30th ANNUAL FRONT RANGE STUDENT ECOLOGY SYMPOSIUM

February 1st & 2nd, 2024
Colorado State University
Fort Collins, Colorado

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GRADUATE DEGREE PROGRAM IN ECOLOGY
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Welcome to FRSES 2024

The FRSES Mission

The Front Range Student Ecology Symposium is a showcase for outstanding ecological research done by secondary, undergraduate and graduate students from schools along the Front Range and beyond. Our entirely student-run symposium is organized like a traditional scientific meeting, with an emphasis on creating a supportive atmosphere for discussion and critique and providing a venue for Front Range students to interact. We welcome the participation of any student doing ecological or ecology-related research, whether at the level of organisms, populations, communities, ecosystems or social-ecological systems. Students may present completed research, research-in-progress, research proposals, senior or class projects, or simply ideas deserving a closer look by ecologists.

From Niches to Networks

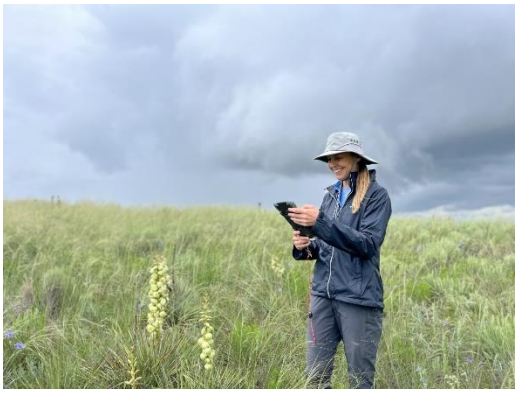
With this year's theme, "From Niches to Networks", we aim to highlight the increased collaboration among researchers within the field of ecology. Over time, there has been a substantial increase in the number of authors on a paper, suggesting an increase in scientific collaboration. While we all still exist within our own scientific niches, the emphasis on networking with other scientists in other research niches is more pronounced than ever before, especially within a field as dynamic as ecology. We found this concept embodied within the work of both our invited speakers, Dr. Christina Alba, and Dr. Olivia Messinger Carril. Dr. Alba, our opening plenary speaker, is an alumna of the Graduate Degree Program in Ecology and through her research at Denver Botanic Gardens, exemplifies our theme by connecting the Denver community to ecology. Dr. Messinger Carril, an author and expert on bee taxonomy and bee-plant networks, exemplifies our theme in a very different way by connecting k-12 students with ecological concepts through education. While both scientists exist within their own scientific niche, they connect with unique groups to explore ecology in a way that includes groups who would ordinarily not deal with ecological concepts.

We hope you enjoy the 2024 Front Range Student Ecology Symposium!

Schedule of Events

Thursday February 1st, 2024		
9 am – 5 pm	**Check-in**	**Outside Ballroom**
9:30 am – 10:00am	**K-12 Welcome**	**Ballroom B-D**
10 am - 11:30 am	**K-12 Campus Tours**	**CSU Campus**
11:30 am -12 pm	**K-12 Lunch**	**Ballroom B - D**
12 pm – 1 pm	**K-12 Workshop and Presentations**	**Ballroom B - D**
1 pm – 2 pm	**K-12 Pollinator Activity**	**Ballroom B-D**
1 pm - 2 pm	**Workshops and Panels** • A facilitated discussion on Careers in Ecology • The BUZZ on Colorado Pollinators	**Room 304-306** **Room 312**
2 pm - 3 pm	**Workshops and Panels** • Demystifying the Oral and Written Exam • Ecology is Non-Binary: Queering current norms and norming diversity • Bridging the Gap between Science and the Media **(1 hr 15 min)** • Your Science in Ten Hundred Words: Building Trust Through Science Communication **(1.5 hrs)**	**Room 304 – 306** **Room 308 – 310** **Room 312** **Ballroom B - D**
3 pm - 4 pm	**Workshops and Panels** • Panning for Nuggets of Science Gold: Reframing Ecological Science Communication • Bridging the Gap between Science and the Media **(1 hr 15 minutes)** • Your Science in Ten Hundred Words: Building Trust Through Science Communication **(1.5 hrs)**	**Room 304 – 306** **Room 312** **Ballroom B - D**
4:15 pm - 5:15 pm	**Opening Plenary with Dr. Christina Alba**	**Ballroom B – D**
5:30 pm - 7:30 pm	**Poster Session & Social Hour**	**Ballroom B – D**
Friday February 2, 2024		
8 am - 3 pm	**Check-in**	**Outside Ballroom**
8 am – 8:30 am	**Coffee & Tea**	**Ballroom B – D**
8:30 am – 10 am	**Oral presentations Session 1:** • Evolutionary Biology • Fish and Wildlife Ecology • Agro-Ecology	**Room 304 – 306** **Room 308 – 310** **Room 312**
10 am – 10:30 am	**Coffee & Tea**	**Ballroom B – D**
10:30 am – 12 pm	**Oral presentations Session 2:** • Urban Ecology • Community Ecology • Disturbance and Restoration Ecology	**Room 304 – 306** **Room 308 – 310** **Room 312**
12 pm – 1 pm	**Lunch**	**Ballroom B – D**
1 pm - 2:30 pm	**Oral presentations Session 3:** • Behavioral Ecology • Global Change and Conservation Biology	**Room 304 – 306** **Room 308 – 310**
2:30 pm – 3 pm	**Coffee & Tea**	**Ballroom B – D**
3 pm – 4 pm	**Closing Plenary with Dr. Olivia Carril**	**Ballroom B – D**
4 pm – 6 pm	**Reception & Awards Ceremony**	**Ballroom B – D**

Plenaries



Opening Plenary: Dr. Christina Alba

Dr. Alba graduated from the Graduate Degree Program in Ecology in 2011 and is now an associate research scientist at Denver Botanic Gardens. She studies the ecological processes that shape plant diversity and distributions across various scales of organization--from individual plants, to populations, to entire communities. Her research questions typically fall under the umbrella of disturbance ecology. For example, she has studied how biological invasions, grazing, drought, fire, and altered hydrology due to green stormwater infrastructure affect plant biodiversity. Dr. Alba also conducts botanical inventories and makes natural history collections to grow the Kathryn Kalmbach Herbarium at the Gardens. Most recently, she has launched a multi-year monitoring effort to determine how various environmental factors shape tree-planting success along an urban greenway.

Closing Plenary: Dr. Olivia Carril

Olivia has been studying bees for over 25 years. She got her start at the USDA Pollinating Insects Research Unit, where her advisor and mentor gave her numerous opportunities to study bees in ecosystems around the western U.S., including an opportunity to study the bees of Grand Staircase Escalante National Monument, a project that she used to complete her Master's degree. She followed this up with a move to Southern Illinois to work on her PhD, studying a specialist bee and its host flowers. She now lives in Santa Fe New Mexico, where she splits her time between teaching science to middle school students and continuing her work sampling bee communities of the west. She is the author of three books on wild bees in North America: The Bees in Your Backyard, and The Common Bees of Eastern and Western North America.

Symposium Information

Abstracts: Abstracts for all oral presentations and posters can be found on our website, frses.org, or at the end of this program.

Participation: This year's symposium includes 32 posters and 37 oral presentations, with exciting work from Colorado State University, Metropolitan State University of Denver, University of Colorado – Boulder, University of Colorado – Denver, University of Colorado – Colorado Springs, University of Denver, University of Northern Colorado, and the University of Wyoming.

Judging and Awards: Judges will be present during the oral and poster sessions. Prizes donated by CSU and local community sponsors will be awarded to the top 3 Graduate and Undergraduate Poster Presentations as well as the top presenter for each Oral Session room.

FRSES 2024 Organizers and Volunteers

Executive Board: Kyle Ruszkowski (President), Ryleigh Gelles (Vice-President), Nicki Bailey (Secretary), Max Schmidtbauer (Financial Officer)

Committee Chairs: Jessie Mader (Outreach), Rose Parham (Abstracts), Matt Sturchio (Media and Marketing), Ryleigh Gelles and Alex Siggers (Fundraising), Josie Otto (Day-Of)

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Workshop Facilitators: Ian Pearse, Lisa Mason, Cozette Romero, Erin Jackson, Aramati Casper, Mikko Jimenez, Lizzy Rylance, Brett Wolk, Natie Magrath Novack, Alissa Iverson, Vanessa Callahan

Judges: Joe von Fischer, Anping Chen, Katie Rocci, DeeDee Wright, Andrew Du, Vilas Brown, Alisha Sharma, Alison King, Janet Prevey, Louise Comas, John Mola, Ruth Hufbauer, Maria Chavez, Stewart Breck, Sarah Hart, Jennie Willis, Dave Lawrence

Symposium Sponsors

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Expanded Schedule

Thursday, February 1st: Workshops and Panels		
1 pm - 2 pm	A facilitated discussion on Careers in Ecology Facilitator: Ian Pearse Moderator: Hannah Horowitz	Room 304-306
1 pm - 2 pm	The BUZZ on Colorado Pollinators Facilitator: Lisa Mason Moderator: Max Schmidtbauer	Room 312
2 pm - 3 pm	Demystifying the Oral and Written Exam Facilitator: CSU Ecology DEI Committee Moderator: Josie Otto	Room 304 – 306
2 pm - 3 pm	Ecology is Non-Binary: Queering current norms and norming diversity Facilitator: Aramati Casper Moderator: Shanelle Wikramanayake	Room 308 – 310
2 pm – 3:15 pm	Bridging the Gap between Science and the Media Facilitator: Mikko Jimenez and Lizzy Rylance Moderator: Elizabeth Diaz-Clark	Room 312
2 pm – 3:30 pm	Your Science in Ten Hundred Words: Building Trust Through Science Communication Facilitator: Denver Botanic Gardens Moderator: Sophia Gulutzo	Ballroom B - D
3 pm - 4 pm	Panning for Nuggets of Science Gold: Reframing Ecological Science Communication Facilitator: Brett Wolk and Katie Magrath Novack Moderator: Sophie Maksymkiw	Room 304 – 306

Thursday, February 1st: Poster Presentations Session 1 5:30 – 6:30 pm (shaded grey below) Session 2 6:30 – 7:30 pm	
1	Matt Schmidt **Grasshopper Herbivory as a Possible Mechanism of Grassland Community Change Under Nitrogen Fertilization**
2	Kelly Tobin **Strength of Top-Down Forces on the Establishment of Diorhabda spp. on Tamarix spp. in the Southwestern U.S.**
3	Izabella Rhomburg **The Effect of Drought on Plant Type Survival in a Seedbank in the Shortgrass Steppe of Northern Colorado**
4	Chance Roberts **Genotypic Variation Effects on Microbial Communities In Drought**
5	Maricela Alaniz **What's up with fire stuff? Using a mesocosm experiment to predict stream macroinvertebrate response to ash and sediment addition following post-fire flooding.**
6	Maddie Amick **Drought Changes the Community Composition of Soil Seed Banks to Further Differentiate from the Aboveground Community**
7	Hannah Horowitz **Territory Level Patterns of Reproductive Output Associated with Habitat Quality for an Island Endemic Bird (Aphelocoma insularis)**
8	Christopher Wicker **The Influence of Operational Sex Ratio on Pair-bond Formation in the Convict Cichlid (Amatitlania nigrofasciata)**
9	My-Lan Le **Identifying what drives the abundance and performance of rare plant species**
10	Sarah Nalley **Mating Traits Shape Responses to Global Change in Nearctic Dragonflies**
11	Kellie Brady **The story underneath: Influence of Photovoltaic produced microclimates on the production of secondary metabolites**
12	Dani Rosario **The influence of cacti on grassland recovery after a four-year experimental drought**
13	Greg Tooley **Revisiting the drivers of Interannual variability in primary production of tallgrass prairie after 29 years of global change**
14	Reilly Allison **Plant decomposition by photodegradation across Land Uses**
15	Stephanie Lemas **Sugars in Soils: A Chemical Analysis of Soil Hexoses**
16	Norah Schroder **The Effect of Fire Severity on Bee Nesting Habitats**
17	Anna Vogt **Comparison of functional composition of the overstory and understory in disturbed riparian forest communities**

18	Michaela Walheim **Long-term impacts of fire severity on the diversity of cavity-nesting bees**
19	Jason Wong **The effects of biocrust inoculum in seedballs on plant recruitment and biomass**
20	Bailey Caldwell **Effects of Seedball Composition and Carbon Addition Treatments on Dryland Plant Germination and Growth**
21	Josh Carrell **Multiscale ecological niche modeling exhibits varying climate change impacts on habitat suitability of Madrean Pine-Oak trees**
22	Sarah Hettema **Evaluating the impacts of fuel treatments on burn severity across the Front Range**
23	Cozette Romero Effects of Invasive Rodent Control on Island Forest Bird Demography and Health
24	Oliver Hoffman **Comparing Soil Health In Southern Minnesota: Agricultural vs Ecological**
25	Brielle Cerep-Funke **Matching ornamental plant palettes with current and future climate**
26	Emily Swartz **The Effect of Seedballs and Activated Carbon on Germination Rates after Herbicide Application**
27	Maria Schonewise **Green Roof Effects on Floral and Nectar Resource Production, and the Utilization of Rooftop Forage by Bumble Bees**
28	Nancy Bartholomew **Does intraspecific bee body size vary across urban parks by land cover or affluence?**
29	Annika Fridberg **Effect of community involvement within management decisions on community tolerance for large carnivores: a literature review**
30	Kelsey Sonius **Wildlife Conservation in La Bendicion: Exploring the role of Indigenous-led Stewardship and Knowledge Sharing in Shaping Conservation in the Tropics of Guatemala**
31	Becca McDonald **Wildlife Education Tools**
32	Kassandra Dutro **Traditional Ecological Knowledge, Indigenous Women, and Traditional Fire Practices in the Far North**

Friday, February 2nd: Oral Presentations Session 1 8:30 – 10 am	
Room 304-306: Evolutionary Ecology	
8:30-8:45	Adaptive Phenotypic Plasticity Evolves in Warm Climates During Range Expansion Eliza Clark, Colorado State University
8:48-9:03	Assessing the Genetic Structure and Adaptation of a Native Butterfly to Changing Elevation Lily Durkee, Colorado State University
9:06-9:21	Examining Evolutionary Ecology of White-Tailed Ptarmigan Using Molecular Techniques Meg Mahoney, Colorado State University
9:24-9:39	Local Adaptation and Underlying Genes in an Alpine-Obligate Finch Erica Robertson, Colorado State University
9:42-9:57	Genoscape and Migratory Connectivity of Loggerhead Shrike Holden Fox, Colorado State University
Room 308-310: Fish and Wildlife Ecology	
8:30-8:45	Occupancy, Abundance, and Productivity of Burrowing Owls Nesting in Eastern Colorado Sarah Albright, Colorado State University
8:48-9:03	The Secret Lives of Colorado's Wildlife: Maximizing Wildlife Data Collection from Camera Traps in Western Colorado Grace Gulig, Colorado State University
9:06-9:21	Factors Affecting Cause-Specific Egg Mortality in a Host-Parasite-Predator System Michael Johnson, Colorado State University
9:24-9:39	Exploring White-Tailed Ptarmigan Habitat Selection in Colorado Nicholas Parker, Colorado State University
Room 312: Agro Ecology	
8:30-8:45	Farmer-led Regenerative Management Practices Impacts on Soil Health in the High Plains Erin Jackson, Colorado State University
8:48-9:03	Dietary Parental Effects in a Generalist Herbivore Emma Sellers, Colorado State University
9:06-9:21	Don't Panic, It's Organic: Building Resilient Pest Management Strategies for Organic Hemp Systems Max Schmidtbauer, Colorado State University

Friday, February 2nd: Oral Presentations Session 2 10:30 – 12 pm	
Room 304-306: Urban Ecology	
10:30- 10:45	Parks, Pollinators and People: Do Bees and Butterflies Prefer Higher Income Parks in Denver, Colorado? Nicki Bailey, Colorado State University
10:48- 11:03	The Effects of Emerald Ash Borer on Temperature Magee Headley, Metropolitan State University of Denver
11:06- 11:21	A Multi-City Comparison of Urban Migration Stopover and the Underlying Social Landscape that Supports It Miguel Jimenez, Colorado State University
11:24- 11:39	Wetland Health and Water Quality in an Urban Greenway: Surveying Co-occurrences of Wetland Vegetation, Mesohabitats, and Aquatic Macroinvertebrates Roy Rutherford, University of Colorado - Denver
11:42- 11:57	Informal Greenspace Availability and Physical Noise Reduction: An Exploration of Equitable Noise Mitigation in Marginalized Urban Communities in the U.S. Jasmine Nelson, Colorado State University
Room 308-310: Community Ecology	
10:30- 10:45	Dominance of Clonal Plants Following Fire Raymond Erskine, University of Northern Colorado
10:48- 11:03	Environmental Factors Driving Parasitoid and Herbivore Abundance in a Tritrophic System Heron Lenz, University of Colorado - Colorado Springs
11:06- 11:21	Wildfire and Forest Thinning Shift Floral Resources and Nesting Substrates to Impact Native Bee Biodiversity in Ponderosa Pine Forests of the Colorado Front Range Ryleigh Gelles, Colorado State University
11:24- 11:39	Long-term Nitrogen and Short-term Precipitation Addition Do Not Interact, but Do Produce Legacy Effects in a Semi-arid Grassland Mary Linabury, Colorado State University
11:42- 11:57	Snug as a Bug in the Forest: Using Emergence Traps to Reveal Cryptic Insect Overwintering Habits Sophia Gulutzo, Colorado State University
Room 312: Disturbance and Restoration Ecology	
10:30- 10:45	The Role of Wet Meadows in Altering Post-Fire Stream Biogeochemistry: Using Nutrient Diffusing Substrates to Evaluate Limitations on Periphyton Production Alyssa Graziano, Colorado State University
10:48- 11:03	Contrasting Effects of Overstory Mortality on Juvenile Tree Vigor in Relation to Microclimates Edward Hill, Colorado State University
11:06- 11:21	Evaluating the Effectiveness of Riparian Forest Restoration using Plant Functional Traits Aziz Syammach, University of Denver
11:24- 11:39	Aquatic Ecosystem and Water Quality Impacts from the 2021 Marshall Fire in Boulder County, CO Lauren Magliozzi, University of Colorado Boulder
11:42- 11:57	Effects of Wildfire Burn Severity on Wild Bee Communities Two Decades Post-fire Alaina Smith, University of Denver

Friday, February 2nd: Oral Presentations Session 3 1 – 2:30 pm	
Room 304-306: Behavioral Ecology	
1:00-1:15	Thermal Acclimation of Metabolic Rate and Cognition in the Honeybee, *Apis mellifera* Elizabeth Rylance, Colorado State University
1:18-1:33	Investigating Mating Signals and Acoustic Challenges in a Nonrhythmic Treefrog, *Dendropsophus ebraccatus* Julianna Mendez, Colorado State University
1:36-1:51	To Eat Their Own: Cyclical Selection Pressures of Praying Mantids Drive the Prevalence of Sexual Cannibalism Archie-Em Walker, Colorado State University
1:54-2:09	Investigating the Role of Premating Behavioral Reproductive Isolation along a Speciation Continuum in a Polymorphic Neotropical Treefrog, *Agalychnis callidryas* Shanelle Wikramanayake, Colorado State University
2:12-2:27	Exploring the Dynamics of Metabolic Scaling in Honeybees: Impact of Group Size, Resource Environment, and Density Kord Dicke, Colorado State University
Room 308-310: Global Change and Conservation Biology	
1:00-1:15	Altered Recruitment Dynamics in Rocky Mountain Forests Under Rapid Climate Change Nick Bither, University of Denver
1:18-1:33	Research on How Heatwaves Affect Insects: An Overview of Commonly Studied Factors Kailey Hicks, University of Denver
1:36-1:51	Understory Plant Biodiversity is Inversely Related to Carbon Storage in a High Carbon Ecosystem Trevor Carter, University of Colorado - Denver
1:54-2:09	Effects of Light Pollution on Fall Webworm Mating Mykaela Tanino-Springsteen, University of Denver
2:12-2:27	Effects of Elevation on Plant Clonal Growth Organ, Clonal Trait Morphology, and Dominance in the Colorado Front Range Jordan Conley, University of Northern Colorado

Poster and Oral Presentation Abstracts

Abstracts are listed alphabetically by last name

Maricela Alaniz Colorado State University	**What's up with fire stuff? Using a mesocosm experiment to predict stream macroinvertebrate response to ash and sediment addition following post-fire flooding.** Increasing frequency of wildfires highlights the importance of understanding how fires affect freshwater streams. Post-fire flooding during the monsoon season can lead to subsequent ash and sediment input into streams which can further affect aquatic organisms. In Colorado, uncharacteristically large fires burned in 2020, including the Cameron Peak Fire - the largest in Colorado recorded history. Flash floods following these fires caused major ash, debris, and sediment runoff in nearby watersheds, affecting water quality and habitat critical to aquatic macroinvertebrates. To understand how varying levels of fire-related sediment affect macroinvertebrate communities, we designed a stream mesocosm experiment with six levels of deposited sediment (ranging from 0 L to 3 L of sediment added). After colonizing mesocosms with macroinvertebrates from the Poudre River near Fort Collins, CO, sediment treatments were randomly assigned to 18 mesocosms with three replicates of each treatment. During the 12-day mesocosm experiment, we measured macroinvertebrate drift, physical chemical conditions, and periphyton. On the last day of the experiment, we collected all remaining macroinvertebrates for identification. Surprisingly, concentrations of diatoms, green algae, and cyanobacteria were significantly lower in all sediment treatments when compared to the control. Preliminary results also suggest that sediment addition decreases macroinvertebrate abundance. Ultimately, the results of this study will inform our future experiments assessing the impact of multiple stressors (e.g., addition of both fire sediment and pollution from mines) in stream communities.
Sarah Albright Colorado State University	**Occupancy, abundance, and productivity of burrowing owls nesting in eastern Colorado** Burrowing owl (Athene cunicularia) populations have been declining in regions across the Great Plains due to nesting habitat loss, degradation, and fragmentation. This decline has been closely linked to declines in Black-tailed prairie dogs (Cynomys ludovicianus), which provide important nesting habitat for burrowing owls and other grassland birds. We examine the effect of black-tailed prairie dog colony attributes on burrowing owl occupancy and abundance. We specifically look at how colony size, activity status, and vegetation characteristics influence these population parameters on 180 survey plots throughout eastern Colorado across two sample years. Results are based on multistate occupancy and distance sampling data collected by paired observers traversing transects through study plots, during the 2022 and 2023 burrowing owl nesting seasons (May-August). Our top multistate occupancy model indicates that prairie dog colony activity level and latitude have significant effects on occupancy probabilities. Prairie dog activity level has a slight negative effect on the probability that a plot is occupied (regardless of reproduction status) but has a strong positive effect on

	the probability that a plot is occupied with successful reproduction. Occupancy was higher in southern CO compared to northern CO. Abundance and density estimates are calculated using distance sampling methods. This two-year study will provide an updated state status assessment of burrowing owl populations across the black-tailed prairie dog range in Colorado that will help calibrate burrowing owl population models incorporating prairie dog colony characteristics and inform future monitoring plans.
Reiley Allison Colorado State University	**Plant decomposition by photodegradation across Land Uses** San Luis Valley agriculture has historically been reliant on the ample water of the aquifer, but productivity is threatened by climate change and overuse, a situation that is further diminished by the high elevation and exposure to solar radiation on vegetation. Typically, water and biotic processes contribute to the decomposition of plant material to build soil, but in a region where water is limited, there are other possible pathways of decomposition. One method of an arid desert decomposition process is that of photodegradation. It, like other decomposition processes, is a critical player in nutrient cycling and thus soil health and viability. The project was designed to determine if differences in organic litter chemistry, land use, and soil properties impact the degree of photodegradation in the San Luis Valley. As no Solar radiation studies have been conducted in the valley across any land use types, I used a litterbag experiment with 270 bags over 6 sites that varied with soil, vegetative material, use, and water use. I hypothesized that the degree of photodecomposition will be a result of litter chemistry in combination with land use/water use. In the valley there are multiple land uses, but here I used three dominant land/water uses, including non-managed “native”, irrigated tilled cropland, and irrigated/non irrigated pasture/meadow. Generally, because lignin is preferentially mineralized via UV radiation, it will be the least concentrated in samples collected over time in the above ground and the surface samples. Then in the below ground samples, I expect more lignin, as the decomposition is not receiving solar radiation or a photo priming effect. Hemicellulose and cellulose will be degraded completely in the below ground samples, as it is preferential for microbial organism, while the surface samples will be slightly enriched in hemicellulose, and the raised sample will be more enriched in it, as the solar does not impact it. Then in relation to water and land use, the native, non-managed, sites are expected to be low in soil organic matter overall, and possibly also have more lignin in the soil, as the species for these sites are higher in lignin and lower lignin in the litter collections. The below ground samples at native sites are expected to have minimal decomposition, as the microbial community is lacking. At the cultivated sites, there is frequent watering and thus the below and surface samples are expected to be depleted of hemicellulose and cellulose, while enriched in lignin. Surface samples will have minimal mass loss as a result of solar evaporating water prior to too much microbial action. Above ground samples will be mostly independent of water and will depend on litter chemistry. The effects of photodecomposition at pasture sites will vary with the availability of water onsite. These results will be useful to the landowners and managers, and others concerned about the impacts of climate change on carbon storage and soil health.

Maddie Amick Colorado State University	**Drought Changes the Community Composition of Soil Seed Banks to Further Differentiate from the Aboveground Community** Climate change is predicted to increase both the frequency and duration of drought in many places around the world. Current research suggests that drought will likely reduce the diversity and percent cover of plant communities. The soil seed bank can help ecosystems recover from disruption, such as drought, and increase plant coverage. However, seed banks have been shown to represent invasive annual species disproportionately, which may further affect the community dynamic during drought recovery. As the soil seed bank is a living system, it is also affected by drought. Drought is thought to limit the time seeds can remain viable in the seed bank and may favor certain seed types. Furthermore, as seed banks are affected by the aboveground species diversity, the seed bank may disproportionately hold seeds preset during drought. The aim of my study is two-fold. I aim to look at the effects of drought conditions on the viability of seeds in the soil seed bank and compare the species found in the soil seed bank to those found in the aboveground plant community. To do this droughted and control soil seed bank samples were grown and compared to the current and historical community. Through this experiment, I aim to better understand how drought affects the soil seed bank and compare the species diversity and makeup of the seed bank to the aboveground community.
Nicki Bailey Colorado State University	**Parks, Pollinators and People: Do bees and butterflies prefer higher income parks in Denver, Colorado?** Pollinating insect populations are threatened by habitat loss and competition from European honey bees in urban settings, but city parks could be a crucial refuge. A park's pollinator community is not only based on the parks management, but the surrounding neighborhoods' housing structures. Of the 250 parks in Denver, Colorado, many of the neighboring homes in wealthier areas feature lawns and gardens, whereas many lower income parks are surrounded by apartments with limited greenspace. We hypothesize that this pattern follows the "luxury effect", where higher biodiversity is found in higher income areas. In this study, we will determine if pollinator diversity and abundance is greater in parks surrounded by higher income neighborhoods in Denver. After visiting 25 city parks three times during the summer of 2023, we found that the parks in the highest income areas had greater native bee and butterfly species richness and abundance than their lower income counterparts. We found no significant variation between the remainder of the parks, suggesting that only extreme affluence could be driving a divide in pollinator diversity in Denver. We also found no significant negative relationship between honeybee abundance and native bee abundance, suggesting that parks supporting native bees may provide enough floral resources to also feed honey bees without competition. These findings will inform management strategies across Denver Parks, thus improving pollinator populations and access to pollination services regardless of neighborhood income level.
Nancy Bartholomew Colorado State University	**Does intraspecific bee body size vary across urban parks by land cover or affluence?** Urban environments are a complex mosaic shaped by social-ecological processes. There is a growing interest in understanding what factors drive bee health within urban environments, but bee "health" is often difficult to quantify. Bee body size

	can serve as an indicator of habitat quality and a proxy for bee survival or fitness potential. In this study, we examine the intraspecific body size of two bee species that are widespread across Denver urban parks: Bombus fervidus and Halictus ligatus. This study seeks to determine if their body size is correlated with factors of interest: level of urbanization, neighborhood income level, honey bee abundance, park floral resource abundance, and park maintenance regime. Bee specimens were collected as part of a survey of 25 Denver parks in 2023. Intertegular distance of the target species was measured to determine body size. Preliminary results of 217 Bombus fervidus workers and 243 Halictus ligatus females will be presented.
Nick Bither University of Denver	**Altered recruitment dynamics in Rocky Mountain forests under rapid climate change** Rising growing season temperatures and attendant increases in aridity in the Rocky Mountain region threaten the historic recruitment regimes of montane conifer species. In particular, near total recruitment failures post-disturbance have been documented near range boundaries of various species. As climatic shifts worsen, recruitment failures are likely to occur in undisturbed forests as well. Yet, precise and species-specific climatic thresholds at which recruitment failures occur have yet to be identified. In 2022 and 2023, we established four field sites along an elevational gradient in the Front Range of Colorado utilizing natural climatic variation to examine the effects of higher growing season temperature regimes on germination, survival, and growth of five common tree species. To evaluate the role of local adaptation in recruitment patterns, seeds for each species were sourced from a northern, central, and southern population in their existing natural range. After two growing seasons, our results indicate that even minor increases in temperature and decreases in soil moisture near a species existing thermal boundaries lead to systematic or even complete recruitment failure. Further, the risk does not appear to be linear, as we observed distinct thermal thresholds in recruitment failure. For some species, however, the southern or central subpopulation showed significantly higher survivorship in the hotter temperature regimes than its northern subpopulation, indicating local adaptation to climate can play an important role in response to warming temperatures and reforestation efforts. Furthering our understanding of how climate change is impacting regeneration and recruitment dynamics of montane conifer species in the Rocky Mountain region is crucial to understanding where the greatest risks exist and for informing future adaptation, management, and restoration efforts.
Kellie Brady Colorado State University	**The story underneath: Influence of Photovoltaic produced microclimates on the production of secondary metabolites** Photovoltaic (PV) arrays require vast amounts of land usage to generate energy. To enhance the value of the land that is occupied by the arrays, combining agricultural practices with PV energy production emerges as a compelling land use solution to match our rising energy and resource demands in our modern world. Dual production of energy and agricultural resources (i.e., Agrivoltaics, AV) involves different fields of research that study the interaction between the microclimates that the panels create from dynamic shading and watering events and the different sectors of agricultural provisioning services that grow

	underneath the panels. Encouraging research from small specialty cropping AV systems in the arid and semi-arid western United States have indicated the potential for reciprocal energy generation and crop yield benefits. Yet, few studies have explored the mechanisms by which crop quality in medicinal plants might be altered by unique PV microenvironments. Varying cultivars of perennial vegetation utilized for medicinal purposes are a prime candidate for AV operation. Indeed, favorable conditions for many medicinal herbs (i.e., cool shaded understories), might successfully be emulated by the shade provided by AV, and the response of these herbs to unique AV microenvironments might provide insight into how AV impacts crop quality more broadly. With such information, responses of medicinal herbs grown under AV systems can reflect their responses in natural understory systems both in terms of quantity (i.e., growth) and quality (i.e., secondary metabolite production). In this study, we present findings on the impact of novel microenvironmental conditions within AV arrays of the varying production of secondary metabolites and growth of peppermint (Mentha piperita) and lemon balm (Melissa officinalis). Sight observations show that the physical structures of the plants are altered, and the most ideal conditions vary between species and is likely not due to chance alone. Questions arise that if the plants are changing their growth response because of known complex growing conditions, that if they are changing factors of their secondary metabolite production (i.e., medicinal properties of the plant) as well? To address this gap in knowledge beds of two popularized varieties of herbs, peppermint and lemon balm, were used to determine how distinct microenvironments (morning sun, midday sun, afternoon sun) altered essential oil production and the integrity of phenolic compounds. The findings when altering light conditions for medicinal herbs on the biomass and essential oil production under photovoltaic arrays hold promise for contributing to the sustainable coexistence of renewable energy and agriculture and further mirror the success for which they grow in natural understory systems.
Bailey Caldwell Colorado State University	**Effects of Seedball Composition and Carbon Addition Treatments on Dryland Plant Germination and Growth** With increasing effects of climate change, dryland ecosystems across the US are facing extreme rates of land degradation. This increases the need for effective restoration strategies that support native plant communities and ecosystem functioning. There is increasing interest in using seed pellets (or “seedballs”) as a restoration treatment to promote germination. Seedballs coat seed inside a mixture of clay, tackifiers, and other soil amendments in an effort to protect seeds until the arrival of environmental conditions favorable for germination. While seedballs have been shown to be successful in promoting plant recruitment in some contexts, best practices for seedball synthesis remain uncertain. We utilized a greenhouse experiment to test how seedballs with different compositions (i.e., seeding methods: broadcast seeding vs seedballs with low, medium, or high clay content, and activated carbon treatments (+granular carbon, +powdered carbon) influenced plant germination and growth. Specifically, we asked: (1) do seedballs promote native plant germination and growth, and (2) does altering the composition of seedballs influence native recruitment outcomes? Overall, seedballs with ratios of medium and high clay increased germination rates compared to broadcast controls. Seedball

	composition interacted with carbon addition treatments to determine germination responses. Specifically, the addition of activated granular carbon in ratios of medium and high clay resulted in the highest rates of plant germination. As for biomass, seed ball composition (clay ratio) did not impact plant biomass accumulation, but the addition of powdered carbon to seedballs increased the total amount of plant biomass. Using these findings, the implementation and application of seedballs can be further refined and potentially used to improve plant germination and growth rates in dryland restoration efforts.
Josh Carrell Colorado State University	**Multiscale ecological niche modeling exhibits varying climate change impacts on habitat suitability of Madrean Pine-Oak trees** Anthropogenic climate change and increasing greenhouse gas emissions are expected to globally impact the biological function, community structure, and spatial distribution of biodiversity. Many existing studies explore the effect of climate change on biodiversity, generally at a single spatial scale. This study explores the potential effects of climate change on the habitat suitability of seven tree species at two distinct spatial scales: the Coronado National Forest (CNF), a local management area, and the Sierra Madre Occidental (SMO), an ecoregional extent. Habitat suitability was determined by extrapolating Ecological Niche Models (ENMs) based on citizen-science tree occurrence records into future climatic conditions using projected 30-year normals for two anthropogenic emissions scenarios through the end of the century. These ENMs, examined at a spatial resolution of 1â€‰km2, are constructed using a mean average ensemble of three commonly used machine learning algorithms. The results show that habitat suitability is expected to decrease for all seven tree species at varying degrees. Results also show that climate-forcing scenario choice appears to be far less important for understanding changes in species habitat suitability than the spatial scale of modeling extent. Additionally, we observed non-linear changes in tree species habitat suitability within the SMO and CNF dependent on forest community type, latitude, and elevational gradient. The paper concludes with a discussion of the necessary steps to verify the estimated alters of these tree species under climate change. Most importantly, provides a framework for characterizing habitat suitability across spatial scales.
Trevor Carter University of Colorado - Denver	**Understory Plant Biodiversity is Inversely Related to Carbon Storage in a High Carbon Ecosystem** Given that terrestrial ecosystems globally are facing the loss of biodiversity from land use conversion, invasive species, and climate change, effective management requires a better understanding of the drivers and correlates of biodiversity. Increasingly, biodiversity is co-managed with aboveground carbon storage because high biodiversity in animal species is observed to correlate with high aboveground carbon storage. Most previous investigations into the relationship of biodiversity and carbon co-management do not focus on the biodiversity of the species rich plant kingdom, which may have tradeoffs with carbon storage. To examine the relationships of plant species richness with aboveground tree biomass carbon storage, we used a series of generalized linear models with understory plant species richness and diversity data from the USDA Forest Service Forest Inventory and Analysis dataset and high-resolution modelled carbon maps for the Tongass National Forest. Functional trait data from the TRY database was used to understand the potential mechanisms that drive the response of

	understory plants. Understory species richness and community weighted mean leaf dry matter content decreased along an increasing gradient of tree biomass carbon storage, but understory diversity, community weighted mean specific leaf area, and plant height at maturity did not. Leaf dry matter content had little variance at the community level. The decline of understory plant species richness but not diversity to increases in aboveground biomass carbon storage suggests that rare species are excluded in aboveground biomass carbon dense areas. These decreases in understory species richness reflect a tradeoff between the understory plant community and aboveground carbon storage. The mechanisms that are associated with observed plant communities along a gradient of biomass carbon storage in this forest suggest that slower growing plant strategies are less effective in the presence of high biomass carbon dense trees in the overstory.
Brielle Cerep-Funke University of Colorado - Denver	**Matching ornamental plant palettes with current and future climate** Due to the influence of climate change, climate models predict a hotter and drier future for Colorado. One impact of these observed and predicted climate trends is an increase in drought intensity and frequency, which can impact the availability of water, an already limited resource. Urban green spaces provide important ecological functions and ecosystem services, but their beautification and maintenance will become more challenging as water availability decreases further. This study aims to better understand how horticulturally significant plant species respond to variations in water availability. Matching plant palettes with the current and future climate may demonstrate a more viable approach to urban restoration and beautification projects in the Front Range of Colorado. A common garden experiment will simulate drought stress in congeneric pairs of showy native Colorado wildflowers, with one species in the pair used commonly in Front Range restoration plant palettes, and the other adapted to hotter and more arid conditions. Phenotypic plasticity, survival, and performance traits will be measured and analyzed to aid in species selection for small scale restoration projects where water is a limited resource. Through this study, we hope to provide insight and recommendations regarding ornamental plant palettes for future urban restoration and beautification projects in the Front Range of Colorado.
Eliza Clark Colorado State University	**Adaptive phenotypic plasticity evolves in warm climates during range expansion** Range expansions of introduced species and populations tracking changing climates are becoming increasingly common. During range expansion, populations may respond to novel conditions through phenotypic plasticity, adaptation, or both. Phenotypic plasticity may “buy time” necessary for adaptation to occur, but may also be an adaptation itself that can better match a population to variability in its environment. Temperature-dependent plasticity in the timing of winter dormancy may be beneficial in mild climates, since it would allow populations additional time for reproduction when temperatures are favorable. Here we study plasticity in the timing of winter dormancy in the northern tamarisk beetle (Diorhabda carinulata), a biological control agent that has undergone a recent range expansion from northern temperate climates to southern subtropical climates. We studied diapause initiation under warm and cool temperatures for four populations collected along a latitudinal and climatic gradient. We found plasticity in diapause initiation evolved such that diapause of beetles from southern sites became strongly temperature-dependent. Using

	phenology models, we assessed the fitness consequences of temperature-dependent diapause and found that this plasticity increased the time available for reproduction for the southern populations, but was maladaptive for northern populations. The evolution of plasticity likely enabled this range expansion into warmer climates, and may be an important way for populations to adapt to novel conditions encountered during invasion and climate change.
Jordan Conley University of Northern Colorado	**Effects of elevation on plant clonal growth organ, clonal trait morphology, and dominance in the Colorado Front Range** Clonality is a mechanism for plants to produce offspring ramets of the same genetic material (i.e., clones). Traits related to clonality play a significant role in the distribution, success, and dominance of clonal plants in a community. These traits allow plants to react to unfavorable conditions rapidly and may offer an advantage over nonclonal plants. Additionally, in generally stressful environments, plants can utilize clonal growth to maximize resource acquisition in times of favorable conditions. Knowing this, we may predict that locations with harsher conditions, such as those in alpine environments, have a higher proportion of species possessing clonal growth organs. However, we do not know the types of clonal growth organs that will dominate at each site, leading to uncertainty about how climate change will affect these communities. Therefore, this study measures clonal and nonclonal plant dominance along the environmental gradient. Additionally, we measured the plasticity of several clonal plant traits for three selected clonal species. Integrating community and individual trait data will inform us of vegetation responses considering climate change. This study aims to collect vital information regarding the vegetation of the Colorado Front Range, which can help us preserve the flora of the high-elevation forest and alpine ecosystems more efficiently by knowing how different types of plants will respond to a changing climate.
Kord Dicke Colorado State University	**Exploring the Dynamics of Metabolic Scaling in Honeybees: Impact of Group Size, Resource Environment, and Density.** Metabolic scaling theory posits a negative allometric scaling relationship with body size.75. This hypoallometric scaling exponent has been observed across diverse species, including social insects. However, in social insect groups, the collective phenotype arises as an emergent property of individual interactions, potentially relaxing constraints on individual metabolic rates and overall group metabolic demand. This study delves into this framework by investigating how metabolic rates scale with increasing group sizes of honeybees (Apis mellifera), while exploring how resource environment and density contribute to the allometric scaling of a group. Our findings reveal a consistent isometric relationship across honeybee groups, regardless of resource environment or density providing clarity on factors influencing the metabolic scaling between social groups.
Lily Durkee Colorado State University	**Assessing the genetic structure and adaptation of a native butterfly to changing elevation** Elevation gradients provide a way to study populations across a range of environmental conditions within relatively small spatial scales. Adaptation to the local habitat may occur in response to the unique selection pressures present at different elevations, resulting in distinct populations adapted to different environments. However, if there is high habitat connectivity, gene flow can slow

	or prevent local adaptation while also maintaining high genetic diversity and large population sizes. Here, we used genomics to investigate the interplay between local adaptation and gene flow between high and low elevation populations in a native butterfly. Our study focuses on the Rocky Mountain subspecies of the clouded sulfur (Colias philodice eriphyle Edwards) (Lepidoptera: Pieridae). The subspecies occupies a wide range of elevations, from the Colorado foothills, where the larvae can be a pest of alfalfa (Medicago sativa), to high meadows containing native legumes (Fabaceae) up to 3000m. Past studies have documented phenotypic differences, including increased dorsal wing melanization at high elevations, which may slow heat loss during flight. Here, we build off this past work by using whole genome sequencing to examine C. p. eriphyle population structure between high (above 2500m) and low (below 2000m) elevation habitats. Genomic analyses will be used to evaluate signals of adaptation to elevation and gene flow of the clouded sulfur butterfly throughout fifteen collection sites in Colorado and Southern Wyoming.
Kassandra Dutro University of Wyoming	**Traditional Ecological Knowledge, Indigenous Women, and Traditional Fire Practices in the Far North** Traditional Ecological Knowledge is one of the ways that human beings understand and interact with their landscape. With the growing concern of climate change and ecological impacts, it is vital for researchers to explore other forms of knowledge and include Indigenous voices. Using the Alaskan landscape as a case study, I aim to explore the intersections around fire offering a new perspective through Indigenous women and girls of the Dene (Athabascan) speaking communities. My focus is centered around women/girls' interactions with their environment and specifically fire from both natural and human made sources throughout the recent and more distant past. In order to achieve a more holistic perspective, I will compare data from Indigenous oral histories, Indigenous language dictionaries, material culture from multiple Interior Alaskan archaeological sites, and publications ranging from multiple disciplines.
Raymond Erskine University of Northern Colorado	**Dominance of clonal plants following fire** Clonal plant traits and response following fire Mountain ecosystems are currently experiencing greater impacts of disturbance (e.g., fire) due to global changes in climate and increasing land use, leading to significant shifts in vegetation dynamics. Clonal plants, characterized by their vegetative reproduction strategies, offer a range of ecologically important traits to cope with disturbances. Yet, post-fire vegetation dynamics often overlook clonality, and their responses to different disturbance regimes remain largely unknown. In the Arapahoe-Roosevelt National Forest, we investigated the response of understory clonal and non-clonal plants to fire in ponderosa pine stands. We collected data from 20 burned and 20 unburned plots (10m x 10m), encompassing species cover and environmental variables. In burned plots, clonal plants exhibited higher overall vegetation cover and diversity compared to unburned plots, whereas non-clonal plants showed no differences. We observed distinct differences in species composition between burned and unburned plots. While a fourth-corner analysis revealed weak relationships between elevation, slope, and some clonal growth organs (CGOs), the overall analysis indicated limited environmental association with species traits. This suggests that differences in species composition between burned and unburned plots are primarily driven by fire disturbance rather than environmental

	factors. Our findings underscore the dominance of clonal plants in ponderosa pine forests after the Cameron Peak Fire. We recommend that forest managers and modelers consider these clonal traits for a more comprehensive understanding of forest responses to disturbances.
Holden Fox Colorado State University	**Genoscape and Migratory Connectivity of Loggerhead Shrike** Grassland birds are experiencing persistent and widespread declines, despite existing conservation efforts. I propose to conduct a comprehensive genetic analysis of migratory patterns in the loggerhead shrike, a grassland species of conservation concern. I will use whole genome resequencing of loggerhead shrike across their full annual cycle to delineate genetically distinct breeding populations and quantify the extent of population connectivity. By creating a map of range-wide genetic variation, my study can be used to inform targeted, region-specific management and conservation strategies, addressing the critical need for a holistic approach to conserving this species.
Annika Fridberg Colorado State University	**Effect of community involvement within management decisions on community tolerance for large carnivores: a literature review** Conflict between humans and large carnivores is a global concern for carnivore conservation as land use and habitat destruction increase shared spaces between carnivores and humans, this increased overlap can represent a threat to human livelihoods. Often, human-carnivore conflict is associated with social conflict between stakeholder groups. This calls for interdisciplinary research frameworks that can address the social dynamics between community members and types of carnivore management. Forms of participatory decision-making can also foster more equitable management and long-term effectiveness. We focus on tolerance as a measure of success for management actions and ask the question: How does community involvement in management decisions impact tolerance for large carnivores within targeted community stakeholders? We aim to review a sample of 10-15 published scientific articles and conduct a theme analysis on the level of community involvement presented within these case studies and its impact on the tolerance for large carnivores. Preliminary results indicate that high levels of community involvement in carnivore management tend to foster tolerance for carnivores and for management. We recommend that more studies concerned with human-carnivore conflict continue to use and develop social science frameworks. We also encourage efforts to involve communities in decision-making where human-carnivore conflict occurs, as a way to design more effective and equitable interventions.
Ryleigh Gelles Colorado State University	**Wildfire and forest thinning shift floral resources and nesting substrates to impact native bee biodiversity in ponderosa pine forests of the Colorado Front Range** Native bees are critical components of ecosystems by providing ~85% of pollination services. Recently, evidence of global decline in bee populations have drawn concern from conservationists, compelling the need for insight on the drivers and mechanisms influencing said decline. In ponderosa pine ecosystems, fire suppression policies implemented throughout much of the 19th century stand structures with closed canopies, suppressed understories, and increased surface fuel loadings. To restore desirable forest structure, forest management efforts often focus on reducing stand densities and reintroducing fire disturbance. However, it remains unclear if these practices benefit important insect taxa,

	including native bees. To address this knowledge gap, bee communities were sampled across the growing season within ponderosa pine- dominant forests of central Colorado to assess effects of fire disturbance on native bee populations. Findings here have implications for forest management and indicate structural elements of ecosystems that can be managed for enhancing bee biodiversity.
Alyssa Graziano Colorado State University	**The role of wet meadows in altering post-fire stream biogeochemistry: Using nutrient diffusing substrates to evaluate limitations on periphyton production** Severe wildfire has the potential to alter ecosystem processes including nutrient cycling and primary production in streams. While nitrogen (N) limitation is common in undisturbed streams, nutrients can remain elevated for decades following wildfire and can impact downstream water quality, aquatic habitat, and food webs. Wetland features such as wet meadows are important hotspots of biogeochemical activity and may play a role in retaining elevated post-fire nutrients. In this study, nutrient diffusing substrates amended with nitrogen (N) and phosphorous (P) were deployed in two burned watersheds and one unburned watershed within the Cameron Peak Fire scar to examine nutrient limitation of periphyton up and downstream of wet meadows. In the unburned stream, periphyton were limited by N and P both above and below a wet meadow. In contrast, in one N-enriched burned stream, periphyton were not nutrient limited upstream, but were N and P limited downstream of a meadow. This pattern was absent in the second burned stream, but overall our preliminary results suggest that wet meadows have the capacity to reset nutrient limitations following wildfire. As wildfire frequency and severity increase throughout the western US, strategies to mitigate their impacts on aquatic ecosystems are needed. Techniques such as Beaver Dam Analogs (BDAs) are increasingly popular in stream restoration, however little is known about their efficacy in post-fire environments. Future study directions include testing nutrient diffusing substrates above and below BDA structures to investigate the consequences of this restoration approach on post-fire nutrient retention.
Grace Gulig Colorado State University	**The Secret Lives of Colorado's Wildlife: Maximizing wildlife data collection from camera traps in western Colorado** Biodiversity loss is a defining issue of the Anthropocene, with a lack of knowledge on many species presenting a major barrier to developing effective management plans. Species monitoring, through methodology such as camera traps, has been commonly used to address knowledge gaps due to their cost effectiveness and opportunity for continuous monitoring. In Colorado, camera traps are being used as part of the Western Slope Mountain Lion Density Study, a project initiated by Colorado Parks and Wildlife (CPW) to gain a better understanding of mountain lion (Puma concolor) population density within the western slope region. However, many species are expected to appear in photos, an opportunity I used to gain a better understanding of overall wildlife biodiversity in the study area, evaluate the presence of bobcats (Lynx rufus), which are a species of interest for CPW, and assess if data from similar large scale monitoring studies can be more effectively extracted. I utilized the CPW Photo Warehouse program to review images taken near Middle Park, Colorado from January to March 2022, identifying species presence in photos. Overall, I observed 24 species of birds and mammals. Additionally, bobcats were observed on multiple occasions across several different camera locations, suggesting that camera traps may be an effective

	method for monitoring bobcats. Further, my data supports previous findings in recognizing that single species camera trap studies can be expanded to monitor multiple species, which provides valuable opportunities for improving conservation strategies in the future.
Sophia Gulutzo Colorado State University	**Snug as a Bug in the Forest: Using emergence traps to reveal cryptic insect overwintering habits** Insect biodiversity bolsters forest health and therefore is critical to the conservation and management of natural resources and ecosystem services provided by forests, such as timber, water filtration, and carbon sequestration. Insects themselves contribute to services including pollination, biocontrol of invasive species, and are a food source for multitudes of other important forest species. However, little is known about more cryptic aspects of the insect life cycle, such as overwintering, and these knowledge gaps prevent the implementation of holistic forest management strategies. In this study, we employ pilot methods to investigate insect overwintering habitat, potential inter-group associations, and potential aggregation behaviors in overwintering insects. We present preliminary results, insights, and ideas for future study.
Magee Headley Metropolitan State University of Denver	**The effects of Emerald Ash Borer on Temperature** Emerald Ash Borer (Agrilus planipennis) is an invasive wood boring arthropod that has decimated Ash tree species in North America since its detection in 2002. It attacks phloem pathways, and eventually kills entire trees within 2-3 years. A symptom of Emerald Ash Borer (EAB) infection is rapid canopy die-off. Since Ash trees account for a high percentage of urban plantings, loss of canopy shade and habitat for invertebrates and wildlife are cause for great alarm. Due to our interest in how canopy loss affects the urban heat island effect, we conducted research on differences in ground and ambient temperatures, and canopy coverage between affected and unaffected sites - those with known infestation of EAB, and those without any infestation of EAB. While we discovered significant differences in ground and ambient temperatures ($P < 0.05$), canopy coverage comparison was not significant ($P > 0.05$). Thus supporting our hypothesis that we should see a significant difference in temperatures, although our prediction that there would be a significant difference in canopy cover was not supported. Our study was limited to late October when leaf drop was beginning, therefore further research should be conducted during spring and summer to complete our understanding of how EAB affects tree canopy at the highest times of coverage, and during higher overall temperatures. Ash trees hold environmental and cultural importance, and have been referenced as keystone species, therefore better understanding of ecological changes as a result of EAB are critical to enhance current protection and prevention of further damage.

Mollie Hendry Colorado State University	**Direct and indirect effects of wildfires on Rocky Mountain lake ecosystems** Decades of fire suppression and shifting climate regimes have increased wildfire occurrence frequency and size across the globe. The effects of wildfires on mountain lake ecosystems has been previously researched, but studies comparatively assessing the direct and indirect impacts of fires in the Rocky Mountain region have yet to be conducted. We propose an analysis of two mountain lake ecosystems, The Loch and Fern Lake, Rocky Mountain National Park, to understand the direct effects of the East Troublesome fire on Fern Lake and to understand the indirect effects of fires over a 40-year period on The Loch Vale. Previous studies have found erosion-driven increases in sedimentation and turbidity, as well as increases in nutrients and changes to dissolved oxygen and temperature in burned watersheds. However, far more Rocky Mountain lakes are influenced by the indirect effects of regional or continental-scale fires that alter air quality and solar radiation. Using long-term meteorological data from the Loch Vale weather station and historical data pertaining to large regional fires, fire effects on the lakes will be evaluated in the context of ash deposition, reduced solar radiation, and novel temperatures. We will analyze observational data to find responses in lake biogeochemistry, temperature, oxygen, and algal primary productivity. We expect to see long-term increases in total nitrogen and net primary productivity for The Loch and Fern Lake, short-term decreases in temperature for The Loch during fire periods, and long-term decreases in dissolved oxygen for The Loch and Fern Lake through analyses of trends over seasons and years. This analysis may provide ecosystem managers the tools to understand the small-scale and broad-scale effects of fire on lake ecosystems across the Rocky Mountain region.
Sarah Hettema Colorado State University	**Evaluating the impacts of fuel treatments on burn severity across the Front Range** With changing climate and an increase in extreme wildfire events understanding the impacts of wildland fuel treatments is becoming more pressing. Quantifying the effectiveness of fuel treatments is difficult for a number of reasons including dynamics between treatment type, time since treatment, weather, climate, the fuels and vegetation present, topography, fire dynamics, suppression actions, and landscape condition. Land managers are now being tasked with the challenge of navigating this rapidly changing landscape of fire. This study investigated fires along the Front Range from Colorado to northern New Mexico establishing a reproducible methodology to evaluate under what conditions treatments achieved their intended outcomes emphasizing the impacts of pre-fire fuel treatments on burn severity. We established an empirical method to better understand the conditions in which treatments effectively reduce burn severity during days of extreme fire spread. Across the Front Range, we found areas that were treated with a combination of thinning and prescribed burning experienced reduced burn severity. The reduction in burn severity primarily occurred when fires burned under less extreme days. This better understanding of the outcomes of treatment efforts will help land managers better utilize resources and employ adaptive management strategies that account for the changing climate.
Kailey Hicks University of Denver	**Research on how heatwaves affect insects: an overview of commonly studied factors**

	Anthropogenic climate change is resulting in wide-ranging consequences for ecosystems and organisms. One aspect of these consequences is the increase in frequency, duration, and intensity of heatwaves. Insects can be heavily affected by heatwaves, and negative responses to heatwaves may play a role in insect declines globally. In turn, this decline would impact the important roles that insects play in essential ecosystem services. We are conducting a comprehensive meta-analysis on how heatwaves impact insects. Using a literature survey with topic-specific keyword searches, we compiled all papers that studied insect individual or population responses to heatwaves. Here, we present the initial descriptive statistics and trends of our research in regards to which factors are most commonly studied regarding insects. Specifically, we will review when and where insect heatwave research takes place, the most-studied insect taxa, guilds, life stages, and dietary habits. Lastly, we review the most-studied fitness measures for insects. Our initial findings demonstrate that the majority of studies are laboratory studies that focus on the effects of summer heatwaves on herbivores, larvae, and Coleoptera in Europe and Asia. Due to the importance of insects in ecosystem services and as indicators of environmental health, a better understanding of insect response to heatwaves will broaden our understanding of ecosystem-wide heatwave impacts.
Edward Hill Colorado State University	**Contrasting effects of overstory mortality on juvenile tree vigor in relation to microclimates** Shifts in resource availability in vegetation communities due to climate change directly affect demographic processes like mortality and regeneration, and indirectly influence structural and compositional dynamics, such as through competition. With greater frequency and severity of broad-scale disturbances, such as drought, wildfire, or flooding, some vegetation communities face rapid and dramatic changes in environmental and resource conditions compounded by extensive mortality and failure of new regeneration. Responses of surviving vegetation immediately during and following these disturbances can inform subsequent development trajectories, including the potential for recovery or continued decline. In this study, we assessed vigor of juvenile pinon pine trees in response to induced overstory mortality (analogous to drought) to assess whether juveniles may benefit from resource release or conversely suffer from increased abiotic stress following loss of sheltering canopy trees. We sampled several ecophysiological parameters across a range of juvenile tree sizes in live and dead overstory environments at a model pinon-juniper woodland site in southwestern Colorado. We also used a subset of plots to intensively sample microclimate conditions across live and dead overstory environments in order to relate these conditions to juvenile vigor. Our results show that juvenile vigor tended to be higher in dead overstory environments as compared to live, but the interaction of juvenile size with overstory environment was not important. Additionally, we observed positive effects of soil moisture, and an interactive effect between overstory type and vapor pressure deficit (VPD). Vigor responses were relatively unchanged with increasing VPD in live overstory environments, but significantly declined with increasing VPD in dead overstory. While further investigation is needed to resolve longer-term outcomes from these responses, our results suggest that juveniles persisting after overstory mortality show higher vigor than those in live overstory when VPD is low. These findings may suggest a

	recovery pathway for piÃ±on pine in these woodlands following extensive overstory mortality, contingent on periods of favorable VPD and soil moisture conditions. Yet, the significant decline in juvenile vigor with increasing VPD in dead overstory environments also emphasizes the importance of live overstory for buffering the negative effects of future hotter droughts on woodland development.
Oliver Hoffman Colorado State University	**Comparing Soil Health In Southern Minnesota: Agricultural vs Ecological** Soil health is the ability of a given soil to function as a living ecosystem that can continuously support above and below ground life. What determines the capacity of a soil to function as a living ecosystem is heavily influenced by land-use and management. In Faribault County, Minnesota, we assessed soil health in ecological and agricultural systems using the Soil Management Assessment Framework (SMAF). This study featured three paired fields: a heavy-disturbance agricultural field (HD) and a low-disturbance tall grass prairie (LD). Soil samples were collected at a 0-15cm depth in August 2023, and SMAF scores (ranging from 0-1; 0 being the “worst” and 1 being the “best”) were assigned to indicators and properties. We hypothesize that LD will yield SMAF scores greater than 0.90 and the HD less than 0.50. Results showed that the overall soil health scores proved less sensitive to management, but biological indicators proved sensitive. This highlights the influence of soil disturbance on the soil microbiome. While our findings offer valuable insights, further exploration is warranted to provide more conclusive results. Subsequent investigation will provide a deeper understanding of the soil microbiomes response to disturbance and explore correlations between soil health quantification and innovative microbiome testing methods.
Hannah Horowitz Colorado State University	**Territory Level Patterns of Reproductive Output Associated with Habitat Quality for an Island Endemic Bird (Aphelocoma insularis)** Territory behavior encompasses complex and dynamic patterns of space use resulting from routine activities associated with basic properties of species life-histories. Unlike species that occupy a territory for only a limited amount of time, once an individual obtains a home range it is confined to that limited area for, ideally, the rest of its life. Both external features of the home range (i.e. habitat structure and composition) and internal features of the individual (i.e. reproductive performance and body condition) account for variations in home range usage and quality. Differences in resource availability among the landscape, along with habitat saturation, results in variation in size, quality, and breeder turnover for each territory. The Island Scrub-Jay (Aphelocoma insularis), an endemic bird to Santa Cruz Island off the coast of Southern California, provides an ideal model system for studying the effects of territory size and quality on reproductive output. Breeding pairs maintain a year-round territory (mean size = 3.5 Â± 0.2 ha), where each territory varies in size (range= 0.4â€“8.9 ha) depending on the vegetation coverage. I hypothesize that variation in territory quality reflects features of the vegetation, which result in more stable year-round food resources. Therefore, higher quality territories (i.e those with consistently higher reproductive output) should be 1) larger to provide a greater abundance of resources, 2) greater in the density of vegetation types associated with higher quality territory needs specific to Island Scrub-Jays, 3) farther apart from neighboring territories in order to decrease overall intraspecific competition between breeding pairs. I used data collected from the 2017-2023 breeding

	seasons (approximately mid- February to mid-June) to quantify territory quality and reproductive output for the Island Scrub-Jay, visually represented in map format via ArcGIS Pro and R. In conclusion, understanding how physical aspects of the territory, along with territorial behaviors, influence reproduction in birds can aid in the conservation planning strategies of territorial avian species.
Erin Jackson Colorado State University	**Farmer-led Regenerative Management Practices Impacts on Soil Health in the High Plains** The adoption of individual conservation practices, such as no-till, cover cropping and diversification on farming operations in the High Plains has risen in recent years in response to increased focus on the importance of soil health. However, soil health is rarely achieved through isolated methods, but rather through a producer's integration and adaptation of a suite of practices to his/her local context, guided by core soil health principles. We conducted a comprehensive on-farm study with 30 farms in Colorado, Kansas and Nebraska to understand the impact of farmer-directed management practices on soil health parameters across a gradient of precipitation and environmental conditions. 12 farms were paired long-term conventional and regenerative farms, and each long-term regenerative practitioner was paired with 2-4 farms adopting regenerative practices at the start of the project to provide technical support. Soil health parameters were assessed at baseline and year 3. Analyses (in-process) will illuminate the soil health parameters that are most responsive to management and which management combinations have the greatest impact on soil health. These results will help inform integrated, farmer-centric regenerative management strategies to improve soil health in the High Plains.
Miguel Jimenez Colorado State University	**A multi-city comparison of urban migration stopover and the underlying social landscape that supports it** As cities expand, the conservation community must recognize their importance in ecological processes. Yet, despite being widespread across North American flyways, the extent to which migratory birds use stopover habitat across urban landscapes remains unclear. Further, historical inequities in urban planning have led to legacy effects, as communities of color and low-income socioeconomic classes disproportionately bear the brunt of environmental pollutants and often lack access to green space. As such, there is growing interest in understanding how ecological and social dimension overlap with conservation issues. Here, we use weather radar data to quantify stopover across urban regions and various demographic datasets to gather key information about where birds are stopping over in cities and who stewards this land. Ultimately, our goal is to quantify the intensity of migratory stopover within and around the five most populous U.S. cities to determine 1) the relative contribution of urban cores to regional stopover and 2) the underlying social landscape that supports it.
Michael Johnson Colorado State University	**Factors affecting cause-specific egg mortality in a host-parasite-predator system** Facultative brood parasitism is a common breeding strategy among North American waterfowl species that aims to salvage or increase an individual's reproductive success, and has been linked to both experience and the availability of suitable nesting sites. Conversely, the consequences sustained by the host include egg loss, reduced hatchability, nest abandonment, and perhaps even increased cues provided to visual predators. Instances of interspecific brood parasitism are common among over-water nesting ducks and no host-parasite

	relationship has garnered more attention than canvasbacks and redheads where parasitic female redheads seek out and infiltrate canvasback nests to lay eggs. We monitored parasitized and unparasitized canvasback nests from 2016-2020 near Minnedosa, Manitoba, and recorded the fates of 3750 canvasback eggs presumed to be part of the host's clutch. Using a multinomial logistic-exposure modelling approach in a Bayesian framework, we assessed competing sources of egg mortality as they related to brood parasitism (i.e., egg displacement), abandonment, and predation, to address whether mortality pressures were compensatory or additive, and correlated with local nesting habitat conditions. Host clutch sizes were smaller in parasitized versus unparasitized canvasback nests and cause-specific mortality estimates showed consistent additive impacts of brood parasitism regardless of local nesting conditions. These results suggest that nesting canvasback near Minnedosa are experiencing consistent and unprecedented rates of parasitic pressure, leading to lower reproductive output with possible consequences for population dynamics.
My-Lan Le University of Colorado - Denver	**Identifying what drives the abundance and performance of rare plant species** Biodiversity is threatened worldwide, both directly and through the cascading effects of environmental change caused by habitat loss and climate change. While some species can shift their distributions based on changing environmental conditions, endemic species with restricted ranges often exist at the intersection of habitat restriction and limited tolerance to environmental change. As individual populations of a species can experience variable environmental conditions and biotic interactions, understanding the drivers that affect rare species population performance and thus overall persistence will improve conservation management. Patterns of spatial and environmental variation are highly context-dependent, often being specific to communities or populations, and quantitative measurements of community ecology and local environmental conditions are missing for most rare species. Using select plant species that are rare and native to Colorado, we propose to investigate the variation of community structure and local environmental conditions within and between populations as potential deterministic and stochastic processes that affect rare plant abundance and performance.
Stephanie Lemas Colorado State University	**Sugars in Soils: A Chemical Analysis of Soil Hexoses** Soil carbon storage is a widely accepted climate engineering strategy for reasons including its high technical potential and low ecological risk. Stored compounds can persist in soils for millennia because of their inability to be consumed by soil microorganisms. These persistent compounds are often characterized by high molecular weight and functional complexity; however, small molecule persistence may also be possible. Our research examines the persistence and carbon storage potential of rare sugars. While some sugars, like D-glucose, are common because they serve biological functions, other sugars are less biologically functional and are thought to be rare in nature. Our preliminary work shows that soil microorganisms can respire some rare hexose sugars, suggesting these sugars may already be present in soils. Little research has been done to determine the presence of rare sugars in soils, however, so not much is known about their identities, quantities, and persistence in soils. There are twelve hexose isomers, and each has seven possible conformations. Distinguishing between these 144 unique structures is a significant analytical challenge. To help resolve this, we

	have developed and implemented a gas chromatography/mass spectrometry (GC/MS) method that allows us to successfully separate the 24 hexose enantiomers. We will describe the method performance and results from the measurement and quantification of hexoses in our crowdsourced soils. Our results will provide an analytical approach to quantifying soil sugars as well as novel insights into their presence and persistence and will enable further research into the carbon sequestration potential of rare sugars in soils.
Heron Lenz University of Colorado - Colorado Springs	**Environmental Factors Driving Parasitoid and Herbivore Abundance in a Tritrophic System** Aphids form colonies on stems, roots, and leaves that feed on, and inhibit the growth of, their host plant. Parasitoid wasps parasitize the aphids, which may limit aphid colony growth. Most research conducted on aphid-parasitoid interactions has taken place in agricultural settings, and little is known about the biotic and abiotic factors that drive parasitoid wasp abundance. From 2017 to 2023, 200 Ligusticum individuals among 20 populations along an elevation gradient were surveyed. Throughout each summer, weekly observational data was collected on the number of aphid colonies and aphid mummies occurring in each population, and host plant seed set was counted at the end of each season. Additionally, insects were sampled from each population via sweep netting in 2017, 2018, 2019, 2020 and 2023. In fall 2023, we sorted these insects by taxonomic order and counted individuals in the families Aphelinidae and Aphidiinae. We found site-to-site variation in the abundance of parasitic wasps and fit a model to determine the drivers of that variation. Parasitoid abundance was greatest in sites with fewer aphids, which may suggest top-down effects limiting aphid colony establishment. Then, temperature data collected at the population level was plotted against insect abundances and seed counts and curves were fit to determine the temperature optima of host plant quality, aphid colonization, and parasitism rate. While these temperature optima describe the temperature at which these responses are strongest, the curves may also help predict how these multitrophic interactions will evolve as climate change progresses.
Mary Linabury Colorado State University	**Long-term nitrogen and short-term precipitation addition do not interact, but do produce legacy effects in a semi-arid grassland** With the rise of industrial agriculture, nitrogen fertilization has altered ecosystems worldwide. In addition, climate change threatens these systems with unpredictable weather patterns, from droughts to floods. The result of these combined events is often unpredictable, but grasslands are sensitive to rainfall timing, so we predict that seasonality of extreme rainfall may mediate their response to long-term fertilization. This experiment was conducted within a semi-arid shortgrass prairie on the front range of Colorado, where nitrogen addition has been ongoing since 2014 (8 levels between 0-30g/m2). An extreme rainfall event (deluge) was applied in mid-to-late summer 2021 and an early-season summer deluge was applied in 2022 to a different subplot. We found that the timing of deluge was highly influential on aboveground plant production: the effect of the mid-to-late season deluge was modest, while the early-season treatment more than doubled production. Both deluges caused legacy effects that increased relative production the year after the deluge event compared to the year of treatment, in fact, interaction between nitrogen and

	deluge treatments only occurred in one post-deluge year. Despite unique initial responses to deluge, post-deluge plots showed similar production legacies. This indicates that short-term production differences due to deluge timing may not reflect long-term results. The factors controlling these legacies are currently unknown, but data analysis is on-going.
Lauren Magliozzi University of Colorado - Boulder	**Aquatic Ecosystem and Water Quality Impacts from the 2021 Marshall Fire in Boulder County, CO** The 2021 Marshall Fire impacted much of the Coal Creek watershed near Boulder, Colorado, posing risks to water quality and ecosystem health. Our team conducted monthly post-fire monitoring of water quality parameters (pH, turbidity, nutrients, DOC, anions, alkalinity, conductivity, and trace and major metals) and stream biota communities (benthic macroinvertebrates and periphyton) at sites chosen to contrast burned/unburned and wildland/urban land uses. Additionally, successful post-fire monitoring partnerships require effective communication of datasets between scientists, land managers, and impacted communities. This monitoring effort leveraged community partners and stakeholders to maximize impact. Key results on water quality parameters and indicator organisms will be presented alongside insights gained from partnerships between our academic group and local stakeholders, such as the use of a public data dashboard to communicate directly with the community and land managers.
Meg Mahoney Colorado State University	**Examining evolutionary ecology of white-tailed ptarmigan using molecular techniques** Alpine species are among the most sensitive to climatic warming, as they already occupy the highest, coolest elevations and thus cannot shift their ranges higher to counteract rising temperatures. White-tailed ptarmigan (Lagopus leucura) are one such susceptible species found in alpine habitats across Colorado. To design effective conservation strategies for these animals, it is crucial to understand the evolutionary mechanisms underpinning how ptarmigan interact with their environments. Leveraging recent advances in high-throughput sequencing, we have sequenced and annotated (i.e., identified functional elements) the entire genome of the white-tailed ptarmigan. From this genome assembly, we are developing a panel of single-nucleotide polymorphisms that will be used to genotype white-tailed ptarmigan samples collected in Rocky Mountain National Park and Mt. Bluesky Wilderness between 2011 and 2023. We will use these results to construct a pedigree of each white-tailed ptarmigan population, which in turn will allow us to assess rates of extra-pair paternity and post-hatch brood amalgamation, both behaviors with important implications for population dynamics and genetic structure. We will also assess genes or gene groups under selection, and, using historical white-tailed ptarmigan samples collected between the 1890s and the 2020s, examine how local adaptation has changed over time. These findings may have important implications for understanding the evolutionary trajectories of white-tailed ptarmigan and other high-altitude species, and for designing effective conservation strategies in the face of rapid environmental change.
Becca McDonald Colorado State University	**Wildlife Education Tools** I completed a community service-based thesis project that involved working with the Northern Colorado Wildlife Center (NCWC) to create two educational tools that can be used to teach the public about wildlife issues. Teaching the

	community about wildlife can build support for environmental issues and promote a better relationship between people and our environment. I focused on the topics of the life stages of a bird and bird feeders. After designing and building these tools, I assessed their effectiveness by conducting a survey about how people's knowledge and attitudes changed after interacting with these tools. I found that the tools were effective in increasing the public's awareness and interest in engaging with wildlife issues.
Julianna Mendez Colorado State University	**Investigating mating signals and acoustic challenges in a nonrhythmic treefrog, Dendropsophus ebraccatus** Mating signals are largely shaped by both abiotic and biotic factors to attract readily available mates. Neighboring males that produce mating signals may overlap, within species that form choruses or leks, which pose challenges for both the signaler and the receiver. A receiver may have difficulty localizing the preferred mate, and a signaler may be outcompeted by its neighbor. Rhythmic species have developed a solution to these challenges by adjusting their temporal patterning, when they hear conspecific neighbors' calls, to avoid overlap. However, some chorusing anurans are nonrhythmic and can also produce overlapping calls, such as hourglass treefrogs (Dendropsophus ebraccatus). Because little is known about how nonrhythmic species address the challenges signalers and receivers face, I will test the acoustic signals, in the form of airborne sounds, in D. ebraccatus to determine a) how the calling strategies of male D. ebraccatus in choruses affect localization and female preference, and b) how changing the calling properties of their mating signals affect their chances at reproductive success.
Sarah Nalley University of Colorado - Denver	**Mating Traits Shape Responses to Global Change in Nearctic Dragonflies** Amid human-driven environmental changes like global warming and land-cover changes, animal habitats are heating up. To persist in thermally stressful environments, animals require traits that facilitate both survival and successful mating. The role of mating traits in animals' responses to global change, however, is poorly understood. Dragonflies serve as ideal subjects for this investigation due to distinct thermally sensitive mating traits: including mating strategies where species either can convectively cool (flyers) or not (perchers) when defending territories; melanin wing ornaments that attract mates but increase overheating risk; and a waxy pruinescence that deters rivals and prevents desiccation. Here, we explored how these reproductive traits affect species'™ persistence in habitats altered by two agents of environmental warming: rising air temperatures and wildfires. Data on local extinctions and environmental change in the US between 1980-2021 were analyzed to test if 1) ornamented species were more vulnerable to warming habitats; 2) pruinose species were less vulnerable; and 3) flyers were less vulnerable. Our results revealed that ornamented species suffered more from climatic warming compared to non-ornamented species, whereas pruinose species exhibited greater resilience, and perchers were actually less vulnerable than flyers. We also found that wildfires negatively affected all species, irrespective of mating traits. These findings collectively indicate that research that considers mating-related traits will be vital for predicting wildlife responses to changing habitats and effectively conserving animal populations under global change.

Jasmine Nelson Colorado State University	**Informal greenspace availability and physical noise reduction: An exploration of equitable noise mitigation in marginalized urban communities in the U.S.** Anthropogenic noise is a pervasive form of pollution in urban contexts. Its impacts on humans and wildlife have been well documented, with high anthropogenic noise contributing to a multitude of health issues in humans and altered movement, vocalization, and other behavioral patterns in wildlife. Unfortunately, anthropogenic noise is often unevenly distributed within cities, with low-income and communities of color having increased noise. Thus, heightened noise levels in marginalized communities represent both a dire equity and conservation issue. Research has demonstrated that greenspaces may mitigate noise both mentally and physically, reducing stress levels for people using the greenspaces and physically blocking and reflecting noise away from people and wildlife through vegetation. However, low-income and communities of color also have reduced access to formalized greenspaces. Thus, some researchers have argued for the use of informal greenspace (accidental or transient greenspaces) to reduce noise levels. However, it has yet to be explored whether various informal greenspaces physically reduce noise and if there are enough of these spaces in marginalized communities to truly provide more equitable greenspace. Here, I preliminarily explore the distribution of informal greenspaces and the relationship between informal greenspaces and noise, measuring the number and area of informal greenspaces in marginalized communities and exploring whether noise is reduced in areas with more informal greenspaces.
Nicholas Parker Colorado State University	**Exploring white-tailed ptarmigan habitat selection in Colorado** While it is predicted that many wildlife species will shift their ranges upward in response to climate change, species in alpine ecosystems already exist at the highest elevations with no opportunity to move. The white-tailed ptarmigan (Lagopus leucura) is an alpine endemic grouse species found across Colorado facing an uncertain future in the state due to climate change, land use change, and increasing human recreation. To help guide management and predict future changes in white-tailed ptarmigan habitat, we first need an understanding of current habitat requirements across seasons. We used location data from radio-marked white-tailed ptarmigan collected at Rocky Mountain National Park (ROMO) from 2013â€“2016 and 2022â€“2023 in a resource selection framework with remotely sensed environmental covariates to model habitat relationships. We found white-tailed ptarmigan use habitats at high elevation that contain greater snow cover. Anthropogenic effects were overall weak, but white-tailed ptarmigan avoided areas with higher road density. Land cover and vegetation characteristics had relatively little influence on habitat selection, yet white-tailed ptarmigan selected increased shrub and bare ground cover. Overall results from these analyses indicate white-tailed ptarmigan habitat use in ROMO is largely driven by abiotic factors that are predicted to change under future climate scenarios, which will ultimately reduce usable habitat. Ongoing research aims to model quality white-tailed ptarmigan habitat within ROMO and across Colorado to help prioritize areas that can be protected to allow for their continued persistence.
Izabella Rhomburg	**The Effect of Drought on Plant Type Survival in a Seedbank in the Shortgrass Steppe of Northern Colorado**

Colorado State University	Drought has a massive impact on the survival rate of plants, as well as dispersal rates of seeds. Long term drought can often outlast the viable dormancy period of many plant species. Plant type can be a determining factor as to whether the seeds survive in the seedbank over the period of drought. In general, forb seeds have a better ability to store nutrients, and therefore a tendency to survive in a seedbank longer. Previous studies suggest that invasive annual forbs have the highest rate of survival on drought affected seedbanks. Our study uses a manipulated five year drought, which is the first study to observe this effect on a seedbank in the short grass steppe. A seedbank is a key aspect determining the landscape's ability to recover from a period of drought. This research is studying the long term effects of drought, and the long term impacts on the composition of the seeds within the seedbank. The surviving species from within the seedbank that are least affected by drought, determine the type of community that reestablishes after the drought period. This can change the landscape and plant communities from what it was before the drought.
Chance Roberts Colorado State University	**Genotypic Variation Effects on Microbial Communities In Drought** Conservation and restoration efforts in North America to maintain natural prairies and grasslands must deal with the challenges of future drought events. As drought events continue to increase in frequency and severity, it is imperative to find ways to mitigate the negative effects of drought. One current restoration practice is reseeding native grasses such as Bouteloua gracilis (Blue grama). However, it is important to understand the adaptability of the seeds to the local climate including the soil microbiome. Plants have associated with microbes throughout evolutionary history - these plant- microbe interactions have been recognized as critical for plant health. Understanding these interactions may provide necessary insight into ways to . We plan to investigate how different cultivars of Bouteloua gracilis interact with droughted and non-droughted microbial communities, attempting to understand the impacts differing microbial communities have on B.gracilisâ€™ fitness. In our experiment, five cultivars of B.gracilis will be planted with either, non-droughted soil microbes or previously droughted soil microbes from a previous experiment in Northeastern Colorado. . A drought treatment will be applied to assess if previously droughted soil microbes can offer resilience to plants. Plant fitness will be measured by measuring plant height, above and below ground biomass, root traits and flowering time. The microbial community composition will also be observed throughout the experiment. Overall, this study will evaluate the legacy effects of drought on microbial communities and whether certain B.gracilis cultivars are more suitable for restoration efforts. This information can be used to inform future conservation efforts in maintaining native grasslands through the increased frequency and severity of droughts.
Erica Robertson Colorado State University	**Local Adaptation and Underlying Genes in an Alpine-Obligate Finch** Alpine species are under heavy pressure due to climate change. With rising temperatures and reduction in snow pack essential to their ecology, many species are undergoing range shifts to stay within their ideal niche. For many alpine species this movement not an option as they are already at the top of their range. Additionally, the presence of local adaptation in these isolated populations can further hinder range shifts. The goal of this study is to identify traits displaying local adaptation in Grey-crowned Rosy Finches (Leucosticte tephrocotis dawsonii)

	and the genes underlying these traits. Feather microstructure, a trait involved in thermoregulatory ability, was found to vary significantly between two populations of Rosy Finch as well as traits such as wing chord and beak morphology. These results suggest that local adaptation is happening between these two populations of alpine-obligate finches. A GWAS will also be performed to determine genes involved in these traits.
Cozette Romero Colorado State University	**Effects of Invasive Rodent Control on Island Forest Bird Demography and Health** The introduction of rats (Rattus spp.) to island ecosystems has resulted in widespread decline and extinction of birds. Rats impact birds by spreading disease, depredating eggs, chicks, and adults, and competing for food, yet the effect of rats on both the demography and health of these species is poorly understood. Our objective was to determine if rodent control can influence physiological effects and demographics of island forest birds. To address this objective, we examined the sex and body condition of four focal Hawaiian forest bird species residing in Kaua'i's Alaka'i Wilderness Preserve in relation to proximity and density of rat traps, as well as topographic variables within their home range. Birds were captured within and around areas that have had active rodent control for the past 5-8 years. Data analysis is currently underway and results of three field seasons of data collection from 2021-2023 will be discussed. Over this period, we collected data from more than 570 focal species captures. This information will be important in prioritizing management actions to protect Hawai'i's ecologically and culturally important avian populations and contribute to a deeper understanding of rat impacts on forest bird health and demography.
Dani Rosario Colorado State University	**The influence of cacti on grassland recovery after a four-year experimental drought** Droughts are expected to increase in frequency, intensity, and duration, leading to high risks of extreme multiyear droughts. Previous research has focused on the impact of multiyear droughts on grassland structure and function. However, the mechanisms that promote grassland recovery after multiyear droughts are not well understood. Cacti are drought-tolerant species that often facilitate the growth of other species in arid and semi-arid systems by creating fertility islands and refuges from herbivory. However, the potential of cacti to facilitate the survival and recruitment of plants after extreme multiyear droughts has not been evaluated. For this project, we investigated the effect of Cacti (Opuntia polyacantha) on the recovery of the Colorado Shortgrass steppe after a four-year experimental drought that reduced annual precipitation by 66%. We compared plant cover, productivity, and phenology of herbaceous plants in plots of cacti clumps and plots where cacti were absent during the first growing season of the recovery period. Our results revealed that recovering plant communities in plots with cacti maintained greater plant cover and greenness throughout the growing season than recovering plots that did not contain cacti and control plots that did not experience drought. Recovering plots with cacti showed an over-compensation of Forb ANPP by more than 250% and a greater recovery of C3 grasses compared to plots with no cacti. However, all plots recovering from the drought, both with and without cacti, showed little to no recovery of perennial C4 grasses. Our findings suggest that cacti play a crucial role in facilitating the recovery of forbs and C3 grasses in the Colorado Shortgrass steppe. As extreme droughts become more frequent, cacti may act as important refuges for the rapid

	recovery of diverse plant assemblages, potentially serving as points of dispersal for these plant species, and increasing grassland resilience at larger scales.
Roy Rutherford University of Colorado - Denver	**Wetland Health and Water Quality in an Urban Greenway: Surveying Co-occurrences of Wetland Vegetation, Mesohabitats, and Aquatic Macroinvertebrates** Urbanization contributes greatly to habitat degradation following historic land-use change and alteration of long-standing ecological communities. Though altered, urban habitat can support mixed communities of introduced and native species that interact across a heterogenous mosaic of available habitat. Habitat can be readily provided by urban green spaces, including habitat corridors like canals. Canals and associated stormwater infrastructure can go overlooked as wetland habitat and in terms of ecosystem services that they provide or could provide with concerted support. Colorado's High Line Canal is one such corridor, a 71-mile expanse of habitat that deserves ecological stewardship. Though work towards outlining the terrestrial ecology context is ongoing, surveillance of standing wetland communities is lacking. Characterizing wetland plant and macroinvertebrate communities within the canal will contribute both ecological information and potentially inform management decisions concerning public health and water quality. Standing vegetation will be mapped and composition assessed via percent cover and richness. Richness and abundance observations will also be made for aquatic macroinvertebrate taxa, including larval mosquito populations that may be both a nuisance and public health concern. Macroinvertebrate observations will be made monthly over the summer, alongside observations of water-quality metrics including water temperature, depth, pH, conductivity, and light availability. With water-quality metric data, co-occurrences of wetland plant stands and aquatic macroinvertebrates can further compound as indicators of ecosystem health and positive water quality. To prepare the canal for a drier future, understanding the composition and function of standing wetland communities is a necessity and may potentially inform ongoing stewardship efforts.
Elizabeth Rylance Colorado State University	**Thermal acclimation of metabolic rate and cognition in the honeybee, Apis mellifera** A pressing challenge in behavioral ecology is understanding how climate change will affect ectotherm behavior in the face of rising global temperatures. Metabolic rate increases exponentially with temperature in ectotherms, which can have acute impacts on both physiology and behavior. However, it is unclear how such increasingly extreme temperatures will affect metabolically expensive processes like learning and memory. Despite the apparent connections between temperature, metabolism, and cognitive function, very few studies have explicitly linked these ideas together in the context of animal behavior. Here, we aimed to address this gap by testing the response of a set of cognitive and metabolic performance parameters to extreme temperature in the honeybee, Apis mellifera. Specifically, we evaluated odor-based associative learning, activity level, and resting metabolic rate. We calculated how the acute responses of each parameter changed with acclimation at 25â„ƒ versus 35â„ƒ, representing optimal vs. heatwave-like foraging temperatures, respectively. We found that post-acclimation responses were overall destabilized for learning, overcompensated for activity rate, and stabilized for metabolic rate.

Matt Schmidt Colorado State University	**Grasshopper Herbivory as a Possible Mechanism of Grassland Community Change Under Nitrogen Fertilization** Grasslands are one of the most abundant and important ecosystem types across the globe. They are a biodiversity hotspot, a significant carbon sink, and provide numerous ecosystem services. However, tallgrass prairie in particular occupies only 3-5% of its former range mainly due to agricultural development. In recent times, some grassland community change can be linked to anthropogenic nitrogen addition. There are many mechanisms through which community change takes place under nitrogen deposition, such as through changing competition dynamics, but a possible mechanism involves changing patterns of herbivory. Grasshoppers are important herbivores in grassland communities due to their abundance and association with nutrient cycling and increased biodiversity. Nitrogen deposition may result in higher forage quality and the possibility of increased grasshopper herbivory. Previous work has found a negative association between increasing nitrogen and a particular dominant grass, which encouraged us to explore grasshopper herbivory as a possible mechanism for community change. We measured grasshopper abundance and herbivory damage to the dominant tallgrass prairie grass, Andropogon gerardii, in a long-term nitrogen addition study within Konza Prairie Biological Station in Manhattan, Kansas. Data analysis is on-going, however, we have observed increased herbivory damage and a vague increase in grasshopper abundance along a nitrogen gradient. These initial findings are promising, but further analysis is needed, including weighting herbivory damage to Andropogon gerardii abundance and considering other covariates.
Max Schmidtbauer Colorado State University	**Don't panic, it's organic: Building resilient pest management strategies for organic hemp systems** After a nearly fifty-year hiatus, the 2018 United States farm bill reintroduced industrial hemp (Cannabis sativa L.) back into the agricultural landscape. Hemp has huge profit potential, however, there are still knowledge gaps with regards to best management practices. A recent, nationwide group of hemp stakeholders and producers were polled on research priorities, with many commenting on the dearth of information on organic productions systems and insect management. Hence, the long term-goal of our research is to provide hemp producers with information that will help them create robust and resilient organic hemp production systems, especially with regards to insect management. The first specific goal of our study is to characterize the benefits organic production systems have with regards to plant resistance to insects pests, and overall plant quality. We hope to achieve this through a series of insect counts and microbiome, phytohormone, and cannabinoid analyses conducted on the same variety of commercially available hemp, planted in both organic and conventionally managed plots. We hypothesize there will be distinct differences in plant quality and insect resistance between the two plots. The second specific goal of our study is to screen 30 breeding varieties of hemp in field for key pests, including the cannabis aphid (Phorodon cannabis). We hypothesize that there will be variation in insect resistance among the lines leading to variation in yield and quality metrics. Through traditional entomological and new age molecular

	approaches, we hope to reveal the benefits of organic management systems, and make recommendations to our growers.
Maria Schonewise Colorado State University	**Green Roof Effects on Floral and Nectar Resource Production, and the Utilization of Rooftop Forage by Bumble Bees** In this study, we investigate the effects of a green roof environment on plant growth and resource production to assess the potential of green roofs to support pollinator diversity and abundance in urban ecosystems. We compared floral phenology, nectar volume, nectar sucrose content, and biomass of various plant species on a green roof and a replicate garden at grade on Colorado State University´s campus in Fort Collins, Colorado. Additionally, mark-recapture methods were used to monitor bumble bee (Bombus spp.) abundance, diversity, and foraging patterns at both sites. We aim to quantify the altered resources produced by green roof plants and compare the utilization of these resources to explore the role green infrastructure can play in urban pollinator conservation.
Norah Schroder University of Denver	**The Effect of Fire Severity on Bee Nesting Habitats** Increased fire severity in western United States forests due to climate change and accumulation of fuels can have lasting impacts on vegetation structure that especially impact pollinators. Fire severity has been found to strongly influence bee abundance, with increasing fire severity often correlated with increasing bee abundance. One mechanism for this relationship is altered nesting habitat due to the effects of fire on forest vegetation. The availability of nesting resources varies with burn severity as well as time post-burn. Previous research has mainly been conducted within 5 years post-burn, but here we examine sites 20 years post-burn to test if burn severity affects bee nesting resources longer term. We quantified the habitat available to ground-nesting bees at 18 sites located in 2 different burn areas (Buffalo Creek and High Meadow). Within each of these 2 fires, we studied 3 burn severities (low burn, high burn, and unburned) with 3 replicate sites for a total of 18 sites. We recorded groundcover using Fire Effects Monitoring and Inventory System groundcover codes. We also recorded the diameter at breast height of snags in every site and percent canopy cover surrounding focal trees. Our findings will help us understand whether post-fire effects due to burn severity continue to affect bee nesting resources after the 5 years that are most commonly studied post-burn. Thus, our research will aid in understanding the long-term effects of fire on native bees and ecosystem function.
Emma Sellers University of Denver	**Dietary parental effects in a generalist herbivore** The environment or experiences of a parent generation can impact the fitness of the next generation, a phenomenon known as parental effects. Diet and levels of stress, for example, can have negative consequences for an individual, but a parental effect is when there is a transgenerational response to these stimuli that manifests in their offspring. Dietary specialists are often the focus of studies of parental effects due to diet because a narrow diet breadth suggests that the offspring environment may be predictable. Dietary generalists, in contrast, are less often studied regarding parental effects and this may be because their large diet breadth makes the future environment less predictable. We investigated whether parental effects exist in a generalist herbivore, fall webworm (Hyphantria cunea, hereafter FW), by testing if offspring fitness and development depended on the host plant on which the parental generation was reared. While

	FW is a dietary generalist as a species, this generalism only manifests at a population level; individual larvae are functionally monophagous as they are isolated on the plant on which their mother lays her eggs. Female FW moths do not disperse far, so when they emerge from their pupae, they likely often oviposit on the same host plant on which they developed as larvae; FW therefore are an ideal study system to test for parental effects in a dietary generalist. We found that FW reared on a low-quality diet can negatively impact offspring fitness and that FW reared on a high-quality diet produce offspring that perform well on all host plants. However, we did not find any evidence that FW reared on a specific host plant "primed" their offspring to do well on that host plant, as other parental effects literature has found for specialist herbivores. This study provides insight into the transgenerational effects of diet in FW and the potential implications for reduced lifetime fitness when a low-quality host plant is selected as an oviposition site.
Alaina Smith University of Denver	**Effects of wildfire burn severity on wild bee communities two decades post-fire** Anthropogenic factors such as fire suppression, land-use, and climate change are changing wildfire regimes globally. While fire is a natural disturbance in many global ecosystems, changes in fire frequency, severity, and seasonality can affect multiple trophic levels of an ecosystem, including insect pollinators. Wild bee (Hymenoptera: Apoidea: Anthophila) populations are decreasing globally due to climate change, disease, habitat fragmentation and land use change. Disturbances like wildfire affect wild bee communities, but recent meta-analyses are conflicted about whether fire harms or benefits bees. We investigated the effects of wildfire burn severity on native bee abundance and diversity across different burn severities in two-mixed severity fires in ponderosa pine, Pinus ponderosa, forest that burned >20 years ago. We also evaluated whether bee diversity and abundance correlated with floral resource availability across burn severities, measured as the diversity and abundance of flowering plant species at our various study sites. We recorded all plant species that we observed bees visiting so that we could assess bee-plant interactions. Our work helps to fill a knowledge gap in the study of disturbances and their impact on insect pollinator communities by studying fire sites that burned more than two decades ago. Our research provides insight into how wildfire might affect wild bee communities during long-term, post-fire forest recovery.
Kelsey Sonius Colorado State University	**Wildlife Conservation in La Bendicion: Exploring the role of Indigenous-led Stewardship and Knowledge Sharing in Shaping Conservation in the Tropics of Guatemala** This paper will begin by explaining the significance of Indigenous knowledges in decision making and the role of local voices in forest conservation. It will express La BendiciÃ³nâ€™s history and the role of the community in the surrounding ecosystem. The report will explore the role of Indigenous knowledge systems in conservation and highlight future management implications through a community context. The methods will be described for obtaining data related to community, avian, and mammalian aspects of the ecology of the area through the use of maps, tables, and summarized analysis. Further surveys and participatory guidance will inform future actions for community-driven conservation efforts, focusing on new research and the expansion of La Bendicion, specifically regarding ecotourism. The report is intended to be presented to La Bendicion for

	a more holistic understanding of forest and wildlife management in order to promote coexistence among locals and nature.
Erin Stewart University of Wyoming	**Truculence or Trickery?: The Function of an Uncommon Song in a Territorial Bird** Intraspecific competition is one of the primary selective pressures shaping the ecology and evolution of organisms. Because physical contact is risky and energetically costly, much of this competition occurs by way of behavioral displays. Among birds, vocal displays (i.e. songs and calls) are commonly used during competition for territories or other resources. Song effort and quality may reflect the singer's resource holding potential (RHP), a combination of competitive ability and aggressive motivation. However, in certain cases, birds may use songs to dishonestly signal RHP by, for example, pretending to be two birds. The frequency of dishonest signaling is poorly characterized. Here, we test the role of an uncommon song type produced by chestnut-backed antbirds (Poliocrania exsul) during territorial defense. We present two alternate hypotheses: first, that birds use the song as an honest signal of RHP, and second, that birds use the song as a dishonest "pseudo-duet" to mimic two birds. We find strong evidence for the first hypothesis, indicating that this song type provides specific and reliable information about the singer. Future work should examine whether dishonest signaling is an evolved or learned behavior, and its prevalence within populations.
Emily Swartz Colorado State University	**The Effect of Seedballs and Activated Carbon on Germination Rates after Herbicide Application** The dual challenge of abiotic limitations and invasive species dominance results in significant barriers to native plant community reestablishment in many degraded drylands. The ability to simultaneously address these challenges could improve seeding-based restoration outcomes. Previous research suggests that seedballs, an agglomeration of seed, clay, and amendments, may promote germination and establishment. Additionally, the use of activated carbon as a seed coating can protect desirable seeds from herbicides. We used a greenhouse experiment to investigate the impacts of seedballs and activated carbon on germination following a recent application of Milestone (Corteva), a common pre-emergent used to control Rhaponticum repens (Russian Knapweed). We used a functionally diverse seed mix that included 19 species commonly seeded in the Colorado Plateau. We asked: To what extent do seedballs, activated carbon, or the combination provide protection against a recently applied herbicide, resulting in increased germination rates and recruitment? Overall, herbicide treatment reduced seeded species germination. However, seedball with carbon treatments increased germination in herbicide replicates and these protective effects were greatest in grass species. These preliminary results indicate the need for further greenhouse and field investigation and could lead to restoration techniques that treat invasive species while simultaneously seeding native species.
Aziz Syammach University of Denver	**Evaluating the Effectiveness of Riparian Forest Restoration using Plant Functional Traits** Riparian forests provide critical ecosystem functions and services but are threatened by human management of the floodplain and changes the natural flow regime of rivers. Along the Garonne River in France, damming and conversion to hybrid poplar tree plantations have resulted in a dramatic decrease in natural riparian forest cover in this region. Recent restoration efforts have

	consisted of either abandoning these plantations or harvesting the overstory followed by abandonment of tree plantation sites that are no longer economically viable. Thus, providing an ideal study system to evaluate the effectiveness of multiple commonly applied passive restoration strategies. An initial evaluation of these strategies found that they failed to restore similar taxonomic composition to near natural riparian forests. However, whether restoration has restored functionally equivalent forests has yet to be evaluated and will provide additional insights. For this study, relevant plant functional trait values were collected from public databases and from a literature search for each species identified at restored and reference sites. Trait values were used to compare similarities in functional composition and diversity among restored, active tree plantations, and reference natural forest sites. Results show that neither functional composition nor functional diversity are completely restored by these restoration strategies. However, similarities in functional diversity and composition among all forested site types (abandoned, active, and natural riparian forests) indicates that certain functional characteristics are being maintained despite intensive management and differences in abiotic conditions among the site types. By using a functional trait approach, these results provide useful insights on how overlaps in functional composition and diversity impact ecosystem properties and functions despite differences in species composition and diversity.
Mykaela Tanino-Springsteen University of Denver	**Effects of Light Pollution on Fall Webworm Mating** Light pollution is a global change driver thought to be related to insect declines, especially for nocturnal and crepuscular insect species such as moths. Indeed, light pollution has been reported to negatively affect moth development, diapause, and reproduction. Fall webworm (Hyphantria cunea) is a moth species native to Colorado that seems to mate during twilight, so artificial light at night could disrupt their mating behavior. We conducted an experiment to examine the effects of light pollution on fall webworm mating. Our experiment was designed as part of a guided inquiry activity for the DU SciTech Camp, a summer camp for middle school students. For the experiment, we paired unrelated male and female moths in mating chambers. For 4 nights, half of the mating pairs of moths were exposed to streetlights and half were exposed only to ambient light. We then checked for mating success the following morning. We had a total of 95 mating pairs. We found that fall webworm moths exposed to the streetlights did not mate and also experienced higher mortality. Our results suggest that light pollution is likely to negatively impact fall webworm moth reproduction.
Kelly Tobin University of Denver	**Strength of Top-Down Forces on the Establishment of Diorhabda spp. on Tamarix spp. in the Southwestern U.S.** Northern tamarisk beetles in the Diorhabda genus are specialist herbivores that were released across the western US as a biocontrol for invasive shrubs in the genus Tamarix. Tamarix have flourished in riparian areas across the West and sites with Tamarix have experienced varying levels of Diorhabda establishment. Previous studies have suggested that predation plays an important role, but limited data are available on how the relative strength and interactions of their predation affects establishment or how environmental factors may affect these interactions. Despite the knowledge that ecological communities include a variety of predators, how the top-down forces of vertebrate vs. invertebrate predation impact beetle populations is not well documented in existing literature.

	We will evaluate how the singular and interactive top-down pressures from invertebrate and vertebrate predators affect Diorhabda presence, as it is currently unknown what ecological pressures impact their survival. To do so, we will quantify potential bird predation pressure using plasticine models of larvae and compare the impacts of predator-exclusion treatments. Our study measuring trophic cascades will help land managers make restoration decisions that consider the multi-trophic interactions in critical watersheds. We aim to better understand the impacts of predation on beetle populations to help determine which Tamarix control and removal methods are appropriate for a given site.
Greg Tooley Colorado State University	**Revisiting the drivers of Interannual variability in primary production of tallgrass prairie after 29 years of global change** Aboveground net primary production (ANPP) is a critical component of grassland ecosystem function. ANPP represents a significant input to the carbon and nutrient cycles and determines forage availability for wildlife and livestock. While the drivers of ANPP are well understood for many grasslands, global environmental change has impacted the structure and function of ecosystems worldwide. These changes will potentially alter the response of ecosystems to their current drivers. To better understand the impact of global change on the drivers of ANPP, we evaluated changes in the interannual variability of ANPP in the tallgrass prairie over the past 45 years. We compared data from a foundational paper evaluating ANPP in response to topography, fire, and growing season precipitation from 1975-1993 against ANPP data in the same plots from 2002-2020. Our results revealed that (1) the difference in grass ANPP between the uplands and lowlands has diverged over time, but the direction of divergence varied by fire frequency. Grass ANPP in frequently burned watersheds has increased in the more productive lowlands but remained constant in the less productive uplands, leading to a greater difference in ANPP between lowlands and uplands. Grass ANPP in infrequently burned watersheds remained constant in the uplands and decreased in the lowlands, causing the uplands to become more productive than the lowlands, whose productivity was previously similar. (2) The sensitivity of grass ANPP to precipitation has not changed. (3) Forb productivity remained constant between periods on frequently burned watersheds but decreased on infrequently burned watersheds. Fire frequency remained the main driver of forb ANPP during both periods, but its effect decreased over time. (4) Increased grass ANPP in frequently burned watersheds did not impact forb ANPP. Overall, our results suggest that the dynamics of interannual variability of ANPP have changed over the last 45 years; however, the direction and magnitude of change varied by topography and fire frequency.
Anna Vogt University of Denver	**Comparison of functional composition of the overstory and understory in disturbed riparian forest communities** Plant functional traits (e.g., seed weight) have been shown to provide a mechanistic understanding of how communities respond to abiotic and disturbance changes. In riparian forest ecosystems, changes in the flow regime, species invasion, and human management have been shown to influence the functional composition of these communities. However, most studies have only included woody overstory species (trees), with only a few including trait values of understory species (herbaceous plants). A benefit of a functional trait approach is

	that it allows us to consider the plant community in ways that are not specific to region or even growth form (trees versus herbaceous species). Thus, it is surprising that there has been no research that compares the functional traits of overstory and understory vegetation against an environmental filter such as disturbance within riparian communities. Restoration and management in the Ebro River Basin in Spain and along the Garonne River in France have resulted in a variety of natural and anthropogenic disturbances. This includes sites with cleared overstory, overbank flooding, cleared understory, and undisturbed sites allowing for the comparison of overstory and understory trait composition to these common disturbance types. To compare the response of understory and overstory vegetation at these sites, 7 reproductive traits were used. Reproductive traits were chosen because reproductive strategies influence a species' ability to respond to disturbance. I helped collect values for these traits from public trait databases for 250 species sampled from 99 sites located along the Ebro River Basin and Garonne River. Trait composition was quantified by calculating community weighted means (CWM) for overstory and understory species at each site. Preliminary data analysis has revealed that across all sites, the understory has significantly heavier seeds on average when compared to the overstory. Additionally, the difference in CWM seed weight between overstory and understory vegetation varies depending on disturbance type. This indicates that the overstory and understory of riparian communities respond differently to disturbance, and the difference in responses is influenced by the type of disturbance at each site. Full analysis of all reproductive traits will provide further insight into how the overstory and understory are responding to both natural and anthropogenic disturbances in this region.
Michaela Wahlheim University of Denver	**Long-term impacts of fire severity on the diversity of cavity-nesting bees** Bees are essential pollinators and vital to ecosystem function, and thus it is important to understand how fire impacts bee communities and diversity. Fire regimes, which are being altered by human activities, impact the resources upon which bees depend, such as nesting material and floral resources. Fire's impacts on bee communities vary depending on the time since the fire and fire severity. However, the majority of previous research has examined the impact of relatively recent fires on bee diversity (<5 years post-burn). We addressed this gap in research by examining the impacts of fire on bee diversity 20 years post-burn. We used trap nests made of bamboo reeds of varying sizes to test if fire severity affected the abundance and diversity of cavity-nesting bees. We installed the trap nests at 2 heights at each of 18 sites that varied in burn severity (high burn, low burn, and no burn). We used the caps bees used to plug the reeds in the trap nests to identify the species. We assessed the effects of burn severity on cavity-nesting bee diversity by comparing bee richness and abundance. Our study will help us to improve our understanding of the long-term impacts of fire severity on bee diversity.
Archie-Em Walker Colorado State University	**To Eat Their Own: Cyclical Selection Pressures of Praying Mantids Drive the Prevalence of Sexual Cannibalism** The highly charismatic praying mantis (order: Mantodea) has long been characterized by sexual cannibalism, where females consume their mates before, during, or after copulation. This behavior is well-documented and several studies have provided evidence for the underlying motives that may be driving it.

	However, little attention has been given to the interaction between individual behaviors, which contributes to the selection of sexual cannibalism as a mating strategy. In this study, I reviewed literature that documents the behaviors of mantids during reproductive encounters that are likely to result in sexual aggression or cannibalism. I found consistent patterns between the behaviors of male and female conspecifics that suggest a cyclical interaction perpetuated by selective pressures. Males selectively choose partners to avoid being sexually cannibalized, thereby maximizing mating potential from a single mating attempt. Females respond to male selectiveness by improving fecundity and condition, often by means of sexual cannibalism. This conclusion is supported by several patterns of behavioral partnerships and allows us to analyze sexual cannibalism not as the result of a single motive driven by one sex, but rather a product of intricate behavioral relationships.
Christopher Wicker Metropolitan State University of Denver	**The Influence of Operational Sex Ratio on Pair-bond Formation in the Convict Cichlid (Amatitlania nigrofasciata)** Operational sex ratio (OSR), the ratio of reproductively available males and females, can affect pair-bond formation, mating success, and overall fitness. Convict cichlids (Amatitlania nigrofasciata) are an ideal study organism because natural populations exhibit OSR variation Our study objective was to determine how varying operational sex ratios affect pair-bond formation. We predict that if OSR affects pair-bond formation, then the mutual mate choice group (2 males: 2 females) will form the most pair-bonds the fastest and that the control group (1 male: 1 female) will form the fewest pair-bonds the slowest. Our study consists of one control and three experimental groups with varying OSRs. The number of days until pair-bond formation and the total number of pair-bonds formed were recorded for all four treatment groups. Our data does not show a significant difference in number of pair-bonds formed nor duration until pair-bond formation between the four treatment groups. However, our data does show that the control (1 male: 1 female), male mate choice (1 male: 2 females), and mutual mate choice (2males: 2 females) had significantly more replicates exhibiting pair-bond formation than replicates having no pair-bond formation. Furthermore, in the female mate choice (2 males: 1 female) there was no significant difference in the number replicates that pair-bond formation occurred compared to those replicates were pair-bond formation did not occur. The hypothesis that pair-bond formation would occur more often when mutual mate choice is present was rejected. However, since in the female-mate choice (1 feamle:2males) there was no difference between the paired and unpaired replicates, this may suggest that male mate choice plays a more important role than female mate choice in pair-bond formation, that female-female aggression is necessary for pair-bond formation, and/or that a 1 female:2 male sex ratio causes too high of male aggression level for pair-bond formation to occur.
Shanelle Wikramanayake Colorado State University	**Investigating the role of premating behavioural reproductive isolation along a speciation continuum in a polymorphic neotropical treefrog, Agalychnis callidryas** We examined the role of premating behavioural reproductive isolation in initiating lineage divergence and maintaining species boundaries. We addressed this in a speciation continuum of the red-eyed treefrog (Agalychnis callidryas). This species shows population level variation in colour patterns, call

	characteristics, skin peptides, and courtship behaviour, indicating that it is at the earliest stages of speciation. We used no-choice behavioural assays with wild, gravid female frogs to quantify mate recognition and preference in response to a series of increasingly divergent stimuli treatments. We characterised the red-eyed treefrog species continuum using SNP data collected by sequencing Ultra Conserved Elements across the species' genome. This data was used to estimate genetic differentiation (Fst) among lineages and construct a phylogeny for the lineages and species in our treatments. Premating behavioural reproductive isolation between populations and species is incomplete, and uniform at the conspecific and heterospecific levels respectively. We conclude that premating behavioural reproductive isolation stalls speciation along the red-eyed treefrog speciation continuum. Future studies should investigate other mechanisms of reproductive isolation as drivers of lineage divergence.
Jason Wong Colorado State University	**The effects of biocrust inoculum in seedballs on plant recruitment and biomass** Over forty percent of global dryland ecosystems are degraded and in need of active restoration. Seed-based restoration is an important restoration strategy in degraded drylands, but seeding efforts are often unsuccessful due to abiotic barriers such as water limitation. As such, innovative restoration strategies are needed to improve dryland seeding success (e.g., microbial inoculation, and seed pellets ("seed balls")). Seedballs, a mixture of clay, seed, and/or other amendments (e.g., nutrients or microbial inoculants), are a method of seeding often used in arid systems to protect seeds and promote germination during restoration. Biological soil crusts (biocrusts) are surface-dwelling biotic communities in drylands that can promote soil functioning and affect plant germination through modification of soil stability, water retention, and fertility. Biocrusts, however, are easily damaged or destroyed by anthropogenic activity, and, for these reasons, are increasingly targets of restoration alongside seed-based restoration. So far, no research has examined the effects of biocrust as a seedball amendment on plant recruitment outcomes. This study aims to answer the question: Does adding biocrust inoculum to seedballs help promote seed germination and biomass production compared to broadcast seeding onto live biocrust inoculum? We conducted a greenhouse experiment to examine the effects of seed ball and biocrust treatments on plant germination and biomass production. Specifically, we tested the effects of two seeding methods (seedballs or broadcast) crossed with three amendment treatments (live and sterile biocrust crumbles or straw as a control treatment). Our results showed that among our seeding methods broadcast seeding onto live biocrust inoculum had higher germination and production than any seedball treatments. When just looking at seedball additives, live biocrust added to seedballs had the highest germination and production among seedball treatments only. These results suggest that adding to the surface of the soil increases germination and biomass of native seeds. Biocrust inoculum also increases germination and production of seeds inside of a seedball.