Montana Chapter of The Wildlife Society

57nd Annual Conference 2019

Building a Conservation Ethic in the New Outdoor Economy

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Liz Bradley, President Elect 2018-19
Montana Chapter of The Wildlife Society

Introduction

Our Greetings! This conference has always been a highlight of the year for me as a wildlife professional. It's an opportunity for all of us to get together in one place, catch up, and share what we've been learning. Whether we are current professionals, retirees seasoned with wisdom or the future generation of wildlifers, it's a great time to visit and celebrate one another's research and accomplishments. We all have something to learn from and help cultivate in each other. I'm honored to be your incoming president and to work with an amazing team to carry on The Wildlife Society tradition by helping put together this conference. I hope you will all enjoy it and ideally, draw a little inspiration from it, too.

Our conference theme this year is "Building a Conservation Ethic in the New Outdoor Economy." It has been 20 years since we explored recreation as a conference topic. I believe it is more relevant now than ever, with a growing recreation economy in Montana. Most of us are outdoor enthusiasts and were likely drawn to wildlife work because of our love of the outdoors. If you're like me, you are happiest with the stars as a roof over your heads. Here's a little more about the theme:

> The outdoor recreation industry is growing faster than ever in Montana. More people are flocking to parts of Montana because of our incredible natural beauty and outdoor opportunities. Wild places that may have been a secret a decade ago are more accessible to people than ever from information sharing through social media and new technologies that make it easier to get there and people are recreating in new and diverse ways. As growing pressures on wildlife and habitat continue to build, we need to foster and grow our constituencies. On the one hand we need more people to get outside and care about wildlife and wild places. But are we adequately connecting and helping build a conservation ethic in this growing sector of the public that are already out there? This conference will explore the changing face of recreation as it relates to conservation and the challenges and opportunities therein.

I was drawn to this topic not only because of its impacts on wildlife conservation but also its relevance to our Montana culture and our own outdoor ethics. We have five outstanding plenary speakers and an excellent banquet speaker who will explore this topic. On Tuesday evening after the welcome reception we will have Movie Night and show four films that explore the wildlife/recreation interface.

The Board has worked hard this year to encourage student participation in the conference by providing more grants for student travel for more colleges, continuing to support our MSU and UM student chapters, and running a student artwork contest (see cover!). Overall, we have a great selection of workshops, talks, speakers, awards, raffles, student participation and social opportunities. Welcome to the 57th Annual Conference!

Plenary Session Abstracts

Montana's New Office of Outdoor Recreation: Economics and Stewardship

Rachel VandeVoort, Director, MT Governor's Office of Outdoor Recreation

Outdoor recreation is not only intrinsic to the Montana lifestyle and a bedrock reason why so many of us call the Big Sky home, it is also one of the most crucial parts of the state's economy. According to the Outdoor Industry of America's most recent figures, outdoor recreation is now the single largest sector of Montana's economy. It generates over $7 billion per year in consumer spending and supports over 70,000 jobs that pay more than $2 billion worth of wages annually. Those figures don't even account for indirect economic effects, such as the thousands of startups and small businesses that choose to locate here because of the state's outdoor recreation opportunities. In many ways, America is in the midst of an outdoor recreation renaissance, a trend driven by a growing appetite to explore and connect with nature combined with rapid advances in innovation and awareness. The National Park Service and its array of sites are enjoying all-time high popularity. State parks across the U.S. are experiencing similar record crowds, including throughout Montana. The evolution of gear and activities is driving more people outdoors in search of unique experiences.The new Office of Outdoor Recreation could play several critical roles in Montana's outdoor recreation economy: from helping protect public lands to helping properly fund the state and federal agencies responsible for the stewardship of our land, water and wildlife. It could also help rural communities gain access to resources to fully capture the benefits of outdoor recreation, from building trail systems to creating better outdoor infrastructure. Protecting and enhancing this infrastructure is essential to conserving our most vital and sustainable resources and we need to reframe the way we look at its impact on the future of Montana's economy.

Intersecting the Recreating Public with Wildlife and Habitat Conservation: It's About Passion, Data and Advocacy

Lauri A. Hanauska-Brown, Wildlife Division, Montana Fish, Wildlife and Parks, Helena

Campaigns such as Hooked on Fishing, Nature RX, Every Kid in a Park and Families Afield urge Americans to get outside to fish, hunt, camp or just observe. Some campaigns focus on increasing access to the outdoors and some even make it less expensive to recreate by offering loaner gear or waived park entrance fees. While increasing the general public's interest in the outdoors is good for them and economies of outdoor industries it does present resource managers with a challenge of balancing the needs of wildlife and habitat with increased human presence. Many recreationists already have a vested interest in the outdoors and may be cognizant of the potential impacts of their activities while people entirely new to outdoor recreation may not. It behooves organizations and agencies to engage all these recreationists as part of the larger conservation army in attempts to limit their impact and put their time outdoors to use. Attentive recreationists can help fill data gaps with new mobile applications such as Survey 1,2,3 and iNaturalist that make it easy for them to report the wildlife or even the weeds they see. Submitting information that is used to inform species distribution models and management strategies can result in recreationists feeling like they are part of the monitoring and conservation team. Citizens who volunteer their time to check osprey nests along the Yellowstone River, hair snares and camera traps for carnivores, and the 180,000 hunters who share information on their game harvest or wildlife observations

each year are part of a team of recreationists vested in wildlife management and conservation. Specific programs like Climbers for Bat Conservation encourage recreationists with a passion for climbing to learn more about the animals they observe during their time on the rock. Climbers in Colorado have become advocates who contribute to bat conservation not only by collecting data but also by bringing climbers resistant to sharing their knowledge into the discussion. Being part of the team creates a sense of stewardship as seen when these same birders, skiers, hunters and climbers show up at public meetings where wildlife management, public land access, and habitat conservation are being discussed. Encouraging recreationists to add their voices to specific campaigns is another way to put their passions to use and secure their investment in the outdoors. Local movements like the Montana Outdoor Heritage Project or federal legislative proposals such as the Recovering America's Wildlife Act provide platforms for recreationists to support legislation and funding that will help conserve the places, access and species they love. Engaging all recreationists through our shared passions, information sharing, and advocacy will hopefully lead to a contagious enthusiasm for conservation and responsible use of the resources they enjoy while outside.

What's Old is New Again: Protecting the Core Tenets of Conservation, North American Model and Ethics is the Path to Growth

Ryan Busse, Chair of the Board of Directors, Backcountry Hunters & Anglers

Hunters and anglers are the traditional "constituency" or "beneficiary" of conservation policy and public lands use. For many years the general assumption has been that this constituency is getting older, more insular and less relevant. This has forced a myriad of questions about the way we manage our resources. Who has the political clout to influence this management? Forces that wish to privatize or monetize land, water and wildlife have seized on this from multiple directions. They have mobilized fear of "a disappearing lifestyle" to encourage segments of outdoorspeople to tear at traditionally proven management policies such as the North American Model. They have embraced media and personalities within it to chip away at ethics, poke at professional management and open political chasms. By doing this they have driven potential new hunters and anglers from our ranks and have repelled growing allied constituency groups in the outdoor sports arena. BHA and other examples I will offer tell another story – a hopeful and exciting story about how the core principles of wildlife professionals are laying the groundwork for dynamic new advocacy and an era of increased participation in the outdoor world. In this new era, ethics, wild places, core principles of wildlife management and the managers themselves are cornerstones of success. It's an era where new people, especially young people, join movements because of wild food and ethical activities which connect them to nature. Where old, divisive assumptions about politics and policies are dissolved. Where people are eager to be participants in improving and protecting resources, not just using them. It's an era where the hard work and dedication of professionals in conservation help drive growth of an org like BHA, which now counts over 30,000 members and is growing every day. Where new hunters and non-hunters join because of a shared vision of the importance of wildness in the lives of everyone.By staying the course and holding to bedrock, fundamental principles, wildlife and resource managers have helped invigorate a new age of activism.

Conservation and Recreation in the Greater Yellowstone Ecosystem

Caroline Byrd, Executive Director, Greater Yellowstone Coalition

Participation in outdoor recreation is increasing and communities of the Greater Yellowstone Ecosystem (GYE) are growing. Increasing recreational pressure is putting demands on resource strapped land management agencies and driving wedges between historically aligned interests around how to balance conservation values and recreational access. The GYE is unique in that it still hosts all the native carnivores and migratory ungulates and is comprised of vast wild landscapes. At the same time, outdoor recreation is important to the social and economic fabric of many places in the west, and threats like climate change and public land transfer highlight the need for a unified conservation and recreation movement. Given this context, we conducted an inventory of outdoor recreational use to better understand the benefits and challenges associated with recreation in the GYE. Following the inventory, we convened a symposium of diverse interests to begin to grapple with the growing tension between outdoor recreation and conservation. People we interviewed said they value wildlife, natural history, and solitude in the places they recreate. Yet we found important areas for wildlife and quiet, wild places intersect with hotspots of recreation infrastructure and demand. There are a variety of challenges ahead in building solutions that balance conservation and recreation, but a common theme at the symposium was interest in finding ways to build a new ethic for recreation in the GYE. At GYC, we think of it as Leave No Trace 2.0, and envision shared commitment to practices that inform how we recreate in the places we love, to ensure they stay wild and healthy for generations to come. Cultural shifts take a long time, but a few key questions surfaced throughout our work that should be considered in any efforts moving forward:

What does a new ethic need to look like (i.e. what are some best recreation practices) and what would it do?

What communities have historically been underrepresented in outdoor recreation and conservation and how do we ensure that building a shared vision for recreation in the GYE is inclusive?

If we are to build a new ethic, how do we collectively change our expectations (especially our expectations of public land management) in ways that ensure our recreational pursuits and conservation values align?

Welcoming Conflict and Cultivating Ethics

Hal Herring, Contributing Editor, Field and Stream Magazine

We're going to see lots of pressures in the years to come. We must welcome conflict, and we must be open minded enough to know that we might find ourselves on one side of it at one time, and another some other time. If peregrine falcons need nesting cliffs to be closed to rock climbing during certain months, then by all means, close them, but be prepared to be specific about the need, and the places. Have the staff to carefully define the need. Blanket closures smack of laziness, and of unacceptable fiat. Make the case. Welcome dissent. Conflict is exhausting, and federal agencies, often with overworked employees, sometimes have little patience with it, but patience for conflict is necessary. Fiats will be met with resistance, and resistance can include anger enough to taint our politics. We have to meet with shared goals. We need, for so-called non-consumptive users (ie. non-hunters and fishermen) to create a way for them to bring money to support the lands and wildlife that we all love. A "backpack

tax" - whatever. And no, it can't be just voluntary. Conflict is great, but when one side of the conflict is footing all the bills, then the argument of the other side is simply not going to be heard with the same gravity it might deserve.We're going to see lots of pressures in the years to come. We must welcome conflict, and we must be open minded enough to know that we might find ourselves on one side of it at one time, and another some other time. If peregrine falcons need nesting cliffs to be closed to rock climbing during certain months, then by all means, close them, but be prepared to be specific about the need, and the places. Have the staff to carefully define the need. Blanket closures smack of laziness, and of unacceptable fiat. Make the case. Welcome dissent. Conflict is exhausting, and federal agencies, often with overworked employees, sometimes have little patience with it, but patience for conflict is necessary. Fiats will be met with resistance, and resistance can include anger enough to taint our politics. We have to meet with shared goals. We need, for so-called non-consumptive users (ie. non-hunters and fishermen) to create a way for them to bring money to support the lands and wildlife that we all love. A "backpack tax" - whatever. And no, it can't be just voluntary. Conflict is great, but when one side of the conflict is footing all the bills, then the argument of the other side is simply not going to be heard with the same gravity it might deserve.

Presentation Abstracts

Alphabetical By Presenter's Name

*** Denotes Presenter**

**** Indicates Student Presentation**

Chronic Wasting Disease in Montana

Emily Almberg*, Wildlife Health Program, Montana Fish, Wildlife, & Parks, Bozeman
John Thornburg, Wildlife Health Program, Montana Fish, Wildlife, & Parks, Bozeman
John Vore, Wildlife Division, Montana Fish, Wildlife, & Parks, Helena
Jennifer Ramsey, Wildlife Health Program, Montana Fish, Wildlife, & Parks, Bozeman
Keri Carson, Wildlife Health Program, Montana Fish, Wildlife, & Parks, Bozeman
Justin Gude, Research and Technical Services, Montana Fish, Wildlife, & Parks, Helena

In the fall of 2018, Montana Fish Wildlife and Parks (MFWP) conducted monitoring and surveillance for chronic wasting disease (CWD) along the northern Hi-Line, around Philipsburg, and south of Billings, MT. MFWP detected 26 new cases of CWD from over 1941 samples tested from mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), elk (*Cervus elaphus*), and moose (Alces alces). Of the new detections, 21 were along the Hi-Line in every county from Liberty County east to the North Dakota border, and 5 were detected within the CWD-positive area south of Billings. Prevalence of CWD in the northern CWD-positive hunt districts on the Hi-Line averaged 2% (95% CI: 1-3%) in mule deer, and 1% (95% CI: 0-3%) in white-tailed deer. South of Billings, CWD prevalence was estimated to be 2% (95% CI: 1-3%) in mule deer and 1% (95% CI: 0-3%) in white-tailed deer. Prevalence varied across hunt districts within the CWD positive areas; for example, among neighboring hunt districts south of Billings, CWD prevalence in mule deer ranged from <1% (95% CI: 0-3%, HD 502) to 6% (95% CI: 3-12%, HD 510). MFWP continues to plan for long-term CWD management in positive areas. In 2019, MFWP will consolidate "CWD positive areas" and "Transport Restriction Zones" into the single moniker "CWD Management Zones," and the southern portion of MFWP Region 7 will be included in the southern CWD Management Zone in anticipation of finding CWD positive cervids in that area. CWD surveillance/monitoring during fall 2019 will be focused in southeastern MT, around Philipsburg, and along the Hi-Line.

Establishing Range for Montana's Rarest Bat Species: the Northern Myotis

Dan Bachen*, Zoology, Montana Natural Heritage Program, Helena
Braden Burkholder, Information Systems and Services, MT Natural Heritage Program, Helena
Heather Harris, Wildlife Division, Montana Fish, Wildlife & Parks, Glasgow
Mike McGrath, Ecological Services, U.S. Fish and Wildlife Service, Helena, MT
Brandi Skone, Wildlife Division, Montana Fish, Wildlife & Parks, Miles City

In 1978 a single Northern Myotis (*Myotis septentrionalis*) was found overwintering in a coal mine along the lower Missouri River. For 38 years this was the only confirmed detection of the species within the state. In response to population declines caused by White-Nose Syndrome across the eastern and central US, the species was listed as threatened by the US Fish and Wildlife Service in 2015. To better understand the species distribution within Montana, we began targeted surveys in 2015 using mist nets along the Missouri, Yellowstone,

Tongue, Powder, and Little Missouri rivers and forested areas in southeastern Montana. Through August 2018, we have conducted 55 surveys and captured 20 individuals at seven sites, expanding the known range to include forests along the Missouri and Yellowstone rivers upstream from the North Dakota border to Poplar and Glendive. Initial surveys following established protocols where nets are placed over water to capture drinking animals captured few Northern Myotis. To increase efficacy, we developed a novel technique targeting flyways within forested areas, which increased capture success at new and previously surveyed sites. Using this capture data, we predicted suitable habitat within and outside of known range with a presence-only model implemented in Maxent. The model indicates moderate to highly suitable habitat exists along the Missouri river upstream of the current known range. Future surveys should target these areas, as well as areas lacking survey effort adjacent to known populations in Wyoming to delineate the species range within the state.

Mission of the Montana Wild Bison Restoration Coalition

James A. Bailey*, Coordinator, Montana Wild Bison Restoration Coalition, Belgrade

Domestication is the major threat to persistence of wild plains bison on native range in the USA. It is the opposite of wild. For Montana bison (*Bison bison*), there is a legal definition and a biological definition of "wild". But there are no wild bison, year-round in Montana. Although Olaus Murie recommended bison restoration in eastern Montana in 1937, the state has been unable to establish a public, wild herd. The landscape on and near the Charles M. Russell (CMR) National Wildlife Refuge is the best location for restoring wild plains bison in the USA. The Montana Wild Bison Restoration Coalition was formed to disseminate information on issues and opportunities for bison restoration in Montana and to promote bison on and near the CMR Refuge (see mtwildbison.org). The Coalition supports at least 1,000 bison on at least 100 square miles of diverse habitat.

Montana's State of the Bird (Monitoring)

Allison J Puchniak Begley*, Wildlife Division, Montana Fish, Wildlife & Parks, Helena
Lauri Hanauska-Brown, Wildlife Division, Montana Fish, Wildlife & Parks, Helena

The State of Montana has a long history of monitoring birds and has some of the most robust data on life history, status and trend. However, inventory and monitoring of some species remains challenging with current methodologies. There are 433 bird species in the state with 283 documented breeders, and 233 overwintering residents. Broadscale landbird monitoring, species or taxa specific surveys and local assessments have all been used to provide a picture of the status of each bird species in the state and inform conservation of sensitive species. Montana Fish, Wildlife & Parks is currently reviewing available avian trend, density and occupancy data from broadscale monitoring programs such as the USGS Breeding Bird Survey (BBS) and Integrated Monitoring in Bird Conservation Regions (IMBCR). BBS provides long-term trend data and IMBCR provides information on population density and species occupancy estimates. Individualized surveys provide increased focus on species of concern or those species or habitats that are underrepresented or inadequately surveyed by large-scale programs. These monitoring programs vary in their ability to provide information necessary for status assessments across species due to difficulties accessing some areas and habitats at biologically relevant time periods and detecting cryptic or rare species. By reviewing these data and incorporating known status and habitat types provided by the Montana Natural Heritage Program, FWP plans to highlight the status of bird species of interest and outline needs for monitoring in the state. Given the different products and methodologies, this summary will also serve to recognize the combined value of these programs, as each program provides different types of biological information to resource managers.

Motus: Developing the Intermountain West Collaborative

William Blake*, Avian Science, MPG Ranch, Florence, MT
Kate Stone, Avian Science, MPG Ranch, Florence, MT

Migration is essential to thousands of species throughout most animal groups. Yet, we still do not know the migration strategies in most species, including winter grounds, migration patterns, and stopover sites. While larger wildlife performs well with tracking devices, most migratory wildlife is too small. The Motus Wildlife Tracking Network helps to fill that void by using small transmitters called nanotags and coordinating the placement of automated receiving units. Researchers deploy nanotags that operate on a single VHF frequency, but with different signal bursts allowing identification of individual organisms. Motus stations then detect the signals in the field, and data are uploaded and shared with collaborators. This community approach to science allows small organisms to be tracked long distances as they pass multiple Motus stations. The Motus network is most active in eastern North America, but also extends to wintering grounds of many western migratory species. In 2018, MPG Ranch established the Intermountain West Collaborative Motus project in the Bitterroot Valley, MT. We are currently expanding the network to gain coverage in more of western Montana and Idaho. We have worked with partners to deploy nanotags on Gray Catbirds (*Dumetella carolinensis*)and several bat species and will expand nanotag work in 2019. Already, we have detected one of our catbirds at a station in Texas. We hope this talk will encourage a dialogue with Montana researchers about potential sites for Motus stations and how they might deploy nanotags to make use of the network.

Avian Response to Old-Growth Maintenance Logging in the Swan River State Forest

Leah Breidinger*, Trust Lands, MT Dept of Natural Resources and Conservation, Kalispell
Ross Baty, Forest Management Bureau, MT Dept of Natural Resources and Conservation, Missoula

Logging in old-growth forests and how to maintain this age class on the landscape have long been concerns in the northwestern United States. Old-growth maintenance silvicultural treatment is a tool the Montana Department of Natural Resources and Conservation (DNRC) implements to retain old-growth attributes, remove encroaching shade-tolerant trees, and create small canopy gaps. Our objectives were to examine how these treatments effect avian diversity and density of associated bird species. We used a Before-After/Control-Impact Pairs (BACIP) study design and paired old-growth stands proposed for harvest (treatment) with untreated stands (control) based on habitat similarity. Vegetation was also measured in study stands. Logging created small openings, reduced basal area by 40%, and reduced overstory canopy cover by 31%. No large changes in bird species composition or diversity were detected. However, relative densities of evening grosbeaks (*Coccothraustes vespertinus*) (P=0.03) and golden-crowned kinglets (Regulus satrapa) (P=0.09) decreased significantly following harvest, while pileated woodpecker (Drycopus pileatus) (P=0.07) and dark-eyed junco (*Junco hyemalis*) (P=0.06) densities increased significantly. Removal of insect-infested trees likely displaced evening grosbeaks and golden-crowned kinglets, while new openings and added logging slash likely attracted dark-eyed juncos and pileated woodpeckers. Old-growth associated birds continued to occupy treatment stands with some species increasing in density and others decreasing under the landscape conditions we observed. We did not evaluate avian survival or reproductive success, which would provide beneficial metrics for further interpretation of results.

Estimating Natal Origins of Juvenile Northern Goshawks using Stable Hydrogen Isotopes

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Robert Domenech, Raptor View Research Institute, Missoula, MT
Adam Shreading, Raptor View Research Institute, Missoula, MT

From 2004 to 2007, we collected hatch-year feathers from 44 juvenile Northern Goshawks (*Accipiter gentilis*) captured at our Rocky Mountain Front banding station near Lincoln, Montana. Due to the relative scarcity and secretive nature of goshawks, little is understood about their migration patterns or the geographic origins of birds encountered at raptor migration count and banding sites. Most studies suggest goshawks are partial migrants, often moving <100km, but select band returns and radio and satellite telemetry have shown that some individuals occasionally travel thousands of kilometers. We performed a stable hydrogen isotope analysis on the feathers we collected from young goshawks to determine their predicted natal origin. We found that 69% of goshawks had predicted natal origins relatively close to our capture site, 24% from areas in northwestern Canada and eastern Alaska, and 7% somewhere significantly south, east or west of our capture site. We did not find any significant patterns with sex and passage date or latitudinal origin, nor did we find a meaningful relationship between latitudinal origin and passage date. Our findings support the current understandings of goshawk migration and dispersal, with most individuals traveling short distances from their natal grounds and a few outliers traveling great distances, not always in a southerly direction.

Miners Gone Birdy! The Importance of Citizen Science and Speciation in Waterfowl Protection at the Berkeley Pit, Butte, Montana

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Gary Swant, GoBirdMontana, Deer Lodge, MT
Mark Mariano, Rampart Solutions, Butte, MT
Lindsay Torpey, Biological Sciences, Montana Tech, Butte
Justine Desjardin, Biological Sciences, Montana Tech, Butte

This work demonstrates how citizen science is improving the waterfowl protection plan at the Berkeley Pit. On November 28th, 2016, tens of thousands of Snow and Ross's geese (*Chen caerulescens* and *Chen rossii*) landed on the Pit during their migration south; roughly 3000 died during the event. The occurrence initiated a change in the waterfowl protection plan at the Pit. For the 20 years prior, avian monitoring took place multiple times per day and mitigation action occurred for every bird observed on the Pit water. Records were taken on bird type, numbers, time of day, and hazing action. Little was known about species, activity patterns, and variation in seasonality which made it challenging to understand the complexities of mitigation actions. In 2017, we trained the mining personnel to identify the waterfowl known to the region so new records include species and sometimes sex and age class. We now have a growing body of data that shows species and corresponding differences in bird activity. We are using these data to understand how these differences vary in fall versus spring migrations and how to match mitigation and bird type. This undertaking exemplifies how utilizing citizen science improves protection efforts. The importance of this initiative is supported by research by Belt and Krausman (2012) who emphasize that well-trained citizens - in this case, miners - generate data and results on par with scientists. Ultimately, we demonstrate how the use of citizen science will result in improved strategies for waterfowl protection at the Berkeley Pit.

Grizzly Bear Recovery and Delisting: Progress Report

Hilary Cooley*, Grizzly Bear Recovery Program, U.S. Fish and Wildlife Service, Missoula, MT

The USFWS listed grizzly bears (*Ursus arctos horribilis*) as a Threatened species in the lower-48 States in 1975 and subsequently designated six recovery zones. Due to the success of conservation efforts and collaboration among a variety of stakeholders, two of these populations (Greater Yellowstone Ecosystem, Northern Continental Divide Ecosystem) have achieved recovery goals and the USFWS is working towards delisting. Conservation success, however, brings significant management challenges as both populations are expanding into human-dominated landscapes. We review population status, management issues, and litigation challenges. We also present updates on recovery and management in the small Cabinet-Yaak and Selkirk Ecosystems and the currently unoccupied North Cascades and Bitterroot Ecosystems.

** Weasely Recognized or Stoatally Camouflaged: Quantifying Coat Color of a Cryptic Predator

Brandon M. Davis*, Wildlife Biology Program, University of Montana, Missoula
L. Scott Mills, Wildlife Biology Program, University of Montana, Missoula

At least 21 species of birds and mammals across the globe undergo seasonal changes in coloration, molting white in winter to match snow cover to reduce predation risk from visually hunting predators. As snow duration decreases, animals in white winter coats become more conspicuous against snowless ground. For example, camouflage mismatched snowshoe hares (*Lepus americanus*) suffer increased mortality compared to camouflaged hares. Yet, the generality of this climate-induced camouflage mismatch across species is unknown. Given the adaptive value of seasonal camouflage against local snow duration, we hypothesize that sympatric color molting species would show convergent coat color phenology. Therefore, we documented coat color phenology of three sympatric coat color changing species in Montana; short-tailed weasels (*Mustela erminea*), long-tailed weasels (*Mustela frenata*), and snowshoe hares. We used a non-invasive sampling framework consisting of remote cameras and bait tubes to quantify coat color phenology for all 3 species, including molt initiation, rate, and completion. Over a 2-year period we deployed >50 remote cameras over >6000 trap nights. We detected >3000 photographic hare events and >1000 photographic weasel events. Although we are currently completing our analysis it appears that there may be phenology differences between hares and weasels. We conclude that camera trapping is a useful tool for quantifying phenology of sympatric coat color changing species, contributing to the growing knowledge base to determine the potential scope for evolutionary rescue to climate change in wildlife populations.

Eating Their Greens: Relationships of NDVI with Elk Forage and Nutritional Condition

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Steve Brown, U.S. Forest Service, Northern Region, U.S. Department of Agriculture, Missoula, MT

The distribution and availability of nutritional resources strongly influence elk (*Cervus elaphus canadensis*) movements and behaviors and are important for females to meet nutritional requirements of lactation, mass gain, and pregnancy. Past studies demonstrated that

elk during the summer select strongly for areas with high values of the Normalized Difference Vegetation Index (NDVI), a remotely-sensed indicator of net primary productivity. There is, however, considerable uncertainty regarding relationships between NDVI, forage availability and quality, and elk nutrition. To fill these knowledge gaps and provide recommendations for managing elk habitat in western Montana, we evaluated the relationships of NDVI with ground-sampled vegetation and nutritional condition measurements from elk in 4 populations (Elkhorn, North Sapphire, and East Fork and West Fork of the Bitterroot). We sampled 510 vegetation plots in summer and 172 elk in fall and winter during 2011-2017. We found some evidence that NDVI was associated with forage quality, forage abundance, and body fat, but not with pregnancy. These results indicate that managing areas for greater levels of NDVI may increase the availability of summer forage and improve the ability of elk to gain body fat; however, NDVI alone is insufficient to fully characterize summer forage. We suggest that combining forest management treatments on public lands with other strategies, such as restricting availability of high-quality forage on private lands, increasing hunter access on private lands, or altering harvest regulations, may provide a more holistic approach to encouraging elk to remain on public lands during the summer and hunting seasons.

Example of Multi-Agency Data Management to Adaptively Manage Centennial Valley Arctic Grayling

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Montana Arctic grayling (*Thymallus arcticus*) declined to about 4% of their perceived historic distribution by the 1990s, which led to formal consideration for listing under the Endangered Species Act. Over the past 70 years numerous hypotheses were posited regarding drivers of the grayling population, including 1) reduction and alteration of spawning habitat, 2) predation by, and competition with, non-native fishes, and 3) limited winter habitat. A multi-agency adaptive management project was initiated to elucidate the relative effect of hypothesized drivers of grayling abundance to direct future management of this population. Data are considered a trust resource. If data are not organized, maintained and accessible, the status, trends, and processes over temporal and spatial scales cannot be addressed. Data are collected by the US Fish & Wildlife Service (USFWS) and Montana Fish, Wildlife & Parks (FWP) and each agency manages it differently. These data include netting, trapping, electrofishing, stream temperature, fish demographics, tagging, spawning habitat, overwintering, beaver dams, and angler harvest data on hybrid cutthroat. FWP Fish Information System (FIS) is a centralized database, commonly referred to as "Godzilla", which houses most fish data for FWP. USFWS does not have a centralized database system but data are entered into relational databases and stored on local servers. The Centennial Valley Arctic grayling database was created to house similarly formatted data from Godzilla and USFWS. The collation of data presented unique challenges. Data are assembled and fed into the models annually, biases are slowly disappearing, and the grayling population is being adaptively managed.

** Annual Elk Calf Survival Following Increased Mountain Lion Harvest

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From 2011 to 2014, we evaluated the factors driving the survival and recruitment of elk (*Cervus elaphus canadensis*) calves in the upper Bitterroot Valley of Montana. After three years, we identified mountain lions as a major source of elk calf mortality and determined that increasing elk calf survival in the southern Bitterroot might have positive effects on elk abundance and recruitment in the area. In 2012, wildlife managers increased harvest opportunity for mountain lions in the study area, which resulted in increased harvest of both male and female mountain lions. To evaluate possible changes in calf survival and cause-specific mortality several years after increased opportunity for mountain lion harvest ended, we monitored 248 elk calves via radio telemetry from 2016-2018 in the study area to determine the timing and cause of death. We estimated period-specific rates of seasonal mortality and cause-specific mortality using data collected prior to (n = 202), during (n = 84), and after (n = 248) increased mountain lion harvest opportunity. Estimated calf survival rates will be compared among the 3 periods of mountain lion harvest opportunity in the upper Bitterroot study area. Possible changes in rates of cause-specific mortality will also be compared among the periods. We will also present the results of an evaluation of the associations between calf survival and (1) spatiotemporal covariates and (2) characteristics of individual calves.

Using GPS Technology on a Migratory Songbird to Determine Overwintering, Migration Route and Connectivity

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Little is known about the connectivity of migratory songbirds in part because mark-recapture methods result in few observations. With rapidly improving technology, tracking devices are becoming more relevant for small animals. We studied migration ecology of Gray Catbirds (*Dumetella carolinensis*) that breed in the Intermountain West. We retrieved 6 geolocator units and, more recently, 12 GPS pinpoint tags that provide information on overwintering location, migration route, and timing of arrival and departure. Our results indicate that catbirds winter in northeastern Mexico and those locations appear to be distinct from wintering locations of eastern Gray Catbird populations. Additionally, our results show that catbirds may have a "second migration" in the spring, moving further south in Mexico at a time when we would expect them to return northward.

** Sugar Content as a Driver of Resource Partitioning Between Foraging Bears and Tribal Harvest of Huckleberries on the Flathead Indian Reservation

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Huckleberries (*Vaccinium* spp.) facilitate important ecological relationships for Native Americans within the Flathead Indian Reservation of Montana and throughout the Pacific Northwest. Huckleberries provide cultural resources such as traditional foods and customs, social elements and economic products. Huckleberries are also an important food source for bears, another culturally important animal for the Confederated Salish and Kootenai Tribes (CSKT) along with many other Native American Tribes. Phenological data on huckleberries is extremely limited.The opportunity for traditional ecological knowledge (TEK) to be utilized to expand knowledge was a key focus for this project. To gain a better understanding of the role that huckleberries play in cultural and ecological networks, ecological characteristics of huckleberries across a range of habitats on the reservation were examined in addition to interviews with enrolled tribal members and tribal elders about historic and modern use of huckleberries. Recorded phenology data at 10 sites at different elevations across the reservation was used to develop a baseline understanding of the time of flowering and berry production. We evaluated the relationship between site productivity of huckleberries and sugar content (measured in brix%) of berries at peak ripeness and compared those metrics with bear use, measured by the amount of bear sign at each site. Bear (*Ursus* spp.) sign was most prevalent at the more remote locations with higher brix% (R2=0.82, p=0.012) and plentiful berries. Finally, community interviews were conducted with adult tribal members about the importance of huckleberries for the tribal community and the people's understanding of the niche bears maintain concerning huckleberries. This research contributes to collaborative studies in Northwest Montana focusing on huckleberries as a food source for bears in the face of climate change, as well as supporting CSKT in asserting traditional food sovereignty.

Using UAVS, Infrared Cameras and Machine Learning to Count Greater Sage-Grouse

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UAVs have the potential to increase data quality and improve efficiency of wildlife monitoring. However, little information exists on how data collected from UAVs compares to traditional visual based surveys. Here we deployed a UAV autonomously over Greater Sage-grouse (*Centrocercus urophasianus*) leks in Phillips County, Montana to compare traditional field-based lek counts to manual and automated UAV video counts. We conducted 28 paired observations of sage-grouse using traditional visual methods and UAV mounted thermal infrared video. For analysis, we manually counted the sage-grouse in the videos, comparing counts of a trained and untrained observer. We completed field counts before each flight to compare counting methods. Results of our analysis show good agreement between trained and untrained observer manual video counts but less agreement between manual video counts and standard field counts. Next, we built an algorithm to identify, track, count, and size the sage-grouse from the videos. While the algorithm worked exceptionally well tracking and counting, more refinement is necessary to detect all the sage-grouse. The algorithm was also able to

detect a size difference between birds which could signify males versus females. However, methods would have to be developed to validate the size difference detected. Overall, our results show that drones in combination with autonomous methods show enormous potential for counting sage-grouse. Furthermore, counting sage-grouse in the spring is difficult and inconsistent given field conditions. UAVs are tools that can help us overcome tough field conditions and give us visual access to otherwise inaccessible leks.

Interpreting and Adapting Monitoring Efforts of a Reintroduced Population of Swift Fox in Northeastern Montana

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Swift fox (*Vulpes velox*) were designated extirpated in Montana in 1969. However, reintroductions initiated in Canada from 1983-1997, reestablished a self-sustaining population in southern Alberta and Saskatchewan and northeastern Montana. Swift foxes are listed as a threatened species in Canada. In Montana, at the northern edge of the species range, swift fox are considered a furbearer, with a limited harvest and a Species of Concern level 3, potentially at risk but abundant in some areas. The swift fox population in Canada and Montana is interdependent and therefore it is important for agencies to collaborate on monitoring efforts that are measured against management and/or recovery goals which may differ across jurisdictional and international boundaries. Four international population surveys have been conducted on the Canada/northeast Montana population in 2000/01, 2005/06, 2014/15, and 2018. Monitoring abundance and distribution of swift fox are key components of the Montana Swift Fox Conservation Strategy. Swift fox are elusive and nocturnal, therefore, conducting surveys for the species is both difficult and expensive. Monitoring data are derived from international population surveys, from harvested fox and anecdotal observations. We will review and compare results of each international survey which has advanced our knowledge of this reintroduced population and has helped guide management of swift fox in northeastern Montana.

** Preliminary Results on the Drivers of Moose Calving Success and the Impacts of Mountain Pine Beetle Epidemics on Resource Selection

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Understanding factors that influence moose (*Alces alces*) calving success and habitat selection are fundamental to the effective conservation and management of the species. The two primary objectives of this study are to evaluate the effects of willow nutrition on calving success of moose and the effect of mountain pine beetle (*Dendroctonus ponderosae*) epidemics on moose habitat selection and movement. Preliminary research by Colorado Parks and Wildlife has identified differences in calving success between two spatially proximate moose populations with similar geographic and biotic features. As moose diet in this

geographic area has been well documented and a majority is comprised of willow (*Salix* spp.), we investigate the degree to which differences in willow forage quality explain differences in calving success. Both moose populations in our study are surrounded by forests that have been impacted by mountain pine beetles. These epidemics affect forest structure and the availability of thermal cover; however, the impact on wildlife is poorly understood. Thermal cover is thought to be especially important for moose in Colorado at the southern extent of their range. This suggests that moose will display stronger selection against impacted areas in this geographic region. We present a preliminary analysis of moose habitat use and predictions of habitat selection based on the date of mountain pine beetle impact.

Limited Permit Mule Deer Buck Hunting Restrictions in Eastern Montana - Historical Information, Analysis and Public Expectation of Hunting District 652

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Hunting District 652 is a limited permit mule deer (*Odocoileus hemionus*) buck only area, found along the east side of Fort Peck Lake in FWP Administrative Region 6. The district was initially established in 1987 to meet public desire to produce "more and bigger mule deer bucks". Population and harvest objectives were established within the Mule Deer Adaptive Harvest Management (2001) guidelines. Mule deer demographics in this district are monitored annually through post-season aerial survey methods. Hunting and harvest metrics are monitored through an annual survey of successful permit applicants via a mailed questionnaire, along with request for a front incisor for cementum age analysis. We reviewed these data to assess whether management objectives set for HD 652 are being met for buck:doe ratios, density of deer and age structure of harvested bucks. These data were compared to similar mule deer buck data from other general hunting season districts collected at the Havre Check Station. During most years since its inception, management objectives set forth for hunting district 652 are met. The general deer season structure is also producing similar metrics during those years. Wildlife managers considering adapting a limited permit mule deer hunting district should have a clear picture of the public's desired outcome for such a season structure, as they relate to measurable management objectives and the likelihood of meeting public expectation.

** Optimal Use of Wildlife Monitoring Resources

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Resources for monitoring wildlife populations are limited and their availability changes over time. The data collected using these resources is critical for making good conservation and management decisions. Determining the optimal way to allocate monitoring resources for data collection based on the amount of information the data provides for conservation and management is a responsible and efficient use of public resources. We develop a method for determining the most optimal scenarios for data collection which simultaneously minimizes cost and maximizes the precision of the abundance estimate. To accomplish this, we developed a new metric which describes the relationship between data collection cost and estimate precision in a single value, the information gain ratio. We used data collected by the Idaho Department of Fish and Game on the statewide mule deer population of Idaho to

develop our method for determining the optimal allocation of monitoring resources. Using the information gain ratio, we characterize the relationship between cost and precision relative to the specific attributes of each mule deer population management unit. Our method allowed us to generate a set of data collection scenarios that were adapted to the specific characteristics of each unit, changed with the availability of monitoring resources, and are easily comparable via the predicted values of the information gain ratio. The collection scenarios detail the type and amount of each data type to collect for the optimal use of monitoring resources. Our optimization method is adaptable across species, scales, data types, and population models.

** Methods to Estimate Recruitment for Social Species with Limited Data

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Population dynamics for social species depend on hierarchical demography that links local, group-level processes to overall population growth. Many social species cooperatively breed, thus recruitment of offspring is affected by both population- and group-level processes. Traditional methods to estimate recruitment for a species that cooperatively breeds may be insufficient because they do not account for hierarchical demography. Furthermore, for a species that is broad-ranging, rare, or elusive, recruitment data may be too difficult or costly to collect. Our objective was to develop a method to estimate recruitment for a social species that accounts for hierarchical demography and does not rely on recruitment data. We developed an integrated population model (IPM), with both population- and group-level processes, to estimate recruitment in a social species. We were able to estimate recruitment from the IPM without data because changes in abundance are a function of survival and recruitment and we had data for survival. We tested the model using simulated datasets under five scenarios without recruitment data. For all five scenarios we ran models with and without the group-level process to determine if hierarchical demography improved estimation. Simulations demonstrated that the model performed well under most scenarios and provided unbiased estimates of recruitment. We found that explicitly incorporating hierarchical demography was important for estimating recruitment in social species. This model can easily be adjusted to estimate recruitment for any social species. Further, by removing the group-level process this model can be used to estimate recruitment for a non-social species when data are lacking.

** Recruitment of Gray Wolves in Montana

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Recruitment is an important vital rate driving population growth of large mammals. Although large mammals are thought to be regulated by extrinsic factors, cooperative breeding may result in intrinsic factors driving population dynamics, specifically recruitment. The majority of studies evaluating the effects of intrinsic and extrinsic factors on recruitment have not been conducted in a social species that cooperatively breeds, and those that have did not explicitly account for the effects of social structure. We evaluated how intrinsic and extrinsic factors affected variation in recruitment for gray wolves (*Canis lupus*)in Montana using an integrated population model. We hypothesized that variation in recruitment was driven by intrinsic factors such as pack size or population size. Alternatively, we hypothesized

that extrinsic factors drive variation in recruitment and predicted that winter severity, forest cover, road density, or harvest would explain the most variation in recruitment. We found that the main driver of recruitment in wolves was primarily intrinsic factors, specifically pack size. Mean number of pups recruited per pack appeared to vary little over time despite changes in management practices and decreased survival of yearling and adults following harvest implementation. Although recruitment does not appear to compensate for changes in survival, the population has remained relatively stable, suggesting that current harvest rates are sustainable. Recruitment in a large bodied, cooperatively breeding species appears to be driven primarily by intrinsic factors.

** Short-Term Response of Snowshoe Hares to Western Larch Restoration and Seasonal Needle Drop

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Old-growth western larch (*Larix occidentalis*) has been degraded throughout much of its historic range due to extensive timber harvest and fire suppression. We examined the effects of a restoration treatment of western larch on snowshoe hares (*Lepus americanus*), a denizen of the boreal forest serving as a focal animal species to indicate the health of the restored ecosystem. In western Montana, we implemented a restoration treatment using "doughnut thinning" to accelerate development of old-growth attributes in larch stands and simultaneously examined the short-term effects on snowshoe hare density, survival and movement. Although typical forest management activities tend to have adverse effects on hares especially in the short-term, we found that the restoration treatment did not affect hare density or survival in the short-term. In addition, despite significant decreases in cover coinciding with the larch needle drop, we found evidence of year-round immigration into larch stands by hares suggesting larch stands are suitable year-round hare habitat. Taken together, our findings suggest that a larch restoration treatment designed to accelerate the development of old-growth attributes can be implemented so as to have no measurable short-term detrimental effects on hares.

Project WAFLS: Predicting Responses of Short-Eared Owl Population Size, Distribution and Habitat Use in a Changing Climate

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The Short-eared Owl (*Asio flammeus*) is an open-country, ground-nesting species found in marshes, grasslands, shrublands, and tundra across North America and around the world. Evidence suggests that Short-eared Owl populations are experiencing long-term, range-wide, substantial declines in North America, but sufficient monitoring data is lacking to quantify any possible trend. Complicating trend analysis efforts for this species is the expected annual variation in breeding densities, believed to be associated with prey availability. We present evidence from four years of surveys, starting in the Intermountain West, but now encompassing eight western states, confirming annual variation in both density and distribution of Short-eared Owls. Furthermore, we have identified the landscapes features where owls are least susceptible to this variation. Lastly, we present climate-informed

projections for the future viability of the species within the region. The results of our work will directly inform the prioritization of actions to help conserve this often neglected species.

** Complementing Visual Surveys with Wildlife Cameras for Long-Term Wetland Monitoring

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Freshwater wetlands support high biodiversity, but are also subject to increased drying under projected climate patterns. Recently, the use of automated tools for monitoring has become more feasible. Using automated tools to complement traditional visual surveys increases observation time at surveyed sites possibly capturing different species, recording within-season dynamics, and expanding our understanding of wetland biodiversity in a changing environment. In 2017 and 2018, we placed wildlife cameras at 6 seasonal and 6 permanent wetlands in Grand Teton National Park for a week each in June and August; we also completed a single visual survey of amphibian species during each of these time intervals. We compared the difference in the number of species detected by each method over the summer to assess temporal changes in wetlands with varying hydrology and evaluate effectiveness of each method for monitoring. Based on preliminary results, changes in species richness over the summer were more related to wetland hydrology than the survey method. Although we found the two methods captured a similar change in richness over time, the species observed were complementary. Cameras added six species from four additional taxa to the four amphibian species detected during visual surveys. Cameras also captured seasonal water-level patterns, which may be used to ground-truth climate-based drying models. Further analysis, including cost/benefit assessments, will help us understand the utility of cameras for monitoring wetlands. Automated surveillance tools allow us to sample cryptic species over large spatial and temporal scales, providing an important contribution to biodiversity monitoring.

** Time-To-Event Density Estimation of Low Density Species With Remote Cameras

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Abundance estimates can inform management policies and are used to address a variety of wildlife research questions, but reliable estimates of abundance can be difficult and expensive to obtain. For low-density, difficult to detect species, such as cougars (*Puma concolor*), the costs and intensive field effort required to estimate abundance can make working at broad spatial and temporal scales impractical. Remote cameras have proven effective in detecting these species, but the widely applied methods of estimating abundance from remote cameras rely on some portion of the population being marked or uniquely identifiable, limiting their utility to populations with naturally occurring marks and populations that have been collared or tagged. Methods to estimate the abundance of unmarked populations with remote cameras have been proposed, but none have been widely adopted. Working with Idaho Department of Fish and Game, we used the time-to-event model (Moeller et al. 2018) to estimate the density of two cougar populations in Idaho. The time-to-event model uses observed encounter

rates at randomly or systematically placed cameras to estimate the abundance of unmarked populations. Obtaining reasonable abundance estimates for cougars from the time-to-event model shows that remote cameras may lower the costs of abundance monitoring for low density, difficult to detect species and make monitoring programs using remote camera grids applicable to a broader array of species. Future work will compare estimates of cougar abundance from the time-to-event model to estimates obtained from concurrent genetic spatial capture recapture estimates.

** Is Habitat Constraining Bighorn Sheep Distributions and Restoration: A Case Study in the Greater Yellowstone Ecosystem

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We used GPS location data from 65 bighorn sheep (*Ovis canadensis*) in the Madison Mountain Range, located in the northwestern extent of the Greater Yellowstone Ecosystem (GYE), to develop and validate winter and summer resource selection function (RSF) habitat models. Two isolated populations of bighorn sheep occurred within the range, but had demonstrated little expansion into apparent habitat even during years of population growth. We hypothesized that habitat was not the primary factor limiting these populations and that the Madison Range could support a substantially higher abundance and broader distribution of bighorn sheep. We evaluated remotely-sensed landscape covariates expected to influence bighorn sheep resource selection and compared sets of biologically-plausible seasonal models with AICc. We validated our results using temporally- and spatially-independent GPS data and predicted potential habitat throughout the Madison Range. Our results indicate that approximately 82% of winter and 42% of summer habitat was unoccupied. Predicted winter habitat occurred in a non-contiguous distribution primarily along the low-elevation, southwest-facing aspects within the Madison Valley, and predicted summer habitat was concentrated along the high elevation ridgelines associated with steep slopes and reduced canopy cover. By linking our winter RSF to population estimates for the Taylor-Hilgard, we predicted the Madison Range may be capable of supporting 2 to 4 times the number of bighorn sheep currently estimated within the range. Our results support our hypothesis and suggest that a strategy focused on systematically restoring a metapopulation may greatly enhance the potential for bighorn sheep restoration within the Madison Mountain Range.

Invasive and Pest Species Information at the Montana Natural Heritage Program

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The Montana Natural Heritage Program (MTNHP) has centralized information on Montana's native species and habitats since its inception in 1985. In October of 2017, MTNHP started managing information on Aquatic Invasive Species, Noxious Weeds, Forest

Pests, Agricultural Pests, other non-native species, and biocontrol species that have been introduced to control invasives. The MTNHP now manages information on over 500,000 observations of more than 700 invasive and pest species and over 50,000 structured survey locations for invasive and pest species and makes that information available on its websites. This presentation will provide an overview of how biologists and resource managers can access information on surveys, observations, predicted habitat suitability models, and descriptive field guide information for invasive and pest species and native species on the MTNHP's Montana Field Guide, Species Snapshot, and Map Viewer websites.

Montana's Spatiotemporal Model for Estimating Gains and Losses of Greater Sage-Grouse Habitat in a Mitigation Framework: Time is of the Essence

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Sagebrush-grassland ecosystems support upwards of 300 species, including several charismatic and high-profile big game and upland bird species. For example, habitat conservation for Greater Sage-grouse (*Centrocercus urophasianus*, hereafter GRSG) directly benefits habitat for mule deer and pronghorn. Big game hunting in counties that contain designated GRSG habitat contributes over $113.5 million annually to Montana's economy. Montana has a deep habitat conservation ethic, which is foundational to maintaining Montana's Outdoor Economy. To address the GRSG conservation needs, Montana and a multi-agency, multi-disciplinary, citizen-based stakeholder group developed a Habitat Quantification Tool (HQT model) to quantify GRSG functional habitat gains and/or losses in a mitigation framework. Montana's HQT model is a geospatial raster model. It differs from other state GRSG HQT models because it incorporates time when estimating changes in available functional habitat caused by development or conservation projects. Using biophysical GBSG habitat attributes, the HQT model first establishes a baseline of existing functional habitat. For individual projects, the HQT model assesses functional acres lost or gained due to development or conservation, respectively, by comparing the baseline to post-project condition. Individual HQT model results are aggregated and summed at regional and statewide scales to determine whether Montana is meeting its goal of no net loss of GRSG habitat. The Sage Grouse Habitat Conservation Program (Program) operates and maintains the HQT model. Using an adaptive management framework, the Program will assess the accuracy of HQT model results. The Program will revise the HQT model through time based on new available science.

Free Lunch, may Contain Lead: Scavenging Shot Small Mammals

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Scavengers are subsidized by hunting remains worldwide. While most studies focus on carcasses of large mammals, shot small mammals likely provide a significant food subsidy as

well. Millions of small mammals are shot each year for damage control and recreation, many being left in the field. Despite this high prevalence of carrion, and the potential for scavengers to ingest residual lead from bullet fragments, the fate of these carcasses is largely unknown. We deployed remote cameras to observe which scavengers consumed shot ground squirrels (*Sciuridae* spp.) and black-tailed prairie dogs (*Cynomys ludovicianus*) in 8 locations across Montana, USA. At least 5 species of mammals and 9 species of birds scavenged, including burrowing owls (*Athene cunicularia*). Scavengers fully consumed 67% of carcasses and partially consumed 9%. Carcasses lasted an average of 24.5 hours before the first scavenger arrived. Of carcasses that were scavenged, mammals ate 16% compared to 84% for birds, with corvids and raptors consuming an equal number of carcasses. Common ravens (*Corvus corax*) and black-billed magpies (*Pica hudsonia*) visited the most carcasses and were often the first to arrive. Overall, our results indicate that a diverse scavenger community consumes shot ground squirrels and black-tailed prairie dogs, and consequently, may be exposed to lead from bullet fragments.

Recent Trends in Ungulate Forage Inferred from Remote Sensing Data Sets

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Forage quality, quantity, and phenology play a large role in regulating the habitat use and population dynamics of wildlife populations. Assessing how forage has changed over time can help inform management decisions. Using several freely available remotely sensed and climate-based datasets, we calculated forage-related metrics such as the timing and duration of spring greenup on a pixel-by-pixel basis across Montana. We conducted trend analysis from 2000-2014, identifying areas of consistent change within the state and summarizing trends on a more local scale. We also assessed variability and consistency of estimates within and across datasets. In general, mountainous regions and adjacent lower elevations display somewhat opposing trends, highlighting the importance of understanding the changes for conservation of migratory ungulates which rely on greenscape gradients to optimize nutritional gain.

**Effects of Rangeland Management on the Ecology of Sharp-Tailed Grouse in Mixed-Grass Prairies

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Temperate grasslands, including mixed-grass prairies, suffer from the greatest levels of habitat loss and degradation of any ecosystem, which can have cascading negative effects. Grazing by livestock is the predominant land use across western North America and directly affects the structure, composition, and productivity of native grasslands. While certain grazing regimes can negatively affect wildlife habitat, properly managed grazing can be compatible with wildlife conservation and is preferable to other land uses that destroy or fragment native grasslands. With large home ranges and differing requirements for nesting and winter habitat, sharp-tailed grouse (*Tympanuchus phasianellus*) require large and complex areas of habitat, making them an ideal indicator species for grassland habitats. Poor range management has been implicated in the decline of sharp-tailed grouse throughout North America, but the effects of specific grazing regimes on grouse populations have not been studied. A better understanding of the ecological impacts of grazing is required to develop effective conservation strategies. We monitored 203 radio-collared sharp-tailed grouse in

eastern Montana to assess the effects of grazing management on grouse ecology and evaluate the effectiveness of specific grazing regimes for improving wildlife habitat. In three years of study, we found that choice of grazing system had no effect on space use and important vital rates (nest survival and adult survival) for sharp-tailed grouse. We observed relatively weak effects of stocking rate and stocking density, but overall the performance of the sharp-tailed grouse population at our study area was not affected by grazing system.

Elephant Friendly Tea: An Example of Wildlife Science-Based Commercialization to Save an Endangered Species

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In the U.S. alone, >84 billion servings of tea are consumed per year, totaling $12.5 billion in annual sales. Almost none of these consumers realize that tea is a death crop helping to drive Asian elephants extinct. Building on our applied population ecology research and local outreach in the India-Bhutan region, we have: a) identified tea production practices that drive elephant mortality; b) identified specific actions to reverse those impacts; c) and incentivized those conservation-relevant tea farming practices through a novel "Elephant Friendly Tea" (EFT) Certification. Through our program tea estate owners who implement EFT actions receive a price premium for their tea, which is then sold under a Certified EFT logo; in turn, global tea consumers have a direct opportunity to support science-based elephant conservation with every cup of tea. We expect EFT to be game-changing for arresting the decline of Asian elephants because – unlike traditional conservation approaches – it both implements incentive-based conservation actions on and around the private agricultural lands where most elephants are killed, and it will create profits that we will fully invest into research and conservation actions across the elephant's range. Critical partners to development of EFT include local villagers and tea professionals, the non-profit certification group Wildlife Friendly Enterprise Network, and University of Montana (who will manage the "EFT Elephant Research and Conservation Fund" created by EFT sales). We believe this model has great potential to address seemingly intractable conservation problems in Montana by developing meaningful win-win wildlife friendly enterprises.

A Winter Energetics Model for Bobcats in a Deep Snow Environment

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Understanding basic energetic requirements of wildlife species is critical to evaluate how individuals persist in their current environments as well as to forecast responses to changed climates or habitats. Indeed, northern range limits are often thought to reflect harsh abiotic conditions that exceed the capacity of individuals to stay in energetic balance. Bobcats (*Lynx rufus*) occur across much of North America; at northern latitudes, they face winter challenges such as deep snows, cold temperatures, and possible food scarcity. We developed an energetics model from field data on movements, body mass, and observed diet of bobcats in mountains of northwest Montana, then evaluated overwinter prey requirements that would enable bobcats to stay in energy balance in this difficult environment. Our model indicated average daily energy expenditures were ~1.41 × basal metabolic rate. For 90 days from December-February, a 10.5 kg bobcat consuming prey items in proportion with the observed diet for bobcats in this area would need about 2.1 kg of deer (Odocoileus spp.), 7 snowshoe hares (*Lepus americanus*), 155 red squirrels (*Tamiasciurus hudsonicus*), 9 woodrats

(*Neotoma cinerea*), and 250 small rodents (*Cricetidae*). Bobcats have considerable flexibility in diet, movements, and both timing and duration of daily activity to adjust their energetic expenditures in winter.

Regional Differences in Winter Diets of Bobcats in Their Northern Range

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When generalist predators have wide geographic ranges, diets may differ dramatically, largely as a result of differing prey communities. Bobcats (*Lynx rufus*) are widely distributed across southern North America, with their northern range edge occurring in southern Canada and in the northern US states. Within this northern range, bobcats are exposed to cold and snowy winters and a limited number of prey species, conditions that are atypical for most of the range of bobcats. We examined winter diets of bobcats in high elevation and very snowy forests in northwest Montana to determine how these generalist predators managed in these harsh conditions in comparison to elsewhere in the northern range. Bobcats consumed 5 major prey types: red squirrels (*Tamiasciurus hudsonicus*) and Cricetid rodents comprised >78% of the dietary biomass, whereas the larger snowshoe hares (*Lepus americanus*), deer (*Odocoileus* spp.), and grouse were consumed much less often. The standardized niche breadth of bobcat diets was 0.29; bobcats from across the northern range also routinely ate multiple prey species, although eastern bobcats appear to consume more lagomorphs than do western bobcats. These results indicate that bobcats remain generalists in difficult winter conditions while preying primarily on small-bodied prey, although bobcats have highly variable diets across their northern range.

An Improved Understanding of Population Dynamics Using Count Data: Insights From Elk in Western Montana

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Understanding the dynamics of ungulate populations is a crucial goal for managers given their ecological and economic importance. In particular, the ability to evaluate the evidence for potential drivers of variation in population trajectories is important for informed management. However, the routine use of age ratio data (e.g., juveniles:100 adult females) to evaluate variation in population dynamics is hindered by a lack of statistical power and difficult interpretation. Here, we show that the use of a population model fueled by count, classification and harvest data can dramatically improve the understanding of population dynamics compared to a model using age ratio data by: 1) increasing the power to assess potential sources of variation in key vital rates, and 2) providing easily interpretable vital rates (e.g., per capita recruitment rates and population growth rates) that are useful to managers. Using a time series of spring count data (2004 to 2016) and fall harvest data from hunting districts in western Montana, we constructed a population model to assess the effects of a series of environmental covariates and indices of predator abundance on the per capita recruitment rates of elk (*Cervus elaphus canadensis*) calves. Results from this modeling approach suggest per capita recruitment rates decline in association with wet springs, dry summers and severe winters, and in interactions between predator communities and the environment. In contrast, the analysis of age ratio data failed to detect these relationships. We

recommend using count data and a population modeling approach rather than interpreting estimated age ratio data as a substantial improvement in understanding population dynamics.

Estimating Carnivore Density Using Spatial Capture-Recapture Models: Sampling Designs and Potential Pitfalls

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Spatial capture-recapture (SCR) models have improved the ability to estimate densities of rare and elusive animals. However, SCR models have seldom been validated even as model formulations diversify to incorporate new sampling methods and/or additional sources of information. The relationship between encounter probabilities, sources of additional information, and the reliability of density estimates, is poorly understood but crucial to assessing reliability of SCR-based estimates. We used a simulation-based approach that incorporated prior empirical work on mountain lions (*Puma concolor*) in western Montana to assess the accuracy and precision of density estimates from SCR models using direct search effort. Our simulations focused on understanding the consequences of: 1) variable probabilities of encounter generated from different levels of search effort, and 2) including additional spatial information from collars. Overall, we found that although low search effort resulted in sparse datasets and highly biased and imprecise estimates of density (relative bias, RB = 0.71, coefficient of variation, CV = 1.16), a combination of increased effort and/or additional information generated unbiased and precise density estimates (e.g., moderate effort and 4 collars, RB = -0.004, CV = 0.19). This work suggests that reliable density estimates can be generated by multiple sampling designs such that additional spatial information from collars can be used to supplement direct search effort when resources are limited, or by increasing search effort when collaring is impractical. Using the open-source code for our simulation-based approach, we further offer recommendations on sampling designs for SCR-based density estimation.

Adventure Scientists: Igniting the Outdoor Community to Collect Game-Changing Data

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Outdoor adventurers have the skills and inspiration to spend hours, days, and weeks every year in regions that are inaccessible to the rest of the population. While carrying out their already-planned excursions or planning new ones expressly for this purpose, they can collect data and samples of critical importance to scientists and conservationists working to address today's challenges to human health and the environment. Adventure Scientists has gained extensive experience and developed repeatable protocols for designing projects and training these highly-skilled volunteers to collect research-grade data. These data are being used by governments, businesses, and others to shape policies and practices that benefit the environment. Scientists get otherwise unobtainable data while adventurers enrich their experience of the outdoors and increase their knowledge of the challenges facing the natural world. Together they have a greater impact than either could alone. This spring, serving a partnership with the Montana Department of Transportation, Adventure Scientists will begin recruiting volunteer teams of cyclists throughout the state to create a comprehensive year-round portrait of wildlife-vehicle collisions on more than 8,400 miles of state and federal

highways. Armed with the results, decision makers then can identify key migration corridors, uncover road crossing "hot spots," and design improved road projects such as overpasses and culverts to prevent collisions and allow humans and wildlife to move freely and safely across a shared environment.

** Estimating Forage Quality and Abundance to Better Understand Mule Deer Resource Selection

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To identify the environmental factors limiting growth of herbivore populations, researchers need to understand how benefits (like forage quality and abundance) and costs (like risk of predation) vary across a population's range, and how individuals select habitat with respect to those resources. For mule deer (*Odocoileus hemionus*) living in northwest Montana, predicting forage quality and abundance over large extents is difficult, since much of their habitat use occurs within dense conifer forest where remote-sensed metrics (like NDVI) are of limited use. Therefore, we are developing a landscape forage model using field-collected vegetation data to estimate how digestible energy per area varies across 3 mule deer population ranges. Preliminary evidence has shown that forage resource availability varies with landcover-type. With this forage model, and along with previously developed predator resource selection functions (RSFs), we will develop an RSF to assess how mule deer make tradeoffs between nutrition and predation risk. This will allow us to identify the mechanisms driving mule deer resource selection, and will guide more effective management of mule deer populations and habitat in western Montana.

Greater Sage-Grouse Response to Bentonite Mining

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The greater sage-grouse (*Centrocercus urophasianus*) has undergone range contraction and population decline because of anthropogenic land surface disturbances; yet, there is little information on the effects of mining on sage-grouse populations. In the Bighorn Basin of Montana and Wyoming, bentonite mining is a growing source of surface disturbance that contributes to loss of sagebrush habitat. We evaluated the response of sage-grouse to active and reclaimed bentonite mining, relative to nesting, brood-rearing, adult breeding, and adult winter habitat, through resource selection and habitat-specific mortality risk analyses, based on female sage-grouse monitored with telemetry from 2011-2015. A greater proportion of our monitored sample was exposed to mining disturbance during winter (65%) than during other seasons (range = 25%-34%). We observed avoidance of all mining disturbance for selection of nesting habitat, adult breeding habitat, and adult winter habitat. Evidence was inconclusive for avoidance of mining for brood-rearing habitat. We also observed increased adult breeding season mortality risk associated with active mining disturbance but observed no effect on nest success. Evidence was inconclusive for increased mortality risk associated with broods and adults during winter. Stakeholders in the Bighorn Basin should be flexible and proactive to minimize the negative effects of bentonite mining on sage-grouse habitat use and demographic rates. Stakeholders should prioritize the conservation of winter habitats because of the influence on a greater proportion of the population and they should strive to perfect mining reclamation to return disturbed sites back to pre-disturbance conditions to minimize long-term effects.

Integrated Carnivore-Ungulate Management: A Case Study in West-Central Montana

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In response to poor recruitment and declining ungulate population trends in west-central Montana, wildlife managers implemented an integrated carnivore-ungulate management program designed to reduce carnivore densities via harvest prescriptions in efforts to increase elk (*Cervus elaphus canadensis*) recruitment and abundance. However, the ability of wildlife managers to use carnivore harvest management regulations as a tool to reduce carnivore population densities and increase ungulate recruitment is unknown. The management objective in this case was a moderate reduction in carnivore densities that sustained carnivore populations and associated recreational opportunities, while also reducing predation pressure on ungulate populations. We assessed the efficacy of this integrated carnivore-ungulate management program by evaluating: 1) the effects of a harvest management prescription on mountain lion (*Puma concolor*) population density using a before-after-control-treatment study design, and 2) patterns in elk juvenile recruitment before and after implementation of the mountain lion harvest treatment. We found that 4-years after the management program was implemented, mountain lion population abundance declined by 26% (90% CI = [0.60, -0.05]) within the harvest treatment area and remained stable within the control area. The per-capita recruitment rate of elk was low and stable in the treatment area prior to the mountain lion harvest prescription (e.g., mean = 0.18, [0.14, 0.22]), increased substantially in the year following the implementation of the harvest prescription (mean = 0.32, [0.24, 0.41]) prior to declining to 0.23 ([0.16, 0.29]) at present, which contrasted with a moderate increase in per capita recruitment rates in the control area. Together these results suggest that the mountain lion harvest treatment moderately reduced mountain lion abundances within the treatment area, as intended, although the effect on elk population dynamics was short-lived. Broadly, this integrated management program achieved carnivore and ungulate population objectives. We recommend wildlife managers applying integrated carnivore-ungulate management programs develop carnivore and ungulate monitoring programs that assess the efficacy of management programs and provide information regarding future management prescriptions designed to achieve carnivore and ungulate population objectives.

** Assessing Habitat Quality for Four Grassland Songbird Species of Concern in Northern Mixed-Grass Prairie

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During the past 40 years grassland bird populations have declined faster than any other avian guild in North America. In northern Montana, four species are experiencing severe population declines, Baird's sparrow (*Centronyx bairdii*), chestnut-collared longspur

(*Calcarius ornatus*), McCown's longspur (*Rynchophanes mccownii*), and Sprague's pipit (*Anthus spragueii*). In 2017 and 2018, we evaluated abundance and nest density of these species in relation to local vegetative conditions with the goal of identifying important breeding season habitat conditions to inform management. We conducted fixed-radius point-counts at 100 sites to estimate local abundance, rope drag surveys to estimate nest density, and vegetation surveys to estimate vegetation structure and composition across grassland habitats in Phillips County, MT. Point-counts and rope drag surveys were carried out with replicated visits to allow estimation of species-specific detection probabilities. Habitat conditions were measured at the plot level (9 ha) to provide information at scales relevant for land managers. The abundance of Baird's sparrows was positively associated with residual grass cover and litter cover. Chestnut-collared longspur abundance was negatively associated with residual grass and shrub cover and had a quadratic relationship with biomass. Plot-level abundance of McCown's longspurs was negatively associated with both shrub cover and biomass. Sprague's pipit abundance exhibited a quadratic relationship with biomass. Limited sample size only allowed inference of nest density for chestnut-collared longspurs which was negatively associated with plot scale biomass.

** Application of a Novel Nest Density Estimator: An Example Using Sagebrush-Steppe Songbirds

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Studies show nest density is an important demographic rate for shorter-lived species, such as sagebrush-steppe songbirds. A recent analytical approach, temporal nest density estimator (TNDE), was developed to estimate the nest density of waterfowl species using data routinely collected to assess nest success while accounting for detection and availability of nests. To understand the general applicability of TNDE to species in other avian orders, we evaluated the performance of TNDE on a songbird species, Brewer's sparrow (*Spizella breweri*). We assessed the TNDE by comparing estimates of nest detection rate and nest density from TNDE to distance sampling methods for 43 Brewer's sparrow nests monitored in 2015. The TNDE method produced similar but more precise nest detection and density estimates than the distance sampling method. Now that TNDE has been validated, we plan on converting it to a Bayesian framework and using it in conjunction with fine resolution remote sensing data to determine nest-site selection for three sagebrush-steppe songbirds: Brewer's sparrows, McCown's longspurs (*Rhynchophanes mccownii*) and vesper sparrows (*Pooecetes gramineus*). These three species are representative of sagebrush specialists, grassland specialists, and generalists that use both, respectively. This study will allow us to explore the capability of TNDE and remote sensing data to assist in habitat selection studies. These methods may allow more accurate nest density estimates on broader scales with less effort, which will aid in identifying priority areas for conservation and management.

Young and Restless: A Guide to Getting Your Own Colony as a Juvenile Beaver

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Interest in using beavers (*Castor* spp.) as an efficient riparian restoration tool has increased dramatically in recent decades. The ultimate goal of most beaver-mediated habitat restoration projects is to establish a self-sustaining population of beavers that can occupy

new habitats over time. Therefore, dispersal is a key process to understand when evaluating the potential for project locations to be settled by beavers. We radio-marked juvenile beavers in the Gallatin and Madison River drainages in southwest Montana to investigate dispersal characteristics, survival, and settlement site selection. Our goal was to improve identification of restoration sites with the highest probability of colonization by beavers. The annual probability of dispersal in our study area was low (0.26 ± 0.24-0.29), and distances and timing of dispersal were highly variable. The probability of a beaver dispersing decreased as local colony density increased, suggesting delayed dispersal. Few radio-marked beavers started new colonies in previously unoccupied habitat during our study. Instead, most dispersers settled in stream segments already modified by previous beaver activity. The low number of new settlement sites and evidence of delayed dispersal suggests most of the suitable habitat in our study area was occupied. We recommend land and wildlife managers assess the density and distribution of beaver colonies around proposed restoration sites prior to project design to evaluate the potential for dispersal into the project area. Beaver dispersal is an important factor in the success of riparian restoration projects, and our work highlights aspects of dispersal that may influence beaver settlement in this context.

** Population Demographics, Breeding Ecology and Responses to Grazing of Montana Sagebrush Steppe Songbirds

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Sagebrush steppe is one of the most threatened ecosystems in North America. Avian adult density estimates are often used to assess conservation actions given the relative ease in collecting data to inform these estimates. However, information on how conservation actions influence life histories such as nest density and nest success are lacking, despite the fact that life histories inform abundance. We investigated songbird adult densities, nest densities, and nest success over multiple breeding seasons in central Montana. Our goal is to understand the relationships among adult abundance, nest density, and nest success, as well as how land management practices, in the form of grazing, influence those patterns. Two grazing systems were compared in our study: a system using a combination of rest and deferment (hereafter rest-rotation) and traditional grazing. For the purposes of our study, we define rest-rotation grazing as changing the timing of grazing in pastures each year, with some pastures alternately rested every few years. Traditional grazing is defined as grazing a pasture at the same annual season each year or all season. Recently, rest-rotation systems have been used as a conservation management tool by the Natural Resource Conservation Service-Sage Grouse Initiative. Their goal is to encourage private landowners to graze their livestock more sustainably to maintain or improve rangeland productivity, while also benefiting habitat for greater sage-grouse (*Centrocercus urophasianus*). We explore the effects of rest-rotation compared to traditional grazing on songbird population demographics during the breeding season.

Demographic Fragmentation of a Protected Wolverine Population Bisected by a Major Transportation Corridor

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Roads fragment terrestrial ecosystems around the globe, but the effects of this fragmentation on biodiversity remain poorly understood. Wolverines (*Gulo gulo*) are snow-dependent carnivores that occur at low densities and they exhibit low genetic diversity at the southern extent of their range where they are snow-limited, rare and fragmented by human development. Therefore, understanding the effect of roads on population connectivity is crucial to effective wolverine management in a changing climate. We examined whether the Trans-Canada Highway, Canada's largest east-west transportation corridor, affects wolverine movement and gene flow in the Canadian Rocky Mountains. We used noninvasive genetic sampling methods to collect DNA samples (i.e. hair, scat) from Banff, Kootenay, and Yoho National Parks and provincial lands in British Columbia and then used population and individual-based genetic analyses to quantify genetic structure of the wolverine population across the highway in the national parks complex. We collected 2586 DNA samples between 2010 and 2013 from which we identified 49 unique individuals (29 males, 20 females). We detected equal numbers of males and females that crossed the highway (4 males, 4 females); however, dispersal and gene flow were affected differently in the two sexes by the transportation corridor. We detected weak population structure in males and relatively strong genetic differentiation in females spanning the highway. Our results demonstrate that sex-biased dispersal across a major highway can lead to genetic isolation and demographic fragmentation in a protected carnivore population, highlighting the urgent need to maintain connectivity for wildlife species over an expanding road network.

How Far Have They Slithered? Genetic Variation Among Garter Snakes in Western Montana

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Snake gene flow across wide geographic regions is poorly understood. Limited sampling opportunities and the challenges posed by microsatellite analysis often prevent researchers from assessing the impact of topographic barriers and the influence of human settlement on the genetics of snake populations. Last year we demonstrated that SNPs significantly improve our understanding of Isolation by Distance for both species of garter snake (*Thamnophis* spp) in Western Montana. Since then we have initially analyzed larger sample sets of the Wandering Garter Snake (*Thamnophis elegans vagrans*) (*N*=192) and Common Garter (*Thamnophis sirtalis*) (*N*=160). These samples were obtained at 77 sites during the 2014-2017 seasons. With these samples we hope to initially understand gene flow on both sides of the Continental Divide. Moreover, herpetologists traditionally assumed that the Continental Divide instigated a subspecies barrier for Common Garters. We hope to determine the efficacy of this assumption in the initial analysis of our data.

** Improving Estimates of Wolf Abundance in Montana

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Estimating wolf (*Canis lupus*) abundance is a key component of wolf management in Montana. Montana Fish, Wildlife and Parks (MFWP) has successfully implemented a Patch Occupancy Model (POM) to estimate area occupied and resulting wolf abundance for the past decade. Estimates of abundance, however, depend on assumptions that territory size is fixed, consistent statewide, and includes minimal overlap; additionally, these assumptions are based on data collected pre-harvest. In reality, territories vary spatiotemporally, and this variability may be even greater under harvest. This variability in turn could affect precision and accuracy of abundance estimates. Furthermore, MFWP requires tools to both keep POM calibrated into the future, and to predict how territorial behavior might change in response to changing environmental conditions or management actions. Critically, these tools must be useful with limited data because intensive monitoring efforts are no longer sustainable. We developed theoretical models of territorial behavior towards accomplishing this goal. Results demonstrate, for example, that territories are expected to be on average smaller where prey are more clumped and abundant, and larger where human influence is greater. Predictions from our models are supported empirically. This provides evidence for how territories will vary based on ungulate populations and human use, which in turn can help guide understanding of the effects of management decisions, e.g., degree of harvest pressure. We are currently parameterizing the models with field data and developing empirical models to contrast with the theoretical models. Altogether, this work will help keep POM calibrated into the future with limited data.

Montana's Greater Sage-Grouse Conservation Strategy All Hands Balancing Conservation and Development Across All Lands

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The Greater Sage-grouse (*Centrocercus urophasianus* or GRSG) inhabits sagebrush grassland habitats exclusively and shares habitat with up to 300 other species. Montana is a key stronghold among the western states. Montana's emphasis on habitat conservation on public and private lands is foundational to supporting and growing Montana outdoor economy. The Montana Sage Grouse Conservation Strategy, implemented by the Montana Sage Grouse Habitat Conservation Program (Program), blends voluntary incentives with regulatory oversight through the permitting process and a new requirement to mitigate for impacts to designated habitat. The Program implements the Greater Sage-Grouse Stewardship Act and Executive Order 12-2015. Key pillars include: 1. a consultation process to guide development; 2. grants to maintain, enhance, restore, and expand habitat; and 3. mitigation to offset impacts of development. Taking an "all lands, all hands" approach, the Program works collaboratively with private landowners, state agencies, and federal land management agencies. Since 2015, the Program has reviewed nearly 1500 proposed development projects

in designated GRSG habitat on public and private lands. Approximately 43,148 acres have been placed in perpetual conservation easements through Sage Grouse Stewardship Fund grants. With the goal of no net loss-net gain preferred, the mitigation system incorporates market-based incentives and a Habitat Quantification Tool to quantify gains and losses of functional habitat due to conservation or development projects, respectively. Successful conservation depends on proactive stewardship of the remaining intact sagebrush landscape. Montana is well-positioned for the range-wide conservation assessment set for 2020.

Identification of Alternate Bat Hibernacula Outside of Caves and Mines in Eastern Montana

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Pseudogymnoascus destructans, the fungus responsible for White-nose Syndrome (WNS) and millions of bat deaths in North America, was recently detected in Wyoming and South Dakota near the eastern Montana border. Given the nature of the fungus to thrive in cold and humid environments, bats are most vulnerable to infection in their winter hibernacula. Outside of caves and mines, we have limited knowledge of bat hibernacula in Montana. However, from long-term statewide acoustic monitoring stations we know that some bats are wintering in locations where cave and mine features are limited. In anticipation of WNS and its potential impacts, we were interested in identifying hibernacula and associated characteristics. In October 2018, we attempted to capture and transmitter bats to identify alternate roosts in eastern Montana. We targeted 4 sites, captured 12 bats, placed transmitters on 10, and successfully identified 9 different roost sites. We will characterize microsite (i.e. temperature, humidity, etc.) and macrosite (i.e. roost structure, nearby water, etc.) features of each roost and assess bat use through winter by placing acoustic detectors near roost sites. Although our results are limited, this is the first documentation of alternate winter hibernacula in eastern Montana. Information on specific hibernacula and associated habitats will help inform bat conservation activities. Additionally, findings will assist in site selection for future WNS surveillance efforts and continued efforts will facilitate future exploration of how hibernacula type influences WNS spread and impacts.

Assessing Occupancy for Montana Species of Greatest Inventory Need

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Montana non-game species classified as Species of Greatest Inventory Need (SGIN) are not sufficiently monitored by standard ecological monitoring programs, typically because they

are locally rare or cryptic, thus evading detection. Yet, these species are often those for which understanding conservation status is most important. We are developing a tool to characterize the survey effort needed to attain estimates of occupied suitable habitat, while accounting for species characteristics and logistical constraints, and incorporating flexible tools recently presented in the scientific literature. Concurrent with tool development, we have used this approach to examine survey designs for assessing suitable habitat occupancy by Great Gray Owls (*Strix nebulosa*). We identified a survey strategy with sufficient power to estimate occupancy of this inconspicuous species using a combination of automated recording units and ground call-playback surveys that can be employed in the coming years. Understanding effort required to obtain occupancy estimates with acceptable bias and precision can support survey design for species conservation work as well as informing whether existing monitoring datasets have sufficient power to address information needs. We aim for this tool to inform ongoing survey efforts for Species of Greatest Inventory Need and to facilitate survey planning for species without survey protocols underway.

Love Triangles Caught on Camera! Exposing the Intimate Relationships Between Hunters, Gut Piles and Scavengers

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As big game hunting season draws to a close, hunters celebrate filling their freezers and the satisfaction of time spent outside. While they enjoy venison backstraps fresh off the grill, scavengers are feasting on a gut pile left in the woods. The U.S. Fish and Wildlife Service estimates that hunters leave 1.5 billion pounds of carrion annually in the field. However, little is known about how scavengers consume this carrion and what role this food source may play in scavenger populations. We asked hunters in the Bitterroot and Missoula Valleys to set up game cameras on gut piles after successful harvests of deer, elk, and moose. Scavengers ranging from Golden Eagles (*Aquila chrysaetos*) to gray wolves (*Canis lupus*) visited the gut piles. Scavengers continued to visit gut pile locations long after obvious food sources were consumed, suggesting the "life" of a harvest goes beyond a matter of weeks. We'll discuss how this project adds to other citizen-science efforts to understand scavenging species in western Montana, and to our ability as scientists to engage with hunters on tough topics like ammunition choices, carnivore management and public land issues. The high level of interest in this project suggests that hunters are able and willing to contribute to scientific research. We expect to continue and expand this project during the 2019 hunting season.

** Effects of Contamination from Oil Extraction on Amphibian Abundance, Survival and Size

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Saline wastewaters (brine) that contain sodium-chloride salts (NaCl) and heavy metals are a common byproduct of oil extraction. Wetlands and streams are commonly contaminated by brines, but there is sparse information on its effects on freshwater vertebrates. Amphibians are especially sensitive to increased salinity because of their porous skin and primarily-aquatic lifecycle. Therefore, we investigated the influence of brines and pure NaCl on three widespread amphibian species; barred tiger salamanders (*Ambystoma mavortium)*, leopard frogs (*Rana pipiens)* and boreal chorus frogs (*Pseudacris maculata*) in the Prairie Pothole Region of Montana and North Dakota. We determined abundance of larvae in 33 wetlands

that spanned a gradient of contamination. We also used lethal concentration 50 experiments to determine the influences of brine and pure NaCl contamination on survival and size. Abundance and survival of chorus frog larvae declined most rapidly in response to increased concentration of brines and NaCl, followed by leopard frogs and tiger salamander larvae. However, survival of larvae was lower when exposed to brine compared to pure NaCl. For larvae that survived experimental exposures, mass and length were lower for larvae exposed to higher concentrations of brine and NaCl. Our results suggest that brine contamination has reduced survival and abundance of larvae, brine is more toxic to larvae than pure NaCl, and that sublethal concentrations of brine and NaCl negatively influence growth of larvae. The persistence and negative influence of salts in freshwater ecosystems underscores the critical need for tools to restore landscapes affected by brine and NaCl contamination.

** Influence of Pre-Breeding Body Condition on Reproductive Metrics of Greater Sage-Grouse

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Many species are subject to carry-over effects, where habitat quality experienced long before breeding may influence subsequent performance and overall fitness of an individual. Pre-breeding body condition has been shown to affect reproductive metrics including: breeding propensity, timing of nest initiation, clutch size, and offspring quality. Although the effects of pre-breeding body condition on reproduction have been well-studied in waterfowl, we know little about carry-over effects for gallinaceous birds. During on-going research in the Centennial Valley in southwestern Montana, we tracked 237 female Sage-grouse (*Centrocercus urophasianus*) for 5 years and monitored nesting activity and broods until 30 days of age. Based on preliminary regression analyses, we did not detect an influence of pre-breeding body condition on breeding propensity, given that most individuals nested (91%, 187/206) if they survived long enough to breed. We did not observe differences in timing of nest initiation based on variation in pre-breeding body condition, but this timing differed substantially among years. We found pre-breeding body condition positively influenced clutch size and offspring weight, however there was substantial unexplained variation. Although we did not find pre-breeding body condition strongly influenced reproduction in this population, other metrics, such as habitat characteristics and the previous season's weather events, may provide insights about the role of carry-over effects in sage-grouse. We are currently investigating other drivers to understand the importance of winter habitat quality on reproduction and subsequently help guide management decisions.

Estimating Occupancy and Activity of Montana Bat Species Prior to the Arrival of White-Nose Syndrome

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The spread of white-nose syndrome (WNS) across the eastern United States has raised conservation concerns for bats and provided motivation for monitoring efforts. Currently, WNS has not been detected in Montana and understanding the impacts of WNS on bats in

western states requires accurate baseline population assessments and continued monitoring after the disease arrives. Within an occupancy model framework, we analyzed mist netting and acoustic records for eight bat species in Montana to estimate baseline distributions prior to the arrival of WNS. We created distribution maps from this model that explain the heterogeneity in occupancy for each species using covariates for forest cover, elevation, ruggedness, and average degree days. We also developed a model for overall bat activity using additional acoustic data. Even after accounting for nightly weather conditions, patterns in overall activity were highly variable across years and detector locations. These analyses can help inform future surveillance efforts for early detection of WNS and future bat monitoring efforts in Montana. We developed tools to help visualize estimates from both analyses when selecting locations for WNS surveillance so managers can focus efforts on locations with high estimated probabilities of occupancy for susceptible species and consistent bat activity. Based on the model estimates, we also provided recommendations for future acoustic monitoring aimed at identifying how bat species are impacted by WNS when in arrives in Montana.

** Precipitation and Reproductive Effort Alter Survival of Turkey Hens in the Northern Black Hills, SD

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Tradeoffs between survival and reproduction are predicted by life history theory. Understanding how reproductive tradeoffs act in concert with abiotic elements to impact survival is crucial for effective management and conservation of wildlife populations, particularly for at-risk or harvested species. During 2016 - 2018, we radio-tracked and collected survival data on 140 Merriam's wild turkey (M. g. *merriami*) hens in the northern Black Hills, South Dakota. We evaluated associations between hen survival and nest incubation, brood rearing, and precipitation. Consistent with life-history theory and the moisture-facilitated nest-depredation hypothesis, increased time spent incubating and daily precipitation amount were associated with reduced hen survival, but the magnitude of the precipitation association depended on incubation status. Seasonal survival was lowest during spring and winter, highest during summer, and intermediate during fall. A hen that did not incubate a nest was predicted to have a higher rate of annual survival (0.54, 95% CI = 0.46 - 0.61) than a hen that incubated a single nest (0.44, 95% CI = 0.33- 0.55); this prediction is based on precipitation data collected in 2017 and assumes the hen began incubation on the median date. We estimated that annual survival for both nesting and non-nesting hens was lower in the northern Black Hills compared to previous estimates from the southern Black Hills. Management options to improve hen survival are limited, but we recommend actions that would reduce hunter-induced hen mortality of this important game species in the northern Black Hills.

The U.S. Fish and Wildlife Proposal to Delist the Canada Lynx

Jim Zelenak*, U.S. Fish and Wildlife Service, Montana Ecological Services Field Office, Helena

In 2000, the U.S. Fish and Wildlife Service listed the contiguous U.S. distinct population segment (DPS) of the Canada lynx (*Lynx canadensis*) as threatened under the Endangered Species Act (ESA) because of the inadequacy, at that time, of regulatory mechanisms in federal management plans. Since then, federal agencies have formally amended most

management plans in the DPS's range to adopt science based conservation measures for lynx or continued to implement conservation agreements in collaboration with the Service. State and Tribal agencies have also worked to conserve lynx populations and important habitats. Research and monitoring conducted since the DPS was listed suggest that resident lynx are naturally rarer and populations smaller in much of the west than previously thought, but they are more abundant in Minnesota and Maine. The 1999-2006 release of lynx into southwestern Colorado has established a resident population there. The Service recently completed a peer reviewed species status assessment (SSA) for the DPS that evaluated the available scientific information and incorporated the opinions of recognized lynx experts to assess the status and viability of DPS populations. Although the threat for which the DPS was listed has been addressed by improved regulatory mechanisms, the SSA recognized that continued climate warming is likely to reduce lynx populations and distribution in the Lower 48 over the long term. However, the Service concluded that the DPS is not at risk of extirpation in the reasonably foreseeable future and is therefore proposing to delist the DPS.

Poster Abstracts

Alphabetical By Presenter's Name
*** Denotes Presenter**
**** Indicates Student Presentation**

** Lure Effectiveness in Detecting Small Mammals, Specifically the Northern Bog Lemming, on Trail Cameras (Poster)

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Mark Hebblewhite, Wildlife Biology Program, University of Montana , Missoula
Mike Mitchell, Montana Cooperative Wildlife Research Unit, US Geological Survey, Missoula
Kristi DuBois, Non-Game Biologist (retired), Montana Fish, Wildlife & Parks, Missoula

Fens and bogs are unique wetlands that support a diversity of small mammals and other rare species. One such species is the northern bog lemming (*Synaptomys borealis*). This species is being considered for listing under the Endangered Species Act so determining their presence is helpful for management. Northern bog lemmings are difficult to trap and when they are caught, experience high mortality rates. Since they are so hard to capture and study, it is difficult to determine presence/absence of this species. This study used a non-invasive trail camera method to detect northern bog lemmings in Finley Fen and Meadow Creek in western Montana. We tested six different types of lure/scent to see if any had better detection rates than muskrat lure which is often used in small mammal studies but is not always readily available and is expensive. The six lures tested were; muskrat lure as the control, almond extract, vanilla extract, strawberry extract, clove oil, and lemongrass oil. Cameras were placed in both fen sites for approximately three weeks and were checked every week. Under each remote camera we placed 6 by 6-inch pieces of plywood with a metric ruler on the sides of the board for size reference. During each check boards received new scent and cameras new memory cards. During the last check before the cameras were removed, the boards were switched between camera sets so that each camera had approximately one week with a different lure under it. Preliminary results suggest that the muskrat lure still produced more photos of small mammals over the time period the cameras were deployed, followed closely in Finley fen by almond extract and strawberry extract. Northern bog lemmings were confirmed in 7 different pictures in Finley Fen, two of which were on almond extract boards.

Bog lemmings weren't detected in Meadow creek, although it was a known bog lemming site as one was trapped there in 1992. The small detection rate for northern bog lemmings indicated that a larger sample size may be needed, or other lure types tested to definitively detect northern bog lemmings in a survey.

** Daily and Seasonal Space Use and Habitat Selection of Greater Sage-Grouse in Carbon County, Montana (Poster)

Erin Birtwistle*, Ecosystem Science and Management, University of Wyoming, Laramie, WY
Aaron Pratt, Ecosystem Science and Management, University of Wyoming, Laramie, WY
Jeffrey Beck, Ecosystem Science and Management, University of Wyoming, Laramie, WY

Greater sage-grouse (*Centrocercus urophasianus*; hereafter 'sage-grouse') are the focus of much research and conservation efforts owing to their obligate relationship with sagebrush (*Artemisia* spp.) and dramatic population declines over the last 50 years. Research suggests female survival, followed by chick, then nest survival, have the greatest impact on population growth, and to sustain sage-grouse populations, focus should be on increasing these vital rates. In addition, recent research has shown habitat partitioning occurs between broodless (i.e., females without a brood) and brood-rearing females such that broodless females have lower mortality risk than females with chicks. Moreover, greater nest attentiveness and incubation constancy can increase nest success. Our study was initiated in spring 2018 in Carbon County, Montana to identify seasonal habitat use and address the most important parameters influencing population growth. Our first objective, to aid the Bureau of Land Management in maintaining sustainable sage-grouse populations on public lands, will focus on natural and anthropogenic landscape features influencing habitat selection during nesting, brood-rearing, summer, and winter life stages. Our second objective is to compare landscape and microhabitat characteristics between brood-rearing and broodless females. Our third objective is to examine nest attentiveness and microhabitat selected during incubation recesses. We captured 39 adult and yearling females in spring 2018 at 6 leks, attached solar-powered, rump-mounted transmitters and monitored 40 nests and 17 broods. In summer 2018, we measured vegetation characteristics (e.g., shrub, grass, and forb cover) at 133 grouse-use and 108 random locations for nests, incubation recesses, and brood and broodless females. Understanding female sage-grouse habitat use during all life stages will aid in directing management on public lands to conserve populations and increase population growth.

** Swainson's Thrush Stopover Habitat In The Bitterroot Valley (Poster)

Shannon Byrne*, Scientific Research Class, Florence-Carlton High School, Florence, MT
Vanessa Haflich, Teacher, Florence-Carlton High School, Florence, MT
Kate Stone, Avian Science, MPG Ranch, Florence, MT

The migratory songbird Swainson's thrush (*Catharus ustulatus*) is a common breeding songbird across North America. We think their populations are in decline due to habitat loss. During fall migration, they travel in large numbers through the Bitterroot Valley. We wanted to study the stopover habitats they use at this time. We used acoustic data from 2017, collected by an autonomous recording unit, at 16 recording stations placed throughout the Bitterroot Valley. The dates ranged from the second week of July to the first week in October. These stations recorded the Nocturnal Flight Calls (NFCs) of songbird migrants, including the Swainson's Thrush. We looked at Swainson's Thrush NFCs that occurred sixty minutes before sunrise because calls given at this time might indicate that birds were close to landing

and stopping over. We used Google Maps to assess the features and vegetation near each station that would offer the habitat we deemed important for migrating birds. We found two sites that had higher Swainson's Thrush calls than other sites: one site north of Darby near the Bitterroot River, and one in the mountains northwest of Florence. These two settings are very similar because they are both located at approximately 3,800 feet, which could indicate an ideal elevation for migration. Additionally, both sites have heavy coniferous forest cover, an important habitat characteristic for Swainson's Thrush. There is not much research available regarding stopover habitat of the Swainson's thrush specifically in Montana. Through this research, we hope to better determine what sites are important to the Swainson's thrush and hopefully be able to preserve said sites to aid the bird in their annual migration.

Conservation Design and Decision Support in the Northern Great Plains Joint Venture (Poster)

Daniel Casey*, Northern Great Plains Joint Venture, Ducks Unlimited, Billings, MT
Kevin Ellison, Northern Great Plains Program, World Wildlife Fund, Bozeman, MT

The Northern Great Plains Joint Venture (NGPJV) covers portions of four states, including 22 counties in eastern Montana. This geography contains some of the most intact, contiguous grassland habitat on the continent, comprising more than 75% of the landscape. It also supports a high diversity of grassland obligate bird species, several of which have seen population declines of 75-90% over the past 50 years. The NGPJV partnership is focused on addressing these declines through the maintenance and management of intact prairie habitats, especially on private working lands. We have developed conservation design and decision support tools to inform voluntary and incentive-based (e.g. Farm Bill) programs and practices, through our Conservation Delivery Network of private lands biologists. Our Conservation Guidance Directory database uses the "plowprint" analysis developed by World Wildlife Fund as a measure of net landscape change (conversion to cropland); using these data in conjunction with soil classes defines both threat and conservation opportunity for each of the counties in the NGPJV. We are then using priority grassland species models (Baird's Sparrow (*Ammodramus bairdii*), Chestnut-collared Longspur (*Calcarius ornatus*), McCown's Longspur (*Rhynchophanes mccownii*), Lark Bunting (*Calamospiza melanocorys*) and Sprague's Pipit (*Anthus spragueii*) to set spatial priorities for habitat restoration, enhancement and protection in a local and regional context. "Conservation Road Show" events at 26 Montana Conservation District offices are helping us address local concerns as we provide technical and financial assistance to our partners. We are using the tool to direct conservation grant money and will be building a web platform to broaden its use in 2019 and beyond.

** Effect of Wildfire Smoke on Nocturnal Bird Migration (Poster)

Natalie Dulac*, Scientific Research Class, Florence-Carlton High School, Florence, MT
Vanessa Haflich, Teacher, Florence-Carlton School, Florence, MT
Kate Stone, Avian Science, MPG Ranch, Florence, MT

Many migratory songbirds travel at night, producing unique nocturnal flight calls (NFCs) for orientation and communication with other individuals. During the fall of 2017, western Montana experienced many wildfires. Preliminary data suggested smoke density may influence bird migration, either by causing more communication from lack of visibility or a decrease in calls due to harmful anatomical effects. The relationship between smoke and NFCs at two locations in western Montana was studied. NFCs were recorded using

autonomous recording units placed at Florence-Carlton High School (FCHS) and east Lolo. Total NFCs were quantified for all species as well as a few individual species: Swainson's Thrush (*Catharus ustulatus*), Savannah Sparrow (*Passerculus sandwichensis*), Chipping Sparrow (*Spizella passerina*) and Wilson's Warbler (*Cardellina pusilla*). Smoke density data was obtained from the Montana Department of Environmental Quality (MT DEQ) in the respective towns. To look at the relationship between smoke and bird activity, Spearman's correlation tests and general linear models that included air quality, time, and location variables to predict the number of NFCs for all birds and individual species were constructed. These variables were analyzed at both nightly and hourly time scales. However, analyses supported only a weak relationship between NFCs and air quality. While analyzing the data differently may result in stronger correlations, it is likely these migration patterns are most influenced by other factors, as smoke may only temporarily alter migration activity. By comparing the frequency of NFCs with smoke density across multiple seasons and locations, a better understanding of the impact wildfire smoke has on migration is hoped to be gained.

** Research in Progress: Assessing the Impact of Increasing Wolf and Grizzly Bear Populations on the Habitat Selection and Foraging Patterns of Cougars in the Southern Greater Yellowstone Ecosystem (SGYE) (Poster)

Jennifer A. Feltner*, Wildlife Biology Program, University of Montana, Missoula

Since the early 2000's, recovering wolf (*Canis lupus*) and grizzly bear (*Ursus arctos horribilis*) populations in the SGYE north of Jackson, Wyoming have been reviving long absent competitive interactions amongst species of the large carnivore guild, potentially leading to behavioral shifts by subordinates such as cougars that can have population and community-level consequences. Research efforts are needed to clarify the responses of cougars following wolf and grizzly bear recovery and resultant impacts to prey populations. In the SGYE, management and monitoring of large mammals is complex. Multiple federal and state agencies, as well as non-profit organizations collect data and conduct research on these species, and anthropogenic impacts ranging from hunting to recreation to supplemental feeding of elk (*Cervus elaphus canadensis*) also play strong roles in the system. However, datasets on the populations, movements and food habits of wolves, cougars, and grizzly bears, as well as their primary prey, elk, from 2001 to the present exist. The aim of this study is to assess the impact of competition from recovering wolves and grizzly bears on cougars by investigating key factors driving cougar habitat selection and foraging patterns, including prey availability, risk of dominant competitor encounter, human activities and other environmental factors. Sixteen years of location data from cougars, wolves, grizzly bears and elk and predation data from cougars shared by my collaborators are currently being analyzed for this study. This project will advance understanding of how competition shapes the behavior of cougars, highlighting potential fitness impacts to cougars and subsequent behavioral shifts that could in turn impact prey species.

** Habitat Selection, Space Use and Demography of Greater Sage-Grouse in North-Central Montana (Poster)

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Mike Borgreen, Glasgow Field Office, Bureau of Land Management, Glasgow, MT
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Lance McNew, Department of Animal and Range Sciences, Montana State Univ., Bozeman

The greater sage-grouse (*Centrocercus urophasianus)* is a sentinel species of sagebrush ecosystems and requires large tracts of intact habitat. Despite the 2015 not warranted for listing decision by the U.S. Fish and Wildlife Service, the sage-grouse is still considered a species of conservation concern. Critical to the not warranted decision is the ongoing development of state-level habitat strategies and sage-grouse focused federal land management plans; both of which require the identification of important seasonal habitats. Recently, federal agencies have identified information gaps associated with sage-grouse habitats in the North-central Sagebrush Focal Area, an important sage-grouse core area in Valley County, MT. In 2018, we began a 3-year study of sage-grouse space use and demography in this area to identify important seasonal habitats in the region. Our primary objectives are to 1) identify conditions influencing seasonal habitat use, 2) evaluate movements and seasonal migration patterns, and 3) evaluate demographic associations with biotic and abiotic habitat conditions and disease risk. During April-May 2018, we captured 45 female sage-grouse and outfitted them with global positioning system (GPS) platform transmitting terminals (PTTs). The transmitters allow us to gather resolute information pertaining to fecundity, female survival, and space use, in relation to seasonal habitat conditions measured both remotely and in the field. We will present preliminary results on demography and space use from our first season.

** Predicting Habitat Suitability for Dusky Grouse in Montana (Poster)

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Claire Gower, Wildlife Division, Montana Fish, Wildlife & Parks, Bozeman
Lance McNew, Department of Animal and Range Sciences, Montana State University, Bozeman

Dusky grouse (*Dendragapus obscurus*), are a forest grouse species found throughout western Montana. Despite being a game species, there has been inconsistent monitoring and few surveys in recent years limiting effective management and knowledge of their ecology in Montana. Previous research indicates that dusky grouse use several different habitat types including conifer forest in the winter and shrub/steppe and grassland communities along the edge of coniferous forests during the breeding season. Our objective was to create a state-wide map predicting relative suitability for dusky grouse occurrence that could be used to identify locations for future surveys. We obtained dusky grouse observations collected during April-June, 2009-2018 from the Integrated Monitoring in Bird Conservation (IMBCR) program and extracted habitat information for detected/not-detected locations using remotely-sensed data. We evaluated relative habitat use with resource selection functions calibrated using generalized linear mixed models. Candidate models representing hypothesized relationships among grouse detections/non-detections and habitat conditions (e.g. forest type and coverage, relative elevation, distance to road) were compared using multi-model inference based on information theory. Preliminary results indicate that relative use for dusky grouse was higher in areas with higher proportions of mixed conifer forest, especially areas with higher proportions of douglas fir and that relative use was lower in grasslands and decreased as the distance to the edge of conifer forest increased.

** Using Ecological Site Condition to Evaluate Habitat Selection by Sharp-Tailed Grouse Broods (Poster)

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Megan Milligan, Dept of Animal and Range Sciences, Montana State University, Bozeman
Lance B. McNew, Dept of Animal and Range Sciences, Montana State University, Bozeman
Jeff Mosley, Department of Animal and Range Sciences, Montana State University, Bozeman

Brood survival, an important vital rate affecting population viability of sharp-tailed grouse (*Tympanuchus phasianellus*), is largely determined by the selection of brood-rearing habitats by females. Both the quantity and quality of brood-rearing habitat are influenced by land management decisions, and therefore, improper rangeland management can lead to habitat degradation and have a negative effect on sharp-tail grouse populations. Many land management decisions affecting brood habitats (e.g., livestock stocking rates, prescribed burning) are based on metrics including the type and condition of ecological sites. However, associations between brood habitat use and these common rangeland assessment metrics have not been evaluated. We developed a method of delineating ecological sites and assessing vegetation condition by comparing current vegetation to the climax communities across our study area in eastern Montana and western North Dakota. We then evaluated selection ratios of radio-marked brood hens in relation to ecological sites and their relative condition. Our results should provide useful information on brood habitat selection relative to habitat assessment frameworks used by rangeland managers and have implications for the management of sharp-tailed grouse brood habitats in the northern mixed-grass prairie.

Invasive and Pest Species Information at the Montana Natural Heritage Program (Poster and Presentation)

Bryce Maxell*, Montana Natural Heritage Program, University of Montana, Helena
Dave Ratz, Montana Natural Heritage Program, University of Montana, Helena
Andrea Pipp, Montana Natural Heritage Program, University of Montana, Helena
Dan Bachen, Montana Natural Heritage Program, University of Montana, Helena

The Montana Natural Heritage Program (MTNHP) has centralized information on Montana's native species and habitats since its inception in 1985. In October of 2017, MTNHP started managing information on Aquatic Invasive Species, Noxious Weeds, Forest Pests, Agricultural Pests, other non-native species and biocontrol species that have been introduced to control invasives. The MTNHP now manages information on over 500,000 observations of more than 700 invasive and pest species and over 50,000 structured survey locations for invasive and pest species and makes that information available on its websites. This presentation will provide an overview of how biologists and resource managers can access information on surveys, observations, predicted habitat suitability models, and descriptive field guide information for invasive and pest species and native species on the MTNHP's Montana Field Guide, Species Snapshot, and Map Viewer websites.

** New Methods for Monitoring Mountain Goat Populations (Poster)

Molly McDevitt*, Wildlife Biology Program, University of Montana, Missoula
Paul Lukacs, Wildlife Biology Program, University of Montana, Missoula
Frances Cassirer, Wildlife Research Unit, Idaho Department of Fish and Game, Lewiston
Shane Roberts, Wildlife Research Unit, Idaho Department of Fish and Game, Boise

Estimating the distribution and abundance of wildlife populations is a critical component to the conservation of wild species. Precise estimates of these parameters enable biologists to productively manage and preserve the animal populations they oversee. Methods for monitoring high density species populations are frequently and continuously being improved upon. However, identifying effective methods for monitoring low density species populations; e.g. mountain lion (*Puma concolor*), wolf (*Canis lupus*), mountain goat (*Oreamnos americanus*) and wolverine (*Gulo gulo*), has proved challenging due to small population sizes and difficulty of access to low density species habitat. Current approaches for surveying low density species (e.g. aerial surveys, baited camera traps, DNA sampling) often provide insufficient information and application of statistical models to these data can be complex. In this study, and in partnership with Idaho Department of Fish and Game, I will test disparate non-invasive, ground-based methods for monitoring mountain goat populations in Idaho, USA. This project will compare and contrast findings from three field and analytical methods: camera trapping techniques, single-observer ground surveys, and double-observer ground surveys. Here, I describe the field methods and statistical models being tested and developed in research project. Additionally, I will present findings from the first field season (June-August 2018) of testing these three methods. By improving occupancy and abundance estimates for mountain goat populations, biologists can begin to make smarter conservation decisions around mountain goat management.

** Effects of Mountain Pine Beetle on Bat Activity in Western Montana (Poster)

Monique Metza*, Ecology Department, Montana State University, Bozeman
Shannon Hilty, Ecology Department, Montana State University, Bozeman
Dr. Andrea Litt, Ecology Department, Montana State University, Bozeman

Bat activity throughout forests is likely influenced by stand structure, which can be altered by disturbance (e.g., fire, silviculture, and pests). The mountain pine beetle (MPB, *Dendroctonus ponderosae* Hopkins) is a major forest pest in the western United States that has caused tree mortality in millions of hectares of lodgepole (*Pinus contorta*) and ponderosa pine (*Pinus ponderosa*) forests. This disturbance can increase coarse woody debris (CWD) and open canopies through fallen snags. Our objectives were to 1) determine whether CWD can be used as a proxy to characterize severity of the MPB effects, and 2) assess how bat activity changes with MPB severity within lodgepole and ponderosa forests in western Montana. We measured CWD, assessed severity of MPB, and deployed acoustic detectors to evaluate bat activity during the early active season, prior to activity of newly volant pups. Ponderosa-dominated sites had lower average volumes of CWD compared to lodgepole sites. Overall, the amount of CWD did increase with MPB severity. We recorded 8.7 bat passes per night on average (95% CI = 3.2 to 14.2 bat passes/night). However, ponderosa forests (95% CI = 8.4 to 38.6 bat passes/evening) had 20.8 more bat passes per night on average than lodgepole (1.13 to 15.1). Variation in bat activity was not explained by MPB severity alone; future analyses will explore the influence of additional forest characteristics to help us understand how to manage forests in a way that is beneficial for bats.

** Effects of Flushing on Sharp-Tailed Grouse Nest Survival (Poster)

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Lorelle Berkeley, Wildlife Division, Montana Fish, Wildlife & Parks, Helena
Lance McNew, Department of Animal and Range Sciences, Montana State University, Bozeman

Intensive demographic studies of prairie grouse provide valuable information to guide management recommendations. However, field techniques are frequently invasive, often necessitating concentrated capture efforts and frequent flushing of females from nests, which could potentially bias estimates of nest survival by altering either bird or predator behavior. Researcher-induced biases in vital rate estimation has serious implications when those estimates are used to inform management. As part of a larger study on the effects of grazing management on sharp-tailed grouse, we monitored 102 radio-marked female sharp-tailed grouse (*Tympanuchus phasianellus*) in eastern Montana for two years to better understand the effects of flushing on nest survival. A randomly selected subset of radio-marked females were flushed from nests 1-2 times by researchers using standard protocols for game bird nesting studies, while the remainder were never flushed during the nesting season. Daily nest survival was significantly reduced for birds that were flushed from the nest, but the effect was mediated by the amount of precipitation received during the nesting period. A significant negative effect was only observed during periods with little precipitation, with reduced nest survival due almost entirely to predation rather than nest abandonment. Overall, our results suggest that research activities can introduce bias into demographic estimates, but that the effect depends on weather conditions.

Nest Success, Behavior and Disturbance of Two Nightjar Species in Western Montana (Poster)

Mary Scofield*, Avian Science, MPG Ranch, Florence, MT
Kate Stone, Avian Science, MPG Ranch, Florence, MT

The Common Poorwill (*Phalaenoptilus nutallii*) and Common Nighthawk (*Chordeiles minor*) are two nocturnal species breeding in western Montana. These ground-nesting insectivores deploy similar reproductive strategies, but have unique behavioral adaptations for nest success. From 2015-2018, we used cameras and monitoring to document phenology, disturbance, and success at 20 Common Poorwill and 14 Common Nighthawk nests. Poorwills arrived from mid-April to May, and laid their first eggs in May to early June. Nighthawks arrived a full month later, and initiated nests soon after arrival. Both sexes of poorwills incubate, brood and feed chicks. Poorwills often had two nests per breeding season. In contrast, just female nighthawks performed nesting duties, and their late arrival allowed for only one nest in a season. We documented disturbances from six different intruder types, from insects like grasshoppers, to rodents like chipmunks. We observed nine behavioral responses to intruders, including flushing off the nest, defensive posturing, and standing over or beside the nest. Poorwill and nighthawk nests were disturbed most by humans, unknown intruders, and rodents. Poorwills were most likely to flush off of nests upon disturbance, while nighthawks often defended the nest with aggressive posturing. Of the nests that we could determine fate, we confirmed failure at eight poorwill (40%) and two nighthawk (12.5%) nests. Most poorwill nests failed when nestlings were left unattended by adults. We don't know what caused nighthawk nest failure. Future monitoring may give more understanding of how nest disturbances impact nesting success in both poorwills and nighthawks.

Habitat and Land-Use Effects on Scavenging Rates and Potential Brucellosis Transmission in Southwest Montana (Poster)

Kimberly Szcodronski*, Northern Rocky Mountain Science Center, U.S.Geological Survey, Bozeman, MT
Paul Cross, Northern Rocky Mountain Science Center, U.S. Geological Survey, Bozeman, MT

Brucellosis, a bacterial disease caused by *Brucella abortus*, is a major concern in the Greater Yellowstone Ecosystem due to potential transmission from elk (*Cervus elaphus*) to livestock. B. abortus can lead to abortion in infected animals and is primarily transmitted between elk and livestock when individuals contact infected abortion materials. Therefore, the risk of transmission may be a function of how long abortion materials remain on the landscape. Previous studies suggest the rate of fetus removal by scavengers may vary spatially and that scavengers may play a vital role in the persistence of B. abortus on the landscape and the dynamics of brucellosis transmission. To investigate fetus removal in southwest Montana, we placed bovine fetuses and placentas at 266 sites within suitable elk habitat during the brucellosis transmission risk period from February-June 2017 and 2018. We used remote cameras to quantify the scavenging rate of abortion material, as well as the community of scavengers that participate in fetus removal. Preliminary estimates suggest abortion materials were scavenged at an average of 84 hours (± 8.5 SE) across all habitat types. When comparing habitat types, fetuses were removed quicker in grasslands (55 hours ± 8.2 SE) than in sagebrush steppe (102 hours ± 17.0 SE) and forest (102 hours ± 7.4 SE). Abortion materials were consumed by a variety of scavengers including magpies, ravens, red-tailed hawks, eagles, turkey vultures, skunks, foxes, coyotes, wolves, mountain lions, and black bears. This research will help identify management options aimed at decreasing the risk of brucellosis transmission from elk to livestock in Montana.

Beyond Words: Thought – A Visual Attempt to Inspire Thoughts on the Climate Crisis (Poster)

Mike Thompson *, Wildlife Division, Montana Fish, Wildlife & Parks, Missoula

The climate crisis presents unprecedented challenges to the wildlife profession, as it does for all of humanity. Does the human animal have the capacity to wrap its mind around it? This poster is an attempt to convey and inspire individual thoughts about the climate crisis where words in scientific or popular literature may fail us, and from individual thoughts may arise actions and initiative beyond our experience. For actions beyond our experience are required of those who strive to make a difference, and of others who would hope to support, rather than impede, their efforts. So, we hope that the visual image of this poster will speak to someone for whom words are not as impactful.

Decoding Avian Migration: Cold Fronts and Their Influence on Nocturnal Flight Calls (Poster)

Carrie Voss*, Avian Science, MPG Ranch, Florence, MT
Debbie Leick, Avian Science, MPG Ranch, Florence, MT
Kate Stone, Avian Science, MPG Ranch, Florence, MT

Passerines respond to a variety of environmental cues during migration. Some research suggests that passerine migration may be influenced by weather variables such as the passage of cold fronts. During fall 2017, we used acoustic recorders at 23 stations to document the nocturnal flight calls (NFCs) of migrating passerines in the Bitterroot Valley. We looked at

correlations between the number of NFCs and the daily change of two weather variables that may indicate an oncoming cold front: temperature and barometric pressure. Cold fronts tend to correlate with migration waves and an increase in nocturnal flights calls. In the future, we intend to include other environmental variables including light pollution, cloud cover, wind direction and precipitation.

Keeping the Crown of the Continent Connected: A Report on Highway 2 Near Glacier National Park (Poster)

John Waller*, Science and Resources Management, Glacier National Park, West Glacier, MT
Tabitha Graves, Glacier Field Station, U.S. Geological Survey, West Glacier, MT

The US Highway 2 corridor separates Glacier National Park from the Bob Marshall Wilderness complex to the south. With increasing vehicle traffic, recreation, and high train traffic, resource managers in the region are concerned that Highway 2 is slowly becoming a barrier to north-south wildlife movement in the Crown of the Continent Ecosystem, and thus, this corridor has been identified as a priority for wildlife connectivity planning. While there have been a number of efforts to understand wildlife connectivity across this corridor, they have tended to be narrowly focused and temporally disjointed. Over the last year, an interagency group of local researchers and managers met in two workshops to evaluate existing research and data sources, identify knowledge gaps, and establish a research framework to increase understanding of wildlife use of the US2 corridor. The long-term goal is to identify explicit management options for preserving trans-highway movements, seasonal migrations, and dispersal movements of animals, plants and ecological processes. This report builds on previous efforts to understand and plan for terrestrial wildlife connectivity across this inter-jurisdictional corridor by beginning a multi-agency conversation for collaborative research and management.