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Abstracts – Oral Presentations
Alphabetical by Presenter’s Name
*Indicates Presenter
**Indicates Student Presentation

Assessing the Presence and Impacts of White-nose Syndrome on Montana’s Bat Populations through Disease Surveillance and Long-term Acoustic Monitoring

Emily Almberg*, Montana Fish, Wildlife and Parks, Bozeman
Kristina Smucker, Montana Fish, Wildlife and Parks, Helena
Dan Bachen, Montana Natural Heritage Program, Helena
Kathi Irvine, US Geological Survey
Christian Stratton, Montana State University, Bozeman
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Jennifer Ramsey, Montana Fish, Wildlife & Parks, Bozeman

In 2019, Montana Fish, Wildlife and Parks, the U.S. Geological Survey, and the Montana Natural Heritage Program designed a plan to assess how the invasion and spread of the fungus *Pseudogymnoascus destructans* (Pd), which causes the disease White-Nose Syndrome (WNS), might impact bats across Montana. The resulting project involves annual, statewide surveillance for Pd and WNS to estimate the arrival and distribution of the disease, and long-term acoustic monitoring to assess bat occupancy and activity. Pd was first detected in Montana in 2020. In 2021, we surveyed 35 sites across the state, 9 of which were Pd-positive. WNS was first confirmed in 2021 among little brown bats (*Myotis lucifugus*) in Fallon, Carter, and Phillips Counties. As of 2021, Pd and WNS detections remain restricted to the eastern half of the state. During the summer of 2021, volunteers and staff from state, federal, and non-profit organizations deployed acoustic detectors at 87 North American Bat Program grid cells. We will use a Bayesian hierarchical model to estimate both occupancy and relative activity before versus after the arrival of WNS. Understanding the impacts of WNS on Montana’s bats will inform decisions about how Montana pursues bat management and conservation strategies—whether it be treatments specific to WNS or ecological approaches toward offsetting the costs of disease. Wildlife and land management agency staff in Montana are currently engaged in a structured decision-making process to understand how best to respond to WNS while trying to maximize the abundance and distribution of bats across the state.

****Glacier's Ghosts: Estimating Canada lynx occupancy and Density in Glacier National Park with a Passive Camera Array during Summer**

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Dan Thornton, Washington State University, Pullman
John Waller, National Park Service

Glacier National Park (GNP) is a large, protected area within the northern Rockies Canada lynx (*Lynx canadensis*) recovery unit, however knowledge of lynx distribution within the park is limited. Traditional means of monitoring lynx are not easily achieved in GNP due to difficulty in access during wintertime. Therefore, our intent was to complete the first park-wide occupancy survey of lynx using an array of passive camera traps during summer, a method recently found to be successful in other southern range edge populations. Within a smaller area of the park, we also tested the possibility of identifying individuals from subtle markings on the inside of the front leg to estimate density via spatially explicit capture-recapture. Finally, we linked park-wide predictions of occupancy with local density to estimate lynx population size across GNP. We found lynx distributed across much of the park and in the density study area we were able to successfully identify ~75% of lynx captures to individual based on coat markings. We estimated average park-wide lynx density at 1.2/100km² (95% CI: 0.7 – 2.2) resulting in an estimated population of 52.4 (95% CI: 29.9 - 91.8) lynx during summer. Our findings suggest that much of GNP is highly suitable habitat for lynx in the summer, with habitat mostly at or above the current elevational and climatic limits used by lynx. Based on our results, we propose that GNP should be considered as a potentially important area for lynx habitat refugia in a warming climate.

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Climatic Conditions and Migration Distance Drive Timing of Autumn Migration in Mule Deer

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Seasonal migration is a behavioral strategy that animals have evolved to exploit seasonally changing resources. A predictable pattern for many ungulates in northern temperate landscapes is to seasonally migrate from low-elevation winter ranges to higher-elevation summer ranges, allowing individuals to exploit a diversity of forage resources during summer while avoiding extreme winter conditions. In Montana, ungulate migrations often cross multiple hunting districts, and the timing of autumn migration often coincides with hunting seasons. Here, we utilize GPS collar data during 2017-2019 from 68 female mule deer (*Odocoileus hemionus*) spanning three distinct study areas in northwest Montana to evaluate the spatial and temporal patterns behind autumn migration. We first conducted descriptive summaries of the timing of autumn migrations with respect to hunting district boundaries and found that deer spanned multiple (up to 8) hunting districts across all 3 study areas. While many deer returned to winter range during archery season, some remained in wilderness until after the general rifle season concluded. Next, we related the timing of autumn migration to environmental variables like precipitation, snow depth, temperature, plant phenology (NDVI), migration distance, and estimates of relative hunting intensity. In addition, we summarized climatic and hunting variables across multiple temporal scales (2-day, 1 week, and 2 week) to identify possible lagged or cumulative effects of environmental conditions on mule deer behavior. We found that

plunging minimum temperatures provided a strong cue for mule deer to begin their migration back to winter range.

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Assessment of Species Diversity and Habitat for Bats in the Limestone Hills of Central Montana

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Bat species use a diversity features as day roosts including man-made structures, caves, trees, and rock outcrops which provide crevices and cavities to shelter in during the day. While roosts such as caves and mines are relatively well studied, roosts in rocks are poorly described. In July and August 2021 we conducted visual encounter surveys of rock outcrops within the Limestone Hills Training Area east of Townsend, Montana to detect roosting bats. Surveyors traversed small cliffs and talus examining cracks and crevices for roosting animals and guano. Across 10 surveys we detected three species of bat: Western Small-footed Myotis (*Myotis ciliolabrum*), Long-eared Myotis (*M. volans*), and Little Brown Myotis (*M. lucifigus*). Roosts were typically in horizontal or vertical crevices between 1 and 3 cm in width with good solar exposure. We found roosts occupied by single individuals as well as females and pups. We also use mist net deployed over water sources and acoustic detector/ recorders placed across the landscape to assess species diversity, allowing the opportunity to compare effectiveness of these methods. The same three species were detected with both roost surveys and mist nets. Using acoustic methods we recorded six species across five sites. While acoustic methods were more effective for assessing diversity than the other methods, detection of bats at rock outcrops and water sources allow assessment of the importance of the features for roosting and drinking respectively, important information for managing these species and the landscapes they inhabit.

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****Testing New Technology for Wildlife-Livestock Conflict Mitigation: An Evaluation of AI Enabled Camera Traps**

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Wildlife-livestock conflicts, including depredation, disease transmission, and resource competition, challenge the economic sustainability of ranches and farms that provide important wildlife habitat. It is therefore important to explore and develop ways to mitigate wildlife-livestock conflicts. Camera trap technology that uses artificial intelligence (AI) has the potential to provide real-time information on the presence, distribution, and spatiotemporal interactions between livestock and wildlife while limiting the amount of useless images resulting from false positive triggers. Our objectives are to evaluate the performance of an edge AI-enabled (“smart”) camera trap and assess applications for wildlife monitoring and wildlife-livestock conflict mitigation. We will assess the performance of the AI-enabled passive infrared (PIR) sensor of the smart camera and its ability to reduce false positive images by comparing it with two traditional game cameras. The maximum detection distance and the probability of detection for

all three cameras were tested in a controlled environment in January 2022. Cameras will be deployed for a field test in March 2022. In an additional field test in spring 2023, we will assess the smart camera's ability to remotely classify wildlife images by species and remotely notify ranchers and wildlife managers of wildlife presence via cellular data connection. Timely and accurate information of wildlife presence would allow for the strategic application of conflict mitigation measures and help sustain critical wildlife habitat on working lands throughout Montana and the western United States.

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Testing the Tools: Highlands Bighorn Sheep Project

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More than a dozen of Montana's bighorn sheep herds have experienced all-age pneumonia die-offs in the past two decades and most have yet to fully recover. Wildlife managers have employed various strategies to help restore these herds such as natural herd re-establishment (hands off approach), augmentations, identification and subsequent removal of chronic shedders of *Mycoplasma ovipneumonia* (M. Ovi), and complete herd removal. Using the Highlands bighorn sheep herd in SW Montana, we designed a 5-year study to explore the efficacy of two additional tools for restoring bighorn sheep herds following a pneumonia outbreak: single detection test and removal, and selenium supplementation. Utilizing the metapopulation structure of the Highlands herd, we will collect two years of baseline information on the five sub-herds that comprise the Highlands metapopulation to 1) monitor disease exposure of individuals, 2) monitor lamb survival, and 3) estimate connectivity of sub-herds. We will then implement a single detection and removal strategy in two sub herds, selenium supplementation strategy in two sub herds, and no management intervention in the remaining sub herd. The efficacy of these treatments will be monitored for an additional two years. An increase in lamb survival, population growth and decrease in M. ovi detections in the sub herds receiving a treatment would indicate success of the management tool. Results of this experiment will add to the management toolbox of struggling bighorn sheep herds across Montana and the intermountain west.

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Bison Restoration to Temperate Grasslands is Associated with Similar Biodiversity Outcomes in upland Habitats but Strong Positive Effects in Riparian Areas in Comparison to Seasonal Cattle Grazing

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Temperate grassland biomes are globally imperiled, and species that rely on them are in precipitous decline as a result. The majority of North America's grasslands are designated as rangelands and are occupied by domestic cattle, but reintroductions of bison to restore evolutionary grazing patterns are increasingly common. Grassland landscapes in western North America have undergone drastic changes since millions of bison occupied this landscape, and the biodiversity effects of bison on modern rangelands remain poorly understood. Here, we test the

biodiversity effects of native versus non-native grazers in the context of a highly diverse grassland ecosystem on the Northern Great Plains of North America. We compared the effects of 2 different grazing treatments common across the region on avian diversity: seasonally grazed and manually rotated domestic cattle, and year-round, free-moving bison. We used a variety of techniques including point counts, camera-trapping and time-series remotely sensed vegetation sampling to evaluate the effects of these two treatments on grassland biodiversity in upland and riparian habitats. We found roughly equivalent bird diversity and species-specific abundance in upland habitats, at sites occupied year-round by bison and seasonally by cattle. In riparian zones, we found that woody vegetation, and native grasses/forbs increased more rapidly over time in bison pastures, and that these changes in vegetation structure were associated with increased bird diversity and cervid occupancy. Our results suggest that both native and non-native grazers can create habitat for a highly diverse assemblage of grassland birds in uplands, but year-round bison grazing has strong positive biodiversity effects on riparian habitats compared with seasonal cattle grazing.

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Identification of Bumblebee Species from Photographs Taken in the Field: Quantifying Effectiveness and Best Practices

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With many bumblebee (*Bombus*) species in decline across North America, there is an urgent need to collect data on the status of bumblebees in Montana; however, bumblebee identification requires specialized expertise and can be difficult in the field. Traditionally, bumblebee specimens have been collected and pinned for experts to view and identify. However, storing and managing specimens presents logistical challenges. In addition, three bumblebee species in Montana are under consideration for listing which may lead to restrictions on lethal sampling. Taking photographs of bumblebees in the field offers a non-lethal alternative that may be more cost-effective, appropriate for species of concern, or suitable for engaging community scientists. We seek to evaluate the effectiveness of identifying bumblebee species in Montana from photographs. In collaboration with BLM Montana/Dakotas, we took photographs and collected specimens of >565 bumblebees between 2018 and 2021. The species of each bumblebee was determined separately from specimens by Montana bumblebee expert Amy Dolan and from photographs by bumblebee expert Rich Hatfield. We will use these data to answer: (1) How frequently were species identified from photographs of bumblebees, and how frequently did these identifications agree with specimen identifications? (2) What methods and practices contribute to successful bumblebee identification from photographs? (3) Are there specific species or castes that cannot be reliably identified to species level from photos? Our goal is to inform viable and efficient methods for sampling and identifying bumblebee species, including species of concern, across Montana and beyond.

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Pronghorn in the Madison Valley - Research-Informed Management Actions and Community-Based Conservation

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Secretarial Order 3362 to improve habitat quality, winter range, and migration corridors for big game provided an opportunity to foster collaboration between Montana Fish, Wildlife and Parks (MTFWP) and private landowners using the best available science to manage habitat. Pronghorn may exhibit long distance migrations while being sensitive to anthropogenic barriers like fences, highlighting the need for data to inform pronghorn habitat management. From 2018 to 2021, 82 female pronghorn were fitted with GPS collars in the Madison Valley. Findings have been applied in many ways to follow the Secretarial Order. First, collar data defined a previously-unknown herd structure involving migratory and non-migratory herds. This information will refine how survey and inventory data will be collected and how harvest may be applied. Second, collar data defined corridors and natural and anthropogenic barriers. Problematic and non-problematic barriers were defined. Third, community-based enthusiasm for pronghorn grew into a collaboration between several non-governmental organizations to work together with private landowners to bring labor and resources to repair and remove fences. Fourth, agencies such as Montana Department of Transportation and Bureau of Land Management worked with MTFWP and private landowners to promote and enhance permeability of pronghorn fence crossings. Finally, findings from this research are beginning to be applied with the Madison County Planners to highlight the importance of development planning in the pronghorn migratory corridor. The numerous ways in which research data have been applied to improve management, develop communication, and facilitate collaboration among stakeholders in the Madison Valley will be discussed.

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Comparing Ancient and Contemporary Bighorn Sheep Populations Using Bones Recovered from Ice Patches in the Greater Yellowstone Area

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Beth Shapiro, University of California, Santa Cruz
Jennifer Thomson, Montana State University, Bozeman
Robert Garrott, Montana State University/Ecology Dept., Bozeman

Bighorn sheep have inhabited the Greater Yellowstone Area (GYA) for thousands of years and remain one of the ecosystem's significant large herbivores. Following the arrival of Europeans and domestic sheep grazing, exotic respiratory diseases introduced into the GYA undoubtedly resulted in catastrophic die-offs of bighorn sheep and strong selection for individuals that could mount successful immune defenses. Archaeologists studying receding ice patches in alpine areas of the GYA, e.g., Absaroka-Beartooth Mountains, have identified numerous ancient bighorn sheep skulls, fragments (e.g., horn cores and sheathes), and post-cranial bones, exposed by melting ice. Representative samples radiocarbon date to between 781 and 6311 calendar years before present. We hypothesized the genomes of the pre-contact bighorn sheep recovered from the melting ice would represent the historic condition of native sheep populations when they were more numerous and free of the diseases introduced by domestic sheep. We compared 26 mitochondrial DNA genomes from contemporary bighorn sheep in the

Absaroka-Beartooth Mountains with six ancient samples by constructing a phylogenetic tree. Using this information, we evaluated how market hunting and domestic sheep diseases may have influenced the bighorn sheep population. Because mitochondrial DNA is only inherited from the mother, and because bighorn sheep groups of mothers and daughters tend to maintain similar seasonal ranges over multiple generations, we also evaluated if the regional spatial structure of bighorn sheep changed after Euro-American settlement. We believe this study will help determine how the bighorn sheep populations inhabiting the Absaroka-Beartooth Mountains has changed over several thousand years.

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Motus Wildlife Tracking - Real-World Case Studies and Partnership Building

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Maggie Blake, University of Montana Bird Ecology Lab, Missoula
Joely DeSimone, University of Montana, Missoula
William Blake, MPG Ranch
Kate Stone, MPG Ranch

The Motus Wildlife Tracking System (Motus) is an international collaborative research network that uses coordinated automated radio telemetry to facilitate research and education on the ecology and conservation of migratory animals. The UM Bird Ecology Lab has deployed Motus tags on several species, including Swainson's Thrushes, Gray Catbirds, Lazuli Buntings, and Pine Siskins. We plan to deploy tags on two grasslands species, Western Meadowlark and Grasshopper Sparrow, this coming summer of 2022. We discuss the results and research directions of tracking wild birds using Motus, as well as the partnership-building opportunities that arise from working with migratory species.

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****Evaluating the Effects of Electric Cables on Urban Howler Monkeys with Local Knowledge and Naturalistic Observation**

Olivia Gervacio Jakabosky*, Montana State University-The Wildlife Habitat Ecology Lab, Bozeman
Rebecca Smith, Para La Tierra
Lance McNew, Montana State University - Wildlife Habitat Ecology Lab, Bozeman

Black-and-gold howler monkeys commonly inhabit urbanized areas of South America often using anthropogenic structures, such as electric cables, to travel across urban environments, which can result in increased rates of mortality. The urban howler monkey troops in Pilar, Paraguay, offer a unique opportunity to understand the dynamic between humans, wildlife, and complex urban habitats. With very little research existing on the howler monkey populations in Paraguay, this study aims to provide initial understanding of the relationship between urban howler monkeys and human populations through an interdisciplinary research approach. During summer 2021, we studied the two most-at-risk monkey troops in Pilar to evaluate whether proximity to electric cables is influencing monkey behavior. We grouped proximity to electric cables into 3 groups, 15 ft, and we grouped behavior into 7 classes: resting, feeding, traveling, playing, mating, grooming, and other. We found evidence that the behavior of the monkey troops had a significant behavior difference across 3 levels of proximity to electric cables ($\chi^2 = 225.8$, $df = 12$, $P < 0.001$). Next, we will fit a multinomial model to further assess the effect of electric

cable proximity on behavior. We also explored the human dimension aspect of the monkey-cable issue by interviewing 104 community members, where views ranged from being concerned for the monkeys to viewing populations as pests. In the future, the results of this study will provide valuable sociological and ecological tools to further assess the nuances and complexities of social-ecological issues in Paraguay.

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****Assessing the Effectiveness of Autonomous Recording Unit Surveys for Detection of Great Gray Owls in Western Montana**

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Hannah Specht, University of Montana, Missoula
Torrey Ritter, Montana Fish, Wildlife and Parks
Kristina Smucker, Montana Fish, Wildlife and Parks, Helena
Claire Gower, Montana Fish, Wildlife and Parks, Bozeman
Allison Begley, Montana Fish, Wildlife and Parks

Montana has classified the Great Gray Owl as a Species of Greatest Conservation Need (SGCN3) and a Species of Greatest Inventory Need (SGIN). Montana non-game species listed as SGIN are not sufficiently monitored by standard ecological monitoring programs, typically because they are cryptic and difficult to detect. We have completed three years of surveys in high quality habitat utilizing Autonomous Recording Units (ARU) and traditional Callback Surveys to assess occupancy of this elusive species. A total of 101 cells in western Montana have been surveyed with ARU detectors, including 30 sites with two detectors deployed simultaneously. Great Gray Owls were detected in 8 of the 101 survey cells. We'll present findings on the effectiveness of ARU surveys for the detection of cryptic owl species, as well as information about the detection of non-target species of information need, and best practices for ARU surveys of owls.

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Camera Trap Density Estimators: Methods Old and New

Guen Grosklos

Camera traps are a cost-effective and non-invasive method for collecting data on wildlife species. Recently, camera trap data has been used to estimate abundances in unmarked animal populations. In this talk, I summarize some of the different camera trap density estimators already in existence and introduce a novel method that uses dynamic processes to estimate landscape-scale abundances. I show how dynamic models may be used to incorporate movement across a landscape and how they may be applied to camera trap data. I compare this new model with four previously developed density estimators by fitting them to individual-based simulations using Bayesian methods. Note that these results are preliminary and future work will show where each of these methods are appropriate given the type of data available.

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Associations Between Public Lands Cattle Grazing and Long-term Trends in Vegetation

Christopher Hansen, University of Montana, Missoula

Cattle grazing is a common practice on public lands in the western United States; however, it is largely unknown how cattle grazing on public lands has affected rangelands. Thus, our primary objective was to identify whether grazing practices were associated with changes in herbaceous vegetation productivity on public lands. To address this objective, we acquired billed Animal Unit Month (AUM) data and above-ground herbaceous biomass data for 12,628 Bureau of Land Management BLM grazing allotments for the past 36 years. We fit linear mixed effects models with annual change and 36-year trends in vegetation biomass as response variables, and grazing intensity (AUM/ha), precipitation, and temperature as predictor variables. Trends in precipitation and temperature had the strongest effects on trends in perennial and annual herbaceous biomass, with allotments that got warmer and drier over time having the largest decreases in biomass. Grazing intensity had weak to no associations with trends in herbaceous biomass. Our results suggest that current cattle grazing practices on BLM allotments were not strongly associated with vegetation productivity for the past 36 years, when considering allotment-scale effects across the range.

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****Behavior-Season Mapping of Sage Grouse use Intensity to Define Habitat**

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Michael Borgreen, Bureau of Land Management

John Carlson, U.S. Fish and Wildlife Service

Lance McNew, Montana State University - Wildlife Habitat Ecology Lab, Bozeman

The greater sage grouse (*Centrocercus urophasianus*) is a focal species in the effort to conserve imperiled sagebrush ecosystems and associated organisms. As sage grouse numbers decline and populations become more isolated, populations in different regions must cope with unique combinations of stressors and are less likely to be replenished by surrounding populations. Therefore, it is critical that we understand and delineate local habitat to inform management decisions. Wildlife-habitat responses are typically inferred from seasonal population-level resource selection models without regard for detailed individual-level phenologies and behaviors. A more comprehensive suite of inferences and predictions may be gained by linking landscape-condition responses with specific behavior-seasons derived from movement data and expert knowledge. Our primary goal was to quantify sage-grouse landscape-condition responses relevant to management and map use-intensity for 7 distinct behavior-seasons. We attached a 22-g solar powered GPS satellite transmitter to 86 female sage grouse in north-central Montana and have collected 188,786 geographic coordinates during 2018-04-24 – 2021-12-28. We monitored females, analyzed movement behaviors, and mapped use-intensity using a combination of field observations, nonlinear-regression movement models, a time-local convex hull approach, and generalized additive models. The relationship and magnitude of associations among sage grouse use-intensity and landscape conditions varied among the 7 behavior-seasons which indicates that behavioral and temporal context is important for understanding habitat physiognomy and use for sage grouse.

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****A Preliminary Look at The Effects of Livestock Grazing on Greater Sage Grouse Nest Success and Hen Survival in Central Montana**

Jenny Helm*, University of Montana, Missoula
Lorelle Berkeley, Montana Fish, Wildlife and Parks
Mark Szczypinski, Montana Fish, Wildlife and Parks
Victoria Dreitz, University of Montana, Missoula

Livestock grazing is a dominant land use in sagebrush habitat, leading to ongoing questions about the relationships between grazing and coexisting wildlife populations. We investigated the effects of livestock grazing on greater sage grouse demographic rates. This work is based on a decade-long collaboration among multiple agencies and private landowners in central Montana. We evaluated whether rotational grazing systems implemented through the Sage Grouse Initiative (SGI) in central Montana can be used to effectively manage sage grouse habitat to support different vital rates. We collected data on livestock grazing and sage grouse demographic rates from 2011-2020. First, we synthesized grazing data in several different ways to investigate both short- and long-term effects of SGI grazing systems on demographic rates. Second, we explored the influence of the different grazing systems on sage grouse nest success and hen survival. Preliminary results suggest that inter-annual variation has a stronger effect on both demographic rates than grazing management. In our ongoing work, we will expand our current preliminary models by adding additional habitat and weather variables. Ultimately, our findings will help inform grazing management to support sage grouse in central Montana.

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Effects of Climate on Western Bumble Bee Declines in North America Now and in the Future

William Janousek*, U.S. Geological Survey
Tabitha Graves, U.S. Geological Survey

The Western bumble bee (*Bombus occidentalis*), once common throughout Western North America is under consideration for listing by the U.S. Fish and Wildlife Service (USFWS). To support the USFWS Species Status Assessment of the Western bumble bee we assessed the relative influence of climate, landcover, and pesticides on the trends in occupancy for the Western bumble bee across its range in the conterminous United States. We used a Bayesian hierarchical occupancy model leveraging 14,457 surveys conducted over 23 years (1998-2020). We found strong support for a negative relationship between occupancy and two climate components: temperature during the warmest quarter and cumulative years of drought. We also found a complex relationship between the presence of Western bumble bee and landcover types with the species being more common in areas of increased forest and shrub cover. These relationships are non-linear and suggest forest/non-forest edge is an important habitat characteristic. We found variable declines in ecoregions across the species range from moderate declines in the Greater Yellowstone Ecosystem (-15%) to much steeper declines in the Cascades-Sierra Nevada-Coastal forests of the western US (-62% to -75%). In Montana, predicted declines are largest in the semi-arid prairies of the Eastern portion of the state (-53%) but still evident in the mountainous Western portion (-37%). We also used a range of future scenarios (based on 4 climate models, 2 emission scenarios, and 3 landcover forecasts) to project occupancy (2050's) and found continued range-wide declines even under the most conservative scenarios.

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****Effects of Survey Conditions on Dusky Grouse Counts in Montana**

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Claire Gower, Montana Department of Fish, Wildlife and Parks, Bozeman
Lorelle Berkeley, Montana Fish, Wildlife and Parks
Lance McNew, Montana State University - Wildlife Habitat Ecology Lab, Bozeman

Dusky grouse (*Dendragapus obscurus*) are a species of upland game bird for which monitoring methods are still being developed. Understanding factors that influence the detections of grouse is crucial for developing survey protocols that maximize observability of grouse and provide unbiased estimates of population size and trends. Our objective was to explore relationships between grouse counts and survey conditions to inform future statewide survey protocols. We conducted multiple 4-minute point counts during the spring mating season from late April–early June 2020. We explored the effect of wind speed, temperature, cloud cover, precipitation, minutes since sunrise, and date on the maximum number of dusky grouse counted at each site using generalized linear models and information theory. The number of grouse observed declined with wind speed ($\beta = -0.06 \pm 0.04SE$), and increased with ambient temperature ($\beta = 0.02 \pm 0.01SE$). The number of grouse counted for date and minutes since sunrise had a positive quadratic relationship, with peak counts occurring from May 5th – May 20th, and between 100- 150 minutes post sunrise. Higher counts were observed when cloud cover was low, and snow had the strongest negative impact compared to other forms of precipitation. These results provide valuable insight for identifying favorable conditions for surveying dusky grouse, which could lead to effective management decisions for this species.

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****Predicting Potential Dusky Grouse Habitat in Montana**

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Effective population monitoring protocols are needed for dusky grouse (*Dendragapus obscurus*). As a first step towards developing a method for unbiased population monitoring, we developed a habitat model to determine appropriate sampling sites. Our objectives were: 1) explore relationships between habitat characteristics and relative probability of use by dusky grouse, and 2) develop a state-wide habitat model for Montana using multiple modeling techniques. We used dusky grouse observations collected during the Integrated Monitoring in Bird Conservation's (IMBCR) spring (April-June) point count surveys from 2009–2020 and extracted habitat information using geospatial datasets for detected (used)/not-detected locations (pseudo-absent). We compared habitat characteristics at used and pseudo-absent locations using resource selection functions and random forests. We evaluated both model techniques using Area Under the Curve/ Receiver Operating Characteristics (AUC/ROC) and with an independent dataset. We averaged the predictions from both models to create a final habitat model for predicting dusky grouse habitat. Overall, we found a number of landscape level metrics to be important for predicting dusky grouse habitat, including tree height, tree canopy, elevation, slope, and several conifer forest vegetation communities. In the future, our model will assist in determining sampling sites for population monitoring.

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****Estimating Variable Pronghorn Survival Across Their Northern Populations**

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Estimating demographic parameters (i.e., survival and recruitment) is critical for tracking and predicting trends in wildlife populations. Learning how demographic parameters change in response to dynamic landscape and climatic conditions can provide ecologists with insight into how wildlife populations might respond to future environmental changes. Further, identifying how demographic rates vary across populations can guide management actions to maximize conservation. In this project, we study how pronghorn population survival rates vary across a range of landscapes throughout their northern distributions. Leveraging GPS location and survival data from nearly 1,000 GPS collared pronghorn across Montana and South Dakota, we estimate annual survival from over 10 populations. South Dakota Game, Fish and Parks (SDGFP) and the University of Montana have partnered with Montana Fish, Wildlife and Parks to collar over 500 juvenile male and female and adult, female pronghorn in northwestern South Dakota, central South Dakota as well as an additional 500 adult female pronghorn across eastern, central, and southwestern Montana. We used a hierarchical Bayesian survival model to estimate annual survival rates and variability across populations. By gaining more insight into how pronghorn survival rates vary across populations, we can begin to ask more probing questions about the mechanisms driving survival across space and time, and adapt conservation actions to best meet management objectives in a changing landscape.

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Spatial and Temporal Patterns of Elk Aggregation on Fossil Butte National Monument

Olivia Miller*, U.S. Geological Survey
Tabitha Graves, U.S. Geological Survey

As wildlife managers strive to limit disease transmission among their herds, information about when and where animals are congregating is crucial for making effective management decisions. We investigated the density of an elk herd that winters on Fossil Butte National Monument, WY over a five-year period from 2005 to 2010 using GPS collar data from 68 female elk to assess the spatial and temporal patterns of disease transmission risk. Using a daily proximity index and kernel density estimates, we determined that contact rates between the elk in each year were highest during the fall and winter months while the elk herd was predominately located on the Monument. This suggests that management actions taken on the Monument may have an important impact on disease transmission risk for the herd across the year, although the herd migrates to a different range in the summer. This information is particularly relevant to the Monument given the Monument's proximity to other locations with Chronic Wasting Disease (CWD). We plan to compare these results with density metrics for an elk herd that winters on the Cokeville Meadows Wildlife Refuge, WY. We anticipate that similar information across additional populations will be useful for untangling the interactions of density, population size, and environmental transmission on disease transmission dynamics.

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****Post-Release Movement by Swift Foxes Translocated to the Fort Belknap Reservation, MT**

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In species reintroductions, monitoring post-release movement of translocated individuals can provide valuable insight into the factors influencing survival, site fidelity, and ultimately, reintroduction success. Swift fox (*Vulpes velox*) populations in Montana are primarily the result of multiple reintroduction efforts onto tribal lands in northern Montana and Canada, yet despite those actions occurring >20 years ago, an approximately 350 kilometer range gap remains between the restored population in northern Montana and southern populations near the borders of Wyoming and South Dakota. The Fort Belknap Indian Community and partners are translocating swift foxes both to promote connectivity in this range gap and to return an extirpated species to Nakoda and Aaniiih sovereign lands. To date, we have translocated and fitted 75 swift foxes with GPS collars to monitor post-release movement and measure progress towards ecological and cultural goals. In addition to an overview of the translocation process and early progress toward reintroduction benchmarks, we present preliminary results on the effects of origin, individual factors, and release strategy on distance travelled in the first two weeks post-release. We discuss the implications of findings from the first two years of translocations in terms of adaptive management of the ongoing reintroduction and for future conservation actions to promote this sensitive species.

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****Ongoing Work to Quantify Livestock Grazing in The Sagebrush Steppe Using Remote Sensing Data**

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Domestic livestock grazing is the primary land use worldwide, but the influence of grazing on rangeland productivity is difficult to quantify due to its dependence on many environmental and management factors. This study examines the effect of livestock grazing on rangeland gross primary production (GPP) while accounting for effects of environmental variables. Specifically, we use Bayesian generalized linear models (GLMs) to regress field-based grazing intensity data on remotely sensed GPP and environmental covariates. Our preliminary results suggest that the grazing levels in our study area minimally influence short-term rangeland productivity when compared to other environmental variables. Our ongoing work will consider other measures of rangeland productivity (e.g., NPP, NDVI), alternate models, and simulations to improve our predictions. Our findings will provide insight into the relationship between grazing and rangeland productivity for use in grazing management.

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Aquatic Invasive Species Management in Western Montana - American Bullfrog and Common Snapping Turtle

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Invasive herptiles can negatively impact native aquatic species through competition for resources, predation, and introduction of pathogens. In response to public reports and the need for updated surveys on invasive herptile infestations west of the Continental Divide in Montana, we undertook a project to survey for and control common snapping turtles (*Chelydra serpentina*) and American bullfrogs (*Lithobates catesbeianus*). We used a GIS to map potential habitat for the focal species to prioritize efforts. We used targeted outreach to collect sightings and educate the public about invasive species. Once we had compiled relevant data, we conducted surveys to estimate the extent of current infestations. Concurrently, we conducted control operations to eliminate snapping turtles and bullfrogs from key areas. During June - September of 2021, we set 78 snapping turtle traps in 40 different water bodies for a total of 593 trap-nights. Trapping success was low, resulting in the removal of 11 snapping turtles and one nest containing 73 eggs. We conducted 110 nighttime calling surveys for bullfrogs and spent 11 nights removing bullfrogs from seven wetlands. Results suggest there is not a well-established breeding population of snapping turtles in west-central Montana, but a breeding population exists in northwest Montana. Bullfrogs in west-central Montana have not significantly expanded their range since the early 2000s, whereas bullfrogs have spread past a key dispersal pinch-point in northwest Montana and are expanding towards Ninepipes Reservoir and associated wetland complexes. We suggest specific, ongoing monitoring and removal efforts to address these invasive herptiles in key areas.

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****Integrating Three Scales of Analysis to Compare Spiny Softshell Turtle Nesting Habitat in Dammed Versus Undammed Rivers**

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Riverine turtles' life cycles are highly adapted to the dynamic river systems in which they live. *Apalone spinifera* (spiny softshell turtle), for example, rely on complex habitat produced through spring-flood pulse flows and minimal anthropogenic modifications for their life processes. The extent and quality of this sort of habitat appears to be increasingly limited by the effects of dams on river systems such as on the Bighorn River, located in south-eastern Montana. In comparison, the Yellowstone River is a relatively undammed river which experiences natural flood pulses. Little research has been done that focuses on how anthropogenic modifications, especially dams, affect spiny softshells' habitats and population structure. Three scales of data were utilized (ground observations of turtle nesting sites; high-resolution (~2cm) unmanned aerial system (UAS) imagery; and medium resolution (10m) Sentinel 2 imagery, to generate a viable estimate of the amount of available spiny softshell nesting habitat in 32.2 km study areas along both the Yellowstone and Bighorn rivers in Montana. Using a smaller study area of 15-hectares within the full 32.2km study as a model for differences in nesting habitat availability

between UAS imagery and Sentinel imagery resulted in about 54% nesting habitat in common on the Yellowstone and almost 86% in common for the Bighorn. These percentages were used to create a corrected full study nesting habitat estimation. When run, the Yellowstone River had almost nine times more APSP nesting habitat than that of the Bighorn. From an ecological and conservation perspective, this is important to consider.

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Real-Time Drone Data Collection for Improved Wildlife Management using a Combination of Radio-Telemetry and Thermal Sensor Technology

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Drones are quickly becoming a popular and valuable tool for wildlife researchers across the United States and globally. With an increasingly wide range of drone platforms and onboard sensors readily available, wildlife managers can now collect data on multiple individuals simultaneously and in real-time to directly inform actions or management decisions on the ground. This includes both radio-telemetry sensors and thermal cameras. These complementary sensors provide unique combinations of data to enable more time and effort to be directed towards managing target animals across broad landscapes, rather than searching for them inefficiently from on the ground. Such tools provide wildlife biologists with valuable real-time data for preventative measures in human-wildlife conflict areas, conservation action for endangered species as well as improving the effectiveness of invasive species control. Here we provide examples of wildlife management projects in the United States and Australia that have successfully used these sensors to provide unique insights into wildlife movements and enhance management.

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A State-Wide Look at Montana's Diverse Avian Datasets

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Since the online platform eBird.org launched in 2002, millions of bird observations have been collected by citizen scientists and amateur bird observers. Today, 10's of thousands of bird observation lists are uploaded each day and the data building up is incredible. Over 391 thousand lists have been submitted by over 13 thousand observers in Montana, with 431 species having been observed. Along with trusted long-term and large-scale bird data series, like the Breeding Bird Survey or the Integrated Monitoring in Bird Conservation Regions effort, and species-specific efforts like annual fall hawk counts, a truly immense body of bird observation data has been amassed. Though the diversity of survey efforts and individual birders' contributions to data collection efforts are crucial to understanding the state's 442 bird species, they are complicated to utilize in their respective silos. Now after a multi-year partnership effort between the Montana Natural Heritage Program (MTHNP) and Montana Audubon millions of bird data records have been reviewed for final acceptance and incorporation into the MTNHP zoological database. The huge effort will directly contribute to improved range analysis tools and updated range extents for dozens of species, in addition to supporting trend analysis for Montana's birds; one of the few groups of species where enough data exists for trend analysis. In some cases, as

with the Lesser Goldfinch, and Gray Flycatcher, the data may help MTNHP assess a status for the first time, and in all cases the updates will be seen immediately through the MTNHP tracker and project

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Grizzly Bear Habitat Selection and Predicted Movement Corridors in Western Montana

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Once-contiguous grizzly bear populations remain largely isolated, and connectivity among federal recovery areas is a key concern for conservation efforts. Research has been needed to assess potential corridors that could promote genetic and demographic connectivity for males and females among recovery ecosystems. Our objective was to model grizzly bear habitat use, movement, and population connectivity. We employed GPS data from male and female grizzly bears in the Northern Continental Divide Ecosystem (NCDE) and an integrated step selection function approach to test hypotheses of habitat selection and simulate movements. Results demonstrate highly individualistic behaviors, with some individuals avoiding and others preferring various features like forest edge, riparian areas, etc. Such individualism supports the need for an individual-based modeling approach to understand and predict grizzly bear behavior. We accordingly first used each individual's model to simulate movements within and near the NCDE using correlated random walks. We then used each model to simulate pathways from the NCDE to nearby recovery areas using randomized shortest paths. Our work is ongoing; however, preliminary results highlight potential pathways that could be targeted for proactive conservation efforts such as habitat conservation, conflict mitigation, and transportation planning.

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Searching for The Horny Toad - Trials and Tribulations to Document Greater Short-Horned Lizards in Montana

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Greater short-horned lizards (GSHL) are a fascinating and cryptic lizard that are poorly documented in Montana. In the State Wildlife Action Plan, they are identified as a Species of Greatest Conservation Need (SGCN3) and a Species of Greatest Inventory Need (SGIN). With recent declines in reptile populations globally, it is important to establish baseline information about occurrence and a way to monitor population trends in the state. We developed a model to identify suitable habitat based on previous studies, existing observations, and expert opinion. We used standard methods for amphibian and reptile visual encounter surveys (ARVES) with sites randomly sampled within suitable habitat across the GSHL range as defined

by the Montana Natural Heritage Program. We sampled 70 sites and observed 18 GSHL from 2016 to 2019 at 6 sites. Our efforts did not produce enough detections to support site occupancy analyses nor examination of variables that affect occupancy or detection probability. We are currently refining our habitat model and adapting our survey protocol based on recent studies and conversations with herpetology specialists to increase detections. In addition to standardized surveys, we also used outreach to request incidental observations from the public. These efforts produced more than 100 additional observations and have proven quite valuable in understanding range and habitat used by GSHL. We will continue to solicit help from the public and ask that if YOU encounter a GSHL, please help us out and let us know!

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Using Drones and Radio Telemetry to Monitor Wildlife in Montana

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We summarize work evaluating the potential use of radio telemetry equipment mounted on a small Unoccupied Aerial System (sUAS), a DJI Matrice 600 Pro drone, to support locating wolf radio collar signals and aerial photography. A Communications Specialist R1000 receiver and Advanced Telemetry Systems 3 element yagi antenna were used to listen for signals from radio collared wolves from the ground. The Matrice 600 landing gear was modified to provide a platform for mounting the receiver electronics, the three element Yagi antenna, and a wireless transmitter/receiver system. A DJI Zenmuse Z30 30x zoom camera was mounted under the drone. Radio frequency noise from the drone controller and motor electronics initially masked weak signals from the collars. Mounting the antenna 1-2 feet above the drone significantly reduced the noise interference. Using the drone to lift the antenna 100 feet up into the air and getting above the treeline resulted in a 20 dB signal improvement over the signal strength from the ground. We plan further testing using a spectrum analyzer in place of the receiver, and a higher gain 5 element antenna to improve direction finding. Additionally, we review how drones have been used to facilitate data collection for wolves and other wildlife in Montana and beyond, and the potential for drones to facilitate more efficient, effective, and precise monitoring and management of wildlife.

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****Wildfire Extends the Shelf-Life of Elk Nutritional Resources Regardless of Fire Severity**

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Large-scale, high severity wildfires are increasingly frequent across the western United States. Fire severity affects the amount of vegetation removed and helps dictate what, where, and how many plants can regenerate postfire, potentially altering the available habitat and nutritional landscape for wildlife including elk (*Cervus canadensis*). To evaluate the effects of fire severity on the Blackfoot-Clearwater elk population's summer nutritional resources, we collected field data and remotely sensed information in years two and three after the Rice Ridge wildfire to compare forage quality across multiple forest types and fire severities and developed

spatiotemporal predictive landscape nutrition models. We used these models to predict forage quality across the landscape and compared the observed landscape of nutrition to an unburned landscape to assess nutritional consequence of the Rice Ridge wildfire. Wildfire increased summer forage quality in both mesic and dry mixed conifer forests regardless of fire severity. Based on our predictive models, we found that wildfire extended the duration in which elk can access high quality forage in the summer. Therefore, shortly after a large-scale wildfire, elk may be better able to meet their requirements which may positively impact elk body condition, reproductive performance, and survival. Fire has frequently been shown to increase summer nutritional resources for elk, however, to our knowledge, this is the first study to analyze the immediate impacts of fire severity on elk nutritional resources.\

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Movements and Habitat Use of Northern Saw-Whet Owls During Fall Migration

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We used radio telemetry to track the movements and habitat use of close to 100 Northern Saw-whet Owls (*Aegolius acadicus*) as they traveled through the Bitterroot Valley during fall migration in 2014 and 2015. We hypothesized that owls would travel south through the Bitterroot River floodplain. Instead, we failed to detect a signal from 19 owls the day after release, suggesting they traveled a minimum of six miles to the east or west into either the Sapphire or Bitterroot Mountains, out of range of our telemetry search. Most of the other owls traveled along the valley periphery, using forested foothills. Most owls exhibited stopover behavior, staying in the same general area for several days between movements. Our greatest nightly distance moved was 40 miles and our greatest distance tracked was 60 miles from the release site. Most owls tracked on the Bitterroot River floodplain roosted high in tall ponderosa pines, in areas with a low density of small trees but a high density of medium-large trees, saplings, and shrubs. We documented one communal roost containing at least three individuals. We only saw half of the owls tracked to an individual tree or shrub; the remaining were too well hidden to detect visually. We did not find pellets and rarely observed whitewash below roosts. These results suggest that methods relying on passive observation to detect owls and/or roost sites likely miss most roost sites, at least during migration.

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****Fatal Attraction for an Imperiled Songbird - Is Cropland in The Northern Great Plains an Ecological Trap for Breeding Thick-Billed Longspurs?**

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Kevin Ellison, American Bird Conservancy
Marisa Sather, US Fish and Wildlife Service
Scott Somershoe, US Fish and Wildlife Service
Lance McNew, Montana State University - Wildlife Habitat Ecology Lab, Bozeman

Population declines of thick-billed longspurs (*Rhynchophanes mccownii*) (-4% annually) are among the most severe of all grassland birds. This species has a unique habitat preference for recently disturbed or sparsely vegetated areas within mixed grass prairie and is known to occur

in crop fields during the breeding season in northeastern Montana. Maladaptive selection may result in crop fields operating as ecological traps, but information on use and demography are lacking. We hypothesized crop fields provide visual cues necessary for territory selection, but frequent human disturbance and increased exposure to weather and predators should result in reduced reproductive success. To address this hypothesis, we 1) used dynamic occupancy models to compare arrival times of territorial male longspurs using data collected with autonomous acoustic recorders, 2) used open population distance sampling models to compare longspur densities and evaluate whether densities changed differentially over the breeding season, 3) compared indices of nest density, and 4) used nest survival models to compare survival rates of nests between crop and native sites. Arrival times of territorial males were similar in both site types. Bird and nest densities responded negatively to growing vegetation and differences between crop and native sites were mediated by drought. Nest survival was similar in crop and native sites (n=240 nests). The data did not support our ecological trap hypothesis: longspurs did not exhibit a clear preference and reproductive output was not significantly reduced in crop fields.

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****Use of Autonomous Recording Units (ARUs) in Assessing Arrival Phenology of a Migratory Bird in The Northern Great Plains**

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Autonomous recording units (ARUs) are increasingly used in avian research to monitor bird populations in place of human observers. ARUs are particularly useful in remote locations and allow researchers to collect continuous and systematic temporal sampling with reduced field effort. As part of a larger study assessing whether crop fields operate as ecological traps for breeding thick-billed longspurs (*Rhynchophanes mccownii*), we used ARUs to compare arrival phenologies of longspurs in crop and native sites (n=20) at the core of their breeding range in northeast Montana. Secondary spillover from native sites into crop fields may indicate preference for native prairie habitats while earlier occupancy of crop sites may indicate preference of crop habitats. We used ARUs to document daily bird occupancy during the month of April in northern Valley County, Montana. We used dynamic occupancy models to estimate initial occupancy in crop and native sites and to derive estimates of latent occupancy across the 24-day survey period. We found no evidence that crop sites were occupied earlier than native sites. Site occupancy increased from 0.56 (0.12 SE) on April 7 to 0.99 (0.01 SE) on April 30 and was similar between crop and native sites. Our results demonstrate that ARUs may be a useful tool for assessing migration phenologies of vocal avian species, particularly once machine learning software is able to accelerate processing times of high-volume recording files.

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Intact Rangelands Outcompete Focal Species as a More Efficient Surrogate for Conservation in The Northern Great Plains

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Maps of species-habitat relationships often underlie our strategies to identify and prioritize areas for conservation. Often a single surrogate species drives conservation design, with the assumption that conservation actions for a well selected species will confer benefits to a broader community. Recent advances in systematic conservation planning coupled with increasingly available spatial data have helped planners incorporate requirements of multiple species. Yet, multispecies prioritization algorithms are still challenged by how to objectively ‘weight’ varying attributes, which has tremendous impacts on resulting area-based prioritizations. We developed an approach to quantify ‘strength of surrogacy’ among species, by building individual models and measuring their ability to encompass a broader wildlife community. We applied our approach to a suite of species models used for conservation targeting in the imperiled grasslands and sagebrush steppe of the Northern Great Plains, where prioritization can help stem the loss of private grazing lands to cultivation. This approach allowed us to measure the relative efficacy of different species as surrogates, and provided a metric to weight models among multispecies algorithms. In this test, we also considered a simple surrogate of intact rangelands, fully agnostic to species data, representing a null model for conservation targeting. Prioritization outputs weighted by species strength of surrogacy among intact parcels give practitioners a roadmap for future investments to maintain these already functioning landscapes for conservation. Furthermore, our measure of intactness vastly outperformed any species model as a surrogate for conservation, highlighting the efficacy of strategies that target large and intact cores for wildlife conservation.

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Montana Chronic Wasting Disease Surveillance and Monitoring - 2021 Season Review

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Montana, Fish, Wildlife, and Parks (FWP) has been conducting surveillance for Chronic Wasting Disease (CWD) since 1998, and first detected CWD in wild deer in 2017. In 2021, FWP prioritized sampling in northwestern, southwestern, south central, and east central Montana. Additionally, FWP continued to target sampling in the Libby CWD Management Zone and conducted a Southwest Montana CWD Management Hunt for a 2nd consecutive year. Surveillance and management efforts focused on maximizing the detection of CWD in new areas, limiting the spread of CWD, maintaining or reducing prevalence of CWD in endemic areas, improving CWD communication and outreach with the public, and providing hunters the

opportunity to have their harvested animal tested for CWD. During the 2021 season, FWP tested 8,525 samples from mule deer (n=3,532), white-tailed deer (n=3,991), elk (n=951), and moose (n=51). Of these, 323 animals tested positive and CWD was detected in 4 new hunting districts (317, 330, 340, and 700). Among positive hunting districts, prevalence estimates between 2017-2021 ranged from Between 2017–2021, CWD prevalence was 6% (95%.CI:.5-7%) in white-tailed deer within the Libby CWD Management Zone and 21% (95% CI:19-23) in white-tailed deer within the Southwest Montana CWD Management Hunt Area. For 2022, FWP will continue to promote proper carcass disposal and transport regulations and advocate sample collection by hunters. Additionally, CWD management actions will be evaluated for addressing high CWD prevalence areas across the state.

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****Responses of Elk to Changes in Travel and Access Management**

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Rifle-hunting on land accessible to the public is the main tool wildlife managers use to manage the abundance of elk (*Cervus canadensis*) in the western United States. Elk are increasingly located on land inaccessible to hunters during rifle season in the western United States, decreasing the ability of managers to reduce the abundance of elk and harvest opportunity for hunters. Management actions are used to balance hunting risk across landscapes and assumed to influence the behavior of elk, but evidence is limited. We evaluated how restricting hunter access and motorized routes influenced the behavior of elk during rifle season in the northern Sapphire Mountains, Montana, USA. We used locations of female and male elk during the rifle season during 2014-2015 prior to restrictions and again in 2019-2020 following restrictions to evaluate elk responses. We hypothesized restrictions would influence the behavior of elk more strongly than other factors since elk have been shown to respond strongly to changes in hunting risk. Additionally, we evaluated how access of elk to hunters during rifle season changed over time to understand patterns in the location of elk. We found no support that elk responded to restrictions. Preexisting use of adjacent land by elk and restrictions mainly to motorcycles likely decreased efficacy of restrictions. Further, access of elk to hunters was low, and decreased over time for male elk.

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