19TH ANNUAL
WILDLAND RESOURCES
GRADUATE RESEARCH
SYMPOSIUM

FRIDAY, APRIL 19, 2024
Welcome to the nineteenth annual Graduate Research Symposium presented by the Wildland Resources Department. Today we have the opportunity to hear from twenty-three graduate students as each presents the ideas that will form the basis of their graduate research. Each student brings an individual perspective and fresh ideas to the department and the research community as a whole. The diversity of presentations you will hear reflect the variety of approaches our students take toward answering important natural resource management and conservation questions.

Today also provides an opportunity for our students to gain experience conveying complex ideas in a public setting and requesting audience feedback. Not all students presenting today will be at the same stage in research development. Many are still thinking about how best to proceed: others have already started the research process. However, all students will benefit from the insight and comments offered by their colleagues.

ABOUT THE SYMPOSIUM

Each of the thirteen M.S. and ten Ph.D graduate candidates have prepared an abstract and a ten minute presentation to share their research proposal or a project update. A five minute question and answer period will follow each presentation. Please use this opportunity to improve the work of your colleagues. Your comments and insights are welcome and expected.

FORMAT OF PRESENTATIONS
# Presentation Schedule

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Gambel oak shrublands are a common sight in the foothills of Utah. These oak shrublands present a wildfire hazard and must be carefully managed, especially along the Wildland Urban Interface. Management of Gambel oak can be a challenge due to prolific resprouting after disturbance. Little research has been conducted on the management of Gambel oak in Utah, and studies performed in the southern end of its range may not be applicable due to variations in vegetative habits between northern and southern sites. I propose to examine the use of fuel treatments (such as prescribed burns, thinning, mastication, and herbicides) on Gambel oak in Utah and the longevity and efficacy of different treatment regimens. I will look at oak regeneration, variations in treatment methods, length of time since treatment, and site characteristics such as elevation, aspect and slope. The response will be measured as biomass of oak regeneration post treatment, and comparisons will be made between varying treatment methods and maintenance protocols. Results may be used to inform future management decisions and promote research into management of similar resprouting species.

Keywords: Gambel oak; Fuels treatment; Longevity; Effectiveness; Utah 
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Advisors: L. L. Yocom & E. M. LaMalfa
Funding Sources: Rio Tinto Kennecott, USU Ecology Center
Mule deer (Odocoileus hemionus) are an ungulate common to mountainous and desert landscapes throughout western North America. In these seasonally variable environments, harsh winter conditions and resource limitation can drive seasonal movements in which mule deer inhabit higher elevation habitats in the summer and lower elevation habitats in the winter. As deer change landscapes, it is suspected that their densities change with respect to different habitats based on resources they provide. Habitat selection of individual deer has been studied extensively, variation in deer density, and how that variation structures according to the environment, has not been specifically explored. Fluctuations in density are important to understand as that can have impacts on larger ecological processes such as population growth, predation rates and infectious disease transmission. Here, we will attempt to calculate mule deer density as it varies by habitat and season. Adult female mule deer were caught and fitted with GPS collars in five different populations throughout Utah. Using GPS collars and landcover satellite data, we constructed parameters for large scale camera grids. We used the parameters to identify camera grid locations on deer summer and winter ranges, avoiding seasonal migrations. By deploying multiple camera grids in each field site simultaneously, we will rotate grid locations used to maximize area and habitat types covered. Utilizing the camera data we collect, we aim to estimate how relative mule deer density varies by habitat type and season to improve insight into landscape level ecological interactions to better understand disease transmission in and amongst populations.

Keywords: mule deer; camera grids; density
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Advisor: Manlove
Funding Sources: U.S.D.A. - APHIS
Formally a subspecies of blue grouse, dusky grouse (Dendragapus obscurus) population monitoring and life history has gone largely unexplored before and after its taxonomic split. Past blue grouse research has been predominantly studies on sooty grouse (Dendragapus fuliginosus) in the Pacific Northwest during the mid to late 20th century. The limited space-use research on dusky grouse reveals significant variability in breeding habitat selection, strong seasonal site fidelity, and breeding-to-wintering site distances exceeding 15km. For the purpose of designing an optimized monitoring program for the Utah Division of Wildlife Resources, I am conducting breeding surveys in the Bear River Range using both autonomous recording units (ARUs) and human observer point counts. I plan to assess the results for consideration of a state-wide monitoring approach using ARUs. I found that the single-note "whoot" vocalization made by displaying males is effectively detected by sound recognition software. I also found that ARUs demonstrate detection distances comparable to the human ear for this species. I am using pointing dogs, noose poles, and walk-in traps to capture dusky grouse. To discern seasonal habitat selection and site fidelity patterns, I am fixing store-on-board GPS units to females. These units provide locations every 20 minutes during the day. I am using this detailed telemetry data to locate nests, track broods, trace migration routes, and assess winter space utilization at a fine scale. I tagged 8 females with GPS units in late summer 2023, and successfully tracked them until they commenced their migrations in mid-fall. During the subsequent winter, I partially downloaded GPS data from aircraft. My plan for 2024 involves tracking surviving females and their broods while aiming to deploy an additional 15 GPS units.

Keywords: dusky grouse; forest grouse; population monitoring; life history
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Advisor: Dave Dahlgren
Funding Sources: Utah Division of Wildlife Resources
Recent literature reviews suggest that additional empirical studies are necessary to understand the effects of predation risk on prey behavior, particularly concerning the extent of these effects and their consistency across different spatiotemporal domains in free-living systems. In the Yellowstone elk-wolf system, it has been hypothesized that elk (Cervus canadensis) increase vigilance at the expense of feeding to an extent that reduces elk nutritional condition, survival, and reproduction. However, previous studies of elk vigilance and feeding responses to wolves have only measured elk behavior during daylight hours and neglected elk responses to other important predators, namely mountain lions. There may be negative alterations in the trade-off between feeding and vigilance during nighttime that have not been accounted for. The goal of this study is to assess the extent that spatiotemporal variation in predation risk in a multi-predator environment affects the time elk spend feeding. I will investigate a mechanism that may drive demographic changes in elk - reduced feeding time in response to risk – over a twenty-four-hour period. As the risk in a multi-predator environment increases, do elk feed less to be vigilant more? To explore these concepts, I will gauge elk body movement utilizing tri-axial accelerometer measurements on collared female elk. I have categorized elk behaviors into eleven distinct categories via observational studies, although my study will predominantly concentrate on two key behaviors: feeding (browsing and grazing) and vigilance (standing head up). To effectively classify and discern the importance of these behaviors within a twenty-four-hour period, I will employ a random forest model. I predict that as predation risk increases, vigilance may increase in older and more vulnerable female elk, but there will be little to no change in the amount of time that younger female elk allocate to feeding. I expect that my results will advance general understanding of prey response to predation risk in wildlife systems.

Keywords: Accelerometer; Biologging; Behavior; Elk; Risk Induced Trait Response
Email: rosemarie.pugh@usu.edu
Advisor: Dr. Daniel MacNulty
Mountain lions (Puma concolor) are obligate carnivores capable of hunting large-bodied prey. Their habitat associations are often characterized by steep heavily forested landscapes and areas occupied by mule deer (Odocoileus hemionus). They also exhibit considerable spatial overlap with feral horses (Equus caballus), a non-native prey species abundant across the American west. There have been several studies examining the effects of a non-native predator on native prey populations, yet there is little literature indicating how a native predator might adapt its habitat use and foraging strategies in response to abundant non-native prey. My study area is a 3,158 km² region of Lincoln County Nevada, where previous research conducted from 2018-2022 evaluated prey-switching in mountain lions. The objective is to determine whether mountain lions hunt opportunistically, choosing habitat that maximizes their likelihood of success regardless of species, or if they are hunting selectively for a particular prey species, choosing habitat that maximizes their encounter rate with particular prey. I will use measures of mountain lion prey identified at kill sites to predict the relative vulnerability of both horses and mule deer. My analysis will consist of developing vulnerability maps for feral horse (HV) and mule deer (DV) using data from kill-site investigations, habitat characteristics, and mountain lion home ranges. I will then overlay individual vulnerability maps with terrain features within mountain lion home ranges to determine if: (1) Mountain lions are selecting deer (their native prey) and opportunistically predating horses (HV < DV) or if (2) Mountain lions are selecting landscape features in which they are more successful and opportunistically taking what is available. Results will aid state and federal agencies charged with managing invasive and native species in rapidly changing ecosystems.

Keywords: Mountain lion; prey selection; Feral horse
Advisors: David Stoner and Kate Schoenecker
My proposed research aims to quantify food availability, habitat, and waterfowl and shorebird (waterbird) populations to construct a bioenergetics model for nonbreeding waterbirds on Great Salt Lake (GSL) wetlands. I am conducting a multi-year observational study to document foraging resource biomass production and waterbird population dynamics within the impounded units of three waterfowl management areas, an impounded migratory bird refuge, and two non-impounded sheetflow wetlands around GSL during the fall and spring migratory season. Since depth is a limiting factor for waterbird foraging, I will also perform a GIS analysis to evaluate how water depth changes under different lake elevation scenarios in high priority bird habitats such as mudflat playas and lacustrine littoral wetlands. I will use biomass estimates to determine the approximate resource value of each habitat type. I will then use published resources on maximum foraging depths for different waterbirds in conjunction with ground truthing from depth estimates during biomass surveys to constrain habitat area maps to reflect current conditions for different species that are constrained to specific water depths. To estimate population-level energy demand, I will conduct ground surveys for waterbirds to calculate area specific density estimates, and proportionally scale to fit long-term state census datasets that run monthly on each of my study areas during fall and spring. This will allow me to estimate total abundance and approximate migration chronology. I will assign foods found in biomass surveys a true metabolized energy value for each bird species, which is calculated using basal metabolic rates that can be adapted from the literature for most species. I can then utilize metrics of bird body condition from banding datasets as well as population and environmental covariates to construct a bioenergetics model that can evaluate how food availability changes under different foraging resource scenarios.

Keywords: Wetland Ecology; Avian research; Population Ecology; Great Salt Lake
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Advisor: M.R Conover
Funding Sources: Utah Division of Wildlife Resources’ Great Salt Lake Ecosystem Program, Utah Division of Water Resources, Sportsmen for Fish and Wildlife, Delta Waterfowl, Utah Wetlands Foundation, US Geological Survey, USU Ecology Center
Animal movement offers insight into everything from individual survival to ecosystem function and its study can uncover important but difficult-to-observe species characteristics. Modern high-resolution biologgers enable researchers to examine animal movement in greater detail than ever before. When combined with traditional GPS and observational data, these emergent technologies offer a fine-scale vantage into previously cryptic animal behaviors and help unlock the mechanistic drivers of animal movement, which in turn, is fundamentally linked to fitness and survival. In wildlife recovery it is essential to understand the vital rates (reproduction and survival parameters) of a population and their drivers to determine the rate which managers might best target for improvement. The federally endangered Sierra Nevada bighorn sheep (Ovis canadensis sierrea; Sierra bighorn), is largely unscathed by disease and habitat loss which have driven declines in other bighorn populations, yet their recovery remains stalled as their population has flattened or declined in recent years. Fine-scale movement data offers researchers an opportunity to better quantify Sierra bighorn vital rates and better understand drivers of fitness, which can help managers meet recovery goals. Here, we aim to couple biologger data from accelerometers with GPS and observational data to gain insight into movement patterns and fitness costs that drive two important contributors to vital rates in Sierra bighorn: parturition and migration. In my first chapter, I hope to improve predictions of parturition and neonatal survival through a combined biologger modeling approach. In my second chapter, I plan to merge accelerometer, observational, and spatial data to discern how fitness informs migration decisions. We hope this combined biologger modeling approach will improve measurements and predictions of essential vital rates and increase understanding of fitness-based drivers of migration in an endangered species.

Keywords: accelerometry; endangered species; migration; parturition
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Funding Sources: California Department of Fish & Wildlife, Utah State University
Cowherds grazing U.S. rangelands today consume a diet dominated by a monotony of grasses, with significant decrements in nutritional value as the season progresses from spring to fall. Such declines create nutritional inefficiencies and significant increments in the production of the greenhouse gas (GHG) methane by livestock. Moreover, grass monocultures are typically devoid of functional biochemicals or plant secondary compounds (PSCs) like phenolics, which are fundamental for the nutrition and health of herbivores. For instance, phenolics have antibiotic actions that reduce populations of methane-producing bacteria and inhibit rates of ruminal proteolysis, which increase the amounts of dietary proteins reaching the intestine. I hypothesized that the provision of a group of phenolics (condensed and hydrolizable tannins) to cattle grazing grass monocultures would enhance the efficiency of nutrient use and reduce enteric methane emissions. Twenty-four Black Angus cow-calf pairs will be allotted to six 9-acre paddocks seeded with meadow bromegrass (4 pairs/paddock). Animals in the Control (Ctrl; n=3) and Tannin treatments (TT; n=3) will graze the grass paddocks and receive a supplement of corn distillers’ grains (DDGS) in the morning, with the addition of a mix of condensed and hydrolizable tannins (0.4% of the diet) in TT. I will determine herbage dry matter availability per unit area in each paddock before and post-grazing, forage nutritional quality, cow and calf body weights, methane emissions, fecal and urinary N, and blood urea nitrogen. We predict that cows supplemented with tannins will gain more weight, reduce enteric methane emissions, and shift their nitrogen excretion from urine to feces, thus increasing efficiency of nutrient use and abating environmental impacts occurring during the cow-calf phase of the beef production system.

Keywords: Methane; tannins; ruminants; rangelands
Email: h.blanchard@usu.edu
Advisor: Juan Villalba
Funding source: This effort was supported by grants from the Utah Agricultural Experiment Station (UTAO+1638), the Pleiades foundation, and the United States Department of Agriculture, National Institute of Food and Agriculture, Award Number: 2021-69012-35952.
Populations of many large carnivores have been increasing and expanding their range across North America in recent decades. The Baldwin Bear Management Unit in the Northern Lower Peninsula (NLP) of Michigan, is experiencing an increase in the black bear (Ursus americanus) population, and subsequently human-bear interactions in this unit, have also been steadily increasing. While population trends suggest this increase in the Baldwin Unit, black bear density is unknown and black bear movement behavior may be influencing what habitat they are choosing to use and when. My study aims to estimate black bear density through non-invasive genetic data obtained via scat detector dogs and movement behavior obtained from GPS collars. Genetic samples will be used to create a spatially explicit mark-recapture model for density estimates, while movement data will be used to create a behavior state interaction model using Hidden Markov Models to determine behavioral states across densities and habitats. Determining density and understanding black bear behavior in this unit will allow managers to better aid in navigating human-bear interactions while effectively managing the population.

Keywords: Black Bear; Michigan; Density; Behavior

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Advisor: J. Young
Funding Source: Michigan Department of Natural Resources and Utah State University
Climate change can potentially have huge impacts on arid and semi-arid systems with potential changes in precipitation patterns posing a major challenge. We need to understand how plants respond to these changes in water availability. The current knowledge of plant water uptake is inferred by root biomass data which is a poor indicator of water uptake. This research proposes a novel approach using hydrological tracers and soil water flow models to quantify water uptake patterns across an aridity gradient in southern Utah to predict vegetation shift. We hypothesize that plants with deeper root distributions will be more abundant on the landscape because they will be able to access water more consistently in the dryer seasons. We will study different plant species including cacti and C4 grasses across three sites with varying aridity levels. We will use tracer injections at different soil depths to identify active roots from non-active root distributions. By running these active root distributions through the soil water flow model Hydrus1D, we can estimate water uptake across different species over time. This approach will not only offer new insights into water uptake strategies for previously unsampled plant types, but also improve our understanding of how vertical root distribution among different plant species influences water uptake and how plant species will respond to climate change. We will validate our water uptake estimates and community composition predictions through observations of soil moisture and plant growth.

Keywords: Hydrologic Tracers; Climate change; Water flow models; Root Biomass
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Advisor Name: A. Kulmatiski
Recovery and conservation of large carnivores is challenging because carnivores continue to be a significant threat to livestock. The gray wolf (Canis lupus) has recovered throughout much of its range in the northwestern USA and livestock producers are often limited to using nonlethal tools to reduce depredation as part of the Wolf Management Plan and the Endangered Species Act. Current nonlethal tools, such as livestock guarding animals and fladry/turbo-fladry, can be effective at reducing conflict, but wolves can become habituated and agencies and livestock producers are interested in applying new technology, such as drones. My thesis research will evaluate the effectiveness of drones as a potential hazing tool on wolves within the vicinity of livestock. I will experimentally test for differences in the response of wolves to hazing with drones that emit human voices (varying voices), other sounds, lights, or a combination of lights and sounds relative to control drones without an attached apparatus. Wolf behavioral responses will include flight initiation distance when initially hazing each wolf, how this varies across different habitats (i.e., flat pasture, forested areas), and whether wolf responses vary across time (i.e., habituation). These findings will contribute to understanding if the use of drones is an effective, novel hazing tool to reduce conflict and improve wolf-livestock coexistence.

Keywords: Drones; Carnivores; Hazing; Nonlethal; Cattle
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Advisor: J. K. Young
Funding Source(s): U.S. Department of Agriculture
Altered fire regimes have profoundly shaped sagebrush ecosystems in western North America. Invasive annual grasses have led to more frequent fires in some areas, while fire suppression has led to conifer encroachment in others. Historically, the effects of fire have been studied more extensively in the greater sage-grouse than in other sagebrush associated avian taxa. The recent decline of pinyon jays has highlighted the need to manage for multiple avian species within the great basin rather than focusing on a single species. With that in mind, I am studying how fire shapes the distribution of four sagebrush-associated species (Brewer's sparrow, sage thrasher, sagebrush sparrow, and green-tailed towhee) and three grassland-associated species (vesper sparrow, western meadowlark, and horned lark) across heterogeneous sagebrush landscapes in northern Utah and southern Idaho. My goals are: (1) to construct density maps for each of these species and observe how fire shapes their distribution, (2) forecast how future fires will affect these distributions throughout the northern great basin, and (3) compare how each species correlates to sage-grouse and pinyon jay abundance. I am using a chronosequence approach, placing point count transects within fire perimeters that burned between 1996 and 2020 and pairing each of these with a reference transect outside of any known fire parameter. All avian species observed from each point along the transect are recorded and binned by minute of detection and radial distance from the point. This method allows for simultaneous estimation of abundance and detection probability when analyzed in a hierarchical framework. This research will inform how land managers evaluate the effects of fire in sagebrush ecosystems and to better conserve songbird populations.

Keywords: Songbirds; Sagebrush; Fire; Community Ecology

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Advisor: Dr. Dave Dahlgren & Dr. Eric Thacker
Funding Source(s): Bureau of Land Management, Utah Chukar and Wildlife Foundation
As a result of decades of wildfire suppression policies, forests across the U.S. were left overgrown. With this excess fuel came increased wildfire risk. In the Uinta Mountains of Utah, the USFS is in the midst of a multi-year project which employs thinning and pile burning to remove potential fuel while also promoting the health of the forest. Felled trees are placed in slash piles to later be burned. Determining whether cavity-nesting bees are nesting in slash piles is a primary focus of this project. One species of particular concern is Bombus occidentalis due to its recent decline and the possibility that it may be nesting in slash piles. To get an idea of what species are present, we conducted sampling via hand netting and trap nests which were left out for the duration of the season. We also collected woody material from piles which was brought back to the lab to monitor for emergence. Next season, we will be taking a more hands-off approach; instead of collecting wood, we will be erecting screened enclosures over piles and fitting them with traps to passively collect insects throughout the season. While a broad goal of this project is to assess how various forest treatments are impacting native bees, we have a particular interest in the potential for slash piles to be functioning as a nesting resource for cavity- and ground-nesting bees. Bombus occidentalis, though not the focus of this project, is a species of particular interest to us due to its recent decline. The aim of this project is to provide land managers with information so that they may implement informed management directives which will maximize both immediate and long-term benefits to the plant and pollinator communities while simultaneously accomplishing their goal of reducing fuel load on the landscape.

Keywords: Bees; Forestry; Fuel reduction; Slash piles
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Advisor: L.L. Yocom & K.K. Graham
Funding Source(s): U.S. Forest Service, USDA-ARS, USU Ecology Center
The Yukon-Kuskokwim (YK) Delta (W Alaska) is currently undergoing large ecosystem changes due to rapid climate warming and increased tidal flooding. In turn, these environmental change drivers may modulate when and where abundant migratory herbivorous birds, such as geese, influence this high-latitude coastal landscape. Predicting alterations in ecosystem functioning requires an integrative understanding of how these forces, alone and in combination, affect key ecosystem properties. In an ongoing mesocosm field experiment established in three different plant communities of the YK Delta found along a flooding gradient, we simulated periodic tidal flooding under both ambient and warmed temperatures, further combined with the absence and presence of simulated goose herbivory. We measured plant community and ecosystem respiration responses. Preliminary, one-year results suggest that responses to warming, flooding, and herbivory vary among communities. We found that (1) in the least flooded and intermediately flooded communities, flooding canceled out the decrease in ecosystem respiration caused by herbivory, ultimately increasing respiration in warmed conditions (in the least flooded community). Not surprisingly, (2) lower biomass with herbivory decreased respiration in all communities. Yet, (3) the naturally most flooded community showed biomass compensation, with herbivory having no effects. Here, flooding alone decreased respiration, with warming partially offsetting this effect. Overall, our results suggest that considering flooding, herbivory, and warming influences, and how they play out across plant communities, is crucial to understand future changes in high-latitude coastal ecosystems. Alterations in ecosystem respiration and plant communities have implications for carbon and nutrient cycling. As an ongoing experiment, future data collection will help inform on sustained ecosystem responses to these environmental change drivers.

Keywords: Carbon flux; Ecosystem respiration; Mesocosm; Plant functional group; Point-intercept method
Email address: Tyler.Williams@usu.edu
Advisor: Dr. Karen Beard
Funding Sources: National Science Foundation (NSF); USU Ecology Center
Alpine regions above the treeline are home to unique and diverse flora and fauna adapted to harsh climatic conditions, providing essential ecosystem services such as water regulation, soil formation, and carbon sequestration. However, these regions are highly sensitive to the impacts of climate change, with the potential for treeline advancement and the displacement of specialized alpine habitats. Bhutan, in particular, has experienced a dramatic 368-meter ascent of the treeline over three decades due to climate warming, resulting in the encroachment of woody plant species into the alpine ecosystem. Adding to the ecological challenges, government restrictions on traditional management practices on rangelands could potentially exacerbate the degradation of alpine rangelands, further threatening the delicate balance of these high-altitude environments. Despite these potential issues, a significant knowledge gap persists regarding the ecological and social impacts of this transformation. Therefore, this study aims to address this gap by assessing the impacts of tree expansion on alpine vegetation dynamics, soil carbon storage, nitrogen and phosphorus availability, and soil fungal taxonomy and functional groups. The study will compare these ecological changes at the community level, comparing between forest, treeline ecotone, and alpine regions under both deciduous and coniferous tree encroachments, while also considering variations between north- and south-facing slope aspects. Furthermore, this study will shed light on how the restrictions on traditional management practices have contributed to the degradation of alpine rangelands, and how these changes have impacted local communities, particularly in the context of the mounting pressures from climate change. By addressing these knowledge gaps, the findings of this study have the potential to inform policy decisions, guide conservation efforts, and enhance our understanding of the complex interactions between climate change, land use, and the resilience of alpine ecosystems.

Keywords: Treeline Expansion; Soil carbon storage; Nitrogen; Phosphorus; Soil fungal diversity; Social impacts:
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Advisor: Y. Zhou
Funding Source(s): Power of One Fellowship, Quinney College of Natural Resources, USU.
Multifunctional foodscapes are being created using strategically selected legume and non-legume forb species spatially distributed as resource patches or “islands of diversity” in a surrounding grass monoculture, designed to enhance rangeland sustainability. I propose to investigate various challenges and opportunities associated with this intervention using novel technologies and analytical methodologies. First, I will test the underlying predicate that free ranging livestock preferentially select for anthropogenically improved habitats over a background matrix of sagebrush steppe. Data was collected on 56 cows over three years grazing an area within Desert Land and Livestock, which contained varying livestock and habitat improvement treatments. Second, I will examine the feasibility and applicability of “islands of diversity” established in monotonous landscapes within commercial livestock operations throughout Utah. USU extension is cooperating with several producers to establish “demonstration plots.” I will assess species establishment and persistence under typical grazing conditions in those operations. Third, I will investigate the applicability of using virtual fencing technology to maintain smart foodscape islands. I will test whether visual cues improve efficacy and rate of learning in virtual fencing, and whether visual cues in conjunction with virtual fence and “islands of diversity” can drive livestock movement and distribution on a landscape. Finally, I will explore the role of plant secondary compounds (PSC) in legumes as agents of epigenetic change in livestock. I hypothesize that appropriate doses of PSC like phenolics will not only improve maternal health (i.e., antioxidant, immunomodulatory, and anti-inflammatory actions), but that those benefits will extend to their offspring via the placenta during fetal development, and through maternal milk during the postnatal period. In summary, I will apply the concept of “island” at the ranch level and then explore how landscape interventions and virtual fencing technology influence habitat selection and “island” use by cows and their offspring health.

Keywords: Smart Foodscapes; biodiversity; virtual fence; epigenetics; secondary compounds; habitat selection
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Funding Sources: USDA National Institute of Food and Agriculture
The Uinta Basin in northeastern Utah is home to many endemic plant species, many of which are threatened by energy development. My research focuses on Flowers penstemon (Penstemon flowersii), which was petitioned for listing under The Endangered Species Act in 2010. After the listing was denied, a boom in energy development occurred threatening the habitat and existing populations of this species. Monitoring was initiated in 2015 and assessed annual survival, plant health, population abundance, reproductive success, and severity of herbivory. Habitat modeling identified key soils required for the species and analysis of population data is ongoing. Energy development remains a major threat, but climate change may also be having an impact on this species.

Keywords: Penstemon, Penstemon flowersii; energy development, rare plants, ESA.
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Big sagebrush (Artemisia tridentata) populations are at risk of decline in the Colorado Plateau due to climate change. Increased temperatures and altered precipitation regimes may create unfavorable conditions for sagebrush, which are already on the southern end of their historic range. As climate changes and resources become more limited, competition (both inter- and intraspecific) for those resources will also increase. The effects of herbivory on sagebrush may also be exacerbated. Our study aims to understand how potential interactions between drought and biotic factors may affect sagebrush density in the Colorado Plateau. We sampled 36 pairs of ~100 m² plots, distributed across three sites in southeast Utah. Plots were selected to represent a range of soil depths and textures. In 2016, one of each pair was fenced to exclude large ungulates. We sampled shrub densities by size class in all plots in 2016, 2022, and 2023. We found that total sagebrush density decreased across all sites between 2016 and 2022, which encompassed a drought period, though the decrease was most pronounced at one of the three sites. The majority of sagebrush occurred in two size classes, 15 – 50 cm and 50 – 100 cm. While we observed moderate reductions in densities of 50-100 cm sagebrush over time, sagebrush densities in the 15 cm – 50 cm size class decreased dramatically (by 66%) between 2016 and 2022. Large ungulate access did not have any significant effect on sagebrush density over time, but declines in sagebrush densities were greater at lower elevation sites compared to higher elevation sites.

Keywords: sagebrush; Colorado Plateau; soil texture; soil depth; herbivory
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The resurgence of wolf (Canis lupus) populations in Oregon offers a valuable lens through which to examine the complex interplay between wildlife and the evolving landscapes they inhabit. Despite concerted recovery efforts, the growth and territorial expansion of Oregon's wolves lags behind neighboring regions, underscoring the need to investigate potential limiting factors. This study focuses on the pivotal role of human-caused mortality of breeding wolves, which may profoundly impact pack stability, reproductive success, and overall population dynamics. Utilizing a 15-year dataset, including 170 GPS radio-collared wolves and records of human-induced mortalities, the research employs population models, statistical analyses, and GIS mapping to elucidate the multifaceted impacts of breeder loss against the backdrop of habitat quality, prey availability, and human land use. Preliminary findings indicate that breeder loss, especially when human-induced during breeding periods, can lead to pack dissolution and lags in reproductive outputs, thereby hindering population recovery. This study aims to explore further the immediate and compensatory responses within wolf packs to such losses, assessing their collective influence on the long-term viability of Oregon's wolf populations. By shedding light on the nuanced effects of key variables on wolf pack dynamics and population trends, this study aims to provide actionable insights for formulating nuanced conservation strategies that respect the wolves' complex ecological roles and conservation needs amidst rapidly changing environmental conditions.

Keywords: Canis lupus; human-caused mortality; pack stability; breeders
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Livestock landscape use patterns play a critical role in shaping the structure and function of rangeland systems. In order to manage for healthy, functioning rangelands, it is essential to understand how these space-use patterns are shaped by the thermal environment and how they might be altered by the increasing temperatures expected with climate change. We will characterize the behavioral responses of Rarámuri Criollo (RC) cattle (a heritage breed adapted to the arid conditions of the Chihuahua region of Mexico) and Red Angus (RA) cattle (a conventional breed) to temperature in the Colorado Plateau, USA. We have outfitted 20 RA and 20 RC cows with GPS- and temperature-enabled collars. We will first examine the effect of air temperature and solar radiation on the temperature recorded by the collars to identify the temperature at which RA and RC cows seek thermal refugia. Second, we will build a habitat selection function that examines the effect of air temperature on cattle site selection. Finally, we will create a spatially and temporally dynamic model linking air temperature to operative temperature to examine how air temperature and microsite characteristics affect the heat load experienced by cattle. RC cows are generally smaller and lighter-colored with less subcutaneous back fat than RA cows, traits that may allow these cows to lose relatively more heat through radiation relative to conventional breeds. Therefore, we expect RA cows to seek thermal refugia at lower temperatures than RC cows. In particular, we expect areas with north-facing slopes and with woody vegetation to provide cooler thermal environments for cows; as such, we expect to see RA cows select for these areas at lower temperatures than RC cows. This research may identify selection for animals with high heat tolerance as a climate mitigation strategy for producers wanting to maintain range condition under increasing temperatures.

Keywords: cattle; heritage breed; climate change; operative temperature; Colorado Plateau
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Carbon sequestration by forests is expected to make up ~25% of emissions reductions solutions and is considered to be one of a few such solutions that is actually affordable and scalable. In Utah, the majority of forest carbon is sequestered through tree growth in spruce-fir-aspen forests. Given the increasing importance of forest carbon in determining emissions policy, it is necessary to understand the drivers and magnitude of tree growth, however, that understanding is currently lacking in these forests. In addition, spruce, fir, and aspen are expected to differ substantially in their responses to climate change. Therefore, a warmer and drier climate could affect growth rates differentially, potentially leading to compositional shifts or reduced carbon sequestration capacity. Therefore, if policymakers are to consider growth in these forests as potential carbon emissions offsets, it is imperative that we account for these sources of uncertainty in our projections. This project seeks to quantify recent species-specific tree growth rates for spruce, fir, and aspen and model the effects of climatic factors and interspecific competition on tree growth. I will first conduct a dendroecological analysis of tree rings collected from several age classes in closed canopy forest monitoring site in Cedar Breaks National Monument to identify which climatic and competitive metrics are most predictive of tree growth. Then, using both tree rings and forest inventory data, I will parameterize species-specific growth models using a Bayesian state-space approach. These models can serve as powerful tools for quantifying and forecasting uncertainty in future forest carbon. Understanding the competitive relationships between these species and the effects of climate on growth will undoubtedly serve managers and carbon accounting policymakers in the region, as well as advance our basic understanding of these systems.

Keywords: tree growth, climate, competition, state-space modelling, carbon policy
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Funding Source: National Science Foundation
Mountain goats (Oreamnos americanus) and American pikas (Ochotona princeps) naturally co-occur in parts of their native ranges. Recent mountain goat transplants have expanded their distribution southward, leading to novel overlap between the two species. However, potential interactions (competition or facilitation) between mountain goats and American pikas remain undescribed. Our study aims to provide critical baseline information about current community dynamics in alpine ecosystems with introduced mountain goat herds. Using two years of GPS collar data from introduced mountain goats (n = 26), we assessed their space-use and resource selection behavior relative to pika-occupied talus slopes in the La Sal mountains of southeastern Utah. We predicted that the potential for interspecific interactions would be high if mountain goats selected habitats near the talus edge, within pika giving-up-distances, where pika foraging is concentrated. Overall, mountain goats selected for proximity to pika habitat and 29% of all used points occurred within 10m of the talus edge, within the maximum pika giving up distance. These results highlight the potential for novel pika species interactions between mountain goats and pikas in our study area. Alpine ecosystems are predicted to be among the most vulnerable to the effects of climate change, which may alter interspecific interactions as species distributions shift upslope. Our research informs management for both species within goat-introduced ranges and provides insights into the potential for climate-induced novel species interactions.

Keywords: Interspecific interactions, animal movement, mountain goat, American pika, community dynamics
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In this study, I examined the effect of pre-fire fuel reduction treatments on wildfire ecological impact – commonly known as burn severity – and post-fire erosion in a high-value forested watershed in Utah. Burn severity is a strong indicator of post-fire erosion risk, and remotely sensed burn severity data, specifically the differenced normalized burn ratio (dNBR), are used in post-fire hazard frameworks to estimate debris flow probability and calculate sediment delivery volumes from burned areas. Fuel treatments that modify or reduce live or dead woody fuels have been shown to alter wildfire behavior and burn severity in semiarid forests of western North America, making fuel treatments a powerful method to proactively address post-fire erosion risks. Here, I used empirical models to simulate fuel treatment effects on burn severity and erosion. I used the LandFire Total Fuel Change (LFTFC) tool to simulate three common fuel treatments: thinning only, burn only, thinning + burn. I applied the burn severity model from Klimas et al. (2024, in pres.) with modified fuel layers created from the LFTFC to estimate continuous dNBR as a function of topography, vegetation and fuels. I used landscape erosion models to estimate debris flow probability and sediment delivery volumes and found that fuel treatments reduced both modeled dNBR, debris flow probability and sediment delivery volumes relative to no-treatment landscapes. Greater dNBR reduction compared to no-treatment scenario was associated with more intensive treatments, with thin + burn showing the greatest reduction in severity and erosion likely because this combination treatment reduced canopy fuel continuity and removed surface fuels. Burning alone was effective at reducing burn severity by virtue of removing surface fuels, while thinning alone was more effective in some vegetation types and fuel models than others.

Keywords: Burn severity, Fuel treatments, Erosion, Machine learning, Fire ecology
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