Biological Sciences – Terrestrial

Viability of User-Paid System of Wildlife Conservation in Montana

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Montana Fish, Wildlife and Parks (FWP) is entrusted with the responsibility to conserve all species of fish and wildlife to meet a variety of public interests and values. To date, users of these resources, namely hunters and anglers, have provided the financial and political support for the state to achieve this mandate. With this presentation, we make the business case for why user participation is critical to the future of fish and wildlife stewardship in the state, and compare current participation trends in Montana to those of other states in anticipation of what we might experience in the future. This will be followed by a brief discussion of the primary factors leading to changes in participation, and how they relate to the user-paid model of wildlife conservation using a conceptual framework. We will then present and discuss a variety of strategic initiatives Montana could explore to address the implications of a changing user demographic. We will conclude by providing an overview of ongoing efforts by FWP to date including the role of marketing and branding of our services and products. We're hopeful that these two presentations will be supportive of TWS-Montana Chapter's efforts to explore ways in which we can promote sound stewardship of wildlife and their habitats in Montana in a manner that is economically and socially sustainable.

Wolf Prey Preferences in Multiple Prey Systems: Insights from the Madison Headwaters of Yellowstone National Park

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We studied wolf prey selection and kill rates during 1996-1997 through 2006-20007 winters in a newly established one predator two-prey system in central Yellowstone National Park. Prey differed substantially in their vulnerability to wolf (*Canis lupus*) predation and wolves preyed primarily on elk (*Cervus elaphus*) but also used bison (*Bison bison*) to varying degrees within and among winters. Winter severity, wolf abundance, distribution, and prey selection varied during the study, concurrent with variations in the demography, distribution, and behavior of elk and bison. Patterns of prey selection trends were strongly correlated to elk calf abundance. While wolves increasingly killed bison with increasing bison: elk ratios, snow pack duration, and wolf numbers, they did not appear to change their preference for elk. Similarly, variation in elk kill rates were not related to or reduced by increases in bison kill rates. The wolf functional response for elk was a Type II, indicative of a preferred prey, and strongly influenced by wolf abundance, as it was positively correlated with increased competition and anti-predator responses of elk. Prey-switching evaluations indicated increasing selection of bison with increasing bison: elk ratios, however no concurrent

decrease in elk predation occurred. Increased bison predation is not solely dependent on relative abundance of the two prey species; therefore it is unlikely at this time that wolf prey-switching will stabilize the system. The pervasive influence of differential vulnerability among prey species and age classes and its effects on the potential trajectories of wolf-ungulate systems in Montana is discussed.

GIS-Based Tools to Improve Land Use Planning for Wildlife Conservation

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Conserving wildlife and habitat connectivity in the face of a growing human population is one of the greatest challenges facing wildlife managers in the 21st Century. The Northern Rocky Mountain region is experiencing some of the most rapid human population increases in the United States, and rural sprawl is now recognized as one of the most serious threats facing Montana wildlife in the near future. To address this challenge, land use planners must incorporate the best available science about wildlife requirements into planning decisions and policy. We developed a suite of GIS-based tools to simplify incorporating scientific information into landscape-level land use planning for wildlife. These tools are designed to be flexible to accommodate a range of wildlife conservation objectives. The current suite includes tools for estimating appropriate development densities likely to provide adequate habitat or movement connectivity for specified wildlife targets, as well as evaluate existing landscapes, or potential development scenarios, to estimate their potential for supporting wildlife. These tools were employed in conjunction with the development of a wildlife overlay in the Madison Valley, Montana. The Madison Valley provides an example of how these tools can assist with creating criteria for development near or within important wildlife areas.

Winter Distribution, Habitat Use, and Browse Utilization Patterns of the Shiras Moose on the Mount Haggin Wildlife Management Area

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Moose (*Alces alces shirasi*) populations across Montana have expanded in the last century, both in geographic range and in population size. This expansion has had a negative impact on moose winter range in some locations where moose have overutilized key browse species such as aspen and willow. Excessive and unsustainable browsing has the potential to reduce local biodiversity and carrying capacity of moose and other ungulates. The browse species of interest in this study are willow (*Salix* spp.), a highly palatable and abundant browse source for moose on many winter ranges, including our study area in southwestern Montana. Knowledge of spatial and temporal patterns of moose willow community use and willow utilization patterns is limited in Montana and would be helpful in moose population

management. The objectives of this study were to determine patterns of willow community use by selected female moose during winter and to quantify willow utilization across the study area to examine population scale habitat use through browse patterns. To accomplish these objectives we deployed GPS collars on 12 cow moose in the winters of 2007 and 2008 and completed large scale, systematic browse surveys in the spring of 2008. Preliminary results indicated that cow moose spend the majority of the winter in or adjacent to willow communities, but overall willow utilization across the study area was low. Our data suggested that while moose have the potential to significantly impact willow communities, this did not appear to be the case on the Mount Haggin WMA at current moose densities.

Public Opinion and Knowledge of Grizzly Bears in the Cabinet-Yaak Ecosystem

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To measure the publics understanding of grizzly bears and their management in the Cabinet-Yaak Ecosystem (CYE), a telephone survey was conducted in Lincoln and Sanders County, Montana. In the summer of 2007, 502 residents of the seven communities within the CYE answered questions about their knowledge and opinions of grizzly bears (*Ursus arctos*) in the CYE and of related management activities. Ninety percent of respondents felt that humans can prevent most conflicts with grizzly bears and 62 percent stated that they would accept changes to current garbage disposal methods if it would help prevent problems with grizzly bears. Fifty-seven percent supported the recovery of the grizzly bear population in the CYE. Support decreased to 44 percent for achieving a population goal of 100 bears. Support increased to 75 percent if population recovery could be achieved without using augmentation. Thirty-three percent stated they were unaware of road access restrictions on National Forest lands, due in part to grizzly bear recovery efforts. The majority of respondents indicated some level of support for grizzly bears, yet had concerns over specific management actions used to achieve population recovery. Respondents were more aware of augmentation efforts in the early 1990's than of more recent efforts, suggesting that managers need to keep the public better informed. Educational efforts may benefit residents' understanding of general grizzly bear biology and of related management practices.

Montana's Conservation Strategy For Rocky Mountain Bighorn Sheep

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Montana Fish, Wildlife and Parks (FWP) is currently in the process of developing a comprehensive Conservation Strategy for Rocky Mountain bighorn sheep (*Ovis canadensis*). The strategy includes the history of bighorn sheep in Montana from decline to recovery. Direction on how FWP monitors and manages populations, herd health, and bighorn habitat is defined. Protocols for resolving situations where bighorn sheep and domestic sheep/goats commingle, recommendations regarding use of domestic sheep/goats for noxious weed control, and a protocol for responding to die-offs have been developed. A Translocation program, including processes for identifying and evaluating potential habitats and prioritizing

transplant sites are included in the strategy. Integral aspects of the strategy are narratives for each hunting district or population. These narratives include a complete history of the individual population, overall management goals, and objectives for habitat, access, and population demographics. As part of the strategy, how individual populations are managed through hunting and translocation is clearly linked to monitoring efforts.

Grizzly Bear Trend Monitoring Research in the NCDE: An Update, 2004-2008

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In 2004, monitoring of grizzly bear (*Ursus arctos*) population trend in the Northern Continental Divide Ecosystem (NCDE) was initiated by Montana Fish, Wildlife and Parks (MFWP) in cooperation with other state and federal agencies. Also in 2004 an interagency field effort was undertaken to enumerate population size of grizzly bears over the entire NCDE using DNA methods. From these data, researchers have recently estimated population size with confidence limits and relative bear density across the NCDE. However, Managers and the public agree that a companion program is needed that would track population trend and female vital rates over time and provide ancillary information on other indices of population health. Having estimates of both size and trend will greatly improve our collective knowledge of grizzly bear ecology and provide more measurable and precise information with which to judge the status of the grizzly population in the NCDE. The purpose of this long-term trend program is to monitor the vital population parameters of grizzly bears by assessing the survival and reproductive rates, as well as trend, by following a number of radio-collared female grizzly bears. We summarize the objectives and field design of population trend and report on our success to date.

Viability of Resident Deer and Elk Hunter Participation in Montana

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The majority of funding for Montana FWP programs is generated or tied to sales of deer (*Odocoileus* spp.) and elk (*Cervus elaphus*) hunting licenses. Future declines in deer or elk hunter participation could therefore have negative consequences for wildlife management and conservation programs. To investigate deer and elk hunter participation rates in Montana, we made use of the FWP Automated Licensing System (ALS) database. Since 2002, the number of individuals buying deer and elk licenses has been roughly stable. We converted the data in ALS to a 6 (yrs) by 255,851 (unique individuals) matrix of resident hunter encounter histories for the period 2002-2007. Using a multi-state mark recapture model, we estimated hunter retention rates, hunter license buying probabilities, and transition probabilities between major age classes, considering hunter sex and region of residence as group covariates. We then used FWP hunter education databases to estimate hunter recruitment rates. Using these estimated rates, we parameterized and analyzed a stage-based population projection matrix. Estimated recruitment rates for teenagers following hunter education courses were sufficient to stabilize

the trend in deer and elk hunter participation, given our estimates of retention and license buying rates, in agreement with the overall trend in license sales for 2002-2007. Based on sensitivity and elasticity analyses of the projection matrix, future hunter participation rates and license sales would be most influenced by increases in recruitment rates and license buying probabilities for middle-aged adult and teenage males. We discuss the implications of these results for FWP hunter recruitment and retention efforts and social trends.

Nutrient Allocation in Egg Formation of Female Lesser Scaup on Lower Red Rock Lake, Red Rock Lakes National Wildlife Refuge

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North American lesser scaup (*Aythya affinis*) populations have been declining for nearly three decades. Recent evidence suggests that decreases in the quantity and quality of wintering and spring staging habitat may be reducing the ability of scaup to obtain the dietary resources necessary to undertake breeding activities. We used stable isotope techniques to explore the relative contributions of endogenous (body) and exogenous (local) reserves in clutch formation and how nutrient contributions changed throughout the clutch formation period. Female scaup body tissue samples (blood, claw, and lipid) were collected from mid-May (shortly after their arrival on the study site) through the nesting period during 2007-08; eggs were collected from nests during 2006-2008. Tissue isotopic signatures from mid-May were significantly enriched in stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope values compared to local dietary sources. Eventually tissue signatures equilibrated with local dietary resources by the end of the egg laying period in early July. Egg albumen, and to a lesser extent lipid-free yolk protein, were primarily derived from local sources. However, approximately half of yolk lipid was derived from endogenous body reserves. There was no significant relationship between isotopic signatures of eggs and the laying date. Our results indicate that while local resources are very important for meeting the nutrient demands of clutch formation, a majority of lipids and some protein are obtained from the spring staging areas.

Blood-lead Levels of Fall Migrant Golden Eagles in West-central Montana

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Lead has long been documented as a serious environmental hazard to eagles and other predatory, opportunistic and scavenging avian species. Due to lead poisoning in the Bald Eagle (*Haliaeetus leucocephalus*) the use of lead shot for waterfowl hunting on federal and state lands was banned in 1991. More recently, lead poisoning from spent ammunition

has been identified as the leading cause of death in California Condors (*Gymnogyps californianus*), prompting the recent ban of lead ammunition within the "California Condor Recovery Zone." Another study on Common Ravens (*Corvus corax*) in Wyoming has shown a direct correlation between elevated blood-lead levels and the on-set of rifle hunting season. Indeed, there is overwhelming evidence showing that lead is still prevalent in the environment and mounting data points to lead based rifle bullets as the primary source. We sampled blood from 42 Golden Eagles (*Aquila chrysaetos*) captured on migration during the fall of 2006 and 2007 to quantify a suite of possible heavy metal contaminants, with an emphasis on lead. Lead was measured in micrograms per deciliter (ug/dl) and ranged from 0 - 481 ug/dl. The blood-lead levels were broken in four exposure stages and our results were as follows: eagles with 0 -10 ug/dl ($N = 18$) were considered background, 10 – 60 ug/dl ($N = 19$) sub-clinically exposed, 60– 00 ug/dl ($N = 2$) clinically exposed and any eagle with $\geq$100 ug/dl ($N = 3$) were considered acutely exposed. In all, we found that 58 percent of the 42 Golden Eagles sampled had elevated blood-lead levels.

A Cooperative Approach to Elk Management in the Wildland/Urban Interface of Missoula, Montana - A Dynamic Strategy for a Growing Problem

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The Missoula Valley in western Montana is home to nearly 800 wintering elk (*Cervus elaphus*), of which 300 are from the North Hills elk herd. From 1980 to 2007, this herd grew from 17 to 290 elk with a 48-percent growth rate occurring between 2000 and 2007. Without an effective harvest, this population is projected to double every five years. With increased residential development in elk winter range, a diverse public's opinion on the management objectives of the herd, and the herd's juxtaposition to the City of Missoula and the Rattlesnake Wilderness and National Recreation Area, wildlife biologists have needed to become more creative with their management strategies. To more effectively manage the herd at a sustainable level and to keep it wild, wildlife biologists from Montana Fish, Wildlife and Parks have coordinated and collaborated with numerous landowners and staff at the University of Montana and the USDA Forest Service. This presentation is an integration of the social and biological sciences, with discussions on the successes and failures of tested strategies to manage elk in the wildland/urban interface. The discussion will include the perspective and efforts of a North Hills homeowner, and data from a Master student's thesis project on survival, habitat use, daily/seasonal movements, and elk redistribution related to hunting pressure as collected with 10 GPS and 11 VHF collars. The discussion will conclude with a description of the adaptive management approaches utilized by Montana Fish, Wildlife and Parks' wildlife biologists, and the efficacy of those strategies.

Effects of Wolf Predation on the Madison Headwaters Elk Herd: Insights for Elk and Wolf Management in Montana

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Studies of the non-migratory Madison Headwaters elk (*Cervus elaphus*) herd in Yellowstone National Park revealed that the herd appeared to be regulated near ecological carrying capacity by food limitation prior to the reestablishment of wolves (*Canis lupus*). Eleven years of post-wolf data indicated a substantial proportion of wolf predation was additive and overwhelmed any potential for the elk to demographically compensate. Thus, wolf predation resulted in a dramatic decrease in elk abundance and the system transitioned from being bottom-up regulated in the absence of a significant predator to strong top-down limitation due to wolf predation. It is uncertain if predation will ultimately regulate the elk population at a lower, alternate state or if predation and other factors influencing elk vulnerability will interact to result in further decreases in elk abundance. Fundamental to this question is the role of alternative prey and the interactions of winter severity and landscape heterogeneity on the vulnerability of elk to wolf predation. We contrast the impacts of wolf predation on elk in different drainages of the Yellowstone study area, as well as nearby areas studied outside the Park, to gain insights into the varying impacts of wolves on elk populations that occupy diverse landscapes in Montana. We suggest that wolves will have little to modest impacts on numbers of elk in most areas of the state, but that additive wolf predation could result in reduced elk numbers in some herds that winter in deep snow, forested environments where limited conflicts with livestock production can result in higher wolf: elk ratios.

Elk Behavioral Responses to the Reestablishment of Wolves: Integrating Multiple Strategies to Accommodate Competing Demands

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Over the past few decades a large body of literature has provided evidence that predators can influence the ways in which prey behave. This in turn may influence prey demography and predator-prey dynamics, and therefore may influence prey populations independent of direct killing. Using data collected from 1991 to 2007, we evaluated the behavior of elk (*Cervus elaphus*) in the Madison headwaters area of Yellowstone National Park in response to the colonization and establishment of wolves (*Canis lupus*). Changes in home range size, fidelity, group size, foraging, and large-scale spatial responses were evaluated. Prior to wolf colonization, grouping behavior was relatively stable and predictable as elk attempted to conserve energy and decrease starvation risk in the absence of wolves. Following reintroduction group size and group size variation increased. This more dynamic behavior

likely reflects a strategy to minimize predation and maximize food acquisition. After wolf colonization, elk moved more over the landscape as they were increasingly encountered, attacked, and displaced by wolves. Home ranges were slightly larger, with some decreases in fidelity. Long-distance dispersal and migratory movements were also adopted away from high-density wolf areas. These apparent predator-avoidance movements were never observed prior to wolf colonization or from areas where predation risk was lower. The decision to forage was heavily influenced by local snow, habitat, and time of day but remained relatively stable with and without the presence of wolves. We suspect that this lack of any substantial change in foraging behavior illustrates that elk can maintain the same level of foraging time and retain a relatively constant level of nutrition. Together these results suggest that in a harsh winter environment, elk can adaptively manage their behavior to cope with environmental constraints both in the presence and absence of wolves.

Grizzly Bear Population Augmentation in the Cabinet Mountains of Northwest Montana

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The Cabinet Mountains grizzly bear (*Ursus arctos*) population was estimated at 15 or fewer individuals in 1988 and believed to be declining toward extinction. In response to this decline, a test of population augmentation techniques was conducted during 1990-1994 when 4 subadult female grizzly bears were transplanted into the area. Two criteria were identified as measures of success: bears must remain in the target area for one year, and bears should ultimately breed with native male grizzly bears and reproduce. Three of four bears remained in the target area for one year or more. One bear died after one year. Reproductive success of any of the remaining individuals could not be established until 2006 when genetic analysis of hair snag samples collected from 2002-2005 was completed. This analysis indicated that at least one of the transplanted bears remained in the Cabinet Mountains and had reproduced. The detected bear was transplanted in 1993 as a 2-year-old and was identified by a hair snag within 5 mi of the original release site. Genetic analysis indicated she had produced at least 4 offspring and those offspring had also reproduced. This information indicates that the original test of augmentation was successful with at least one of the transplanted individuals. The success of the grizzly bear augmentation test has prompted continuation of this effort. The Northern Continental Divide Ecosystem area of north central Montana has been the source of four additional bears transplanted to the Cabinet Mountains during 2005-2008. Monitoring of these recent transplants is described.

Demography and Genetic Structure of a Recovering Grizzly Bear Population

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The threatened grizzly bear (*Ursus arctos*) population in northwestern Montana has been managed for recovery since 1975, yet no rigorous data were available to monitor program success. We assessed population status using data from one of the world's largest noninvasive genetic sampling efforts and 33–years of physical captures. Our population estimate, N= 765 (CV = 3.8%) was double the working estimate. Based on our results, the recent human–caused mortality rate approached a sustainable 4 percent although the high proportion of female mortalities raises concern. Genetic interchange has recently increased in areas exhibiting generations of low gene flow. This study illustrates the power of molecular techniques to rapidly assess populations at landscape scales and provide detailed demographic and genetic data needed to guide and evaluate recovery efforts.

Relationships Between Elk and Nonnative Weeds on Montane Winter Ranges in Western Montana

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Through physiological and competitive mechanisms, spotted knapweed has become established in many critical winter-range habitats, primarily in the northwestern United States and southwestern Canada. In areas of high density, elk (*Cervus elaphus*) may reduce the competitive ability of native grasslands through overgrazing. I predict that the benefits of weed spraying to reduce knapweed biomass are reduced in areas of high elk density and elk density and knapweed cover are positively correlated with high elk density creating high levels of weed biomass. A linear regression was calculated using vegetation data against kernel density estimates obtained from GPS telemetry locations in the North Hills Elk Herd of Missoula Valley, Montana. This analysis shows a trend for increased and decreased percent cover of knapweed and native grasses at high elk densities respectively, providing support for our overgrazing hypothesis through the mechanism of apparent competition. Fecal diet analysis further shows and avoidance of knapweed and a selection for native grasses and forbs as well as invasive cheat grass. Finally, elk exclosures were constructed and will be measured annually for comparisons between forage class (native, invasive) biomass and elk densities on herbicide treatment areas using a statistical analysis of covariance. This information is essential in understanding the secondary effects of weed spraying in areas of high ungulate densities. With this understanding, management may be better informed how to spend limited resources for invasive weed control. If benefits of weed spraying are diminished at high ungulate densities, managers will need to adopt very different weed control treatments.

From Magic to Tragic: The History of Wolf Recovery and Management in Northwest Montana

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In 1973, Northwest Montana wolf (*Canis lupus*) recovery began with Dr. Bob Ream, University of Montana Wolf Ecology Project, and a handful of volunteers trying to verify presence. Verified presence increased slowly until 1986 when the first pack and reproduction, the Magic Pack, was documented. Since then and until recently, the Northwest Montana Recovery Area (NMRA) was the slowest growing, and survivorship of individual wolves was the lowest of the three recovery areas within the Northern Rocky Mountain Population (NRMP). In the last three years the NMRA population rate of increase is now similar to the Greater Yellowstone Recovery area. The NRMP wolf population reached recovery goals in 2002 and will soon be delisted. During this 35 year recovery period numerous biologists working for University, Federal, State, Tribal, and private interests monitored and managed the population and devoted much to the success of the project. The numerous events, stories, and people behind its ultimate success are colorful and scattered with both accomplishments and set backs. Managers developed a complex bag of tools for population monitoring and management, livestock conflict resolution, and public relations unique to wolves. Wolf management is one of the more controversial programs that face wildlife professionals, and as the wolf population increases so do the challenges. An increased wolf population is met with increased public concerns on multiple issues including ungulate hunting opportunity, livestock interests, human safety, and domestic dog conflicts. Emotions have run high recently when managers have been severely criticized by diametrically opposing publics for either killing too many wolves or for white-tailed deer declines believed to be caused by wolves. The future holds yet more challenges with litigation, pending wolf hunts, as well as the same challenges of the past.

Why is this Grizzly Bear in my Backyard? Managing Human/ Grizzly Bear Conflicts in Northwest Montana

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The question may seem simple, "Why is this grizzly bear (*Ursus arctos*) in my backyard"? A reasonable answer would be "Because it has probably found something to eat." While the question and answer are basic, the solutions and prevention of future conflicts are more complex. From 1993 through 2008, there were 244 management captures of grizzly bears in Northwest Montana. These captures ranged from responses to grizzly bears causing property damage to incidental captures. Interagency Grizzly Bear Committee (IGBC) Guidelines give direction on capture and fate of the bear, but it is up to the Bear Conflict Management Specialists to work with both the grizzly bear and the people on the ground. Techniques to deal with the grizzly bears include relocation, on-site releases, hazing, aversive-conditioning, securing attractants, and removal from the population. Techniques to deal with the people include education, assistance in securing attractants, and citations. Just like people, grizzly bears are all individuals, and what might work in one situation might not work in all situations. Methods for dealing with and preventing conflicts is evolving as new techniques and technology gives grizzly bear managers new tools and options. The ultimate goals are to keep people safe and to keep grizzly bears alive and in the wild.

An Ecological Risk Assessment of Wind Energy Development in Montana

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In 2008 the United States led the world in wind power generation, providing 35 percent of the nation's new electrical generating capacity. Montana ranks fifth among states for wind energy potential. Wind facilities are not stand-alone features—they cover vastly more area than the footprint of the turbines, requiring extensive road systems and transmission corridors. The challenge for wind energy development in Montana is to produce relatively clean energy that does not contribute to global climate change, while minimizing impacts to biodiversity. We have completed an ecological risk assessment at coarse and fine scales for Montana. We utilized a diverse assemblage of wildlife species of concern, selecting for those that research suggests would be the most susceptible to wind energy development. We estimate that in total about 17 million ac of available good-to-superb wind energy potential exists within Montana, and of that, at least 7.7 million ac have a high risk to potentially impact species of concern. We strongly suggest that these areas be avoided as locations for wind energy development, rather than considering mitigation approaches, as the lands identified are often critical habitat for multiple species.

Modeling Predicted Distribution And Landscape-Level Habitat Suitability For Montana Wildlife Species

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Models predicting spatial distribution and habitat suitability are critical for natural resource managers making decisions that impact species for which there is limited information. We are using presence-only data in conjunction with pseudo-absences in program Maxent to model the distribution and landscape-level habitat suitability for Montana wildlife species. Our primary goals are to produce (1) continuous statewide outputs as a tool to identify variables that limit species' distributions and areas that need field surveys; (2) binary outputs that can be used to create lists of predicted species for various administrative boundaries and, (3) outputs showing marginal, suitable, and optimal habitat classes at a local landscape-level. To date, models have identified scale dependent responses to environmental variables, opportunities to extend the known ranges of species, areas that support potentially isolated populations in need of conservation efforts, areas that are critical for maintaining landscape connectivity, areas that may provide the best habitat for reintroduction of species that have declined, and areas where exotic and nonindigenous species are most likely to become established. In general, inductively based Maxent models provide realistic depictions of species distributions when survey data is available for a region. However, deductive models will still be important for representing some species distributions in areas lacking survey effort. Models will be used for various planning efforts including Montana Fish, Wildlife, and Parks' Crucial Areas and Corridors Assessment. Model outputs can be obtained from the Montana Natural Heritage Program or the Montana Fish, Wildlife, and Parks' Information Management Bureau.

Status of Lentic Breeding Amphibians and Aquatic Reptiles in Montana

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We developed a statewide inventory and monitoring scheme for lentic breeding amphibians and aquatic reptiles in Montana. We stratified sampling by 11 ecoregions and surveyed 6741 potential lentic sites on public lands between 2000 and 2008 within 429 randomly selected 12-digit hydrologic-unit-code watersheds. Surveys and associated incidental observations have resulted in over 11,400 species occurrence records to date. Watershed and site breeding rates of 10 amphibian species and occupancy rates of four aquatic reptile species support previously noted declines of the Western Toad (*Bufo boreas*) and Northern Leopard Frog (*Rana pipiens*) in western Montana. We used classification trees to examine patterns in rates resulting from different groupings of major habitat features that are able to be affected with management actions. Seven of the 10 amphibian species and the Common Gartersnake (*T. sirtalis*) were detected at significantly fewer sites when fish were detected. Presence of emergent vegetation was positively associated with the proportion of sites where breeding or occupancy was detected for all but one of the amphibian and reptile species examined and appeared to partially mitigate the presence of fish. Resource managers could enhance habitats for wetland herpetofauna by (1) creating new lentic sites on the landscape either directly or through the reintroduction and protection of beaver, (2) creating emergent vegetation at portions of existing sites that currently lack it via rotational fencing to temporarily exclude grazing, and (3) eliminating some introduced fish populations. All observations and survey locations, including digital photographs of sites surveyed are available at: http://nhp.nris.state.mt.us/Tracker.

The Impact of Climate Variation on Columbia Spotted Frog Survival in a High Mountain Ecosystem

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Amid growing concern over the impacts of long-term climate change, a fundamental challenge for wildlife biologists is determining how animal populations will respond to a changing climate. In amphibians, little research has addressed how climate variation may affect vital rates and population sizes. We evaluated the relationship between annual age- and sex-specific survival rates and local and global climate variables using a nine-year mark-recapture dataset of Columbia spotted frogs (*Rana luteiventris*) from the Bitterroot Mountains. Local climate variables included peak snowpack, winter length, summer length, and growing degree days. Global climate variables included the Southern Oscillation Index (SOI) and the North Pacific Oscillation (NPO). We estimated annual survival for four age classes: juveniles, subadult and adult females, and adult males. We found that survival in this population was best predicted by snowpack and winter length. In this model, an increase in snowpack resulted in a decrease in juvenile ($b = -0.083 \pm 0.007$), adult male ($b = -0.036 \pm 0.016$), and

adult female (b= -0.037±0.015) survival, and had no significant effect on subadult survival (b = -0.011±0.027). An increase in winter length led to a slight increase in survival, but only for juveniles and adult males. These results suggest that a warming climate with less severe winters might be good for montane frog populations. Survival is only one vital rate, however, and future work will determine the influence of climate on other vital rates such as growth and fecundity, as well as examine the contribution of intrinsic drivers to population variation.

Hunting Access Management on Private Lands in Montana

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In the summer of 2008, a study of hunting access on private lands in Montana was conducted cooperatively by Colorado State University, Montana Fish, Wildlife and Parks, and the Western Association of Fish and Wildlife Agencies. The purpose of this effort was to examine the extent to which Montana landowners are providing hunting access and the approaches they use to manage access on their property. The focus was on access for hunting of deer, elk, antelope, and upland game birds (defined to include pheasant, sharp-tailed grouse, and Hungarian partridge). The study also included an assessment of landowner values toward wildlife and wildlife management. Data were collected via a mail survey administered to a randomly-selected sample of landowners with ≥ 160 ac. A total of 1418 landowners participated, resulting in an overall response rate of 47 percent. The majority of landowners indicated that hunting occurs for the species that are present on their lands. Landowners in the eastern region of the state reported the highest levels of hunting occurrence across species, except for elk. The largest difference in hunting occurrence across regions was reported for upland game birds – 63 percent of respondents from the western region with upland game birds on their property allowed access, compared to 80 percent in the East and 74 percent in the central region. For the ungulate species (deer, elk, and antelope), hunting tended to occur more often for male animals. The average number of hunters/year allowed on private lands was highest for elk and lowest for antelope. The two most common forms of access management reported by landowners were "non-Block Management hunting without a fee" involving mostly hunters who are (1) family/friends and (2) NOT family/friends. The third most frequently selected approach was the Block Management Hunting Access Program. By facilitating a better understanding of how hunting is currently managed on private lands in Montana, these results provide a baseline that can assist FWP in developing plans for working with private landowners on issues related to hunting access and wildlife management in the future.

Public Attitudes Towards Black bears in Missoula, Montana

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Successful wildlife management actions and policies depend on public acceptance. Management actions minimizing human-black bear (*Ursus americanus*) conflicts are controversial, and research that articulates public attitudes in a diversity of situations is often

lacking. Our objectives were to examine public attitudes towards black bear management of residents in the Wildland-Urban Interface (WUI; where bears and humans coexist) and the city core, i.e., where no bears are present. We also examined the effects of education and information (EI) efforts to minimize human-bear conflicts. Two questionnaires were distributed to residents living in Missoula, Montana before (2004) and after (2008) EI efforts were implemented. Residents living in the city core and the WUI both attracted bears with bird feeders, BBQ grills, and gardens but had significantly different frequencies of available vegetation and garbage. In the WUI, the frequency of available native and non-native vegetative bear food was significantly higher, whereas the frequency of outdoor garbage storage was significantly lower. In 2008, attitudes were not significantly different between residents in the WUI and the city core. The 4 yrs of EI efforts did not alter resident behaviors that produce attractants in the WUI. However, the EI efforts in the WUI did increase support for non-lethal management actions. Managers may be able to use EI efforts to gain support for black bear management actions, but must realize that behaviors producing attractants may be spatially ubiquitous and difficult to modify.

Assessing Ecological Impacts due to the Operation of Libby Dam, Montana

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Damming of rivers represents a cataclysmic event for large river-floodplain ecosystems. By altering water, sediment, and nutrient flow dynamics, dams interrupt and alter a river's important ecological processes in aquatic, riparian, floodplain and surrounding terrestrial environments. The Kootenai Tribe of Idaho and Montana Fish, Wildlife and Parks, with the support of numerous subcontractors, are currently exploring the ecological impacts related to the operation of Libby Dam. To assess the cascading effects, KTOI personnel and subcontractors are developing indices to assess individual abiotic and biotic components. These individual assessments will be combined into an Index of Ecological Integrity (IEI) at a geomorphic reach or subbasin scale. The IEI will be used to assess, mitigation, monitor, and rehabilitate the Kootenai River Floodplain.

Long-Term Monitoring of Osprey Populations In Western Montana

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Ospreys (*Pandion haliaetus*) are important apex predators and continue to be important indicators for environmental contaminants in aquatic ecosystems. Although osprey populations made rapid recoveries in Montana after the 1972 ban on the use of DDT, there have been surprisingly few studies monitoring osprey populations since then. During the last 20 yrs some osprey populations in western Montana have declined over 75 percent, and are now approaching the low numbers of the DDT era. The causes and geographical extent of these declines are not known, although companion studies have shown some very high levels of mercury in osprey chicks. For these reasons, we are establishing a long-term monitoring program for ospreys in western Montana. Here we report on our osprey studies on Flathead Lake and adjacent watersheds, which appear to be a major stronghold for ospreys. During

the summer of 2008, we located and monitored 87 osprey nests on Flathead Lake. At least 69 (80%) of these nests were occupied; a sub-sample of 47 of these nests had 1.9 chicks produced per productive nest. This is above the productivity estimated to maintain stable osprey populations.

Fat but not Happy: The Effects of Supplemental Feeding on Stress Hormone Levels of Wyoming Elk

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On 23 feed grounds in Wyoming, elk (*Cervus elaphus)* were provided with supplemental feed throughout the winter. Brucellosis seroprevalence of feed ground elk is 26 percent whereas other elk in the Greater Yellowstone Ecosystem have a brucellosis seroprevalence of 2-3 percent. The aggregation of elk during peak transmission allows brucellosis to persist in the fed populations. In addition to creating the opportunity for disease transmission, the aggregation of elk on feed grounds may have detrimental physiological effects. Other studies have shown that chronically high stress hormone concentrations can suppress the immune system and lead to increased disease susceptibility. Potential stressors on the feed grounds include high densities, large group sizes and aggressive social interactions. In this study we investigated how supplemental feeding and environmental variables affect stress hormone levels in fed and unfed populations of elk. We also manipulated resource distribution on the feed grounds to examine how feeding density affects stress hormone levels and aggression rates. Results show that elk on feed grounds have stress hormone levels significantly higher than unfed elk. Experimental reduction of feed density did not have an effect on stress hormone levels or aggression rates. Group size and density during feeding were important predictors of stress hormone levels. This study indicates that feed grounds are not only creating an epidemiological setting for disease transmission, but also creating a physiological state that may increase susceptibility to disease. The impact of these stress hormone concentrations on disease susceptibility remains unknown, but may potentially be an important driver of disease dynamics in feedground elk populations.

Changes in Elk Resource Selection and Distributions Associated with the Madison Valley Late-Season Elk Hunt

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Changes in resource selection associated with human predation risk may alter elk (*Cervus elaphus*) distributions and availability for harvest. Using Global Positioning System (GPS) data collected from telemetry-collared cow elk, we evaluated effects of refuges (areas where hunting was prohibited), spatial variation in hunting risk and landscape attributes on resource selection within an established Greater Yellowstone Area wintering range and we evaluated elk distributions during and outside of a late-season hunting period. Refuge areas and landscape attributes such as habitat type and snow water equivalency (SWE) affected resource selection. During the hunting period, selection for refuge areas increased, and we estimated odds of elk occupancy in refuge areas more than doubled. Elk selection for flat grasslands

increased as SWE increased likely because these areas are heavily windswept leaving grasses exposed for foraging. Elk distributions differed during hunting and no-hunting periods, and during the hunting period elk distribution shifted to privately owned land where hunting was prohibited. Risk-driven changes in resource selection resulted in distributions that reduced the availability of elk for harvest. Elk selection for areas where hunting is prohibited presents a challenge for resource managers that use hunting as a tool for managing herd sizes.

The Montana Legacy Project – Conservation of Forest Lands in Western Montana

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The Montana Legacy Project implements an agreement between Plum Creek Timber Company and a partnership between The Nature Conservancy of Montana and The Trust for Public Land for the acquisition of 312,000 ac of Plum Creek lands in western Montana. The goals of the project include: protection of the area's clean water and abundant fish and wildlife habitat, maintenance of forests in productive timber management, and promotion of public access for fishing, hiking hunting and other outdoor recreation. The project includes several areas where Plum Creek lands are in a checkerboard ownership pattern with public lands. The potential conversion of these lands to subdivision and development could significantly fragment wildlife habitat, interrupt movement corridors, restrict traditional public recreational access, and increase the costs of wildfire protection and the provision of local services. This project is the result of collaboration by many individuals and organizations from across the state. Business leaders, sportsmen, elected officials, federal and state agencies, conservationists, citizen groups and others are working together to conserve the important resource values within this project area.

Estimation of Black-tailed Prairie Dog Colony Acreage in Montana

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The first statewide inventory of black-tailed prairie dog (*Cynomys ludovicianus*) colonies in Montana was conducted in the mid 1980s and produced an estimate of 120,000 – 130,000 ac. A cooperative statewide inventory effort (1996 -1998) yielded a minimum estimate of 66,000 ac of occupied habitat. However, this inventory did not include areas where access was denied and results of alternate survey efforts. The minimum management objective for black-tailed prairie dog abundance in Montana is 90,000–104,000 occupied ac, according to the statewide management plan. A current, comprehensive, and rigorous statewide estimate of prairie dog acreage was needed to determine the area of Montana occupied by black-tailed prairie dog colonies. We surveyed known black-tailed prairie dog distribution in Montana using an aerial line-intercept survey stratified by county from June to August, 2008. We recorded the length of prairie dog colony intercepts on approximately 35,000 linear mi on 771 transects in 32 counties in central and eastern Montana. Transects were flown in fixed-wing aircraft in an east-west direction at ~ 110 mph at < 300 ft above ground level. Prairie dog

colonies were detected in 21 counties. We recorded roughly 750 prairie dog colony intercepts. We attempted to ground truth 10 percent of detected prairie dog colonies along transects, and at least one black-tailed prairie dog colony intercept in each county. Data analysis is ongoing at this time. However, preliminary results indicate black-tailed prairie dog occupancy exceeds Montana abundance objectives. A comprehensive analysis is expected to be complete in April, 2009.

Effects of Cattle Grazing on Small Mammal Communities at Red Rock lakes National Wildlife Refuge

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Cattle grazing is a common land practice on public lands in the West that can have complex impacts on both wildlife and vegetation. However, many studies of wildlife response to grazing only compare grazed versus ungrazed treatments, ignoring the dynamic nature of grazing and the many levels of grazing intensity and frequency commonly utilized. We undertook the current study to better understand the response of small mammals to the frequency of cattle grazing in wet meadow habitats on Red Rock Lakes NWR. Three adjacent grazing units were selected for study with grazing frequencies of 1, 3, and 8 years of rest in 2007 and 0, 2, and 4 yrs of rest in 2008. Two randomly placed trapping grids were placed within the *Juncus balticus–Carex praegracilis* vegetative alliance (wet meadow) in each unit. Trapping occurred from late June–August each year. Vegetation was quantified in each unit each year using point-intercept transects. We conducted raptor surveys during 2008 to examine raptor response to vole abundance. Voles (meadow and montane; *Microtus* spp.) made up the overwhelming majority (~99%) of individuals captured. Results from 2007 indicated that vole abundance increased with increasing rest from grazing. Vole abundance in 2008 was substantially lower and did not follow the same pattern as 2007–in 2008 the unit with an intermediate level of rest (2 yrs) had the highest abundance. Raptor numbers tracked vole abundance closely in 2008. Additional years of study will be necessary to determine the role grazing plays in vole population dynamics.

Recent Advances in the Analysis of Occupancy and Abundance Data in Response to Management Activities

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Recent advances in the analysis of occupancy data collected from repeated visits to sampling stations will be presented along with an example analysis of avian community responses to prescribed fire. The occupancy analysis is a Bayesian hierarchical model, allows fixed and random effects, and is a composite analysis that allows researchers to estimate management effects for rare species as well as community level indices such as species richness. Additional examples of applied research projects that have used Bayesian hierarchical models will be briefly discussed to demonstrate the flexibility of the method and

introduce the audience to techniques they may not be familiar with. Additionally, an example using variable circular plot, i.e., distance data, will be presented demonstrating an analysis of red squirrel (*Tamiasciurus hudsonicus*) densities in response to prescribed fire. These methods are appropriate for studies designed to investigate the impact of management practices on wildlife species and represent improvements over previous techniques.

As the World Turns: Managing Wolves and Navigating the Legal Labyrinth

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This is the 29th year that wolves (*Canis lupus*) have been in northwest Montana and the 14th year that wolves have been in southwest Montana. It's the 5th year Montana Fish, Wildlife and Parks (FWP) has led wolf management. And it's the 7th straight year in which the northern Rockies biological recovery goal was met. The real success story is that roughly 88 percent of the recovered wolf population lives outside national parks. Through it all, science has advanced and the rhetoric has ebbed and flowed. Somewhere in the midst are the biological, political, and social realities of managing a recovered population. Outside national parks, wolves share a landscape with people who have very diverse viewpoints about wolves and their management. Like other wildlife species, Montana's wolf population is subject to checks and balances, including strong reproduction in some areas, disease, vehicle strikes, and mortality due to conflicts with people. Montana's population is secure, but dynamic. At the end of 2007, Montana had a minimum of 422 wolves in 73 packs, 39 of which were breeding pairs. In 2008, the legal framework was equally dynamic when federal government efforts to delist the northern Rockies population were challenged. Wolves were delisted for about 4 mos before a federal judge reinstated federal legal protections through a preliminary injunction and then permanently when the federal government withdrew its decision. Delisting efforts were renewed late in 2008 and carried forward into 2009. This will be summarized and an FWP program update will be provided. See also: www.fwp.mt.gov/wildthings/wolf

CCAA Impacts on Birds of the Big Hole Watershed

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Amy Cilimburg, Montana Audubon, Helena, Montana 59624

Through the Big Hole CCAA, a coalition of groups has undertaken extensive restoration work aimed at improving habitat conditions for the last remaining fluvial population of Arctic grayling in the U.S. Riparian-associated birds are also likely to respond positively to such restoration activities, and this is significant because riparian habitats support a greater diversity of breeding birds than any other habitat type in Montana. In the summers of 2007 and 2008 the Avian Science Center obtained permission from participating landowners along the Big Hole River to document bird communities during this pre-restoration phase. We surveyed birds at reference points that serve as the target habitat condition for restoration efforts, and impact points that are currently impaired, but likely to improve with restoration activities. We also measured vegetation at each point to evaluate vegetation quality. We

detected 107 species across the two survey years, and this represents 44 percent of bird species (107/245) known to breed in Montana. This speaks to the outstanding diversity of birds associated with riparian areas in the Big Hole watershed. Both the vegetation characteristics and bird communities were decidedly different between reference and impact sites. Thirteen of the 25 most frequently encountered bird species were detected on a significantly higher proportion of reference points while six species were more frequently encountered on impact sites. We suggest using the occurrence of five species: willow flycatcher (*Empidonax traillii*), veery (*Catharus fuscesens*), northern waterthrush (*Seiurus noveboracensis*), fox sparrow (*Passrella iliaca*) and song sparrow (*Melospiza melodia*), all of which were encountered much more frequently at reference sites, to evaluate the success of restoration work in future years.

Temporal Comparisons of Great Blue Heron Rookery Distribution, Abundance and Reproductive Success in the Lower Yellowstone River Basin

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In response to declining trend information from Montana Audubon Society, Breeding Bird Surveys, and as part of an ongoing effort to assess the status of eastern Montana's non-game wildlife and identify critical habitats, we assessed the distribution and abundance, occupancy and reproductive success of great blue heron (*Ardea herodias*) rookeries within the lower Yellowstone River Basin. We conducted an aerial census of the lower Yellowstone, Tongue and Powder river corridors to document existing rookeries. Rookeries were revisited prior to fledgling abandonment to assess reproductive success. We compared the distribution, abundance and reproductive success of rookeries along the lower Yellowstone River to data from similar surveys conducted in 1976 and 1988. Great blue heron rookery abundance and reproductive success were also compared to river flows during corresponding time periods. Between 1976 and 1988, active rookery abundance increased from nine to 18 but declined back to nine by 2008. The average number of occupied nests per active rookery for each time period was 14 in 1976, 16.8 in 1988 and 12.1 in 2008.Rookery distribution showed temporal variance, however, some areas supported rookeries during all survey periods. Reproductive success data were not available for 1976. Comparisons between 1988 and 2008 showed that the percentage of reproductively successful rookeries in 1988, when river flows remain primarily below average, was 61 percent. During 2008, when river flows were consistently above average, the percentage of successful rookeries decreased to 44 percent. Combined data suggested that great blue heron rookery abundance and reproductive success along the lower Yellowstone River fluctuates temporally in response to various ecological factors, yet to be fully understood.

Managing Black Bears and Cougars with People Problems

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The Flathead Valley area and most of northwest Montana is currently growing at a rate of 6 percent/ yr. Given the increasing human population and expanding residential development in the urban interface, there will continue to be bears (*Ursus* spp.) and cougars

(*Puma concolor*) living in close proximity to homes and human activity centers. During the 2007 and 2008 field seasons we received 774 and 881 black bear (*Ursus americanus*) conflict calls, respectively, concerning incidents of some kind. Most of these black bear calls occurred between May 1 and November 30, during 2008 that results in 881 calls in a 7-mo period or 126 calls/mo or 4.1 calls/day – everyday. During the 2007 and 2008 field seasons we received 70 and 152 cougar conflict calls, respectively, concerning cougar conflicts of some kind. The 6 yrs previous to 2008 we received an average of 68 calls/year concerning cougar conflicts. This dramatic increase in cougar conflicts in 2008 reflects an increasing cougar population trend in the last few years. Through continued education efforts it will be possible to disseminate the best available information to pre-emptively reduce human / wildlife conflicts. The continued use of a bear trap to relocate or trap and aversively condition program will address bears that have already made a positive association with people or their dwellings. The continued response to cougar conflicts will reduce (though not eliminate) the potential public safety issues that exist anywhere there are healthy cougar populations. It is our hope that we will be able to maintain the public tolerance for these highly prized big game animals in western Montana by maintaining this effective wildlife conflict, safety and education program.

Bird Distribution in Montana: Opportunities for Public Involvement

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Montana's diverse landscapes provide habitat to a wide assortment of birds. Climate, ecology, and human activity can influence landscape changes and patterns of bird distributions across the state. Every year, birdwatchers, biologists, and landowners document the occurrence of common and rare bird species throughout Montana. The Montana Bird Distribution program promotes stewardship of birds and their habitats by using information gathered by Montana's citizens to track the distribution and seasonal occurrence of the 409 bird species documented in the state. Over 30 new species have been documented in the state of Montana since 1980 through this program. As of 2003, 29 species appeared to be increasing their distribution across the state, e.g., tundra swans, several flycatcher species, and 27 species appeared to be decreasing their distribution, e.g., stilt sandpipers, 2 species of rosy-finch. The Montana Bird Distribution partnership consists of Montana Audubon, Montana Bird Records Committee, Montana Natural Heritage Program, and Montana Fish, Wildlife and Parks. The Partnership collects observations by professional and nonprofessionals, maintains a high-quality database of observations, and disseminates information via a website and *P.D. Skaar's Montana Bird Distribution* book series. Publication of the next book edition is planned for 2010 and observations are due by 31 December 2009 for inclusion in this edition. Here we present examples from the previous edition and a tutorial on *Tracker*, the web-based system for contributing data points.

Patterns of Movement in Black-Backed Woodpeckers

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Black-backed woodpeckers (*Picoides arcticus*) inhabit recently burned forests, forcing both sexes to regularly disperse during the course of their lifetime. Yet we know little about their pattern of dispersal, including both distance traveled and the range of habitat types colonized for reproduction. We collected genetic samples from 274 black-backed woodpeckers across North America. We found a large amount of gene flow across the boreal forest and used a simulation approach to test if this pattern is best explained by frequent colonization of burned patches. We then used the fire history in the boreal forest to estimate the average distance between fires to determine if burned patches are readily available for colonization. Finally, we estimated the average dispersal distance based on the genetic relatedness among birds in our study. In combination, this information can be used to help prioritize land management decisions, such as salvage logging, that affect black-backed woodpecker populations.

A GIS Tool for Conducting Landscape-Scale Habitat Quality Assessments

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Evaluating and quantifying human impacts and improvements to wildlife habitat at large scales is a continuing challenge for wildlife managers. To help such evaluations, we have developed a GIS-based habitat modeling tool that quantifies the number and quality of home ranges for species of interest in existing, historical, or potential future landscape conditions. We used this tool in a 1.5-million ac landscape in northern Idaho to model habitat-based species viability for eight species of concern. This presentation will focus on the results for Canada lynx, northern goshawk, and flammulated owl. We developed habitat potential maps at the scale of the home range for each species. Models were created for existing, historical, and predicted future habitat conditions. Future habitat conditions were projected based on an objective of maintaining or restoring 20 percent representation of historical conditions. Model runs were used to produce an estimate of the number of high, moderate, low, and very low quality home ranges, with implications from this for likely persistence of each species. Improvements in future habitat quality varied among the species, but improved the most for those species dependent upon drier forest types where greater restoration efforts are needed and planned. The ability to model habitat-based species viability allows land managers to estimate the impacts or improvements to wildlife species of concern that are likely to result from development, management or restoration activities.

Terrestrial Poster Session

Modeling Predicted Distribution and Landscape Level Habitat Suitability for Montana Wildlife Species

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Scott Story and Joy Ritter, Information Management Bureau, Montana Department of Fish, Wildlife, and Parks, Helena, Montana 59620

Models predicting spatial distribution and habitat suitability are critical for natural resource managers making decisions that impact species for which there is limited information. We are using presence-only data in conjunction with pseudo-absences in program Maxent to model distribution and landscape-level habitat suitability for Montana wildlife species. Our primary goals are to produce (1) continuous statewide outputs as a tool to identify variables that limit species' distributions and areas that need field surveys; (2) binary outputs that can be used to create lists of predicted species for various administrative boundaries and, (3) outputs showing marginal, suitable, and optimal habitat classes at a local landscape-level. To date, models have identified scale-dependent responses to environmental variables, opportunities to extend the known ranges of species, areas that support potentially isolated populations in need of conservation efforts, areas that are critical for maintaining landscape connectivity, areas that may provide the best habitat for reintroduction of species that have declined, and areas where exotic and nonindigenous species are most likely to become established. In general, inductively based Maxent models provide realistic depictions of species distributions when survey data is available for a region. However, deductive models will still be important for representing some species distributions in areas lacking survey effort. Models will be used for various planning efforts including Montana Fish, Wildlife, and Parks' Crucial Areas and Corridors Assessment. Model outputs can be obtained from the Montana Natural Heritage Program or the Montana Fish, Wildlife, and Parks' Information Management Bureau.

Status of Lentic Breeding Amphibians and Aquatic Reptiles in Montana

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We developed a statewide inventory and monitoring scheme for lentic breeding amphibians and aquatic reptiles in Montana. We stratified sampling by 11 ecoregions and surveyed 6741 potential lentic sites on public lands between 2000 and 2008 within 429 randomly selected 12-digit hydrologic-unit-code watersheds. Surveys and associated incidental observations have resulted in over 11,400 species occurrence records to date. Watershed and site breeding rates of 10 amphibian species and occupancy rates of four aquatic reptile species support previously noted declines of the Western Toad (*Bufo boreas*)

and Northern Leopard Frog (*Rana pipiens*) in western Montana. We used classification trees to examine patterns in rates resulting from different groupings of major habitat features that are able to be affected with management actions. Seven of the 10 amphibian species and the Common Gartersnake (*T. sirtalis*) were detected at significantly fewer sites when fish were detected. Presence of emergent vegetation was positively associated with the proportion of sites where breeding or occupancy was detected for all but one of the amphibian and reptile species examined and appeared to partially mitigate the presence of fish. Resource managers could enhance habitats for wetland herpetofauna by (1) creating new lentic sites on the landscape either directly or through the reintroduction and protection of beaver, (2) creating emergent vegetation at portions of existing sites that currently lack it via rotational fencing to temporarily exclude grazing, and (3) eliminating some introduced fish populations. All observations and survey locations, including digital photographs of sites surveyed are available at: http://hhp.nris.state.mt.us/Tracker.

The Pathogenic Chytrid Fungus in Montana Amphibians

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The chytrid fungus (*Batrachochytrium dendrobatidis*; Bd) is pathogenic to many amphibians and has been linked to declines and extinctions in a number of species around the globe. We collected 484 tissue samples and swabs of ventral surfaces of nine species at 161 locations across Montana in the course of fieldwork between 1998 and 2005. We detected Bd in 161 samples taken at 64 sites between 1998 and 2005 for six species; *A. tigrinum*, *B. boreas*, *B. woodhousii*, *P. maculata*, *R. luteiventris*, and *R. pipiens*. Overall, 40 percent of sites had at least one species test positive and, across all species, 33 percent of samples tested positive. We detected Bd in samples taken throughout the active season of these species across Montana at a variety of elevations, in a variety of habitats, and up to 17.5 km from the nearest road. However, a higher percentage of samples and sites (37 to 41 and 47 to 66 percent, respectively) tested positive for Bd within 1 km of roads. While this effort provides no definitive evidence, Bd, acting alone or synergistically with other stressors, appears to be the most likely cause of declines observed in *B. boreas* and *R. pipiens* populations in western Montana in light of its widespread distribution and association with declines in other regions. Further evaluation of the status of Bd and other amphibian pathogens in Montana is warranted and strict adherence to protocols preventing the spread of these pathogens is needed.

Improving Science Literacy Through Visual Communication

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Communicating science effectively to diverse audiences including natural resource managers, policy makers, and the general public, has broad implications for implementing science-based solutions to environmental problems such as those associated with non-native species invasions. If audiences are able to understand and assess scientific information, they are more likely to make decisions based on facts rather than on hearsay or speculation. Frequently, popular press articles on invasive species are designed to promote fear-based responses. Previous work in an ecological publication identified that even invasion biologists use militaristic and combative language as metaphors, often leading to an inaccurate perception of invasive species and loss of scientific credibility, which can be counterproductive to achieving conservation and management goals. Scientists and educators are natural collaborators to increase the science literacy about the biology and ecology of non-native species invasions to audiences, while consistently maintaining scientific integrity and credibility. Further, as increasing numbers of research granting entities require an outreach and education component in project proposals and outputs, proven ability to effectively present and disseminate scientific information to diverse audiences is becoming highly valued. This poster presents examples of how visual design strategies and learning theory can be used to engage audiences and communicate science effectively.

Seroprevalence of Canine Parvovirus and Canine Distemper in Wolves in Relation to Human Activity in the Canadian Rocky Mountains

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Diseases affect social carnivores that occur in high density areas, like wolves (*Canis lupus*). Carrier species (feral dogs, coyotes, foxes) travel between the urban/wildlife interface; thus, transmitting diseases to wolves. We sampled 99 wolves from the years 2000 to 2008 for canine parvovirus (CPV) and canine distemper virus (CDV) in Banff and Jasper National Parks and surrounding areas of the Canadian Rockies. Of the 99 wolves, 92 tested positive

for CPV, 22 tested positive for CDV and 22 tested positive for both diseases. We tested whether seroprevelence of CPV and CDV was higher closer to human activity (roads, town sites, campgrounds, federally designated Indian reserves) and as a function of sex, age class, and different wolf packs using mixed-effects logistic regression models. CPV and CDV seroprevalence was found to be higher in areas closer to human activity and was higher in younger age classes of wolves. Understanding disease transmission between urban areas and wildlife areas with high wolf densities, like the Canadian Rockies, could yield pertinent information about disease profiles. Disease profiles from the Canadian Rockies could help conserve the recently delisted wolf species in areas like Yellowstone National Park where human activity is high relative to wolf activity.

Dynamics of a Harvested Moose Population in Southwest Montana

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Floodplain riparian habitat provides relatively stable and important wintering habitat for moose in the Rocky Mountains. The Centennial Valley (CV) in southwest Montana contains the largest wetland complex in the Greater Yellowstone Ecosystem, and the associated riparian habitat supports one of the largest and highest-density wintering Shiras moose (*Alces alces shirasi*) populations in the Northern Rocky Mountains. Most of this habitat is encompassed by Red Rock Lakes National Wildlife Refuge (Refuge), situated in the eastern extent of the valley and within Montana Fish, Wildlife and Parks hunting district 334 (HD 334). We utilized 4 decades of winter aerial survey (1966-2008) data from HD 334 to investigate relationships among winter moose abundance, snow pack, and hunter harvest of antlerless moose. Winter moose abundance steadily increased during the period 1966-2008 at an average annual rate of 2.2 percent (SE = 0.48%), but per capita productivity (calf: adult ratio) simultaneously declined. As predicted, winter snow pack was positively related to moose abundance on the survey area. Hunter harvest of antlerless moose negatively affected moose abundance, but the effect differed for the two age classes (calves vs. adults). Our results indicate that previous levels of hunter harvest were sustainable; however this occurred at a time when few other moose predators were present. Future harvest management will have to take into account increasing numbers of predators in southwestern Montana.