does not apply to my ranch __Cows/Ewes birthing

		__Newborn calves/lambs __1-7 days of age __7-21 days of age __3 weeks – 8 weeks of age __Older than 2 months __Old/Geriatric/Sick Stock
7	What age/stage of livestock are most frequently attacked by wolves (select all that apply)?	__Does not apply to my ranch __Cows/Ewes birthing __Newborn calves/lambs __1-7 days of age __7-21 days of age __3 weeks – 8 weeks of age __Older than 2 months __Old/Geriatric/Sick Stock
8	What age/stage of livestock are most frequently attacked by mountain lions (select all that apply)?	__Does not apply to my ranch __Cows/Ewes birthing __Newborn calves/lambs __1-7 days of age __7-21 days of age __3 weeks – 8 weeks of age __Older than 2 months __Old/Geriatric/Sick Stock
9	What age/stage of livestock are most frequently attacked by bobcats (select all that apply)?	__Does not apply to my ranch __Cows/Ewes birthing __Newborn calves/lambs __1-7 days of age __7-21 days of age __3 weeks – 8 weeks of age __Older than 2 months __Old/Geriatric/Sick Stock
10	What age/stage of livestock are most frequently attacked by black bears (select all that apply)?	__Does not apply to my ranch __Cows/Ewes birthing __Newborn calves/lambs __1-7 days of age __7-21 days of age __3 weeks – 8 weeks of age __Older than 2 months __Old/Geriatric/Sick Stock
11	What age/stage of livestock are most frequently attacked by grizzly bears (select all that apply)?	__Does not apply to my ranch __Cows/Ewes birthing __Newborn calves/lambs __1-7 days of age __7-21 days of age __3 weeks – 8 weeks of age __Older than 2 months __Old/Geriatric/Sick Stock
12	What age/stage of livestock most frequently attacked by hawks/eagles/buzzards/ravens (select all that apply)?	__Does not apply to my ranch __Cows/Ewes birthing __Newborn calves/lambs __1-7 days of age __7-21 days of age __3 weeks – 8 weeks of age __Older than 2 months __Old/Geriatric/Sick Stock
13	What age/stage of livestock are most frequently attacked by stray dogs (select all that apply)?	__Does not apply to my ranch __Cows/Ewes birthing __Newborn calves/lambs __1-7 days of age __7-21 days of age __3 weeks – 8 weeks of age __Older than 2 months __Old/Geriatric/Sick Stock

14	What was the first year you noticed a livestock kill for each predator species?	______Foxes ______Coyotes ______Wolves ______Mountain lions ______Bobcats ______Black bears ______Grizzly bears ______Hawks/Eagles/Buzzards/Ravens ______Stray Dogs
15	What month of the year is the worst predation month for you (check all that apply)?	__January __February __March __April __May __June __July __August __September __October __November __December
16	What month of the year do you calve/lamb (check all that apply)?	__January __February __March __April __May __June __July __August __September __October __November __December
17	How many head of <u>mature cows/bulls</u> did you lose in the last year for each predator species?	____N/A – I don't raise cattle ____Foxes ____Coyotes ____Wolves ____Mountain lions ____Bobcats ____Black bears ____Grizzly bears ____Hawks/Eagles/Buzzards/Ravens ____Stray Dogs ____Unknown
18	How many head of <u>calves</u> did you lose in the last year for each predator species?	____N/A – I don't raise cattle ____Foxes ____Coyotes ____Wolves ____Mountain lions ____Bobcats ____Black bears ____Grizzly bears ____Hawks/Eagles/Buzzards ____Stray Dogs ____Unknown
19	How many head of <u>mature ewes/rams</u> did you lose in the last year for each predator species?	____N/A – I don't raise sheep ____Foxes ____Coyotes ____Wolves ____Mountain lions ____Bobcats ____Black bears

		____Grizzly bears ____Hawks/Eagles/Buzzards/Ravens ____Stray Dogs ____Unknown
20	How many head of <u>lambs</u> did you lose in the last year for each predator species?	____N/A – I don't raise sheep ____Foxes ____Coyotes ____Wolves ____Mountain lions ____Bobcats ____Black bears ____Grizzly bears ____Hawks/Eagles/Buzzards/Ravens ____Stray Dogs ____Unknown
21	Is livestock predation greater with any of these landscape, weather, or management features (check any that apply)?	__Going to a public grazing allotment __Rough country __Forested country __Shrubby country __Severe winter weather (snow/ice/cold) __Severe summer weather (drought) __Sick animals __Old animals
22	What are the most effective strategies to mitigate predation losses to <u>foxes</u>?	__Not a problem __Guard animals __Fencing __Herding __Stalling at night __Shooting __Trapping/snaring __Private trapper __Government trapper
23	What are the most effective strategies to mitigate predation losses to <u>coyotes</u>?	__Not a problem __Guard animals __Fencing __Herding __Stalling at night __Shooting __Trapping/snaring __Private trapper __Government trapper
24	What are the most effective strategies to mitigate predation losses to <u>wolves</u>? (*Any indication of mitigation methods perceived as effective are assumed to be within the scope of the law and practiced under the appropriate permissions or by federal technicians.*)	__Not a problem __Guard animals __Fencing __Herding __Stalling at night __Shooting __Trapping/snaring __Private trapper __Government trapper
25	What are the most effective strategies to mitigate predation losses to <u>mountain lions</u>?	__Not a problem __Guard animals __Fencing __Herding __Stalling at night __Shooting __Trapping/snaring __Private trapper __Government trapper
26	What are the most effective strategies to mitigate predation losses to <u>bobcats</u>?	__Not a problem __Guard animals __Fencing

		__Herding __Stalling at night __Shooting __Trapping/snaring __Private trapper __Government trapper
27	What are the most effective strategies to mitigate predation losses to grizzly bears? (*Any indication of mitigation methods perceived as effective are assumed to be within the scope of the law and practiced under the appropriate permissions or by federal technicians.*)	__Not a problem __Guard animals __Fencing __Herding __Stalling at night __Shooting __Trapping/snaring __Private trapper __Government trapper
28	What are the most effective strategies to mitigate predation losses to black bears? (*Any indication of mitigation methods perceived as effective are assumed to be within the scope of the law and practiced under the appropriate permissions or by federal technicians.*)	__Not a problem __Guard animals __Fencing __Herding __Stalling at night __Shooting __Trapping/snaring __Private trapper __Government trapper
29	What are the most effective strategies to mitigate predation losses to hawks/eagles/buzzards/ravens? (*Any indication of mitigation methods perceived as effective are assumed to be within the scope of the law and practiced under the appropriate permissions or by federal technicians.*)	__Not a problem __Guard animals __Fencing __Herding __Stalling at night __Shooting __Trapping/snaring __Private trapper __Government trapper
30	What are the most effective strategies to mitigate predation losses to stray dogs?	__Not a problem __Guard animals __Fencing __Herding __Stalling at night __Shooting __Trapping/snaring __Private trapper __Government trapper
31	Do your livestock change any behavior when predators are in the area (select all that apply)?	__Hard to work __Increased exit rate out of squeeze chute __Hard to gather __Nervous __Low conception rate __Low birth rate __Delayed birth season __Low weight gains __Reduced grazing time __Change in distribution and grazing patterns
32	How does the designation of ‘predator’ animals, ‘trophy’ animals, or both complicate or improve the management of livestock losses to predators?	Open Answer…
33	Do you have any other concerns or opinions you would like to express related to livestock predation in Wyoming?	Open Answer…

WSG

Wyoming Sportsman's Group

P.O Box 1735 - Gillette, WY 82717
307-660-0636

DATE: May 3, 2015

TO: Wyoming Animal Damage Management Board
FROM: Wyoming Sportsman's Group
RE: Duck Creek Predator & Habitat Improvement Project

We are the Wyoming Sportsman's Group, a non-profit organization that was just developed in March of 2014. Our mission is to promote the conservation of our natural resources of fish and wildlife, development of sportsmanship, and value of fishing, hunting and shooting sports.

Other national wildlife organizations were very successful in their fundraising events in the northeast Wyoming area, but very few local projects were being supported by these national organizations. Our organization was created to help local projects that support the sportsman in the area. We feel that the Duck Creek Predator & Habitat Improvement Project is a great project for the northern part of Campbell County. It includes public as well as private land and fits our criteria for our projects that we are looking to fund. Our contribution to this project will be $3,000.00 for 2015.

Duck Creek Predator & Habitat Improvement Project

Campbell County Predator Management Board

May, 11th 2015

1.0 Introduction

Because of their popularity and wide distribution, mule and black-tailed deer (collectively referred to as 'mule deer,' *Odocoileus hemionus*) are one of the most economically and socially important animals in western North America. In a 2006 survey of outdoor activities, the U. S. Fish and Wildlife Service (USFWS) reported nearly 3 million people hunted in the 19 western states (USFWS 2007). Although this included hunters who pursued other species, mule deer have traditionally been one of the most important game animals in the West. In 2006 alone, hunters were afield for almost 50 million days and spent more than $7 billion in local communities across the West on lodging, food, fuel, and hunting-related equipment. The mule deer is valued as an integral part of the western landscape by hunters and non-hunters alike. According to the 2006 USFWS survey, 25.6 million residents in 19 western states spent more than $15.5 billion that year "watching wildlife." The value of having abundant populations of such a charismatic species as mule deer cannot be overemphasized. Thus, social and economic impacts of mule deer declines are critical to all agencies that manage mule deer and the habitat they rely on.

Historical accounts suggest mule deer were not abundant during the 19th century (Julander and Low 1976, Connolly 1981). The population increased after the turn of the century, reaching its maximum densities in the 1950's and early 1960's. The population declined in the late 1960's and has fluctuated since. In more recent years, comparatively higher abundance was documented in the early 1980's and 1990's. However, the population apices are believed to be lower with each subsequent cycle. Possible factors include declining habitat quality and quantity, competition with elk, drought, and predation.

The Campbell County Predator Management Board (CCPMB) (Wyoming) recognizes the importance that the mule deer as well as other big game animals play in our local economy and ecosystem. Over the last several decades, many landowners and sportsman in northeast Wyoming have commented on the decline of mule deer numbers. While the Wyoming Game and Fish Department (WGFD) has done a great job looking at overall herd health and numbers, often due to budget restrictions, some sub-populations of mule deer don't receive adequate monitoring and management. The CCPMB believes that the decline of deer numbers may have a correlation with the 1972 executive order issued by President Nixon banning the use of all toxicants for predation control measures, and the high numbers of predators (coyotes, bobcats, mountain lions) in the area are one of the reasons why the sub-population is in decline.

The CCPMB is attempting to enhanced predator control efforts in a designated area in northeast Wyoming. Following the enhanced predation control. The CCPMB and WGFD will begin a variety of enhancement projects located within the project area boundaries.

2.0 Project Area

The Duck Creek Predator and Habitat Improvement project (DCP) is located in Campbell County, WY (**Figure 1**). Two project areas have been previously located by the CCPMB (a treatment area, and a non-treatment area).

Big game animals and predator species are dynamic, and move across the region depending on various external pressures. Within a three mile perimeter of the project area(s), the following acres will benefit from the enhanced predation control:

- Bureau of Land Management (Public Lands) – 39, 558 acres
- Bankhead Jones Land (Public Lands) – 9,286 acres
- United States Forest Service (Public Lands) – 4,922 acres
- State Lands, Wyoming & Montana (Public Lands) – 24,692 acres

Total acreage of public lands enhanced by this project – **78,458 acres**

2.1 Benefit to the Public

The CCPMB understands the importance of hunting and livestock production. They believe strongly that the a main reason for the continual decline of mule deer, pronghorn, elk, and wild turkey numbers are due to the high amount of predators in the area. By implementing a project such as this, we believe it will help in determining the proper level of predation control and inversely positively enhance the overall deer, pronghorn, elk, and wild turkey numbers in the region. CCPMB will also implement habitat improvement projects in the area. The project area is a semi-arid/arid environment making water a limited resource. Through different conservation measures, water improvement and development could greatly improve habitat increasing deer, pronghorn, elk and wild turkey numbers in the region.

The project area falls into the following:

<u>Mule Deer</u>

Hunt Area – 18 (See Attachment B)
Herd Unit – 319, Powder River Herd

<u>Pronghorn</u>

Hunt Area – 17, 18, 19 (See Attachment C)
Herd Unit – 339, 351

<u>Elk</u>

Hunt Area – 129 (Attachment D)

<u>Wild Turkeys</u>

Hunt Area – 3 (Attachment E)

3.0 Objectives

The objectives of the project include:

- Conduct a high level of predation control efforts; and
- Increase water availability for big game species; and
- Improve water quality and riparian degradation

4.0 Project Design

The CCPMB is anticipating a 3 year project implementation timeline. The project has been broken down into 2 phases detailed below.

4.1 Phase 1 – Predation Control

Lethal control methods are required to stop coyote depredation or to reduce the coyote population in an area. Various lethal control options are available, including traps, snares, shooting, denning and toxicants. The effectiveness, selectivity, and specificity of each method will be considered before being utilized. Each method requires varying degrees of skill and experience to be made effective. Usually a combination of control methods is most effective. (Dorsett, 2013)

All of our predator controls methods will be done by qualified and professional trappers. All locations of predators removed from the treatment area will be documented via GPS location. The CCPMB still has landowner agreements for predation control in the non-treatment area, therefore, control will continue in that area. However, for the treatment area, the amount of active control will be twice as much, and we will use the following methods as the non-treatment area.

Currently the CCPMB administers predation control on approximately 1.8 million acres of land. As a part of the declining big game population in the area, the project design is to increase the amount of predation control on the treatment area compared to the non-treatment control area. The various treatments are listed below.

4.1.1 Leg hold Traps

The steel leg hold trap is a mechanical capture device that is a versatile tool for coyote control. Traps can be set to work in various situations. A No. 3 or No. 4 trap size is recommended for coyotes.

4.1.2 Snares

The snare is a mechanical device consisting of flexible wire cable loop and locking device that tightens around the coyote's body as it passes through the loop. Snares are made of flexible cable, usually 1/16 to 3/32 inches in diameter. The length of a snare varies, but they usually are between 32 and 48 inches long. (Dorsett, 2013)

4.1.3 Calling and Shooting

Hunting coyotes by attracting them within shooting range with predator calls can be effective in some cases. Calling coyotes during daylight, especially in the early morning hours, is best. Calling and shooting is a selective tool, but requires some skill. Calling success improves in areas of high coyote populations. To be successful in areas of low coyote density, it is critical to be in the right place at the right time when you call. (Dorsett, 2013)

4.1.4 Denning

Denning is the practice of removing coyote pups and/or the parent coyote from the den during whelping season, from April through June. The primary purpose of denning is to reduce or stop predation by adult coyotes that are killing large mammals to feed their pups. Normally if the pups are removed the predation by the coyote will stop (Crosby and Wade, 1978). Denning is a highly selective technique, however, tracking skills and knowledge of coyote behavior is required for the den hunter to be consistently successful.

during dry times. Placement of guzzlers is crucial to optimize production. Placing them on south facing slopes allows them to catch more moisture during winter months and reduces the amount of evaporation during summer months (Practical Wildlife Applications of Wildlife Water Drinkers, 2012).

4.2.3 Riparian Fencing

Riparian fencing can be a good way to eliminate grazing pressure and improve overall riparian health. There is exclusion fencing, eliminating all grazing, and rotational grazing. Grazing riparian areas during plant dormancy can reduce pressure on riparian plants while still utilizing vegetation. Restricting access points to riparian areas can also improve riparian health. Fencing off corridors and placing crushed rock or another suitable material can eliminate trampling effects caused by livestock and wildlife (Machtinger, 2007).

5.0 ESTIMATED COST

In a short time we have had generous support for the project proposed by the Campbell County Predator Management Board. The local sportsman and wildlife enthusiasts understand how valuable the efforts are. In this area of northeast Wyoming, public land is a premium. Much of the population depends on the relative small amount of public land in the area to recreate.

5.1 Current Contributions

Currently, the CCPMB has several donations, and are very appreciative of those who have supported. Below is a listing of the current project contributions and amounts. We are confident that additional contributors will participate in the project.

Table 1: Current Funding

2015 Contributing Party	Amount
Wyoming Sportsman's Group	$3,000
Habitat Management, Inc.*	$1,000
	$4,000

5.2 Anticipated Funding Opportunities

With projects of this scale, helping enhance almost 78,500 acres, funding is always a priority.

Table 2 displays our estimated total project cost. The CCPMB will also seek funding from the following organizations, as well as others:

- Mule Deer Foundation
- Rocky Mountain Elk Foundation
- Sportsman for Fish and Wildlife
- Wild Turkey Federation
- Wyoming Heritage Foundation
- Private Partners
- Any other interested parties

Table 2: Estimated Project Cost

Phase 1 Tasks	Estimated Cost
Task 1 – Define Scope of Work, Develop Monitoring Protocols, Build Maps	$500.00
Task 2 – Help Secure Funding For Project*	In Kind
Task 3 – 2015/16 Predation Control (36 Plane flight hours, gunner, trapper)	$31,060.00
Task 4 – Report Preparation	$1,000.00
Phase 1 Total	$32,560.00
Phase 2 Tasks	**Estimated Cost**
Development of 2 water guzzlers	$6,000.00
Development of 2 springs	$8,000.00
Two miles of riparian fencing	$12,000.00
Phase 2 Total	$26,000.00
Estimated Total of Project	**$58,560.00**

*In Kind services by Habitat Management, Inc. Up to $1,000.00

6.0 References

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Attachment A: Wyoming G&F Letter

WYOMING GAME AND FISH DEPARTMENT

5400 Bishop Blvd. Cheyenne, WY 82006

Phone: (307) 777-4600 Fax: (307) 777-4699

wgfd.wyo.gov

March 11, 2015

Kenda Ford
Campbell County Predator Management District
5201 Tarry
Gillette, WY 82718

Dear Kenda:

Per our agreement with ADMB, we are providing you with the deer and antelope hunt areas in Campbell County that meet the fawn to doe ratio guideline for predator management work for the benefit of wildlife based on Wyoming Game and Fish Commission policy. The following hunt areas had post hunting season ratios of less than 65 fawns per 100 does for mule deer and pre-hunting season ratios of less than 65 fawns per 100 does for antelope. The Department's highest priority for predator management work focusing on coyotes is in areas where both mule deer and antelope meet the criteria for predator control work. We have included maps showing deer and antelope hunt areas for your reference.

Deer Hunt Areas: None
Antelope Hunt Area: 18

Poor fawn recruitment was observed in Antelope Area 18 in northeast Campbell County. Therefore, we suggest that predator control efforts to benefit wildlife could be focused on this part of Campbell County in areas with lower densities of antelope where predator control may help with survival of fawns.

We are concerned about sage-grouse populations throughout the Sheridan Region. Predator control work targeting red fox, raccoons, and skunks in nesting and brood rearing habitat surrounding sage-grouse lek sites would remove potential nest predators. The majority of nesting occurs within a couple miles of a lek so that would be the most beneficial area to focus this type of predator control to benefit sage-grouse.

Dustin Kirsch (687-7157) is the Department liaison to your board. Please give Dustin a call if you have any questions or concerns.

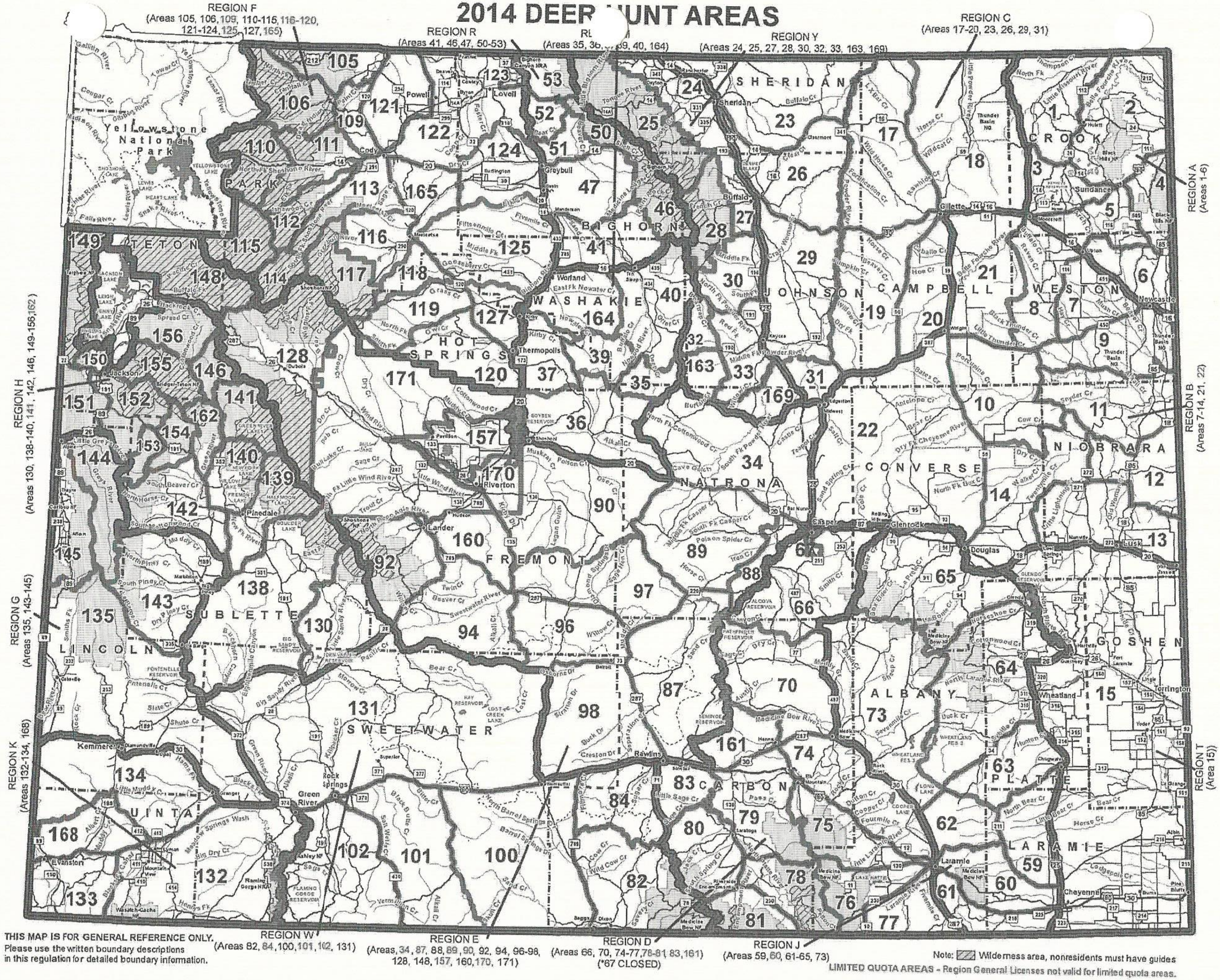
Sincerely,

Joseph E. Gilbert

Joe Gilbert
Sheridan Regional Wildlife Supervisor
(307) 672-7418

JG/lj

2014 DEER HUNT AREAS



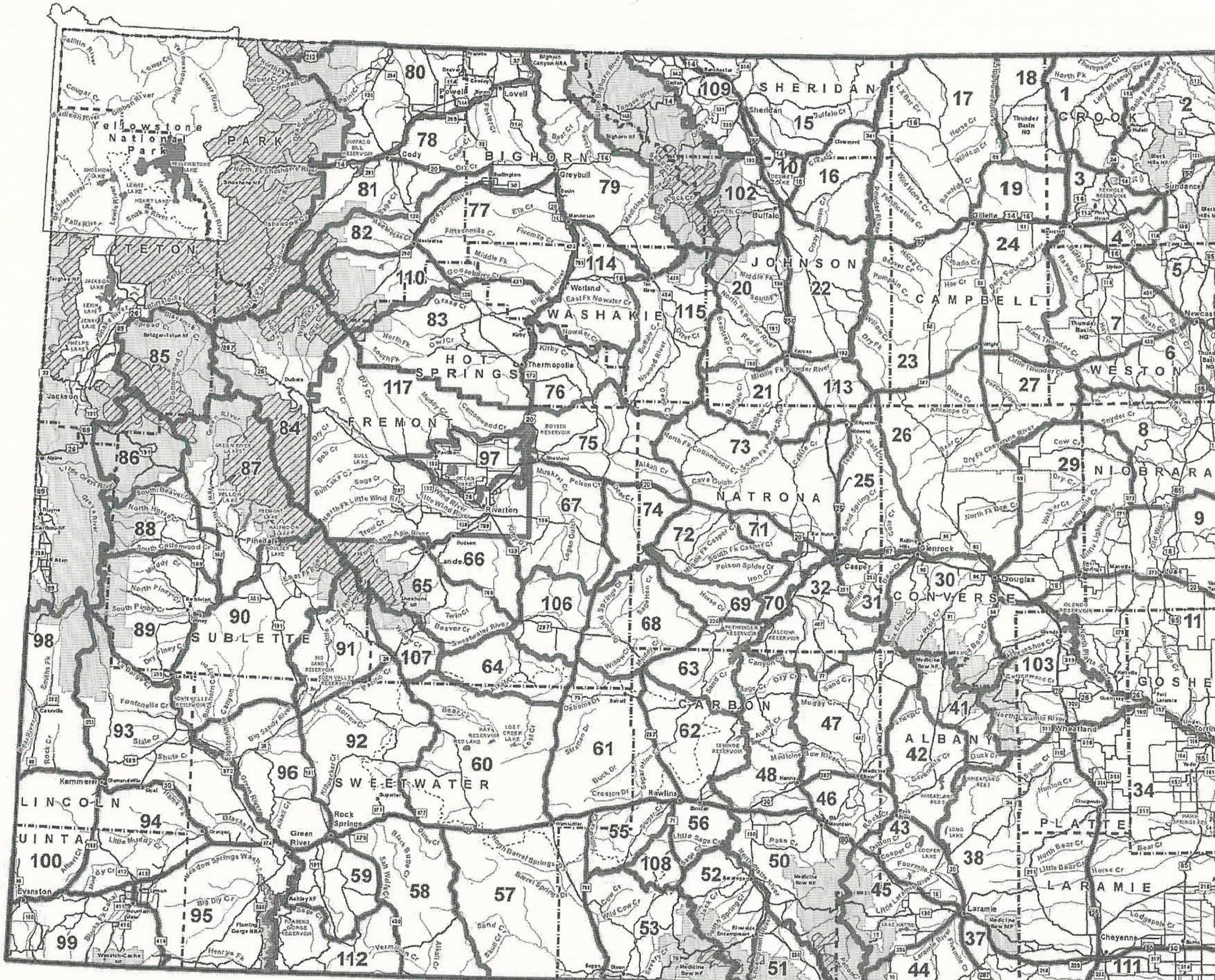
THIS MAP IS FOR GENERAL REFERENCE ONLY.
Please use the written boundary descriptions in this regulation for detailed boundary information.

Note: Wilderness area, nonresidents must have guides

LIMITED QUOTA AREAS - Region General Licenses not valid for limited quota areas.

Attachment C: Pronghorn Hunt Area Map

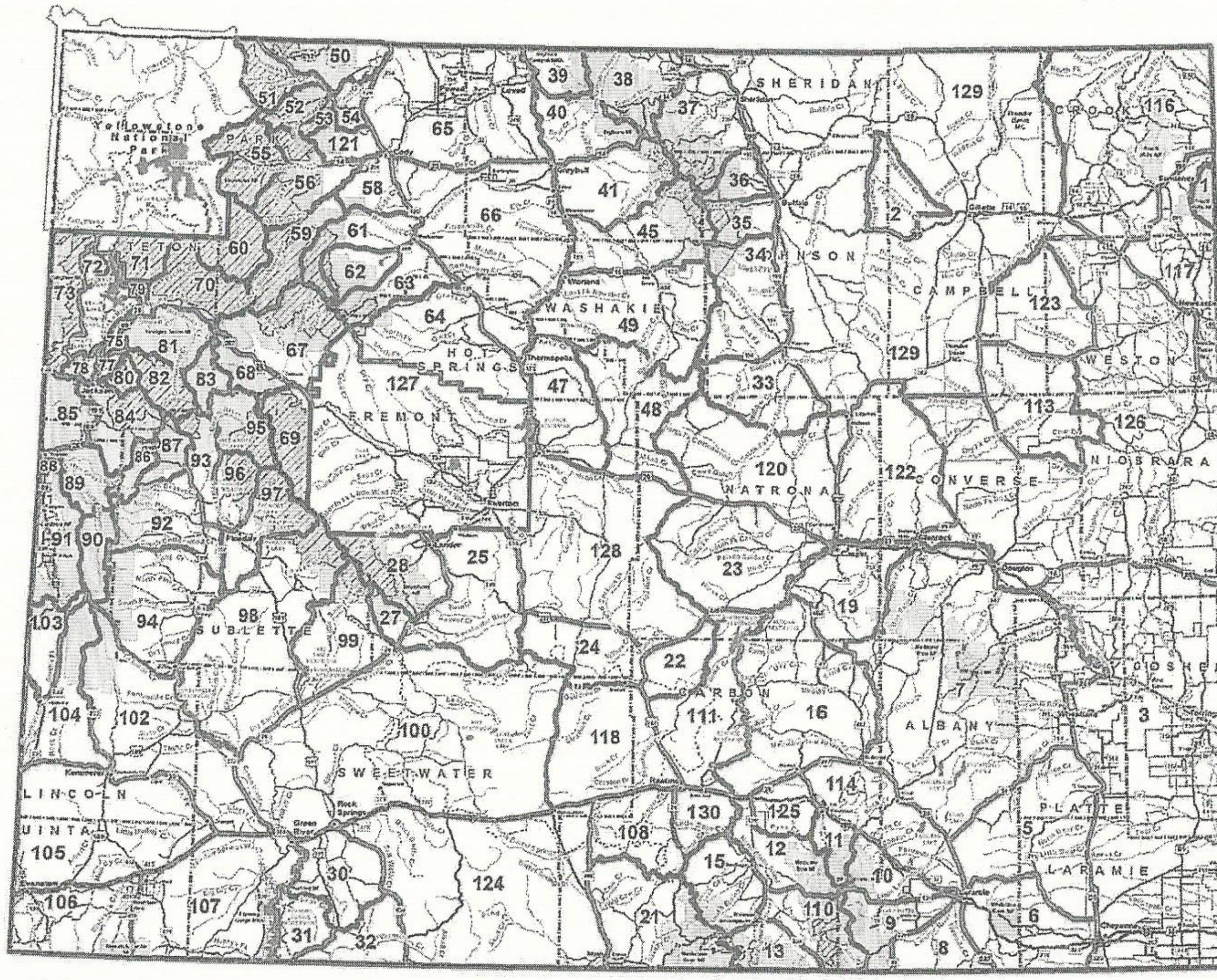
2014 ANTELOPE HUNT AREAS



THIS MAP IS FOR GENERAL REFERENCE ONLY. Please use the written boundary descriptions in this regulation for detailed boundary information.

Note: Wilderness area, nonresidents must have guides

ELK HUNT AREAS

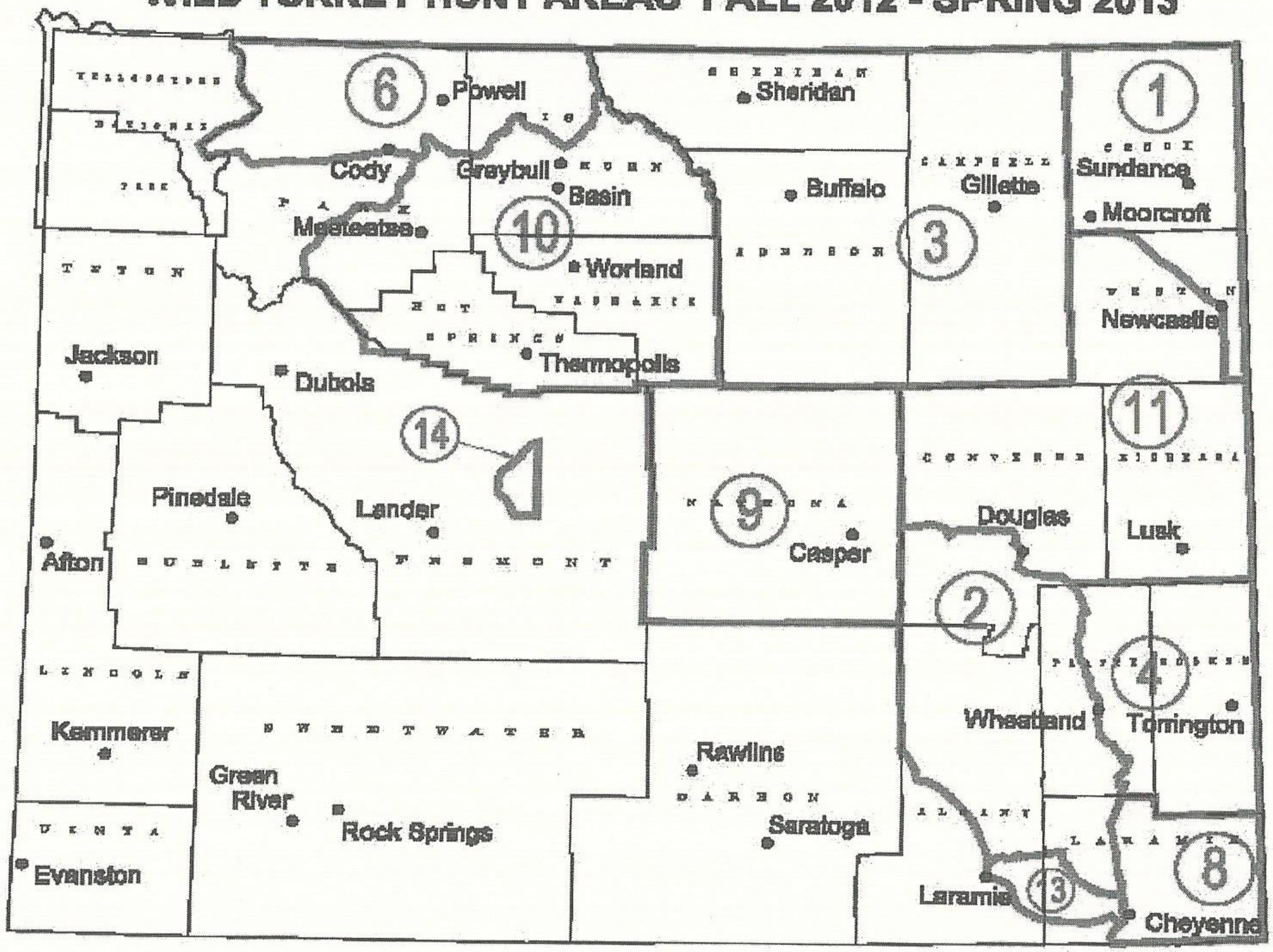


THIS MAP IS FOR GENERAL REFERENCE ONLY. Please use the written boundary descriptions in this regulation for detailed boundary information.

Note: Wilderness area, nonresidents must have guides

Attachment E: Wild Turkey Hunt Area Map

WILD TURKEY HUNT AREAS FALL 2012 - SPRING 2013



THIS MAP IS FOR GENERAL REFERENCE ONLY. Please use the written boundary descriptions in this regulation for detailed boundary information.

Attachment F: Letters of Support

To Whom It May Concern

Up until last year I operated an outfitting business in the Adon area as well as some other areas. After 26 years I was forced to discontinue my operation due to ranchers requesting that I do not take any more mule deer and antelope in those areas because of lack of animals. I had already decreased the amount of animals taken for the last 10 years or more.

I also operate a spraying business and do weed control in those areas as well. In the last year I have noticed a considerable increase in both deer and antelope fawns as well as other animals and birds.

Last year was a good year as far as moisture goes but that wasn't the only good year we've had in the last 10-15 years.

In all the areas I have observed I feel the animals have been on a steady decline for 30 years or more.

It takes time and everything possible including intense predator control to build those herds back up. All the research and studies I've read say the same thing, predator control is necessary to help mule deer and antelope herds rebound from a decline.

With that in mind I would like to see those involved continue funding for the predator control and other projects that are planned for those areas.

Thank you,

Former owner of High Plains Outfitters

Merv Griswold

Merv Griswold

To whom it may concern:

I feel the Adon Predation Program really helped conditoins in my area. I had been watching populations fall for the last decade or so until fawn survival rate was below 20% before hunting seasons. The program increased the survival rate to over 80% and the herd numbers this year are better than they have been for a number of years.

This program helped other animals and birds as well. Rabbits and birds also benefited to a large extent.

An oil well is going to be drilled south of my ranch boundary & the 2-mile radins extends onto my ranch. The biologists doing the survey in April told me they are finding sage grouse numbers & lecks in better numbers than they anticipated. I am seeing the same thing as I saw quite a few hens with chicks around last summer.

Please fund this Program as I believe it has benefited this area quite a bit.

Thank you.

Dave Shippy

1-307-282-4913

To who it may concern:

My name is Don Hamm and I reside at 1686 Adon Rozet, Wyo I am in the mule deer study area. My family has ranched in this location since the early 1940's and have witnessed the ebb and flow of game and predator numbers.

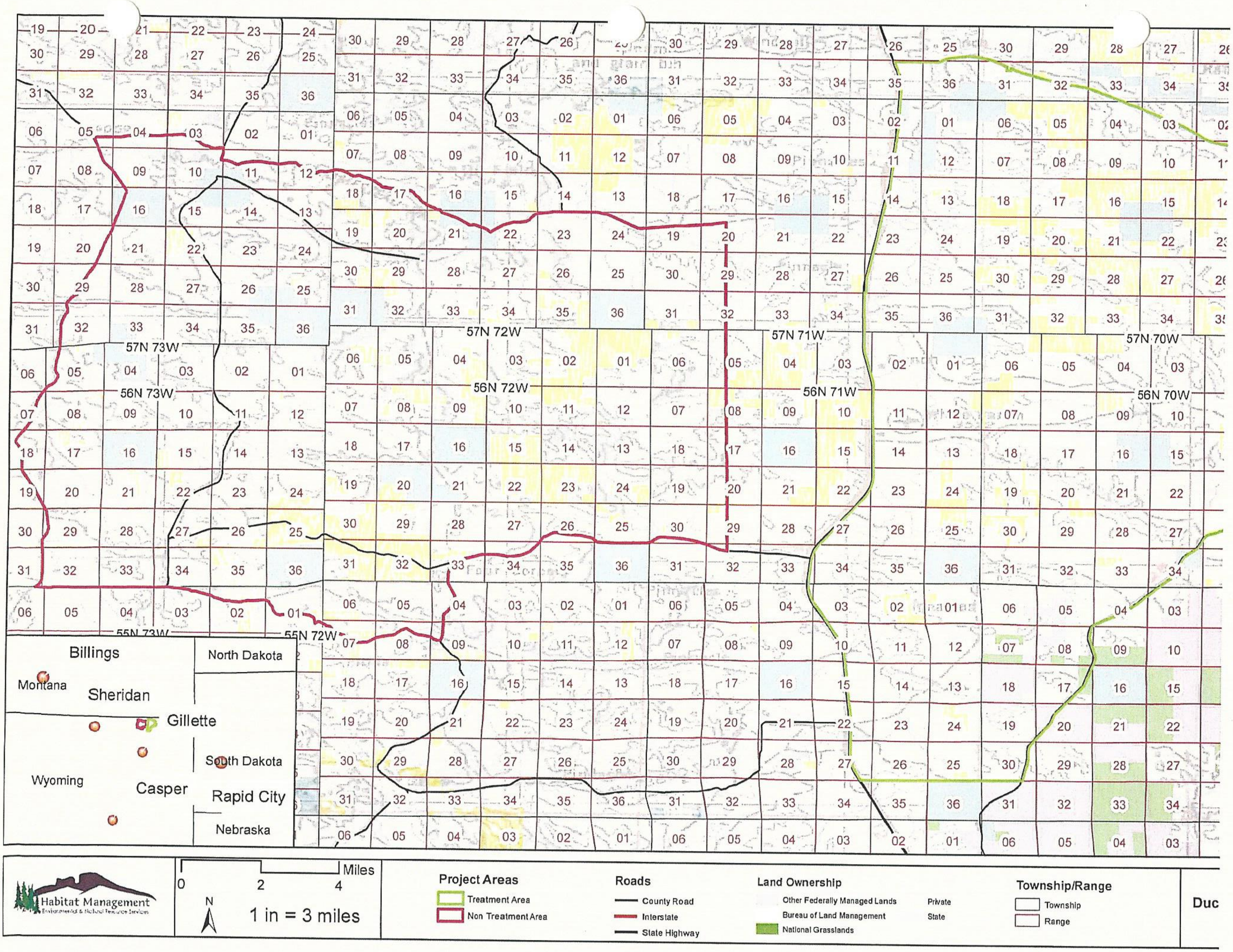
I have always been a advocate of predator control and was elated when the study area was announced. I was equally disappoint the study was not refunded for another year.

In the last year I have noticed more deer and antelope fawns surviving the fall and winter. I have also seen more game birds including sage grouse, rabbits and song birds. These numbers have increased in the last 12 to 18 months. The only thing that has change is the increased efforts to control coyotes. I strongly urge reconsideration of the decision. This would help wildlife numbers and return our game habitate to a more historic level

Don Hamm

DIVOGA

Figure 1: Duck Creek Predator and Habitat Improvement Project Map



57N 73W
56N 73W
55N 73W
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56N 72W
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57N 71W
56N 71W
57N 70W
56N 70W
Billings
Montana
Sheridan
Gillette
Wyoming
Casper
North Dakota
South Dakota
Rapid City
Nebraska
Habitat Management
0 2 4 Miles
N
1 in = 3 miles
Project Areas
Treatment Area
Non Treatment Area
Roads
County Road
Interstate
State Highway
Land Ownership
Other Federally Managed Lands
Bureau of Land Management
National Grasslands
Private
State
Township/Range
Township
Range
Duc

Project Title: Coyote control targeted on mule deer fawning areas at Cedar Mountain
Brief Description of Project: Program of targeted predator control on key fawning ranges when it is most effective for the benefit of mule deer in the Uinta mule deer herd unit. Work targeted using data from the radio collar study
Submitted By / Affiliation: Jeff Short / Wyoming Game and Fish Department

The project area is located within Uinta and Sweetwater Counties in deer hunt area 132. This is within the Uinta mule deer herd unit and is commonly referred to as the Cedar Mountain area. The project commenced May 1, 2012 and will run through July 2014.

The Uinta/Cedar Mountain deer herd has not been able to fully recover from a severe population crash that occurred in the early 1990's. Manipulations of hunting season strategies alone have not improved overall herd numbers. Fawn recruitment continues to suffer and post season fawn ratios are not adequate to grow this herd to our objectives.

Several studies have found that the vast majority of coyote caused mortalities on mule deer occur in the first two months of their lives. This predation is usually by a select number of coyotes occupying specific fawning ranges. It is often intensified during times of low availability of alternate prey, depressed deer populations and where fawns are vulnerable due to habitat limitations. This may be the case at the present time since rabbit populations are at a low, mule deer numbers are depressed and deer in the area are experiencing low fawn recruitment. It has been found that coyote control done to benefit mule deer is far more effective if done in high intensity on specific fawning ranges immediately before, during and right after the fawning and done to specifically target coyotes active in those areas.

From our recent mule deer study funded in part by ADMB we have gained valuable information on the mule deer population in the area. We found that 98% of captured does were pregnant in the winter. This high pregnancy rate is typical for mule deer. We followed those radio collared does in June and found that at least 80% of pregnant does had a minimum of one fawn at side. During the following December we flew extensive classification surveys in those areas and found a fawn:doe ratio of only 46:100. That means on average only 46% of does still had a single fawn surviving to 6 months of age. This is a very low figure indicating a very dire situation for the mule deer herd. Doe survival was very high from the previous winter at 96% and doe condition appeared to be at or above normal. Mule deer fawning habitats are very limited in this area and the amount of quality habitat is most likely restricting the ability to grow fawns to 6 months old. Coyote predation on fawns is exacerbated by the small areas available for mule deer fawning habitat. A coyote can be very effective at hunting fawns when there are small patches of quality fawning habitat to hunt. The identified fawning habitats have not received predator control treatment in the past. A three year intensive coyote removal effort was advised. The Muley Fanatic Foundation of Wyoming (MFF) funded year one of this work in 2012. ADMB and the MFF jointly funded year two and three of the project in 2013 and 2014. After treatments we can look at post treatment faw:doe ratios to determine the effectiveness of our efforts.

The Uinta County Predator Board provides personnel, support, ground work and local expertise in the coyote removal efforts. They contract with a competent vendor to complete the aerial gunning operations. The funding allows for approximately 12-15 hours per year of helicopter coyote removal. This is time specific on identified mule deer fawning ranges. Maps of key identified fawning ranges are provided to the Unita County Predator Board. Those maps have been updated yearly as new data is analyzed. Coyote removal is conducted immediately prior to, during or immediately after mule deer fawning. This typically occurs in the first week of June in this area. This maximizes the benefit to mule deer. After the project is complete and all data is collected by the end of 2014 we will be able to analyze changes in Fawn:doe ratios in Hunt Area 132

ADMB budget expenditures

helicopter coyote removal	$ 5,000.00

ADMB Project Final Report

The Wyoming Game and Fish Department used the ADMB funding to purchase a bear trap for the Sheridan Region. C&C Welding constructed and painted the bear trap for the quoted amount as proposed to the ADMB (Figure 1). The bear trap was built last fall and transported to the Sheridan Region early spring of 2016 and will be used to mitigate any human-bear conflicts (Figure 2).

C & C Welding, Inc

243 Blackburn
PO Box 1964
Cody, WY 82414
Phone (307)527-5280
Fax (307)587-7575
ccweld@inbox.com

PROPOSAL

April 6, 2015

Wyoming Game & Fish
2820 Hwy 120
Cody, WY 82414
ATTN: Dusty

REF: Build 1 Bear Trap

Propose to furnish all material and labor for 1 bear trap.

Labor and material total cost for 1 bear trap $5,750.00.

Charles Wittick, President

Figure 1. Bear Trap Quote

Figure 2. Completed bear trap.

May 2, 2016

FY16 FINAL PROJECT REPORT

July 1, 2015 – June 30, 2016

Project Title: Green River Region Bear Trap Trailer

Brief Synopsis of Project: Purchase a new box style bear trap trailer for the Green River Region. Use to respond to black bear depredation, damage, and health and safety conflicts and complaints in southwest Wyoming.

Project Details: As black bear conflicts and livestock depredation incidents have increased in recent years, the region's ability to respond and handle calls has diminished with only one viable trap. The addition of a new and far-improved trap will enhance our ability to adequately and effectively respond to the public's needs.

Project Status: The bear trap trailer was designed and constructed by C & C Welding on Cody, Wyoming and delivered to the Wyoming Game and Fish Department in March 2016. The trap has been plated and provisioned with necessary equipment and supplies to respond to black bear incidents. To date, the bear trap has not been deployed but we anticipate use in late spring and summer when bear problems typically increase.

Submitted by: Steve DeCecco
Wyoming Game and Fish Department
351 Astle Avenue
Green River, WY 82935

Phone: 307-875-3223
E-mail: steve.dececco@wyo.gov