2016 CCTWS Annual Meeting Abstracts

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Plenary Session Abstracts:

From 'Capture' to Web Apps: How customized software can up your game

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It is widely recognized that modern computer software makes wildlife management and research easier and allows increasingly complex tasks to become routine. Over the past several decades, incredible strides have been made in the development and distribution of software for wildlife biologists. Much of the innovation is rooted in Colorado. Unfortunately, data storage and reporting rarely keep pace with the rapid expansion of data analysis software. Such disconnects in workflow can lead to missed opportunities where data are not used to their fullest extent and new information is slow to emerge. Modern computing has trended toward customizable applications hosted on distributed server networks. Here we present an example of a customizable server-based software system, PopR (https://popr.cfc.umt.edu), which merges wildlife management agency databases with state-of-the-art statistical software for real-time wildlife data analysis, population modeling and reporting. The interface to PopR is a secure website allowing access from any location with internet access and from any platform (personal computer, smartphone, tablet, etc.). PopR connects to remote data sources through an application program interface (API). PopR implements Bayesian integrated population models combining multiple data sources. PopR also implements individual data source analyses such as survival, sightability, herd composition, among other data sources. Finally, PopR generates reports and figures for rapid dissemination of results.

When looking to the future of software for wildlife biology, we ask: "what if the analyses needed to support allocation of deer and elk harvest were as simple as a Google search?" Google's approach to searching the internet provides a useful heuristic for merging innovative statistical research with wildlife management. Not unlike an internet search, the technical side of wildlife management requires the synthesis of multiple sources of information, routine accomplishment of key tasks and extraction of useful information from noisy data. Modern statistical procedures can often provide the information managers seek, but the associated complexity is an unwanted annoyance. By leveraging the power of customized software we can automate these procedures and generate reports, essentially giving managers the ability to just 'Google it'.

Unmanned Aircraft Systems Operations

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The use of unmanned aircraft, or drones, continues to grow in popularity for both hobbyists and professionals alike. Not surprisingly, natural resource managers have found many applications for drone flights. However, Federal Aviation Administration (FAA) rules and regulations continue to change in an effort to address safety, security and privacy concerns. A basic understanding of the regulations surrounding drone use will allow natural resource managers to best determine if a drone flight is appropriate and to ensure that drone operations meet federal regulations and guidelines.

Enhanced Bacterial Pathogen Detection Using Optimized Sample Collection, Culture and Laboratory Diagnostics

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Respiratory disease has often been cited as the single greatest obstacle to restoration and management of healthy bighorn sheep populations across the west. Although researchers have been unable to agree on which respiratory pathogens are responsible, most agree that *Mannheimia haemolytica*, *Mycoplasma ovipneumoniae* and *Bibersteinia trehalosi* are all pathogens of concern. The Wyoming Game and Fish Department (WGFD) monitors three mountain goat herds and five bighorn sheep herd units for these respiratory pathogens. Animals are captured by helicopter net-gunning, drop net, or immobilization drugs. Numerous samples are collected from each animal including nasal, tonsil, and ear swabs, feces, and blood. We optimized field sample collection techniques to ensure microbial viability and recovery, including collecting multiple swabs from the tonsillar crypts and immediate inoculation of Columbia Blood Agar (CBA) or Columbia Selective Agar (CSA) plates. Bacterial cultures are initiated in the field followed by intensive testing at the WGFD Wildlife Health Laboratory. We used published PCR protocols to screen all the bacterial growth from culture plates for *Mannheimia* and *Bibersteinia spp* leukotoxins (Dassanayake et al. 2010), followed by *Mannheimia spp* specific leukotoxin (Shanthalingam, et al. 2014) and finally a PCR to detect *M. haemolytica* (Angen et al. 2009). The addition of these PCRs to our standard culture protocol resulted in the identification of 29% more leukotoxin positive *Mannheimia spp* (including *M. haemolytica*) than by gross identification of bacterial colonies on CBA or CSA. *Mannheimia haemolytica*, *Mannheimia spp* (*M. rumenalis* or *M. glucosida*), *Bibersteinia trehalosi* with leukotoxin, and *Mycoplasma ovipneumoniae*, were recovered from most bighorn sheep and mountain goat herd units. To date, we have been unable to correlate the occurrence of these pathogens to the overall health of the herd (e.g. survival, lamb/ewe ratios). Disease sampling and analysis will continue in the future; including the evaluation of trace minerals, pathogen genotypes, herd genetics, and environmental factors on herd health.

The process of integrating infrared technology into wildlife management and research.

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Wildlife research is expensive to begin with, utilizing technology makes research more expensive, and wildlife management is perpetually underfunded which makes integrating technology into wildlife management and research programs extremely difficult. Wildlife researchers and managers can work together to maximize resources and accomplish mutual objectives with new technology, but often their collaboration is not enough. Integrating infrared technology into wildlife management and research has also required a third party from the private sector. Even when necessary collaborations are in place, obstacles to successfully integrating technology remain. I describe some of the challenges with integrating technology into wildlife management and research and what has been accomplished with aerial infrared technology. Surveys using aerial infrared technology have been conducted for sharp-tailed grouse, sage-grouse, waterfowl, pelicans, cormorants, wolves, bear, elk, deer, antelope, bighorn sheep, moose, neonate ungulates, bats, feral pigs, and feral horses. I focus on how aerial infrared technology has been integrated into research and management, specifically, for conducting sage-grouse and sharp-tailed grouse lek counts. The first phases of using aerial infrared for lek counts was determining if accurate counts could be obtained and provide wildlife managers with reliable information. The second phase was to compare the vehicles, personnel, time, and money required to obtain lek counts using traditional ground-based and aerial infrared techniques so wildlife biologists could assess the costs and benefits of both techniques. The third phase was to estimate detection probability of both ground-based and aerial infrared lek counts to determine if datasets were compatible or if data require adjustment.

Experimental Infrared Survey Flight
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During the lekking season (mid March – April), Colorado Parks and Wildlife (CPW) staff conduct surveys for plains sharp-tailed grouse (*Tympanuchus phasianellus jamesii*) in areas of known occupancy and nearby appropriate habitat. These surveys are conducted by driving designated routes along county roads and stopping to survey at predetermined locations. Challenges to conducting surveys include: optimal weather conditions of wind less than 10 MPH, zero precipitation, temperatures above 20 F, and a narrow daily timeframe of approximately 2 hours around sunrise. In April 2015, Colorado Parks and Wildlife conducted an experimental flight using infrared video technology to compare survey efficiency with ground methods. The flight lasted about two hours and covered approximately 24 square miles viewing suitable habitat and one known lek location. This lek was detected during the course of the survey. Color and infrared stills and video images were recorded. Species such as coyotes, pronghorn, meadow lark and domestic cattle were visualized. Though not enough data was collected for population analysis, the experimental flight showed strong potential application for doing grouse surveys in remote locations.

Technical Session Abstracts:

Land-Use Change within Mule Deer Ranges is Associated with Reductions in Recruitment
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Jessica R. Sushinsky, Wildlife Conservation Society and Colorado State University
A. Andrew Holland, Colorado Parks and Wildlife
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Land-use change due to anthropogenic development is pervasive across the globe, and commonly associated with negative consequences for wildlife. While land-use change has been linked to shifts in the behavior of animals, little is known about its influence on population dynamics, despite the relevance of such information for conservation. We conducted the first broad-scale investigation correlating temporal patterns of land-use change with the demographic rates of mule deer, an iconic species in the western United States. We employed a unique combination of long-term (1980-2010) data on residential and energy development across western Colorado, in conjunction with congruent data on deer recruitment, to quantify annual changes in land-use and correlate those changes to annual indices of demographic performance. We also examined annual variation in climate conditions, which are well-recognized to influence ungulate productivity, and provided a basis for comparing the relative strength of different covariates in their association with recruitment. We found that increasing residential and energy development within deer habitat were correlated with declining recruitment, particularly within winter ranges. Residential housing had >2 times the magnitude of effect of any other factor, and energy development had a similar effect size to climate variables known to be important to ungulate dynamics. This analysis is the first to correlate a demographic response in mule deer to residential and energy development at large spatial extents relevant to population performance. Our results underscore the significance of expanding residential housing on deer populations, a factor which has received little research attention, despite rapid growth across the landscape.

Lessons Learned During the Design and Construction of Phase 1 of the State Highway 9 Wildlife and Safety Improvement Project

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The first wildlife overpass in Colorado is completed and functioning along State Highway 9 (SH 9). During 2015 CDOT finished the first of a two phase project to construct two wildlife overpasses and five wildlife underpasses along 10.5 miles of SH 9 south of Kremmling. In addition to the overpass there are three large wildlife underpasses, deer fence, escape ramps and deer guards on the completed phase of the project. SH 9 is the first of its kind in the state, with the sheer number of wildlife crossing structures concentrated in one area and the only wildlife overpasses. Colorado Department of Transportation and Colorado Parks and Wildlife along with the consulting firm ECO-resolutions have started a long-term monitoring study of the project to determine the effectiveness of the wildlife mitigation features. The north half of the project has only been completed a couple of months but already many lessons have been learned including design recommendations, agency communication needs, and project modifications.

Population Viability of a Small, Isolated Population of Mountain Lions Relative to Interactions between Demographic, Genetic, and Landscape Processes

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We conducted a population viability analysis (PVA) for mountain lions (*Puma concolor*) in the Santa Monica Mountains (SMMs) in southern California. This small population is immediately adjacent to Los Angeles and connectivity with adjacent populations is limited due to anthropogenic barriers. Consequently, the population has the lowest genetic diversity documented for mountain lions aside from Florida panthers and there is concern regarding local extinction due to combined demographic and genetic factors. We constructed an individual-based population model that simulated breeding events and assigned genotypes to offspring using empirical demographic and genetic data. We used the model to estimate population growth, extinction probability, and future genetic structure of the population. We also explored the potential influence of increased immigration in the SMMs. Our model indicated that the population was demographically stable ($\lambda = 1.01$) although there was some probability of extinction from demography alone within the next 50 years due to stochasticity in a small population. However, the model predicted that genetic diversity may decline to levels similar to those observed in the inbred Florida population within 50 years under current landscape conditions. Thus, inbreeding depression could compromise demographic performance and dramatically increase extinction risk in the absence of additional gene flow. Importantly, modest increases in immigration, such as might be achieved by implementing a proposed highway crossing structure, appeared to be sufficient to maintain genetic diversity. Our results highlight the importance of explicitly considering demographic, genetic, and landscape dynamics in PVA and provide a novel modeling framework for doing so.

Birth Site Selection by Mule Deer and Predation Site Characteristics in a Natural Gas Development Area

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Natural gas development potentially impacts wildlife populations and their habitat, especially in regards to ungulate species. Of special importance are impacts on reproductive success (e.g., birth site selection and neonatal survival) that are influential for ungulate population dynamics. Birth site selection by mule deer is the result of deer trading off nutritional demands and minimizing predation risk of neonates. To investigate this trade-off, I fit resource selection functions (RSFs) to examine the influence of natural gas development and environmental factors on birth site selection and habitat characteristics of predation sites in the Piceance Basin of northwestern Colorado, USA during 2012–2014. Females selected birth sites farther from producing well pads and with more cover for concealing neonates and appeared to minimize neonate predation risk over nutritional demands of lactation when choosing birth sites. Predation sites were characterized as being closer to development and in habitat that possibly provided favorable microclimates for neonates and abundant high quality forage for lactating females. My results suggest natural gas development and environmental factors (e.g., slope, habitat type, aspect) can influence birth site selection with predation site characteristics likely related to foraging habitat selection. Consequently, I recommend that developers and mangers apply my RSF model to comparable mule deer habitats and develop maps that predict high and low use areas for birth sites when planning development or other landscape manipulations. Developers and mangers should then consider strategies to avoid or mitigate impacts in high use areas to maintain cover for concealing neonates, potentially enhancing survival.

Bacterial pathogen transmission from domestic to wild cats

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Disease poses a substantial threat to rare species worldwide. Spillover of multi-host pathogens from domestic to wild species may occur when a) closely related domestic and wild species co-occur and b) the high-density domestic species acts as a maintenance host with transmission to the rarer wild relative. Wild and domestic felids are susceptible to many of the same pathogens, and co-exist near the interface of natural and developed landscapes. Our study evaluates transmission of *Mycoplasma haemominutum* (*Mhm*), an erythrocytic bacterial parasite, between free-ranging domestic cats and their wild counterparts in Colorado and California. We trace transmission pathways by genotyping the 16S rRNA bacterial gene in 63 positive blood samples from domestic cats (n=20), pumas (n=20) and bobcats (n=23), creating maximum likelihood phylogenetic trees and assessing relatedness among isolates. We determined that while *Mhm* is primarily species-specific, cross-species transmission of *Mhm* is occurring and follows the trophic network upwards from domestic cats to pumas. Our results support direct transmission as the primary mechanism for pathogen transfer of *Mhm*, and suggest that wild felids, particularly pumas, may be at risk for spillover of harmful pathogens from domestic cats.

Foraging ecology of black bears in urban environments: guidance for human-bear conflict mitigation

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Urban environments offer wildlife novel resources that vary spatiotemporally at fine scales. Property damage, human injury, or other human-wildlife conflicts can occur when wildlife use these resources. We studied black

bears (*Ursus americanus*) in Aspen, Colorado from 2007 to 2010 to quantify bear foraging on natural and anthropogenic resources and to model factors associated with anthropogenic feeding events. We collected fine-scale spatiotemporal data by tracking GPS-collared bears at 30-min intervals and backtracked to bear locations within 24 hours of use. We used discrete choice models to assess bears' resource selection, modeling anthropogenic feeding (use) and five associated random (availability) locations as a function of attributes related to temporally changing natural and human food resources, urban characteristics, and land cover characteristics. We backtracked to 2,675 locations used by 24 bears and classified 20% as foraging locations, where 77% of feeding events were anthropogenic. We documented inter- and intra-annual foraging patterns in which bears foraged extensively in urban areas when natural food production was poor, then switched to natural food sources when available. Garbage was the most frequent anthropogenic food source that bears used. Selection of foraging sites was also influenced by proximity to riparian habitat and presence of anthropogenic fruit trees with ripe fruit. We found that while 76% of the garbage containers at random locations were bear-resistant, 57% of these bear-resistant containers were not properly secured. Conflict mitigation should focus on reducing available garbage and anthropogenic fruit, particularly near riparian areas, to make urban environments less energetically beneficial for foraging.

Habitat Use of an Alaskan Dall Sheep Population: An Occupancy Modeling Approach

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Anthropogenic disturbances, such as military training, are increasingly recognized for potential effects on mountain ungulate populations. Dall sheep (*Ovis dalli dalli*) is an iconoclastic species that is important for hunting and wildlife viewing opportunities in Alaska and across the species range. Currently, military training is expanding into potential Dall sheep habitat within two training areas of Fort Wainwright, Alaska. Therefore, the U.S. Army requires a better understanding of the spatiotemporal habitat use of sheep to avoid disturbances to the population. Studies of these mountain ungulates often rely upon aerial surveys to assess population size and regional habitat use. Infrequently, camera traps have been employed to estimate population size and presence of mountain ungulates, but little use has been directed towards Dall sheep. We utilized an array of camera traps, taking triggered and hourly timelapse images, to determine the probability of Dall sheep habitat use based on seasonal and site covariates. Camera traps captured nearly 8,000 images of sheep during a continuous 15-month sampling period. Habitat use models suggest that abiotic covariates such as slope, snow depth, and distance to escape terrain are the most important factors determining habitat use. Detection probabilities were constant temporally and were higher if the camera was positioned on wildlife trail vs not. Our results suggest that the best training opportunities to avoid sheep habitat use is during summer and early-fall, specifically in areas with less than a 50% slope and more than 500 meters from escape terrain.

Airports, Wildlife, and GIS… Oh my!

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Over the past few decades, wildlife strikes with aircraft have resulted in over 255 human fatalities and substantial financial losses worldwide. USDA APHIS Wildlife Services continues to provide an integrated wildlife damage management program for our civilian and military airfields to mitigate wildlife threats to aviation safety. By utilizing GIS and GPS mobile mapping technology when collecting field data, airport wildlife biologists can visualize management efforts and wildlife activity trends to further understand, manage, and educate the aviation community and the public about wildlife hazards.

Restoration of Wet Meadows and Riparian Systems in the Upper Gunnison Basin, Colorado: Building resilience in the face of climate change for Gunnison sage-grouse

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Gunnison sage-grouse (*Centrocercus minimus*), a federally threatened species, rely on mesic areas such as wetlands, wet meadows, seeps and springs, and mountain swale communities to raise their chicks. These mesic areas typically have a greater diversity and abundance of plants and insects than nearby sagebrush uplands. Mesic areas encompass a small percentage of the overall sagebrush-shrubland ecosystem, so maintenance, restoration, and building of resilience of these areas in a changing climate should be a priority to conserve the species. Already compromised by lowered water tables, erosion, and encroaching shrubs, these mesic areas are likely to be further degraded by climate change. To address these impacts, the Gunnison Climate Working Group (GCWG)[1], a diverse group of public and private partners, is working to increase resilience – the ability to maintain hydrologic and ecological functions – of mesic areas. Since 2012, the group has implemented innovative, yet simple restoration methods (e.g., rock structures) designed by restoration expert, Bill Zeedyk. Rock structures mimic natural processes by slowing water during spring runoff or monsoon rains, increasing sediment deposition and water retention, enabling wetland plants to expand. To date, the GCWG and its partners have installed 750 structures restoring approximately 125 acres along 23 stream miles on public and private lands within seven watersheds. In one treatment area, cover of wetland plants increased from 12% to 50% over three years. Additional research is needed to link the expansion of wetland plants to enhanced sage-grouse chick survival and population growth.

Necklace-style radio-transmitters are associated with changes in display vocalizations of male Greater Sage-grouse

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Radio-transmitters are used widely in wildlife research and allow researchers to track individual animals and monitor their activity. However, to provide unbiased information about a population, transmitters must be deployed on a representative sample of animals and must not alter the behavior of the individuals. Greater Sage-grouse (*Centrocercus urophasianus*) have been studied intensively using radio-transmitters for several decades. A previous study demonstrated that males fitted with necklace-style radio-transmitters were less likely to attend leks than those without transmitters. However, how transmitters affect the behavior of males that do attend leks has not been investigated. Therefore, we investigated whether radio-transmitters alter the characteristics of male sage-grouse strut vocalizations. We recorded vocalizations from collared and non-collared adult male sage-grouse on three leks in south-central Idaho and from two leks in northern Nevada. We evaluated 13 characteristics of vocalizations, and found that four characteristics differed between collared and non-collared males. Collared males had a narrower bandwidth for the primary whistle, a shorter primary whistle, and a shorter secondary coo than non-collared males. Additionally, primary whistle frequencies produced by collared birds fell outside the normal range of variation for non-collared males throughout the range of sage-grouse. Some acoustic characteristics of sage-grouse strut vocalizations have been linked to success in mating, and therefore our results suggest that collars may reduce male mating success by altering the production of breeding vocalizations. It is important to

consider the impacts of radio collars on all aspects of grouse behavior when designing and implementing studies and interpreting their results.

The conservation value of tropical agroecosystems to migratory and resident birds in the Guatemalan Highlands

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Reconciling agricultural production with conservation is an increasingly complex task, especially in tropical regions where high levels of biodiversity and poverty converge. A diverse agricultural matrix integrated with forest remnants can be a useful example of how avian diversity can be conserved in a highly modified landscape, though many studies have been restricted to only a few species or a single season. We studied the relative ability of Q'eqchi' Mayan agroecosystems to support resident and migratory birds at local and landscape scales in the Central Highlands of Guatemala, a region known for its remarkable biocultural diversity. Specifically, we examined the use of three forest and three non-forest habitats (monoculture, polyculture, shaded coffee, pine plantation, secondary and primary forest) by six Neotropical migrant, four endemic, and five forest resident species across resident breeding and non-breeding seasons. We identified habitat associations of individual species using single-species, single-season occupancy models. In general, species responded to structural diversity and forest cover in the landscape, though forest residents may specialize even more during the breeding season. Our findings indicate that the value of agroecosystems to birds of conservation concern can be improved by retaining >20% canopy cover in farms and >60% in forest habitats, maintaining 150-550 trees/ha, protecting epiphytes, and managing landscapes for 25-40% forest within the matrix. Our paired research also shows diverse agroecosystems and forest support rural livelihoods in the region by diversifying diets and income streams. Conservation of tropical forests, therefore, depends upon effectively managing agroecosystems to support rural livelihoods and wildlife.

Effects of thinning treatments in piñon-juniper woodlands on avian occupancy in the Arkansas River Valley, Colorado

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Piñon-juniper woodlands occupy 21 million acres in Colorado, more land area than any other forest type in the state, and at low elevations often coincide with human exurban developments. Fuels treatments as a fire mitigation strategy have been implemented on over 20,000 acres of piñon-juniper lands by the Royal Gorge Field Office of the BLM in the Arkansas River Valley (Chaffee and Fremont Counties). Forests were thinned using a hydroaxe or on some sites they were hand thinned with chainsaws followed by piling and burning or lop and scatter. I studied 29 treated sites and 29 paired controls from 2012 to 2015 to assess the effects of thinning treatments on the species composition, richness and occupancy of piñon-juniper birds. I used multi-scale occupancy models in Program Mark to derive detection probabilities and to determine the most explanatory models for treatment and covariate effects on bird species. Over 80 species of birds occupied the study sites; species richness was greater on treated sites. Occupancy of some piñon-juniper obligate species was negatively effected by treatments, whereas ecological generalists benefitted from the treatments. Woodland thinning treatments are completed in a patchy array leaving mature trees within treatment boundaries. This method of thinning may reduce impacts to piñon-juniper obligate birds.

Can the variation in songbird mercury be explained using trophic level, phylogeny and foraging guild?

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Mercury is a toxic pollutant found globally that bioaccumulates in organisms and biomagnifies up the food chain. Even in small amounts mercury is harmful to songbirds. In songbirds, mercury alters behavior, reduces immune

response, and ultimately leads to lower reproductive success. For these reasons mercury pollution is a concern when it comes to conservation of songbird species. A large amount of variation in mercury levels among songbird species has been found, however, this variation has yet to be fully explained. Foraging guild is predicted to affect mercury bioaccumulation due to unique assemblages of insects found within each foraging guild, and similarly, phylogeny could affect mercury levels if closely related species metabolize mercury in the same way. This study examines the effects of trophic level, phylogeny, and foraging guild, to determine the effect each of these variables has on mercury bioaccumulation. By examining all three of these factors simultaneously, I will be able to tease apart subtle differences in mercury levels caused by foraging guild and phylogenetic differences from the more general effect of trophic level.

Mapping, prioritizing, and increasing seasonal habitats for greater sage-grouse in the Parachute-Piceance-Roan population in northwestern Colorado

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Many local populations of greater sage-grouse face continuing habitat loss and disturbance associated with increasing energy development. In such populations, wildlife managers need accurate fine-scale maps of important seasonal habitats to reduce conflicts with land use, defensible methods for prioritizing such habitats, and effective mitigation options to increase habitat locally. I'll provide an update on recent cooperative research efforts in the Parachute-Piceance-Roan population in northwestern Colorado to answer these key management and conservation questions. We conducted population-level, multi-scale resource selection function analyses with generalized estimating equations to model, map, and prioritize sage-grouse seasonal habitats using VHF location data from 2006-2010, and we used absolute validation index analyses to help identify important areas predicted to have concentrated use. We examined sage-grouse response to removal of encroaching pinyon-juniper using pellet surveys before and after treatment on control and treatment sites from 2008-2015. Preliminary results suggest that removal of sparse pinyon-juniper from otherwise suitable sagebrush habitat showed mixed success at increasing use across plots. Moreover, substantial inter-annual variability in pellet density within suitable habitat in this population complicated testing of treatment effects. However, preliminary results from a 3-year pilot study by Conoco-Phillips suggest that simultaneous removal of both serviceberry and sparse pinyon-juniper may be more effective and is worth further investigation.

Evaluation of Population Monitoring Strategies for Greater Sage-Grouse (*Centrocercus urophasianus*) in Northwestern Colorado: Genetic Mark-Recapture as an Alternative to Traditional Lek Counts

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Recent declines in greater sage-grouse (*Centrocercus urophasianus*) populations and substantial restriction of pre-settlement distribution of the species have been observed nationwide. Successful management and conservation of greater sage-grouse populations requires accurate and defensible estimates of population size and trend, however, the use of lek count data to accurately estimate these has been criticized. For this reason, the development of innovative methods to evaluate the lek count index and monitor greater sage-grouse populations is critical. We employed a non-invasive, genetic mark-recapture method to estimate abundance and pre-breeding sex ratio of a small, low-density population in northwestern Colorado. Samples we collected during two

consecutive winter seasons from 2012- 2014. We collected nearly 2,500 fecal pellet and feather samples to identify individual birds and their recapture histories using DNA extraction and microsatellite analysis methods developed by the USGS Molecular Ecology Laboratory in Fort Collins, CO. We are currently in the final stages of genetic analysis and will be reporting preliminary data.

Gunnison Restoration-Resilience Project: The Impacts of Riparian Restoration on Insect Abundance, Diversity, and Ecosystem Health

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The Gunnison Restoration-Resilience Project, a collaboration between local land owners, federal land agencies, and local advocacy groups, seeks to improve the health and the functionality of riparian areas by installing a series of earthen, rocky, water retaining and spreading structures along at-risk riparian corridors. This project seeks to monitor the effects of riparian habitat restoration on invertebrate populations, specifically the diversity and abundance of species that are preferred by young Gunnison Sage Grouse (*Centrocercus minimus*), or GUSG, in their first 55 days of life (Patterson 1952, Klebenow and Gray 1968). Starting May 2015, insect monitoring was conducted along the riparian corridor in both areas with structures in place (treated) and their corresponding control sites (untreated). Treated sites were shown to have significantly ($p > 0.05$) higher insect abundance than untreated sites. Insect minor order abundance was affected by both treatment and vegetation type, which indicates that restoration doesn't influence insect assemblages uniformly. Although there is only one year of data, these results indicate that projects like this significantly impact ecosystems from the bottom up.

Cougar Predation Behaviors: The What, When, Where, and Why

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Conflicts between humans and large predators can stem from the occasional human safety concern to competition for game and food resources. Understanding the behaviors of an exemplary large carnivore is important for understanding these conflicts between predators and humans. Using a five-year dataset from GPS collared cougars on the Colorado Front Range, we studied predation behaviors taken place in a range of remote, rural, exurban, and suburban environments. Sampling the cougar population and feeding sites revealed what the cougars ate. When a cougar ate, or how often it fed (presented as per-capita kill rates), was determined by predictive models. Spatial analysis of cougar kill-sites and movement data determined geographic associations with these behaviors to determine where predation events occur. A step-selection function analysis then revealed why cougars fed in localities where conflicts between cougars and humans are more likely to occur. In summary, cougars ate primarily deer, elk, and meso-carnivores (domestic and wild). Kill rates on mule deer and meso-carnivores are among the highest reported. What the cougar ate, was determined by where hunting activities took place. Non-traditional meso-carnivore prey species were found to be killed more often near human development. Why would a cougar utilize a risky geographic locality where conflicts with humans are bound to occur? Because, the cougar was hungry.

Poster Abstracts:

Application of the Bighorn Sheep Risk of Contact Tool and Best Available Science to a Domestic Sheep Allotment Analysis Process: the Fisher-Ivy/Goose Allotment, Rio Grande National Forest.

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The need to maintain effective separation between domestic sheep and bighorn sheep on free range conditions is widely recognized as the most prudent action that can be taken to reduce the potential for interspecies disease transmission. Current Forest Service direction to achieve these objectives is to utilize a risk assessment process where management objectives include maintenance or enhancement of bighorn sheep populations. Historical accounts suggest that Rocky Mountain bighorn sheep were common on the Rio Grande National Forest during early settlement period of the mid- to late 1800's. As in many areas of the western United States, these herds were largely decimated by the early 1900s. Currently, 11 bighorn sheep herds containing an estimated 1,100 individuals occur or partially occur on the Forest with ample unoccupied habitat available. Domestic sheep grazing has also been an important local cultural and economic activity since the early settlement period. Domestic sheep numbers peaked at about 245,000 during the 1920's, however the Forest still supports approximately 11,500 sheep on roughly 26 different allotments. Some of these allotments occur in proximity to or even overlap known or suspected bighorn sheep core herd range and/or summer source habitat. This poster presentation displays aspects of our recent quantitative analysis involving the Fisher-Ivy/Goose Allotment, including graphs and figures associated with our use of the recently produced Bighorn Sheep Risk of Contact Tool to help inform the Risk Analysis and decision. Our use of the Risk of Contact Tool is a first for the Forest Service Rocky Mountain Region, and we display why we suggest its use and application to be representative of the best available science in informing this issue on a landscape scale.

A Standardized Framework for Using Camera Traps to Monitor Wildlife Crossing Structures

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Camera traps are a commonly used monitoring technique for assessing wildlife use of road-crossing structures, including bridges, culverts and overpasses that were either designed for wildlife passage or structures built for other purposes that may also function for wildlife passage. Informed camera monitoring is necessary for calculating structure passage rates by different species and evaluating the features of a structure that may facilitate or inhibit wildlife passage. In many instances, however, cameras are placed at crossing structures without clear objectives and are limited in their ability to collect useful data. Alternatively, a strategic approach to camera monitoring allows researchers to answer more nuanced questions about wildlife preferences and crossing structure effectiveness.
Standardized, objectives-based methods for monitoring wildlife crossing structures will equip researchers and managers with consistent datasets across monitoring sites and research studies in Colorado, allowing for more robust comparisons of structure effectiveness and species' behavioral responses. We present a standardized framework for camera trap monitoring at crossing structures to enhance the utility of camera trap data and to promote the comparability of camera trap data among monitoring locations. This framework includes a step-by-step process for evaluating how study objectives inform the selection of monitoring sites; camera placement and distance from structures; the selection of appropriate camera settings to maximize capture rates; the care of cameras and batteries to maximize performance; and the use of rigorously tested protocols for analyzing images and classifying species-specific passage rates, adaptation rates, seasonal patterns and other performance measures.

Building Design for Energy Efficiency and the Potential Benefit to Birds

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Hundreds of millions of birds are killed every year in North America by colliding with building glass. Compared to other causes of bird mortalities, this risk is substantial, perhaps biologically significant to bird populations, and is likely only surpassed by the effects of habitat alteration. Birds lack the ability to perceive glass as a barrier due to its transparency and reflectivity. Additionally, night-time lighting can attract birds to buildings, particularly in foggy conditions, where they either collide with the structures or become exhausted trying to find a way out. Design methods and material alterations can reduce the reflectivity and transparency of glass used in structures, as well as reduce the impacts of night-time lighting, resulting in the reduced risk of collisions. Because glass reflectivity and transparency, and lighting efficiency are critical in energy efficient building design, bird-friendly design features can complement design for energy efficiency. This presentation compares bird mortalities associated with several types of structures and compares bird collisions resulting from contemporary building design with those resulting from a net-zero energy office building at the National Renewable Energy Laboratory in Golden, Colorado. This presentation will also explain the recently developed U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) pilot credit for bird-friendly design and "Bird Collision Threat Rating" calculation.

Investigation of Vegetation Management Strategies to Improve Breeding season habitats for the Northern Leopard Frog (*Lithobates pipiens*) on two state wildlife areas along the Rio Grande River in Southern Colorado
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Study Sponsored and Funded by: Wetland Dynamics, LLC. & Colorado Parks and Wildlife

This project investigates vegetation management strategies that could promote breeding habitat for the Northern Leopard Frog (NLFR; *Lithobates pipiens*). The study is located along the Rio Grande in southern Colorado on the Rio Grande (RGSWA) and Higel State Wildlife Areas (HSWA). The project occurred during the breeding season to investigate the use of different management strategies in tall emergent habitats. Manipulation of vegetation height was used to mimic natural processes such as herbivory and burning on RGSWA along with haying/grazing strategies on HSWA. Weekly surveys were conducted at 33 sites with three replicates of two by four meter plots. Sites were chosen in similar tall emergent vegetation to compare NLFR presence/absence under differing management strategies. A control, a single cut, and weekly cut plots (30 cm in height) were established at each site. Water depth and temperature, surface area flooded, vegetation height, and a plant species list were also documented within each plot. A total of 33 frogs on RGSWA and 16 frogs on HSWA were observed within plots from May through July. Frogs were present more often in plots that were cut weekly on both RGSWA and HSWA. More frogs were observed in the plots after breeding season ended suggesting metamorphs were selecting habitat with less structure and height during dispersal. This study could be expanded by conducting surveys into the dispersal stage. Additional data collection in the following years along with an expanded effort to look at dispersal habitat could help determine better management strategies for increased recruitment.

Assessing Bias in Human-Black Bear Conflict Reporting in Durango, Colorado
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Growing numbers of human-black bear conflicts have led to concerns over public safety, high management costs, and the ecological effects of nuisance bear removal. Many state wildlife management agencies use voluntary public reporting as their primary measure of the location and frequency of human-black bear conflict. However, there is little research that assesses potential bias in the number of conflicts that are reported by the public, compared to where conflicts actually occur. Because of bias in the type and location of reported conflicts wildlife managers could potentially misallocate resources targeting conflict areas and fail to recognize effects of management actions to reduce human-black bear conflict. To assess potential bias, we compiled black bear trash conflict data from Colorado Parks and Wildlife, the City of Durango, and Bear Smart Durango (local non-profit organization). We geocoded locations from those public reports and then assessed overlap of locations with black bear trash conflict that were directly observed through systematic sampling from 2011-2015. Using public reports

and direct observations, we created kernel density estimation maps of reported and observed conflict to determine overlap. The overlap between reported conflict and observed conflict was comparable, with high density reported and observed conflicts occurring in similar areas, yielding similar "hot spot" areas. This research helps to confirm the validity of using public conflict reports to aid in black bear management decisions in prioritizing where to best allocate key resources (i.e. bear resistant trash cans, culvert traps, etc.) to mitigate human-black bear conflict areas

Continuing Monitoring of Mustela Nigripes (Black Footed-ferret) at Soapstone Prairie Natural Area Using Remote Trail Cameras

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Once thought to be extinct but due to a small, 18 ferret population found near Meeteetse, Wyoming and rather productive and successful captive breeding efforts by the U.S. Fish & Wildlife Service Black-Footed Ferret Recovery Program those numbers are much higher into the hundreds. In 2014, the National Black-Footed Ferret Conservation Center released 42 Black-Footed Ferrets at Soapstone Prairie Natural Area. In 2015, using Pit tag readers it was determined that only six Black-footed ferrets survived. One of those six Black-footed ferrets was a lactating female implying that the ferrets had been reproducing. With continual monitoring efforts by both the U.S. Fish and Wildlife and the CSU Camera Traps we hope help monitor the movements and activities of the ferrets. We hope that one day the Black-footed ferret populations will continue to grow and self reproduce. The Camera Project uses the data collected by trail cameras for educational outreach opportunities to elementary schools and other Science related events such as STEM.

An Analysis of Items Carried in the Mouths of Carnivores

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Eighty percent of the global human population now resides in or around urbanized areas. As a result, mammalian carnivore species in these areas have altered foraging patterns in response to residential development and the subsequent availability of anthropogenic resources. This paper describes and discusses the diverse array of items carried in the mouths of carnivores along a gradient of human development. Camera trap captures of six carnivore species (*Puma conolor*, *Canis latrans*, *Vulpes vulpes*, *Lynx rufus*, *Urocyon cinereoargenteus*, *Felis catus*) carrying objects in mouth across five study grids (including a spectrum of wildlands, exurban development, and wildland urban interface sites) are analyzed to identify objects as natural food items, natural nonfood items, and anthropogenic items. Natural food items are identified to the most detailed level of taxonomic classification possible. Nonfood items are described generally as objects with little to no energy consumption value. Anthropogenic items are described as both subsidized food items and nonfood items to the greatest probable detail. Items captured in the mouths of each of the six carnivore species are discussed in relation to 1) the rate of items carried in mouth, 2) proximity and degree of residential development surrounding each study grid, 3) the body size, foraging patterns and human development sensitivity of the carnivore species, and 4) possible applications for urban carnivore education and conservation.