

# BIOLOGICAL SCIENCES – TERRESTRIAL

## ABSTRACTS

### MONTANA CHAPTER OF THE WILDLIFE SOCIETY 50<sup>TH</sup> ANNUAL MEETING

*50 Years of Partnerships:  
What have we learned and where are we headed*

February 28 - March 2, 2012

Great Falls, Montana

**General Abstracts**  
Alphabetical By First Author's Last Name  
(\* Denotes Presenter)

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## INCORPORATING ECOHYDROLOGIC VARIABLES INTO MODELING OF PATTERNS OF MONTANE-MAMMAL DISTRIBUTION AND ABUNDANCE

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Montane ecosystems have been suggested by both paleontological and contemporary research to often be systems of relatively rapid faunal change, compared to many valley-bottom counterparts. In addition to often (but not always) experiencing greater magnitudes of contemporary change in climatic parameters than species in other ecosystems, mountain-dwelling wildlife must also accommodate often-greater intra-annual swings in temperature and wind speeds, poorly developed soils, and generally harsher conditions. We present new results of ecoregional-level analyses of American pikas (*Ochotona princeps Richardson*) that illustrate how biologically relevant derived hydrological variables can be important to predictors of abundance. We also present new results from the Northern Rocky Mountains that illustrate how behavioral plasticity can, in at least some cases, 'soften' the boundaries of species' bioclimatic niches. Landscape Conservation Cooperatives and Climate Science Centers are newly emerging efforts that may contribute greatly to broad-scale, mechanism-based investigations to inform management and conservation of diverse montane wildlife and the ecosystem components with which they interact. Based on our empirical findings and our review of the literature, we propose tenets that may serve as foundational starting points for our expanding research on montane animals across the Northern Rocky Mountain Region.

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## **MODELING CARNIVORE SIGN DATA: A CASE STUDY WITH THE CARNIVORE GUILD IN A RANCH IN EASTERN MONTANA**

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Track deposition patterns by carnivores on a 54 km<sup>2</sup> ranch in eastern Montana were recorded with a sand strip passive index survey method over the course of 33 days. Carnivore tracks identified included coyotes ( $n = 17$ ), bobcats ( $n = 8$ ), feral cats ( $n = 6$ ), pumas ( $n = 1$ ), and long-tailed weasels ( $n = 1$ ). Using temporal, weather, and habitat covariates, coyote intrusions were modeled with generalized linear models using a negative binomial distribution and log link. An information theoretic approach using the Akaike information criterion adjusted for sample size (AICc) to compare the relative support of multiple models indicated that habitat type had a strong influence on coyote track deposition, and that weather and temporal covariates were comparatively poor descriptors of coyote track patterns. Autocorrelation functions revealed no evidence for daily temporal autocorrelation of coyote intrusion numbers in either habitat, and a Spearman's rank correlation coefficient suggested little between-habitat daily intrusion correlation ( $r = -0.21$ ). Use of open areas by coyotes has been well documented in the literature, and the data analyzed in this report are in agreement with said studies.

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## **BIO-ENERGETIC VALUE OF THE FLATHEAD AND SMITH VALLEYS IN NORTHWEST MONTANA FOR SPRING WATERFOWL MIGRATION**

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The abundance of lakes, rivers, streams, wetlands, and agricultural lands of the Flathead and Smith Valleys in northwest Montana attracts a significant number of migratory waterfowl moving from wintering grounds to breeding habitats each spring. These diverse habitats provide food and resting areas for thousands of waterfowl and other waterbirds each year. These valleys are also undergoing rapid habitat transformation due to growth in human population with concomitant conversions from rural agricultural and riparian habitats to more residential and commercial development. To quantify the current extent, distribution, importance, and species that use this area as a spring stopover, we initiated a randomly stratified, weekly, simultaneous waterfowl survey of selected areas from early March through April. We began in spring 2010 and will continue through spring 2012. The data will be extrapolated to the entire study area and for the 2-month period to develop an estimate of total annual waterfowl feeding days by species. Habitat data are also being incorporated. Preliminary results from first 2 years of data indicate that the 4 most common migrant waterfowl species, in order of total numbers counted, are Mallard, Northern Pintail, Canada Goose, and American Wigeon. Preliminary extrapolations of waterfowl survey data in terms of bioenergetics will be summarized.

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## USING REMOTE CAMERA TECHNOLOGY TO SURVEY SHARP-TAILED GROUSE LEKS IN MONTANA

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Some of the biggest challenges in conducting lek surveys for sharp-tailed grouse in Montana are weather-related road access, distance between leks, visibility, and determining the maximum number of males and females at the lek. The optimum time to survey peak dancing displays on leks is during the first few hours of morning daylight in April. Surveys are traditionally conducted by biologists with binoculars or scopes in vehicles racing between distant leks to count sharptails before the dancing stops for the day. Vehicular access to private land, snowstorms, muddy roads, and difficult hiking create problems in reaching leks during the peak mating season, and thus limit the efficacy and scope of sharp-tailed grouse surveys. Biologists have used aircraft to locate new sharp-tailed grouse leks but this method is costly and not commonly employed. The authors found no reports of remote cameras being used to count sharp-tailed grouse on leks. The objective of this study was to determine if remote cameras would be an accurate and cost-effective tool to survey sharp-tailed grouse leks. The resulting camera images recorded more birds at a lek than ocular estimates or flushing counts yielded. Additionally, the cameras worked well in all types of weather conditions, were low maintenance, reduced human disturbance to leks, and were cost-effective. Incidental data collected included visitation to leks by predators, length of lek abandonment post-disturbance, and effects of weather conditions on dancing.

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## MOOSE MANAGEMENT IN SOUTHWEST MONTANA: INSIGHTS FROM FOUR YEARS OF FIELD RESEARCH

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From 2007-2010, Montana Fish, Wildlife and Parks conducted research on moose ecology on the Mount Haggin Wildlife Management Area in southwestern Montana. In this presentation, we will briefly review our methodology and results, but will largely focus on the management implications of this research and potential ideas for future research. The goals of this research were to determine the habitat selection of cow moose during winter with an emphasis on willow community importance and to examine population-scale willow browse utilization through browse patterns. We also sought to contribute to a foundation for future research on moose in Montana. Using browse surveys on willow (*Salix* spp.) and GPS collars on cow moose, we were able to determine the current intensity of willow browse and basic habitat use of cow moose (e.g. home range size and location), and to model variables associated with both browse utilization and habitat selection. Management implications of the browse surveys include suggestions regarding sample sizes and sample site placement for future monitoring of willow community health or browse utilization. Additionally, species preference by moose has implications for riparian restoration. The habitat selection analysis showed the importance of willow and conifer communities and has implications for habitat conservation and aerial survey methods. Future research on moose ecology in Montana should focus on the impact of changing habitat and climate on habitat selection and population dynamics, the role of predation on populations of moose, and improving aerial or other survey techniques to more accurately monitor moose population trends.

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## CLIMATIC VARIATION AND AGE RATIOS IN BIGHORN SHEEP AND MOUNTAIN GOATS IN THE GREATER YELLOWSTONE AREA

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Using management data regularly collected by state and federal agencies, we indexed recruitment rates of bighorn sheep and mountain goats in the Greater Yellowstone Area (GYA) by calculating young:adult ratios. Annual and long term regional climatic conditions were indexed using data from Natural Resource Conservation Service Snotel sensors across the GYA. Linear regression models were used to assess hypotheses that recruitment rates in bighorn sheep and mountain goats in the GYA were associated with annual and regional variation in climatic conditions. The initial dataset consisted of 685 bighorn sheep lamb:ewe ratios from 21 herds since 1960 and 184 mountain goat kid:adult ratios from 18 herds since 1966. After censoring data, 369 bighorn sheep records remained, which were split into three seasonal subsets, and 123 mountain goat records remained in a single dataset. Findings suggest that recruitment rates in bighorn sheep and mountain goats were associated with annual variation in both pre-birth and post-birth climatic conditions, interacting with long term regional climate conditions. Additionally, strong interactions were found between precipitation during the birthing season and winter severity. Collectively, these findings suggest that recruitment in bighorn sheep and mountain goat populations in the GYA may be sensitive to changes in future climate conditions and that the response may vary regionally across the GYA.

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## EVALUATING BOTTOM-UP AND TOP-DOWN EFFECTS ON ELK SURVIVAL AND RECRUITMENT: A CASE STUDY IN THE BITTERROOT VALLEY

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Understanding the contribution of recruitment rates to overall growth rate in ungulate populations is a fundamental challenge in wildlife management. Ungulate populations with low recruitment rates may result in population level declines over time. In the southern Bitterroot Valley of western Montana, the decline of elk (*Cervus elaphus*) populations and calf recruitment occurred concurrently with wolf (*Canis lupus*) recovery. However, a multitude of abiotic, bottom-up and top-down factors likely affect recruitment rates and the relative affects of these factors on elk calf survival rate likely vary temporally throughout the first year. We studied cause-specific mortality of elk calves to understand the role of competing mortality risk on calf recruitment in the East Fork and West Fork of the Bitterroot Valley, Montana. A total of 66 neonatal elk calves were captured in spring 2011 and an additional 31 6-month

olds in late November 2011. We will analyze survival using a Weibull parametric survival model, and cause-specific mortality using a competing risks framework. Preliminary analyses suggest the potential for competing risks between black bears, mountain lions, and wolves. As the study progresses into the second year, we will evaluate the role of summer range nutritional resources on maternal condition, lactation performance, and calf birth weights and survival. Our study will fill a gap regarding the role of summer vs winter mortality in elk and the role of nutrition in first year survival. The study will complement previous studies on elk population dynamics and inform elk population management following carnivore recovery.

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## **MOVING WILDLIFE UNDER US HIGHWAY 93 IN MONTANA'S BITTERROOT VALLEY THROUGH WILDLIFE CROSSING STRUCTURES**

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The impediment that the Bitterroot Valley's roads and vehicle traffic pose for wildlife movement can be partially mitigated with wildlife crossing structures. This study evaluates 18 wildlife crossing structures installed by Montana Department of Transportation along US Highway 93, south of Missoula. Through the use of camera traps, this ongoing study evaluates the efficacy of these crossing in allowing wildlife to move safely under the road, and in reducing wildlife-vehicle collisions between the communities of Lolo and Hamilton. Photographic data on white-tailed deer use were analyzed for success rate and rate of repulsion. Use of structures by other species of wildlife was also analyzed. In three years of post-construction monitoring, success rates ranged from zero to two white-tailed-deer passes per day. Carnivores were photographed using crossings and moving over the highway at grade. At this time, bridge structures have a higher success at passing white-tailed deer that approach them than culverts, except for a large (6 m wide and high) steel culvert, which worked as well as bridges. Fencing to crossings is important: bridges without wildlife fencing had success rates well under 0.2 deer passes per day. At this time overall trends appear to suggest that: wildlife fencing, more vegetation at the ends of structures, and wider structures result in higher success rates for white-tailed deer. When the study is completed in 2015 we will have a better understanding of the structure and landscape variables important to facilitate wildlife use of wildlife crossing structures.

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## **TIMING OF CATTLE GRAZE AS A MANAGEMENT TOOL FOR PLANT AND INVERTEBRATE COMMUNITIES IN THE CENTENNIAL VALLEY, MONTANA**

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Grazing is an important natural disturbance in the western US. While many studies have focused on the effects of grazing intensity and frequency, little is known about the importance of graze timing and how it can affect plant and invertebrate community structure and productivity. Timing may be a critical factor for promoting ecological heterogeneity,

biological diversity, and abundance of food resources for native birds. Our primary goal is to understand how timing of graze and climate variability interact to influence plant and invertebrate communities throughout the growing season in wet meadows and grasslands in the Centennial Valley of southwest Montana. In 2011, control (no graze), early graze (beginning June 15), and traditional late graze (beginning July 15) treatments were established and replicated in a heterogeneous, irrigated, wet meadow habitat. From June-September, plant and invertebrate communities were quantitatively sampled to examine dynamics of biomass and diversity. In 2012, a similar experimental design will be implemented in a less-disturbed and drier native grassland. A new component will examine interactions between climate variability and timing by incorporating a water-addition treatment to simulate the extra moisture resulting from a wet year. We predict that increased climate variability will likely impact wet meadow and grassland habitat plant and insect phenology, with timing of graze becoming particularly critical during dry years. We will discuss results from 2011 and where we plan to go in 2012 with the water-addition treatment.

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## SPATIAL SEARCH AND EFFICIENCY RATES AS COMPONENTS OF WOLF PREDATION RISK

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Anthropogenic linear features are hypothesized to increase wolf (*Canis lupus*) predation risk for a threatened ungulate, woodland caribou (*Rangifer tarandus caribou*). Previous research has shown that these features are selected by wolves while searching for prey, but their effect on the net efficiency of predation, measured in kills per day, has not been addressed. We use resource selection and proportional hazards modeling to assess the spatial drivers of both search and efficiency rates of wolf predation in a multi-prey system. Topographic variation consistently affected wolf search rates and the predation efficiency of wolves while searching. However, the effects of anthropogenic footprint upon the total predation risk imposed by wolves were mediated solely by changes to wolf search rate; wolf predation efficiency generally did not change with proximity to anthropogenic linear features as previously hypothesized. Predicted models of the cumulative hazard encountered by wolves validated well with among-pack variation in kill rates, suggesting that spatial hazard models allow the scaling up of local heterogeneity to population-level dynamics. Lastly, we estimated an integrated spatial model of relative predation risk as the product of both search and efficiency rates, which captured the distinct contributions of spatial heterogeneity to each component of risk.



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# INITIATING GPS & VHF TELEMETRY STUDIES ON MOUNTAIN UNGULATES IN THE GREATER YELLOWSTONE AREA

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Telemetry studies on bighorn sheep (*Ovis canadensis*) and mountain goats (*Oreamnos americanus*) in the greater Yellowstone area (GYA) are relatively rare, especially in comparison to other large mammals. There is therefore a significant dearth of detailed information on mountain ungulate demographic and spatial ecology as well as competition dynamics between the non-native mountain goat and the native bighorn sheep. The Mountain Ungulate Research Initiative is seeking to gain this valuable management and conservation information by initiating GPS and VHF radio telemetry studies across the GYA. We have selected ten study sites that represent the varying ecological settings of this ecosystem with differences in climate, geology, herd size, disease history, land use and management, migratory and non-migratory herds, sympatric and allopatric herds, and high and low elevation ranges. In addition, we have developed a dual collar, multiple deployment strategy to efficiently maximize collection of ecological data and support long-term research goals. This includes the deployment of a GPS collar simultaneously with a VHF collar for each animal instrumented. After two years of fine spatial- and temporal-scale data collection the GPS collars will release for recovery while the VHF collars will remain on animals to obtain an additional five years of demographic data. The recovered GPS collars will then be refurbished and redeployed with new VHF collars on additional animals. The presentation will describe these telemetry studies and strategies, as well as report on the progress of current and planned telemetry study efforts.

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## GEO-STATISTICAL METHODS FOR DETECTING ELK PARTURITION SITES FROM GPS COLLAR DATA

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There is an increasing awareness of the importance of juvenile survival in ungulate population dynamics, and the accurate prediction of parturition habitat may allow for more effective management. Detecting birth sites in a statistically rigorous way, however, often requires intensive field efforts that may not be possible for all studies. We developed a hierarchical two-stage clustering analysis for identifying elk parturition locations, which can

be conducted retrospectively using only GPS location data. We validated our approach using a dataset of 59 adult female elk (*Cervus elaphus*) fitted with both a Global Positioning System (GPS) collar (30-minute sampling interval) and vaginal implant transmitter (VIT). For the top parameter set, approximately 80% of estimable parturition sites were within 1 km of their respective VIT location. Roughly 10 % of our predicted birthing locations were over 2 km away from the VIT location, but many of these events could be filtered from the analyses due to their clustering attributes. Designed to minimize Type II errors this filtering also removes a subset of birthing sites that close to VIT locations, and magnitude of this effect varied across parameter sets. Sub-sampling of the GPS dataset from 30 min to 1, 2, 3, and 6 hour intervals resulted in modest reductions in the efficacy of our approach. With the use of GPS collars in ungulate studies on the rise, our approach provides managers with additional information on birth site locations at no additional cost over and above a typical GPS study.

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## ANALYZING CLIMATE DATA FOR WILDLIFE STUDIES

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Climate is one of the driving forces affecting wildlife and fisheries. Access to daily data from SNOTEL stations in the mountains and Climatological stations in the valleys provides data on temperature, precipitation and snow that can be interpreted to help understand response to climate variables. Dates of spring and fall green-up, growing degree-days and forage production can be derived. Snow water equivalent (SWE) can be estimated from Climatological stations. Start of snow accumulation, maximum accumulation and date of maximum SWE, and date of melt-out can be determined for each station. Critical temperatures are different for each species and accumulated effect of cold temperatures can be determined from daily minimum temperatures. Long-term trends and annual variations can help explain fluctuation in population, reproduction, predation and mortality. Relationships have been developed relating plant phenology to climatic variables for lilacs (which have been used as a surrogate for estimating growing seasons) and Whitebark Pine. SWE can be related to migration and predation.

Keetch Byram Drought Index (KBDI) was developed for fire spread analysis but can also be used as an index to soil moisture. Index of Winter Severity (IWS) can be calculated for various areas and species using a combination of SWE, forage production and critical temperatures. Streamflows can be related to SWE, soil moisture, spring precipitation and temperatures.

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## POPULATION TRENDS OF BIGHORN SHEEP AND MOUNTAIN GOATS IN THE GREATER YELLOWSTONE AREA

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Bighorn sheep (*Ovis canadensis*) and mountain goats (*Oreamnos americanus*) are important components of the large mammal community in the Greater Yellowstone Area (GYA) and are of considerable public interest. However, foundational ecological research concerning these species is limited. We analyzed historic bighorn sheep and mountain goat population counts collected by management biologists using ln-linear regression to estimate herd growth rates ( $\lambda$ ). The analyzed dataset consisted of 538 bighorn sheep counts since



1971 and 120 mountain goat counts since 1966. Most mountain goat count units experienced a positive growth rate and increased their distributions over recent decades. Bighorn sheep growth rates were more variable among the 26 recognized herd units in the GYA. We used the historic count data to evaluate the hypothesis that sympatry of non-native mountain goats with bighorn sheep adversely affected bighorn sheep populations. This was accomplished by comparing the growth rates of sympatric herds with that of allopatric herds. There was no evidence that sympatric herd growth rates were significantly lower than allopatric herd growth rates. We caution, however, that many counts in consecutive years suggested larger changes in abundance than what would be reasonable to expect from biological processes. We suspect that variability in counts likely reflects varying detection probability and the overall difficulty of counting mountain ungulates. Therefore, conclusions derived from these data should be further evaluated with more detailed demographic studies in the future.

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## **INTER-INDIVIDUAL ISOLATION BY DISTANCE: IMPLICATIONS FOR LANDSCAPE GENETICS**

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Many approaches to understanding the influence of landscape on gene flow account for isolation by distance, a phenomena where individuals that are closer together are more likely to be more closely related. Most theoretical research has focused on isolation by distance between populations. We simulated the expected isolation by distance patterns between individuals within a finite population and found an asymptotic pattern. New null models are needed in landscape genetic approaches to correctly account for isolation by distance patterns. We will briefly review isolation by distance and discuss the factors (time, variance in dispersal, and mutation rates) influencing isolation by distance patterns. Our results have implications for estimating how difficult it is for animals to move through the landscape.

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## **THE EFFECTS OF SPECIAL MULE DEER BUCK REGULATIONS ON MULE DEER POPULATIONS AND HARVEST**

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We evaluated the effects of 3 restrictive season types on mule deer population and harvest characteristics in 41 Montana hunting districts (HDs). Using a mixed-effects, before-after-control-impact modeling framework, we analyzed 6 harvest and hunter use response variables, and 4 population response variables. Buck:doe ratios increased by 0.42 bucks:100 does and 0.33 bucks :100 does per year, following changes to a shortened season and limited permits, respectively. We found no significant change in buck:doe ratios in unlimited permit HDs. All restrictive season types resulted in declines in hunter numbers and days. HDs with no restrictions, with limited permits and with unlimited permits also showed a downward annual trend in hunter numbers. In shortened season HDs, a significant loss in hunter

numbers was followed by a slow return of hunters back to those HDs. Limited permit HDs had a statistically greater proportion of bucks with  $\geq 4$  points on at least one antler, a lower number of bucks harvested annually, and a smaller total number of  $\geq 4$  point bucks harvested than in HDs with no buck restrictions. For those same 3 response variables, unlimited and shortened season HDs were not different than HDs without restrictions. In all three restricted regulation HDs there was an annual increase in the observed spring fawn:adult ratios even though the general trend was for a decreasing fawn:adult ratio of 0.83 fawns:100 adults per year in HDs with no restrictions.

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## **PREDICTING PREY POPULATION DYNAMICS FROM KILL RATE, PREDATION RATE AND PREDATOR-PREY RATIOS IN THREE WOLF-UNGULATE SYSTEMS**

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Predation rate (PR), kill rate and predator-prey ratio's are all thought to be fundamental statistics for understanding and managing predation. However, relatively little is known about how these statistics explain prey population dynamics. We assess these relationships across three systems where wolf-prey dynamics have been observed for 41 years (Isle Royale), 19 years (Banff) and 12 years (Yellowstone). Theoretical simulations indicate that kill rate can be related to PR in a variety of diverse ways that depend on the nature of predator-prey dynamics. These simulations also suggested that the ratio of predator to-prey is a good predictor of prey growth rate. The empirical relationships indicate that PR is not well predicted by kill rate, but is better predicted by the ratio of predator-to-prey. Kill rate is also a poor predictor of prey growth rate. However, PR and predator-prey ratio's each explained significant portions of variation in prey growth rate for two of the three study sites. Our analyses offer two general insights. First, it remains difficult to judge whether to be more impressed by the similarities or differences among these 3 study areas. Second, our work suggests that kill rate and PR are similarly important for understanding why predation is such a complex process. We conclude with a review of potential management applications of predator-prey ratio's and the assumptions required to understanding prey population dynamics.

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## BAT ACTIVITY IN RIVERINE STANDS OF NATIVE PLAINS COTTONWOOD AND NATURALIZED RUSSIAN OLIVE IN SOUTHEASTERN MONTANA

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Replacement of native riverine gallery forests by woody exotics is a significant conservation issue throughout the western United States. Controversy surrounds the management of Russian olive (*Elaeagnus angustifolia*), a small Eurasian tree now naturalized in the west, because its detrimental effects to native vegetation are offset to some degree by resources (food and cover) it provides for some wildlife species. We examined the relative use by bats of plains cottonwood (*Populus deltoides*) and Russian olive by measuring bat activity with electronic bat detectors in stands dominated by each plant species (cottonwood: 12, Russian olive: 6) along the Yellowstone and Powder rivers in eastern Montana. Bats were detected in all stands, but activity was greatest in those dominated by cottonwood. Bat activity was also positively correlated with percent canopy cover of cottonwood. Snags and dead limbs, loose bark, and cavities, all important roosting habitat for bats, were most prevalent in cottonwood stands; cavity-making birds (woodpeckers, nuthatches, chickadees) were also significantly more evident in cottonwoods. We conclude that naturalized Russian olive in the northern Great Plains is inferior riverine habitat for bats relative to native cottonwood gallery forest.

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## DEVELOPMENT OF A REGIONAL FENCE MODEL WITH IMPLICATIONS FOR WILDLIFE MANAGEMENT

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Barbed and woven wire fence are ubiquitous features across much of western North America, yet their effects on wildlife have received less attention than those of other anthropogenic features. At this time, no geospatial fencing data is available at broad level scales; potentially making wildlife modeling of vagile species less accurate and conservation planning less reliable at various scales. Here, we model fence density across 13 counties in Montana's Hi-Line region, based on publicly available GIS data and assumptions created from local, expert knowledge. The resulting fence location and density GIS layers are based on assumptions about where fence locations occur in association to different types of land tenure, land cover and roads. Locations of fences were collected via GPS along random 3.2 km long road transects ( $n = 738$ ) to assess overall model accuracy. Using a confusion matrix to determine variation between field and modeled fence locations, the total accuracy of the

model was 73% and Kappa was .40. Although we found inaccuracies associated with large parcels (>3 contiguous sections) of cultivated agriculture, our model is a promising step towards delineating fencing across the west. These general rules may be used and refined in the other areas based on the regional historical context. This new data may advance both wildlife research and management/mitigation activities. Using the relative density of fences across a region can prioritize conservation efforts at this broad scale. In addition, modeled fence locations provide useful and accurate information at a local scale.

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## **SPECIES-SPECIFIC SCALING TO DEFINE AND CONSERVE THE NORTHERN GREAT PLAINS REGION**

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Prairie ecosystems are in a continuous state of flux, shifting by processes that include variable weather patterns and climatic conditions, disturbance regimes, and more recently, human-induced modification. Similarly, wildlife resources fluctuate across the landscape as a result of these ever-changing conditions; however, human alterations have increased, removed, and manipulated the ecological processes of the prairie. Specifically, the spatial scales at which humans manage and interact with the landscape are often inconsistent or incompatible with the scales required for the persistence of wildlife populations. Our synthesis demonstrates how the spatial scales at which wildlife in the Northern Great Plains of North America operate have been constrained by human intervention. This process of anthropogenic scaling has affected the decline of many native wildlife populations and in some cases has resulted in the complete extirpation of species from the landscape. We use historical observations and recent quantitative data to describe the primary cause of spatial scale alteration for prairie focal species (i.e. plains bison, pronghorn, grassland birds, Greater Sage-grouse, black-tailed prairie dogs, swift fox, prairie rattlesnakes) using migration, home range, distribution, and dispersal distances as metrics. We then describe the role that spatial scale plays in wildlife management of the prairie landscape from the non-profit, state, and federal perspective and how these entities are managing at the scales of each focal species.

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## WHAT HUNTERS PREFER AND VALUE ABOUT MULE DEER HUNTING IN MONTANA

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During Montana's biennial process for establishing hunting seasons, Montana Fish, Wildlife & Parks (FWP) listens to issues, advocacies, opinions and values brought forward by diverse mule deer hunters. In recent years, vocal constituency groups have advocated for season structures that provide more opportunity to harvest mature mule deer bucks, reflective of the recent direction of mule deer management in much of the west. In an effort to better quantify the views and preferences of the Montana hunting public in general, FWP conducted surveys of both resident and nonresident mule deer hunters. Results from the survey confirm that mule deer hunting is very important to Montana's hunters, consistent with the fact that deer hunting is by far the most popular hunting activity in Montana. Approximately two-thirds of the survey respondents prefer less restrictive mule deer hunting regulations compared to more restrictive regulations that increase the probability of harvesting mature bucks by limiting opportunity. Surprisingly, trophy hunting was the least important reason expressed by survey respondents for hunting mule deer in Montana. Many respondents did express concerns about a variety of access related issues. Despite these concerns, respondents reported being generally satisfied with overall mule deer hunting opportunities in Montana, and nearly half of the respondents rated opportunities to hunt large mule deer bucks in the state as being better than average. FWP intends to use results from this survey in the consideration of future management of this important game species that is so highly prized by Montana hunters.

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## MULTI-SPECIES BASELINE INITIATIVE: GETTING THE MOST BANG FOR THE SURVEY AND MONITORING BUCK

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Human dominated landscape change is occurring at unprecedented rates and there is much concern for how land use planners can help species remain resilient over time. However, for many species we lack a baseline understanding of the most basic of biological information such as range and distribution. Even a single survey of little known taxa groups can yield a wealth of information. For instance, our 2010 multi-species survey of 172 sites in the U.S. Selkirk Mountains yielded the first verifiable Idaho detection of magnum mantleslugs (*Magnipelta mycophaga*) in 68 years (17 specimens from 11 sites) and a higher than expected detection rate of the Idaho state imperiled (S2) fir pinwheel snail (*Radiodiscus abietum*) (105 specimens from 45 sites). Even species more charismatic than invertebrates often suffer from a lack of basic understanding. For instance, our 2010 Selkirk Mountain survey obtained the first verifiable lynx (*Lynx canadensis*) detection in the U.S. portion of that range in 18 years. The Multi-species Baseline Initiative (MBI) is driven by a diverse group of partners including not-for-profits, universities, tribes, state, and federal agencies. MBI's goals are to (1) describe the occurrence and distribution of multiple species, emphasizing species of greatest conservation need, in the Idaho Panhandle and adjoining mountain ranges and (2) implement a single long term monitoring plan for these species. We have divided our 23,825 km<sup>2</sup> survey area into 953 5x5 km survey cells. During 2010 and 2011 we conducted 476 surveys for beetles, terrestrial gastropods, and forest carnivores at 476 (50%) of our survey cells.

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## **INFECTION AND IMMUNITY IN BIGHORN SHEEP METAPOPULATIONS: DYNAMICS OF PNEUMONIA**

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It is widely accepted that reducing contact between domestic and wild sheep limits pneumonia introduction, where domestic sheep transmit pathogens to bighorns. However, in some places, pneumonia persists for many years, even as local domestic inhording decline. We focused on one such system, the Hells Canyon region. We used an extensive long-term dataset to assess the evidence that pneumonia-causing pathogens induce an acquired immune response in bighorn sheep by reconstructing pneumonia exposure histories, and evaluating the impact an individual's exposure history has on its survival. We found evidence of protective immunity lasting approximately two years, and saw that translocated individuals suffered much higher pneumonia risk than residents. Surviving many past pneumonia events decreased an adult's risk in future events, although lambs born to ewes with many past exposures were at higher risk than their peers. These results are consistent with a disease that produces some chronic carriers that shed to their lambs for many years. Interestingly, while we might expect that the impact of chronic carriage on a population should decline over time and allow for population recovery (through senescence of carriers), we instead saw a trend of increasing lamb pneumonia mortality. Our findings corroborate long-held hypotheses about the presence of a chronic carrier state, and suggest that better understanding specific mechanisms leading to chronic carriage will help clarify the costs and benefits surrounding various management strategies.

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## **APPLICATION OF STRUCTURED DECISION MAKING TO ELK ARCHERY REGULATION DECISIONS IN MONTANA**

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Prior to 2008, 22 hunting districts (HDs) in Montana had limited-draw, either-sex rifle permits, while the archery season was open for either-sex hunting to anyone possessing a general elk license. In addition, an unlimited number of hunters could obtain an either-sex archery elk permit in the 7 Missouri River Breaks HDs, where rifle hunting of bull elk is also limited. In 2008 the Montana Fish, Wildlife and Parks (MFWP) Commission implemented limited-draw archery regulations in these districts. These regulations have been very controversial since they were implemented. Certain public sectors have argued fervently for changes to these limited regulations in every MFWP season-setting process since 2008, and legislation that would reverse these regulations was introduced and defeated in the last two legislative sessions. In response to the contentious debate on this topic, in 2011 MFWP staff and the Montana Cooperative Wildlife Research Unit facilitated a 10-citizen working group composed of landowners, public sporting interests and commercial/fee hunting perspectives.



Using a Structured Decision Making (SDM) process, the working group developed a problem statement, fundamental objectives and assessed the performance of multiple archery season options relative to the fundamental objectives to arrive at an elk archery season proposal. In December of 2011 the MFWP Commission used these results as a basis for tentative season proposals that they distributed for wider public input and comment. Here we present the results of the SDM process and the working group proposal, as well as subsequent MFWP Commission action relative to the proposal.

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## A COMPARISON OF WOLF DEPREDATION SITES IN AREAS WITH MIGRATORY AND RESIDENT ELK

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As large carnivores recover in many wilderness areas and mixed-use landscapes, wildlife management agencies must seek ways to minimize private property damage while maintaining viable populations. Although much is known about carnivore-livestock conflicts, drivers of these processes in the Northern Rocky Mountains are still emerging amid the dynamic conditions of recovering predator populations (gray wolves [*Canis lupus*] and grizzly bears [*Ursus arctos horribilis*]), declining elk productivity, and the re-distribution of migratory and resident elk subpopulations. There has been little research to date that examines the influence of fine-scale elk distribution and movements on patterns of livestock depredation. In this study, we analyze four years of cattle depredation data, two years of summer and fall wolf predation data ( $n = 4$  wolves), and three years of elk movement data ( $n = 86$  elk) to assess the influence of migratory and resident prey on the location and occurrence of wolf depredations on cattle. Wolves living in migratory elk areas face low densities of their preferred prey in summer, when elk depart for higher elevations inside Yellowstone National Park (YNP), while wolves living in the resident elk area have access to abundant elk year-round. Wolves living in both areas have the potential to interact with several thousand head of cattle. We used logistic regression to compare the relative influence of landscape features on the risk of livestock depredation in the migratory and resident elk areas. Locations of wolf-killed cattle showed differences between the migratory elk area and the resident elk area. Depredation sites in the resident elk area were associated with habitats closer to roads and with high elk density, while depredation sites in the migratory elk area were associated with dens, streams, and open habitat away from the forest edge. Our findings indicate that knowledge of ungulate distributions and migration patterns can help understand and predict hotspots of wolf conflict with livestock.

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# THE EFFECTS OF CHANGES IN ELK ARCHERY REGULATIONS ON ELK HUNTER EFFORT AND HARVEST, 2004-2010

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We evaluated the effects of changes in elk archery hunting seasons in eastern Montana on hunter numbers, days, and densities and elk harvest. We compared 2 time periods (2004-2007 and 2008-2010) and grouped hunting districts (HDs) into 1 of 4 season types. The 4 season types were limited permits in the Missouri Breaks (7 HDs), limited permits in non-breaks HDs (22 HDs), adjacent HDs were in close proximity to the limited permit HDs that we hypothesized might receive additional hunters displaced from the two more restrictive archery permit areas (22 HDs), and our pseudo-control season type included the rest of the HDs in the state (110 HDs). It appeared, from a statewide perspective, that changing the archery regulations to limited permits in 27 HDs didn't cause a statistically significant hunter shift to the 22 HDs identified as areas hunters would likely select if restrictions forced them to choose a new area. The only significant changes in hunter numbers and days were decreases in non-resident hunter numbers and days in the Missouri River Breaks HDs. Although the decrease in non-resident use may have had an economic impact in the local area; statewide, there was no change in non-resident use. Pseudo-control HDs showed decreases or no change in harvest response variables. Therefore, the significant harvest increases and/or lack of significant harvest declines in the limited permit areas might be interpreted as a relative success since most of these hunting districts are above population objectives for elk.

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# USING OCCUPANCY SURVEYS TO ASSESS SUMMER RESOURCE SELECTION OF SYMPATRIC BIGHORN SHEEP AND MOUNTAIN GOATS IN NORTHERN YELLOWSTONE

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Both bighorn sheep and mountain goats are generalist herbivores that overlap extensively in broad food and habitat requirements, but there have been few studies examining the potential for competition between sympatric populations. One area in which native bighorn sheep are living in sympatry with non-native mountain goats is the southern Gallatin Mountain range within and adjacent to the northwest boundary of Yellowstone National Park. Existing data of bighorn sheep and mountain goat observations for the area vary in spatial precision and records of areas where observers looked for but did not detect animals are not available. To gain a better understanding of the relationship between bighorn sheep and mountain goats and their habitat, it is necessary to understand resource selection and the extent of overlap in resource use among sympatric populations on fine spatial and temporal scales. In order to meet this need we designed and implemented formal, ground-based occupancy surveys during the summer of 2011. A crew of four spent 113 observer days in the field and hiked approximately 210 miles recording presence-absence data for both mountain ungulates. A total of 6,932 sample units were surveyed, with 68 bighorn sheep and

95 mountain goat groups detected. Detection probabilities for bighorn sheep and mountain goats were 66.9% and 54.5% respectively. We summarize the objectives and field design of the project and report on our efforts to develop enhanced habitat models which will provide managers with additional ecological insights.

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## **USE OF A HUMAN DISTURBANCE MODEL TO ASSESS IMPACTS OF ANTHROPOGENIC DEVELOPMENT ON WILDLIFE**

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In an effort towards developing consistent and reliable methods for addressing the impacts of subdivision development and other anthropogenic disturbances on wildlife, I developed a GIS model to predict the extent and magnitude of human-caused disturbance. The model estimates cumulative disturbance from point and linear sources, produces output at a fine scale to provide comparisons of different development configurations, and allows variability of input parameters depending on the species of interest. Output can be used for a standalone analysis or used in conjunction with habitat models to assess reductions in habitat quality or connectivity value resulting from human disturbance. Examples of model output are presented to illustrate how the model has been previously used in the planning and assessment processes and how it can also be used to assess impacts of energy development.

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## **HIERARCHICAL FORAGING ECOLOGY OF YELLOWSTONE BISON AND DEVELOPMENT OF REMOTE SENSING TECHNIQUES FOR MANAGEMENT OF BISON AND OTHER HERBIVORES ACROSS THE INTERMOUNTAIN WEST**

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To help address the controversy concerning movement of bison outside Yellowstone National Park and identify potential areas for bison relocation, we determined seasonal foraging habitat selection by bison at 4 hierarchical levels, the dominant hierarchical level of selection by Yellowstone bison, inter-annual consistency of use of grazing locations, and developed remote-sensing techniques for determining spatio-temporal estimates of herbaceous vegetation availability and forage utilization at a landscape scale. Without accounting for differences in sward biomass among vegetation types, selection of vegetation types was inconsistent among hierarchical levels. However, development and use of a biomass index accounted for differences in offtake rate among vegetation types that resulted in consistent selection across hierarchical levels for upland vegetation types over mesic lowland types. Monitoring of known feeding sites over successive years further indicated preference of upland vegetation types. Results suggest the feeding site level as the dominant level of selection and that Yellowstone bison exhibit behavior expected of energy maximizers in both the short- and long-term. Remote sensing techniques providing spatially-explicit estimates of standing crop of herbaceous vegetation were developed at 4 locations across diverse habitat in MT and Yellowstone Park, WY. Estimates of forage utilization were developed for the Yellowstone Park location. Results of this project increase our understanding of the spatial and temporal dynamics of bison foraging ecology both inside and outside Yellowstone

National Park and offer remote-sensing techniques relevant to the management of all grazing herbivores throughout the intermountain west.

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## THE BLACKLEAF WILDLIFE MANAGEMENT AREA: 30 YEARS OF VEGETATION MONITORING

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Changes in native plant community cover and composition are generally gradual and affected by multiple environmental factors. Detection of vegetative trend can be difficult without long-term data collection efforts. Management of the Blackleaf Wildlife Management Area includes emphasizing the occurrence of highly productive, diverse plant communities that provide the best possible forage and cover for native wildlife species. To help accomplish this management goal, a range condition and trend survey was initiated shortly after purchase of the property to establish baseline vegetative condition. Fourteen permanently marked transects were established and species' cover values monitored every four years from 1979 - 2009. The area was rested from livestock grazing from 1979 - 1989; a non-traditional rotational grazing system was initiated in 1990. Rough fescue (*Festuca scabrella*), Hood's phlox (*Phlox hoodii*) horizontal juniper (*Juniperus horizontalis*) and shrubby cinquefoil (*Potentilla fruticosa*) were selected as indicator species that reflect overall plant community trend. Response of grasses, forbs and shrubs over the 30 year period are discussed, as well as individual species' trends. In general, while total plant cover remains static, grasses are increasing, forbs are declining. Vegetative response to a long-term rest livestock grazing system is presented as well.

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## GENETIC POPULATION STRUCTURE OF MULE DEER *ODOCOILEUS HEMIONUS* ACROSS MONTANA

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We conducted a genetic assessment of mule deer (*Odocoileus hemionus*) population structure across Montana in an effort to understand dispersal routes across the landscape. To assess genetic structure we genotyped 14 microsatellite loci in 359 individuals sampled primarily within Montana. Smaller samples were included from Wyoming, Colorado and Utah in order to provide a regional context for the levels of population structure observed within Montana. Additionally, we sequenced the control region of the mitochondrial genome of 76 individuals subsampled from our original samples across Montana. To avoid potential influences of a priori population designations, individual based analyses were used to test relatedness across the landscape. Weak isolation by distance characterized mule deer individuals across this region. In addition, we did not detect any evidence of spatial autocorrelation in discrete distance classes as small as 10 km. Female mule deer had higher average individual pairwise genetic distances than males, indicating the presence of a

contemporary male bias in dispersal rates. Mitochondrial DNA indicated the potential for either reduced overall or female-specific dispersal between a subset of the sampling regions within Montana. Finally, we were unable to detect a genetic signature of past translocations of mule deer across Montana. Taken together these results indicate that within this landscape mule deer populations are characterized by high levels of connectivity and experience few, if any, barriers to dispersal.

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## **HOW WELL CAN WE PREDICT WILDLIFE CORRIDORS? TESTS OF ALTERNATIVE MODELING APPROACHES IN MIGRATORY ELK AND DISPERSING WOLVERINES**

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Landscape connectivity has become a key focus of conservation biology as natural habitat is increasingly fragmented by human land use. Several landscape modeling approaches are now relied upon to identify likely dispersal and migration corridors and guide conservation planning. However, the predictive accuracy of these methods has seen limited testing against empirical movement data, which limits confidence in their utility and confuses selection of appropriate methods for a given application. To address these issues, we used GPS collar data from migrating elk and dispersing wolverines to evaluate the ability of common modeling approaches (cost-distance/least-cost path models and circuit theory models) to predict observed movement routes. While both methods made generally similar predictions, cost-distance models consistently outperformed circuit theory models, and predictive success was much higher for elk than for wolverine movements. Furthermore, the form and complexity of underlying landscape resistance maps influenced model performance and revealed unforeseen differences between models. These findings illustrate that corridor model performance depends greatly on focal species and landscape characteristics as well as selection of appropriate methods for the application at hand.

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## **TRUMPETER SWAN PRODUCTION AND HABITAT IN THE CENTENNIAL VALLEY, MONTANA**

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The Trumpeter Swan Society (TTSS) initiated a pilot project in 2011 in the Centennial Valley to document existing conditions on historic trumpeter swan nesting territories. Swan production in the Greater Yellowstone region surrounding Yellowstone National Park has declined significantly over the past fifty years, particularly in the Centennial Valley, Montana, which historically has been the primary production area in Greater Yellowstone. Current low production raises serious concerns over the viability and sustainability of trumpeter swans in the Centennial and the entire region. The lack of a long-term comprehensive restoration strategy for Greater Yellowstone nesting swans, and particularly the changing management emphasis on Red Rock Lakes NWR, further emphasize the need to improve swan production in the Centennial Valley. Apparently suitable nesting territories are available and may be occupied but production is not occurring, and a growing number of non-breeding adult swans

are present. Lima Reservoir is the dominant water feature in the lower half of the Valley but widely fluctuating water levels affect quality waterfowl habitat, including some swan nesting territories and areas used intermittently by up to 150 non-breeding trumpeter swans. In cooperation with the Centennial Valley Association which represents 30 landowners in the Valley, TTSS monitored swan production and collected basic wetland information on the 15 most frequently used trumpeter swan territories outside Red Rock Lakes NWR. In some years, these territories have surpassed refuge swan production. This effort documented swan use and characteristics of nesting territories including wetland type and water availability, availability and quality of emergent and aquatic vegetation, and human influences such as livestock grazing, presence of fences in the wetland, and potential disturbances. Potential wetland enhancement projects were identified that could encourage trumpeter swan use. Trumpeter swan monitoring and site-specific habitat assessments are planned for the next 3-5 years.

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## **DOCUMENTING BASLINE WINTER ACTIVITY LEVELS OF BATS IN MONTANA WITH ACOUSTIC MONITORING**

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We deployed acoustic monitoring stations at 3 locations (Lewis & Clark Caverns, Toeckes Cave, and McDonald Mine) in Montana from January through mid-May, 2011. The goal of this monitoring effort was to document winter base-line activity data to potentially use acoustic monitoring as a surveillance tool for White-nose syndrome (WNS). Each monitoring station was equipped with an Anabat detector, temperature data logger, and solar panel array to allow long-term, remote monitoring. The monitoring stations recorded bat activity (bat passes) and temperature outside of hibernacula. External monitoring minimized potential human disturbance to the hibernating bats or any potential spread of *Geomyces destructans*, the fungus responsible for WNS. Studies conducted by Bat Conservation International at White-nose syndrome affected hibernacula in the eastern U.S., have shown dramatic increases in activity levels at WNS vs. non-infected WNS sites during the hibernation period. If this pattern also holds true in the western U.S., documenting pre-WNS baseline activity levels may allow for acoustic monitoring as a surveillance tool for potential spread of WNS.

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## **EVALUATING ASPEN RESPONSES TO CHANGES IN ELK ABUNDANCE, DISTRIBUTION AND BEHAVIOR FOLLOWING WOLF REESTABLISHMENT IN WEST-CENTRAL YELLOWSTONE NATIONAL PARK**

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The reintroduction of wolves to Yellowstone National Park created a unique “natural experiment” to study trophic interactions in a large-scale terrestrial system among wolves, elk, and aspen. This study utilized data from a long-term elk demography study that was



established prior to wolf reintroduction. Significant changes in the abundance and distribution of the Madison headwaters elk herd were observed following wolf reestablishment. The spatial arrangement of these changes made it possible to directly test for the occurrence of a density-mediated trophic cascade. The objectives of this study were to answer the following questions: 1) was there a marked decrease in browsing pressure on aspen where elk densities declined, and 2) was there a corresponding plant-growth response indicating that aspen were released from browsing pressure? Historical browsing conditions and aspen height were observed for 31 aspen stands to assess the occurrence of a density-mediated trophic cascade following wolf reintroduction. Browse conditions and aspen morphology in stands where elk densities declined dramatically following wolf reintroduction were compared to stands that experienced persistent heavy browsing throughout this period. A major decline in browsing pressure along with a modest increase in aspen height and leader longevity was detected, supporting the hypothesis of a density-mediated trophic cascade. However, the magnitude of the growth response was weak, suggesting that browsing was not the dominant limiting factor to aspen growth in the study area and that aspen may be more strongly limited by bottom-up regulation.

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## **DEVELOPING PRIORITIES FOR THE GREAT NORTHERN LANDSCAPE CONSERVATION COOPERATIVE: STATE WILDLIFE ACTION PLANS (SWAP) AS ONE PIECE OF INFORMATION**

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Landscape Conservation Cooperatives (LCCs) are public-private partnerships that focus on natural resource challenges which transcend political and jurisdictional boundaries and require a more holistic, collaborative, and adaptive approach to conservation that is firmly grounded in science and strives to ensure the sustainability of land, water, wildlife and cultural resources. The Great Northern LCC, covering Western Montana and parts of several other states and provinces, is nearing completion of a process that synthesizes conservation priorities among the 25 organizations represented on the Steering Committee and their partners. This Strategic Conservation Framework identifies priority species, ecosystems, and ecosystem processes across the landscape represented by the Great Northern LCC based on synthetic summarizations of five state-based Wildlife Action Plans, 40 other regional conservation planning documents, and focused interviews with key personnel across the region. Here we report on the process by which we analyzed data from the State Wildlife Action Plans (SWAPs) of ID, MT, OR, WA, and WY and from Strategic Habitat Conservation as one piece of information for strategic planning. Thirty-five species of greatest conservation need (as defined in the SWAPs) were identified as having commonality across the five states.

The ranges of these species were then overlain and a map of areas with the greatest number of species of conservation need can be visualized across the Great Northern LCC.

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## **BLM’S NATIONAL GREATER SAGE-GROUSE PLANNING STRATEGY — WHAT IT MEANS FOR MONTANA**

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The Bureau of Land Management (BLM) is responsible for managing over 50% of the remaining Greater Sage-Grouse habitat throughout their range. In July, 2011 the BLM National Greater Sage-Grouse Planning Strategy was released as a supplement to the 2004 BLM National Sage-Grouse Habitat Conservation Strategy and the 2006 Western Association of Fish & Wildlife Agencies (WAFWA) Greater Sage-Grouse Comprehensive Conservation Strategy. This was in part due to the March 2010 petition decision by the U.S. Fish and Wildlife Service as “Warranted but Precluded” and settlement discussions between the FWS and Nongovernment Organizations (NGOs) over candidate species. The listing decision identified inadequate BLM regulatory mechanisms as a major factor in this decision. Principle regulatory mechanisms are conservation measures in Resource Management Plans (RMPs). Habitat for the Greater Sage-Grouse is found within five planning units in Montana. In December 2011 BLM issued instruction to offices on; 1) how BLM is to manage activities occurring within habitat for the Greater Sage-Grouse until RMPs amendments or revisions are completed, and 2) management actions and conservation options to be considered when developing RMP amendments or revisions. RMPs are to be completed or revised by December, 2014. This direction identifies actions for BLM programs with the potential to impact Greater Sage-Grouse. BLM is committed to reducing threats to Greater Sage-Grouse habitat on BLM lands in Montana through changes in management.

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## **DETERMINING THE INFLUENCE OF HUNTER ACCESS ON ANTLERLESS ELK B LICENSE HARVEST IN SELECT AREAS OF SOUTHWEST, CENTRAL AND EASTERN MONTANA**

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Antlerless elk hunting is a critically important tool for wildlife managers to help manage populations of elk. Montana Fish, Wildlife & Parks (FWP) conducted a survey following the 2010 general big game hunting season to determine the effect that hunter access might have on Antlerless Elk B License utilization and associated harvest in select areas of the state where concerns have been expressed about hunting access. A mail-back survey was used to determine, the extent to which respondents were able to gain access to public and private lands to hunt antlerless elk, what types of properties respondents were able to secure permission to hunt, the extent to which respondents were able to successfully harvest antlerless elk, and respondent satisfaction with the Antlerless Elk B Licenses they received in

2010. Questionnaires were successfully mailed to a total of  $N = 5,297$  Elk B License holders and there were a total of  $n = 2,954$  survey respondents resulting in an overall response rate of 56 percent. Survey results revealed several key findings that have significant elk population management implications. While respondents used different hunting access or property types to varying degrees the type of property accessed played a prominent role in determining antlerless elk harvest success rates and antlerless elk harvest distribution. A majority of the survey respondents who hunted or attempted to hunt using their Antlerless Elk B License reported that they were satisfied with the license they received in 2010.

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## OCCUPANCY DYNAMICS, ROOST HABITAT AND PREY OF MEXICAN SPOTTED OWLS IN UTAH

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Mexican spotted owls (*Strix occidentalis lucida*) occupy canyon habitats that have received less attention than owls in forested environments, and yet canyon environments represent a significant portion of the owl's range. In Utah, the owls occupy narrow and steep-walled canyons that attract high levels of human use, including climbing and hiking through nest areas, and human use levels have strongly increased in the canyons, for example, permits for access to popular climbs and hikes increased over 1700% during 1998 to 2002 in Zion National Park. To examine potential effects of recreation on the owls, we studied temporal variability of detection, occupancy, local extinction, and colonization probabilities. Our study sites included several National Parks and BLM resource areas. Our primary objective was to examine effects of recreation on site occupancy dynamics. We also investigated reproductive success, roost habitat, and prey selection. The analysis of detection rate showed strong support for constant detection probability of 89% for spotted owls among 47 sites. For both single owls and owl pairs we estimated initial occupancy rate of 83% for mesic sites and 43% for relatively xeric sites. We found that recreation was not associated with occupancy, detection, nor extinction and recolonization probabilities. Although reproductive rates varied by year, recreation was not negatively associated with production of fledgling owls per site. We also studied prey selection and roost habitat in the canyon environments. Roosts were placed on steep-walled cliffs with greater number of perches than adjacent habitats, and roosts possessed relatively high overhead tree cover, cool daytime temperatures, and thus a suitable thermal environment in the arid canyons. Pellets collected at roosts sites, upon dissection, indicated that rodents were primary prey, but also included birds, bats, and various arthropods. Woodrats (*Neotoma* sp.) dominated the prey frequency and biomass.

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### MECHANISMS DRIVING NONNATIVE PLANT-MEDIATED CHANGES IN SMALL MAMMAL POPULATIONS AND COMMUNITIES

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Nonnative plants can dramatically alter habitat of native animals through changes in vegetation structure and availability of food resources. Range expansion by nonnative cheatgrass (*Bromus tectorum L.*) is an acute threat to persistence of native species in the sagebrush-steppe ecosystem of southwestern Montana. As climate changes over the next century, rangelands in Montana are likely to become more hospitable to this invasive grass. Although declines in small mammal diversity and abundance previously have been documented with cheatgrass invasion, we know little about the underlying mechanisms driving these changes. We will explore potential mechanisms for nonnative plant-mediated changes on three species of native mammals: deer mouse (*Peromyscus maniculatus*), montane vole (*Microtus montanus*), and sagebrush vole (*Lemmiscus curtatus*) in sage-steppe communities at the Gravelly-Blacktail Wildlife Management Area (WMA). We will quantify changes in vegetation characteristics in areas invaded by cheatgrass; based on this information, we will develop experimental treatments that mimic individual modified characteristics. We will apply these treatments to randomly selected plots on the WMA and establish appropriate controls. Using standard capture-mark-recapture methods, we will estimate abundance and species diversity of small mammals and make comparisons between treated and control plots to quantify effects. We will also quantify and compare body condition, predator avoidance, and diet to explore additional mechanisms driving changes in mammalian abundance and diversity. Identifying the mechanisms for how cheatgrass invasion alters populations and communities of native species will provide critical information to inform conservation and management of some of Montana's native small mammals.

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### CITIZEN SCIENTISTS ADD TO OUR UNDERSTANDING OF BIRD POPULATIONS AND STATUS ACROSS MONTANA

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Montana Audubon, our partners, Audubon Chapter members, and bird enthusiasts across the state are increasingly involved in contributing time and talents to understanding bird populations, habitat associations, and trends. Birders contribute sightings to eBird or Tracker, reporting their observations from field excursions and their backyards. This information helps inform Montana Species of Concern listings and influences bird conservation and science priorities in the state and beyond. Montana Audubon also encourages citizen monitoring projects for single species and guilds, from Black Swifts to nightjars. We are now home to the Greater Sage-grouse Adopt-a-Lek program which coordinates citizen scientists to monitor sage-grouse on over 50 breeding leks across Montana every spring. Finally, our Audubon

chapters adopt and monitor Important Bird Areas across the state in order to conserve species of conservation concern and their habitats. Find out more about all these volunteer efforts.

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## **GOOD ANIMALS IN BAD PLACES: EVALUATING LANDSCAPE ATTRIBUTES ASSOCIATED WITH ELK VULNERABILITY TO WOLF PREDATION**

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Vulnerability of prey to predators is heavily influenced by their respective physical and behavioral characteristics; however their interactions with landscape, and climate, collectively termed “environmental vulnerability,” may also assume considerable importance. Little is known about the impact of environmental vulnerability in large mammal systems, where post-encounter vulnerability may assume more importance than encounter probability. This study utilized 18 years of survival and mortality data for radio-collared elk (*Cervus elaphus*), in concert with abundance, distribution, and habitat use data prior to and following restoration of wolves (*Canis lupus*) to Yellowstone National Park to evaluate the relationship between environmental attributes and elk mortality. We modeled the odds of mortality for 108 elk in 1257 animal sample intervals from 1991-2009 across a range of environmental conditions and gradients of wolf predation risk to evaluate: 1) The relationship between landscape, habitat, and environmental attributes and elk vulnerability to wolf predation and 2) Changes in the attributes related to elk mortality before and after wolf colonization. In the absence of wolf predation, mortality risk for elk was primarily associated with physical attributes of elk known to influence starvation mortality. Following wolf reintroduction mortality risk was more strongly associated with characteristics of the landscape and climate within an animal’s home range. These environmental influences resulted in substantial changes in distribution and abundance of elk in the study system and suggests environmental heterogeneity may have an important influence on wolf and elk distributions and dynamics.

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## **WILDLIFE BARRIER FENCES AND PRONGHORN HABITAT CONNECTIVITY CONCERNS IN EASTERN MONTANA**

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Historically, eastern Montana was one of the largest sheep producing regions of the west. Although sheep production has decreased dramatically in the past three decades, several hundred miles of woven-wire and sheep tight fences continue to dissect this landscape. These fences are known to hinder wildlife movement patterns, cause entanglement mortality and

interrupt daily and seasonal habitat use. Miles City Field Office Bureau of Land Management (MCFO BLM) has removed 83 miles of such wildlife barrier fences since 2004. A more wildlife friendly, four-wire fence is constructed to maintain livestock distribution while reducing impacts to wildlife, most notably, pronghorn movements. Since 2009, 57 miles of wildlife barrier fences have been removed and modified, of which 47 and 29 miles were within crucial mule deer and pronghorn winter range. Since 2004, nearly \$100,000 of contributed funds and materials have been provided through partnership with MCFO permittees. These funds have resulted in additional miles of barrier fence being removed on deeded lands. Interagency efforts in 2010 with Montana Fish, Wildlife and Parks led to an agreement with TransCanada Pipeline Company to ensure the removal of 23 miles of wildlife barrier fences on deeded lands in southeastern Montana. MCFO continues to identify wildlife barrier fences for removal and pursues partnerships in an effort to address habitat connectivity concerns at a landscape scale.

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## SOIL MODIFICATION AS A RESTORATION TOOL TO REDUCE OLD WORLD BLUESTEMS IN TEXAS COASTAL PRAIRIES

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Nonnative Old World bluestem (OWB) grasses (e.g., *Bothriochloas*, *Dichanthium* spp.) have become dominant throughout the southern and central Great Plains, altering native plant communities and habitat quality for wildlife. Although conventional management strategies have not resulted in elimination or reduction of these grasses, modifying soil conditions to favor native plants may be an alternative restoration tool. We examined efficacy of 10 soil modification treatments (soil disturbance alone, pH increase, pH reduction, carbon addition, addition of soil mycorrhizae, and each combined with seeding of native vegetation) on 60 research plots at the Welder Wildlife Foundation Refuge in southern Texas in summer 2011. We sampled soil chemistry, vegetation density, cover, and height, and abundance of soil, terrestrial, and flying arthropods four and eight weeks after initial treatments. Severe drought prevented plant growth on treated plots and may have decreased the efficacy of soil treatments, especially pH reduction. As such, we compared vegetation and arthropod communities only between undisturbed plots dominated by native vegetation and dominated by OWBs. Species richness of vegetation was higher on plots dominated by native vegetation (4.4 species/m<sup>2</sup>, *SE* = 0.6) compared to plots dominated by OWBs (2 species/m<sup>2</sup>, *SE* = 0.5). Arthropods were more abundant in native vegetation (175 individuals/m<sup>2</sup>, *SE* = 4.1) relative to OWB-dominated plant communities (41, 1.3). Isopods and ants were the most abundant groups overall, although some of these taxa are nonnative. We will continue to collect data over the next two years to explore further soil modification as a restoration tool in grasslands impacted by OWBs.



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# NESTING HABITAT AND BEHAVIOR OF SPINY SOFTSHELL TURTLES *APALONE SPINIFERA HARTWEGI* IN THE MISSOURI RIVER, MT

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Little is known about the nesting behavior and habitat of the western spiny softshell (*Apalone spinifera hartwegi*) in Montana where they are at the northern extent of their range and are a state Species of Concern. Our objective was to document nesting behavior, habitat, and timing in a 97-kilometer reach of the Missouri River. We radio-tagged 47 female turtles and attempted to locate nesting areas using telemetry, visual surveys from jet boat and on foot, and by observation from shore-based blinds. We located 27 nests; 15 were on islands, 12 were aggregated, and 2 were depredated. Nesting occurred following the peak river stage from about July 7 to July 28. Twenty-three nests were in mixed gravel and 4 nests were in sand substrates. Distance from water's edge to the nest ranged from 1.9 m to 27 m and height of nest above the water surface elevation ranged from 0.25 m to 1.9 m. Vegetation at nest sites was sparse, ranging from 0 to 15 percent vegetative cover. Emergence of hatchlings was documented for 17 nests and occurred from about September 1 to September 20. All 17 successful nests were in gravel substrate; we did not document any emergence from nests in sand. Lack of emergence from sand nests may be related to the cumulative thermal regime in the nest chamber during the period from peak discharge until the onset of freezing in autumn. In 2012, we will investigate the thermal environment in gravel and sand nesting substrates.

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## HOW TO ATTRACT A LOON

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Prospecting is a behavior observed in many species when breeding territories are limited. This behavior has been observed in Common Loons. Yet, in Montana there are an abundance of unoccupied territories and competition for occupied territories is still fierce. we used Common Loon decoys and calls to find out if we could attract non-breeding loons to unoccupied territories. We found that there is a pattern between a loon landing on a territory and the presence of loon decoys ( $p = 0.11$ ,  $n = 42$ ). We also discovered a more expedient way ( $p = 0.05$ ) to collect loon band observations using the decoys ( $n = 14$ ). The data collected will be helpful in understanding loon behavior and will help guide future management actions.

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## MANAGING MONTANA'S GOLDEN EAGLES IN A LANDSCAPE OF DEVELOPMENT: A COLLABORATIVE APPROACH

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The Montana Golden Eagle Working Group, an active coalition of agency representatives and eagle experts, was convened in April 2011 to address information needs and management recommendations for Golden Eagles in the state. Current data indicates Golden Eagle populations may be declining across the western United States and stable or declining in Montana. New energy and subdivision development may exacerbate these population trends through direct mortality, indirect and direct habitat loss and alteration, and increased disturbance. However, we lack information that is necessary to evaluate population-level impacts of new development. In 2009, the U.S. Fish and Wildlife Service (USFWS) published a final rule authorizing limited issuance of permits to take Bald and Golden Eagles where the take is consistent with the goal of increasing or stable breeding populations, is associated with and not the purpose of an otherwise lawful activity, and cannot practicably be avoided despite the implementation of advanced conservation practices. Consequently, limited take of eagles may be authorized relative to energy development or other activities while managing for no net loss to the population. This means the USFWS must identify potential eagle mortality sources, the impact of potential mortality on the population, and impact avoidance, minimization, and compensatory mitigation strategies. The Golden Eagle working group is drafting a monitoring strategy and management recommendations for Golden Eagles in a landscape of development. Here we provide information on working group activities which are focused on allowing for continued development while simultaneously conserving one of Montana's most charismatic birds.