



Rocky Mountain National Park Biennial Research Conference 2026

Park Stewardship: From Discovery to Decision



Photo Credits: National Park Service Arrowhead Patch worn by conference participant, Rocky Mountain Conservancy (Cover); Community Scientists in alpine tundra, Kristi Odom (Welcome); Wetland inside the Beaver Creek Exclosure, NPS Photo/M. Richter (Conversation Café)

Welcome to the Rocky Mountain National Park Biennial Research Conference

Hosted by the Continental Divide Research Learning Center
Presented by Rocky Mountain Conservancy

This year's conference theme, "**Park Stewardship: From Discovery to Decision,**" highlights the essential connection between research and action.

Collaboration between Rocky Mountain National Park and its partners is fundamental to advancing scientific discovery and guiding management decisions. Park staff and research partners conduct critical studies to develop science-informed management strategies, while students, community scientists, and volunteers contribute through hands-on data collection.

The Biennial Research Conference showcases projects that span the full continuum from discovery to decision. Topics include wildfire effects and forest management, information gleaned from historic structures, changes in the alpine tundra, restoration of wetland ecosystems, wildlife research, and long-term monitoring of park resources. These efforts support the adaptive management of natural and cultural resources in the park, for the enjoyment of current and future generations.

Thank you for participating in the 2026 Biennial Research Conference made possible by the Rocky Mountain Conservancy. We hope this event provides you with opportunities to learn, discuss, collaborate, and to develop a deeper appreciation for stewardship of our National Parks.

Paige Lambert – Continental Divide Research Learning Center
Rocky Mountain National Park



Conversation Café: Wetlands in Rocky Mountain National Park



Join Rocky Mountain National Park staff and partners for structured, small-group discussions on wetland ecosystems and their importance.

Advanced sign-up during on-site registration is required.

2026 Rocky Mountain National Park Award Recipients

Community Science Award Recipient – Colorado Pika Project (CPP)

The Community Science Award recognizes community science projects or individuals who have made substantial contributions to public engagement in science and/or helped to address management-relevant issues through public-data collection.

Photo Credit: Kristi Odom, kristiodom.com



Partnership Award Recipient – NPS Wildlife Health Branch

The Partnership Award recognizes organizations that have made a substantial contribution to the management of RMNP through collaboration, knowledge-sharing, and co-production of science and research.

Photo Credit: Jenny Powers



Stewardship Award Recipient – Christopher Kennedy

The Stewardship Award recognizes individuals who have made lasting, impactful, and/or substantial contributions to helping resolve critical management questions or challenges and demonstrated commitment to the National Park Service mission and core values.

Photo Credit: Jonathan Lewis





Schedule of Events

Rocky Mountain National Park Biennial Research Conference

Park Stewardship: From Discovery to Decision



Wednesday March 4, 2026

8:00 – 8:30 AM	Morning Mixer and Coffee	
Welcome		
8:30 – 8:50 AM	Gary Ingram CDRLC Staff	Conference Introduction, Land Acknowledgement, and Awards
Fire Effects and Forest Management		
8:50 – 8:55 AM	Moderator	Session Introduction
8:55 – 9:15 AM	Jill Baron	Distinguishing Wildfire and Anthropogenic Sources of Nitrogen Deposition in Loch Vale Watershed, Rocky Mountain National Park
9:15 – 9:35 AM	Leah McTigue	Colorado Fires and Biodiversity
9:35 – 10:00 AM	Nate Williamson Christina Fossum	A tale of two fires: Exploring Forest community change within RMNP's Lodgepole Pine ecosystem following the East Troublesome Fire and the re-introduction of prescribed fire to RMNP's front country Ponderosa pine ecosystem.
10:00 – 10:20 AM	Benjamin Helms	Terrestrial Laser Scanning Estimates of Frequent-Fire Forest Structure in the Colorado Front Range
10:20 – 10:40 AM	Kevin Willson	A management tool to visualize restoration treatments that achieve historical overstory structure from present-day forest structure
10:40 – 11:00 AM	Break	
Learning from Historic Structures		
11:00 – 11:05 AM	Moderator	Session Introduction
11:05 – 11:25 AM	Nicole Arendt	This is NOT HGTV – Mission 66 and Learning to Love and Preserve Boring Midcentury Buildings
11:25 – 11:45 AM	Michael Welsh	Archival Research, Document Analysis, and Database Development of Historic Irrigation Structures in Rocky Mountain National Park
11:45 – 1:00 PM	Lunch	
Next Generation Science: Rocky Mountain Conservancy Research Fellows		
1:00 – 1:10 PM	Moderator	Session Introduction
1:10 – 1:30 PM	Chris Maienza	Arboreal Armageddon: Post-fire Plant Communities in Rocky Mountain National Park
1:30 – 1:50 PM	Theo Kuhn	Long-term stream temperature trends, sensitivity, and the role of groundwater in RMNP streams
1:50 – 2:10 PM	Katie Gannon	Algal Blooms in Mountain Lakes: What drives their growth? And what are the consequences for nearshore biogeochemistry?
2:10 – 2:30 PM	John Lambert	A field survey of the preparedness of wilderness day hikers and trail runners in Rocky Mountain National Park
2:30 – 2:50 PM	Break	
Challenges and Changes for Alpine Ecosystems		
*Presentations within this session are available virtually. The link for virtual participation can be found at go.nps.gov/RMNPConference2026		
2:50 – 3:00 PM	Moderator	Session Introduction
3:00 – 3:20 PM	Daniel F. Doak Claire Powers	Analysis of GLORIA alpine plant community data across the southern Rockies: Climate and species traits shape responses of the alpine flora to a changing world
3:20 – 3:40 PM	Chris Ray	Will pikas be lost from the park?
3:40 – 4:10 PM	Ann Mills Michelle Gibbons	Rocky Mountain National Park Alpine Tundra Restoration: Past, Present, and Future
4:10 – 4:45 PM	Panel: Alpine Tundra Ecosystem Stewardship <i>Join park staff and partners for a Question and Answer panel discussion on alpine ecosystem stewardship.</i> Kyle Patterson – Management Specialist, Jim Bromberg – Restoration Ecologist Mitch Hauptman – Law Enforcement Specialist	
4:45 – 4:50 PM	CDRLC Staff	Day 1 Wrap Up



Schedule of Events

Rocky Mountain National Park Biennial Research Conference

Park Stewardship: From Discovery to Decision



Thursday March 5, 2026

Poster Session		
8:00 – 9:00 AM	The poster session is an opportunity to read about a variety of research projects and activities in the park and engage in discussion directly with the presenter. Join us for coffee and light breakfast snacks.	
Welcome		
9:00 – 9:05 AM	CDRLC Staff	Welcome and Introduction
Restoration in Action: Wetland Ecosystems		
9:05 – 9:10 AM	Moderator	Session Introduction
9:10 – 9:30 AM	Isabel de Silva Shewell	From Design to Digging in: Updates on Wetland Restoration in the Kawuneeche Valley
9:30 – 9:50 AM	Itai Boj dak-Yates	Stream Restoration Monitoring on Beaver Creek, Kawuneeche Valley, Rocky Mountain National Park
9:50 – 10:10 AM	Linda Zeigenfuss	Coming of Age... EVMP at 15 Years
10:10 – 10:30 AM	Hanem Abouezz Will Deacy	High-altitude thermal infrared aerial surveys for estimating moose populations and demographics in Rocky Mountain National Park
10:30 – 10:35 AM	CDRLC Staff	Announcements
10:35 – 10:50 AM	Break	
10:50 – 11:50 AM	Conversation Café: Exploring Wetland Ecosystems Join RMNP staff and partners for structured, small-group discussions on wetland ecosystems and their importance in the park. <i>Advanced Sign Up is Required for Participation</i>	
11:50 AM – 1:00 PM	Lunch	
Science for Adaptive Wildlife Management		
1:00 – 1:10 PM	Moderator	Session Introduction
1:10 – 1:30 PM	Rachel Billings	A Tale of Two Pikas: Acoustic & Genetic Characterization of Hybrid Zone Dynamics
1:30 – 1:50 PM	Airy Peralta	Accounting for thermal refugia in American pika habitat in Rocky Mountain National Park
1:50 – 2:10 PM	Emily Golden-Beam	Coyote Microbiomes Reveal Biological Responses to Human Recreation and Urbanization
2:10 – 2:30 PM	Boyd Wright	The Poudre Headwaters Project: A Cornerstone of Greenback Cutthroat Trout Recovery Efforts
2:30 – 2:50 PM	Break	
Understanding Change with Long Term Monitoring		
2:50 – 3:00 PM	Moderator	Session Introduction
3:00 – 3:20 PM	Noah Estrada	Vegetation Shifts in the Colorado Front Range, 1972-2025
3:20 – 3:40 PM	Scott Rashid	Boreal Owl (<i>Aegolius funereus</i>) and Northern Saw-whet Owl (<i>Aegolius acadicus</i>) Research in RMNP
3:40 – 4:00 PM	Mary Jade Farruggia	Long-term trends in the biogeochemistry of Rocky Mountain headwater lakes reveal complex patterns and drivers
4:00 – 4:20 PM	Jennifer Nestler	From Backlog to Action: Collaborative Data Management in the Rocky Mountain Network
4:20-4:30 PM	CDRLC Staff	Conference Wrap Up

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Oral Presentations

High-altitude thermal infrared aerial surveys for estimating moose populations and demographics in Rocky Mountain National Park

Hanem Abouelezz (National Park Service)

Will Deacy (Rocky Mountain National Park)

hanem_abouelezz@nps.gov

william_deacy@nps.gov

Resource managers need accurate estimates of moose populations to maintain ecological balance. Traditional counting methods, like low-altitude helicopter flights, can be disruptive and less precise, especially for elusive species. To overcome these challenges, Rocky Mountain National Park biologists developed an aerial survey protocol that uses thermal infrared (TIR) technology to count Shiras moose in the park. Initial surveys occurred in 2019 and 2020 and covered most of the park. In 2025, the survey was repeated to produce the first parkwide estimate of moose abundance. In this presentation, NPS biologists will explain the method in detail, present new results from 2025, and show how moose abundance and demography have changed over the past 6 years.

Keywords: *Shiras moose, resource management, thermal infrared technology*

This is NOT HGTV – Mission 66 and Learning to Love and Preserve Boring Midcentury Buildings

Nicole Arendt (Rocky Mountain National Park)

nicole_arendt@nps.gov

The last major service wide construction campaign in the National Park Service is known as Mission 66 (1945-1972). A very different architectural style from the Rustic style typically associated with the NPS, and reflective of the time in which they were constructed and the needs of the program, all structures constructed within the Mission 66 period have now passed the fifty-year age point related to potential eligibility for the National Register of Historic Places. The large number of aging structures, and now potentially historic structures has led to challenges with completing needed work to bring these structures up to current standards and to meet current needs. Recently, new pathways have been developed to facilitate this work, while maintaining the character of these historic (and potentially historic) structures. Rocky Mountain National Park has been exploring ways to use these new pathways to maintain these structures.

Keywords: *Historic structures, Mission 66, compliance*

Distinguishing Wildfire and Anthropogenic Sources of Nitrogen Deposition in Loch Vale Watershed, Rocky Mountain National Park

Dr. Jill Baron (U.S. Geological Survey, Colorado State University)

jill.baron@colostate.edu

Lauren Magliozzi, Colorado State University;

Kimberley Corwin, Colorado State University;

Lillian Naimie, Colorado State University;

Jeff Collett, Colorado State University;

Emily Fischer, Colorado State University

Atmospheric deposition of reactive nitrogen affects the ecology and biogeochemistry of mountain lakes across the western United States, with increased algal productivity, shifts in algal assemblages, and nitrogen saturation documented in many alpine systems. Agricultural sources have long been recognized as major contributors to nitrogen inputs at Loch Vale watershed in Rocky Mountain National Park. However, the role of wildfire smoke plumes as vectors for reduced nitrogen deposition in the form of ammonia and ammonium remains poorly understood. Quantifying smoke's impact is particularly critical as wildfire frequency and intensity increase across the West. Using the long-term water quality dataset from Loch Vale, this study examined relationships between smoke events and nitrogen deposition patterns by combining water quality data with satellite-derived smoke location data. Temporal correlations were calculated between major ammonium wet deposition events, fine particle carbon concentrations, ammonia from a passive ammonia collector, and wildfire smoke presence, and Seasonal Autoregressive Integrated Moving Average with Exogenous Variables (SARIMAX) models were applied to assess associations between smoke and lake chemistry while controlling for precipitation and hydrologic discharge. Preliminary analyses suggest that wildfire smoke is associated with elevated reactive nitrogen species and dissolved organic carbon in Loch Vale. Lag time analysis indicated that some smoke impacts on lake chemistry were immediate, with most effects emerging and persisting over 7–14-day periods following smoke events. This work helps distinguish between wildfire and other anthropogenic contributions to nitrogen deposition and lake biogeochemistry in RMNP, informing air quality management strategies and predictions of how intensifying fire regimes may affect this sensitive alpine ecosystem.

Keywords: *Nitrogen, wildfire smoke, Loch Vale*

A Tale of Two Pikas: Acoustic & Genetic Characterization of Hybrid Zone Dynamics

Rachel Mae Billings (PhD Student, University of Colorado Boulder)

rachel.billings@colorado.edu

Chris Ray, University of Colorado Boulder;

Jessica Castillo Vardaro, San Jose State University

The American pika is a conspicuously vocal small mammal whose physiological needs and limited dispersal range may make it more vulnerable to climate change. In this study, we characterize an area around Mt. Chapin where two subspecies of American pika (*Ochotona princeps princeps* and *O. p. saxatilis*) are thought to hybridize in Rocky Mountain National Park (RMNP), Colorado, USA. This hybrid zone was first sampled in 2012 for a study of spatial overlap between subspecies as revealed through genetic analysis of pika scat. Our current sampling is designed to infer any expansion/contraction or movement of the hybrid zone since 2012, and to understand the factors influencing gene flow between these subspecies. As in previous studies, we sequenced part of the pika's genome (mitochondrial cytochrome-b) to classify subspecies from pika fecal pellet samples collected along five transects spanning the potential hybrid zone in 2024. Based on samples analyzed to date, there has been no clear shift in the area occupied by either subspecies, although there is preliminary evidence that the southern subspecies (*O. p. saxatilis*) is expanding northward. Moreover, acoustic samples of pika calls were found to correspond to subspecies, as indicated by previous studies. What does this mean for the pikas of RMNP? The influence of hybridization on a species' reproductive success can be significant, as hybridization can introduce new genetic material for adaptation, or (conversely) result in less viable or inviable offspring. Understanding changes in this hybrid zone (which may be due to shifting geographic barriers or changing behaviors), will help reveal the potential impacts of climate, construction, noise, tourism, and wildfire on pikas of both subspecies throughout the park.

Keywords: *Pikas, hybridization, genetics, speciation*

Stream Restoration Monitoring on Beaver Creek, Kawuneeche Valley, Rocky Mountain National Park

Itai Bojdak-Yates (Graduate Student, Colorado State University)

itai.bojdak-yates@colostate.edu

Ava Becker-Church, Colorado State University;

Sara Rathburn, Colorado State University

Beavers dramatically modify riparian corridors by damming streams to create their preferred habitat. These dams increase overbank flow; recharge groundwater; slow water and sediment transport; increase floodplain resilience to fire, flood, and drought; and diversify aquatic and riparian habitat. The headwaters of the Colorado River, in the Kawuneeche Valley, Rocky Mountain National Park, historically supported tall willow and other native vegetation in wetlands created by beavers. In recent decades, however, heavy browsing by ungulates has caused the decline of tall willow and the loss of beavers. Following the collapse of willow and beaver populations, water tables dropped, streams straightened and incised, and the ecosystem shifted from a willow-dominated wetland to a drier grassland. In the fall of 2024, twenty-nine in-stream wooden structures were constructed in a reach of Beaver Creek, a tributary of the Colorado River in the Kawuneeche Valley, to mimic the effects of beaver dams. Prior to construction, various hydrologic and geomorphic indicators were quantified along the planned restoration reach. In the summer of 2025, we quantified the response of these indicators to the structures. We surveyed inundated areas at high and low flows, measured discharge along the reach throughout the season, surveyed the channel thalweg and fifteen cross-sections, measured sediment accumulation behind the structures, and surveyed sediment sizes. We found that 1) the area of overbank flow increased fourfold between peak and lower flows, with a maximum area of over 12,000 m²; 2) discharge decreased by up to 25% along the reach; 3) the thalweg aggraded by an average of 5 cm, with up to 50 cm of aggradation in places; and 4) in-channel sediment became up to 50% finer. These findings suggest that the in-stream structures created several desired effects, including increased overbank flow and floodplain connectivity, increased groundwater recharge, and decreased sediment transport.

Keywords: *Beaver, willow, stream restoration, Colorado River*

Kawuneeche Valley Restoration Collaborative

Isabel de Silva Shewell (Rocky Mountain National Park)

isabel_shewell@nps.gov

The iconic headwaters of the Colorado River flow through the Kawuneeche Valley. The valley was one of Colorado's most significant wetlands, stretching more than 8 miles long and over a half-mile wide. Heavy browsing by elk and moose reduced tall willow cover in this part of Rocky Mountain National Park by 98% since 1999 (Cooper et al. 2025). This browsing created a community of short, unhealthy willows unsuitable for beavers and other riparian species. Without adequate food and building materials, beavers abandoned the valley, nearly 94% of ponded areas dried up, and non-native plants invaded.

The Kawuneeche Valley Restoration Collaborative (KVRC) was formed in 2020 with the intent to reverse these trends. Rocky Mountain National Park is joined by other federal, state, and local agencies as well as non-profit groups such as Rocky Mountain Conservancy. Over the next 10–20 years, KVRC plans to expand tall willow stands to create suitable habitat for beavers throughout the valley. Project activities include installing instream structures and ungulate exclosure fences, planting willows and other wetland species, and removing non-native plants. Collectively, these actions aim to rewet the floodplain, raise the water table, reduce channel erosion, improve water quality, and provide high-quality habitat for wetland plants, birds, fish, insects, and other wildlife. Restoring ecosystem functions to these wetlands will also increase resilience to drought and wildfire.

In this talk, I will provide an update on Beaver Creek, KVRC's first restoration project. I will briefly summarize the science and design behind the restoration and discuss preliminary results that highlight its successes. I will also preview the next restoration project at Onahu Creek, scheduled to begin this year.

Keywords: *Wetland restoration, riparian, willow, beaver, LTPBR*

Analysis of GLORIA alpine plant community data across the southern Rockies: Climate and species traits shape responses of the alpine flora to a changing world

Daniel Doak (Professor, University of Colorado Boulder)

Claire Powers (Doctoral Student, University of Colorado Boulder)

daniel.doak@colorado.edu

claire.powers@colorado.edu

Erin Borgman, National Park Service;

Kristin Legg, National Park Service;

Dana Witwicki, National Park Service

To test for community-wide climate change effects in otherwise pristine alpine areas, we analyzed data from five sets of GLORIA (Global Observation Research Initiative in Alpine Environments) monitoring sites in national parks and protected areas across the Rocky Mountains of the western USA, including data from RMNP. Each site was visited between 2 and 4 times from 2003 to 2021. Across all sites and species there is strong evidence for turnover of the flora in the sampling areas, with originally absent and rare species disproportionately increasing over time and common species more often declining. Graminoids and shrubs have increased more than forbs, as has been found or suggested in other studies. Multiple climate variables had significant influence on changes in plant cover. Higher latitude study regions showed more muted signs of community change than did the southerly sites. Also, species with lower latitudinal ranges tended to increase more over time, while more species with more northerly ranges declined. Within these general trends there are substantial differences between species, but there were no strong patterns in these effects that would suggest additional generalizations between species groups. Overall, we find that alpine plant communities across the five study regions are already showing strong responses to climate change, and that these effects are predictable based on climate effects and individual species traits.

Keywords: *Alpine, plants, climate, species turn-over*

Vegetation Shifts in the Colorado Front Range, 1972-2025

Noah Estrada (MS Student, University of Northern Colorado)

noah.estrada@unco.edu

Katie Marascio, University of Northern Colorado;

Scott Franklin, University of Northern Colorado

Evidence shows a changing climate across the globe and especially in mountain systems. Data indicates a variety of distributional shifts, but mostly an upslope shift in natural vegetation in response to elevated disturbance regimes and climatic variability. Previous studies within Rocky Mountain National Park (RMNP) are consistent with these points and suggest upslope shifts of forest overstory species and an increase in species richness in mesic montane forests. By establishing just over 300 plots within RMNP in the 1970's, Dr. Robert Peet provided a unique opportunity for researchers to quantify climate change's impact on forest vegetation through long-term monitoring. We re-sampled Peet's plots using the Carolina Vegetation Survey (CVS) protocol during the summers of 2025 and will continue in 2026. We have two questions. 1) How have forest communities within RMNP changed since the 1970's? Our second question was a bit more specific, how have understory communities changed in mesic montane forests? We hypothesized an upslope shift across every community type and an increase in understory species' evenness and richness. Our preliminary results support both hypotheses. Our research underscores the importance of long-term data collection in ecological research and validates a growing body of evidence that shows upslope shifts in natural vegetation.

Keywords: *Distribution shifts, vegetation dynamics, Colorado*

Long-term trends in the biogeochemistry of Rocky Mountain headwater lakes reveal complex patterns and drivers

Mary Jade Farruggia (Postdoctoral Research Scientist, University of Colorado Boulder)

mj.farruggia@colorado.edu

Timothy Fegel, USFS; Charles Rhoades, USFS; Michael Meyer, USGS; Jill Baron, Colorado State University; Isabella Oleksy, University of Colorado Boulder

Global change factors such as warming, weathering, and atmospheric deposition can reshape nutrient and biogeochemical pathways to and processes within lakes. Mountain lakes are typically in small, sparsely populated basins, where water quality responses stem from changes in the environment and integrate signals from their surrounding catchments. Consequently, mountain lakes can be ideal systems to investigate the effects of global change on biogeochemistry. In recent decades, the Southern Rocky Mountains have experienced major changes in climate and atmospheric deposition, including warming summer and fall air temperatures, altered precipitation patterns and composition, and changing dust deposition. However, we do not know whether there are regional responses in lake biogeochemistry, and if so, what the drivers of change are.

Long-term biogeochemical monitoring conducted in and near the Loch Vale watershed in Rocky Mountain National Park since 1983 and across high-elevation Wilderness lakes in Colorado by the US Forest Service since 1985 has revealed changes in surface water chemistry in response to global change. For the first time, we combine these datasets to quantify patterns and trends in lake biogeochemistry in 7 lakes in Rocky Mountain National Park and across 35 additional high-elevation mountain lakes in Colorado. We found a high degree of both spatial and temporal heterogeneity in lakes' chemical constituents. There is variability in both the magnitude and direction of biogeochemical trends despite most lakes experiencing similar variability in climate and atmospheric deposition. A combination of large-scale trends in climate and deposition and local-scale factors such as land cover type and geology together help explain disparate lake-specific trends. These heterogeneous patterns highlight both the challenge of characterizing drivers of change in montane ecosystems, and the importance of monitoring efforts in capturing representative insights into regional change.

Keywords: *Mountain lakes, biogeochemistry, global change*

A tale of two fires: (1) Exploring Forest community change within RMNP's Lodgepole Pine ecosystem following the East Troublesome Fire and (2) The re-introduction of prescribed fire to RMNP's front country Ponderosa Pine ecosystem

Christina Fossum and Nate Williamson (Rocky Mountain National Park)

christina_fossum@nps.gov

nathan_williamson@nps.gov

In 2020, the East Troublesome Fire burned through a significant portion of the Lodgepole Pine forest on the western side of Rocky Mountain National Park. Prior to this wildfire, the park's fire ecology program had established permanent monitoring plots within the west side Lodgepole Pine ecosystem and coincidentally, seven of these plots burned in the East Troublesome fire and seven did not burn. This provided an excellent opportunity to examine the effects of wildfire on the park's Lodgepole ecosystem.

Over the past year and a half, Rocky Mountain National Park has conducted 3 prescribed burns in the front country ponderosa pine ecosystem along the eastern entrance of the park. This is following a long period where fire's natural role in these ecosystems was excluded. We analyze the effects of these burns with respect to ecosystem restoration as well as wildfire risk mitigation and explore the integration of TLS (Terrestrial Laser Scanning) with traditional fire ecology field measurements to better characterize fire's influence on overstory canopy structure as well as understory fuels structure.

Keywords: *Prescribed fire, TLS, ponderosa pine, lodgepole pine, wildland fire, East Troublesome Fire*

Algal Blooms in Mountain Lakes: What drives their growth? And what are the consequences for nearshore biogeochemistry?

Katie Gannon (Graduate Student, University of Colorado Boulder)

katie.gannon@colorado.edu

Abigail Ross, University of Colorado Boulder;
Isabella Oleksy, University of Colorado Boulder

Mountain lakes are vital “water towers for humanity” providing freshwater for adjacent lowlands, mediating the flow of essential nutrients, and processing carbon from the surrounding landscape. However, even when located in protected areas like National Parks and Wilderness areas, mountain lakes are still vulnerable to regional air pollution, especially nitrogen deposition. Lakes in the southern Rocky Mountains are experiencing both warming temperatures and increased atmospheric nitrogen deposition. These shifts have led to changes in the nearshore benthic environment, which is a hotspot of biogeochemical activity in clear lakes. Locally in Rocky Mountain National Park (RMNP), sediment core reconstructions demonstrated that nitrogen deposition and recent climate warming interacted to increase total algal abundance and alter community composition toward dominance by filamentous algal blooms (FABs) in Sky Pond and The Loch, two iconic lakes in RMNP. Experimental evidence suggests that this type of primary producer outcompetes diatoms in warmer, nutrient-rich conditions. However, little is known about how FABs alter the nearshore biogeochemistry of mountain lakes. Therefore, in this study we ask: (1) how do the biogeochemical conditions differ in areas with FAB growth compared to areas without FABs in the shallow nearshore areas of Sky Pond? And (2) how do these conditions vary throughout the summer? We hypothesize that, throughout the summer season, areas with FAB growth will have elevated concentrations of nitrogen and phosphorus in the sediment pore water due to relatively high-availability of nutrients in areas of groundwater upwelling. Further, we anticipate that high rates of photosynthesis in nearshore areas with FAB growth will lead to higher concentrations of algal-produced dissolved organic carbon compared to areas with no FABs. Discoveries from our initial findings in the summer 2025 will inform ongoing management decisions and future monitoring work in the RMNP.

Keywords: *Mountain lakes, algal growth, environmental change*

Rocky Mountain National Park Alpine Tundra Restoration: Past, Present, and Future

Michelle Gibbons (Rocky Mountain National Park)

Ann Mills (Rocky Mountain National Park)

michelle_gibbons@nps.gov

ann_mills@nps.gov

Rocky Mountain National Park's alpine tundra begins at an elevation of 11,000 to 11,500 feet and comprises about one-third of the park, making it one of the largest protected expanses of alpine tundra in the contiguous United States. Vegetation in this treeless ecosystem is adapted to persevere and thrive under harsh environmental conditions. Despite the hardness of the tundra, repeated human activities (e.g. parking, walking) in the last century have degraded areas along Trail Ridge Road (TRR), Old Fall River Road (OFRR), and near popular tundra hiking trails, leaving scars on a landscape that once thrived with tundra vegetation. Compounding these impacts, ongoing research in alpine tundra communities elsewhere has documented altered species phenology and composition as a result of a changing climate. Without active restoration, past research by Dr. Beatrice Willard beginning in 1959 has indicated passive recovery of these highly degraded sites could take hundreds of years or more.

Effective restoration of damaged areas is complex and requires extensive planning prior to project implementation. We review key completed projects from the past 20 years, primarily focused along TRR, and discuss site selection, restoration methods, and field outcomes. Current management has expanded to include restoration of popular backcountry locations and ongoing monitoring of visitor impacts to evaluate site restoration potential. Since 2010, five alpine tundra restoration projects have been completed resulting in 80,138 plants planted, 100 cubic yards of topsoil spread, and approximately 8,000 staff hours utilized.

Lessons learned from past projects and similar work on other public lands allow for an adaptive management approach for future tundra restoration. Long-term monitoring and interdisciplinary collaboration remain essential to protect RMNP's alpine tundra—an ecosystem defined both by its resilience and its fragility.

Keywords: *Tundra restoration, alpine tundra, Trail Ridge Road*

Coyote Microbiomes Reveal Biological Responses to Human Recreation and Urbanization

Emily Golden-Beam (PhD Candidate, University of Colorado Boulder)

emily.beam@colorado.edu

Dr. Joanna Lambert, University of Colorado Boulder;

Dr. Nicholas Schulte, Jonah Ventures

Human-altered landscapes, including federally protected national parks, create novel and rapidly shifting physiological and ecological pressures for wildlife. One understudied pathway for detecting such pressures is the gut microbiome, which reflects diet, host physiology, and allostatic load. To test hypotheses about the impacts of anthropogenic stressors on wildlife biology, we collected scat from free-ranging coyotes (*Canis latrans*) across a gradient of habitats spanning the Denver Metropolitan Area, Boulder County Open Space, and Rocky Mountain National Park. We used DNA metabarcoding of 16S rRNA genes to profile gut microbial taxa and compared community composition and phylogenetic structure across regions. We detected a significant effect of region on microbial community composition ($p = 0.005$, $R^2 = 0.044$) and a near-significant effect on phylogenetic structure ($p = 0.097$, $R^2 = 0.039$), suggesting that major microbial lineages remain stable while finer-scale taxa shift across landscapes. By identifying regional patterns of microbial composition and diversity, we assess how coyote physiology responds to a spectrum of anthropogenic pressures, from heavily urbanized environments to protected wilderness. Collectively, our findings clarify biological responses to recreation and urbanization and highlight microbial indicators that can inform stewardship decisions balancing human use with wildlife resilience.

Keywords: *Coyotes, gut microbiome, wildlife physiology, urbanization*

Terrestrial Laser Scanning Estimates of Frequent-Fire Forest Structure in the Colorado Front Range

Benjamin Helms (Graduate Student, Colorado State University)

ben.helms@colostate.edu

Chad Hoffman, Colorado State University;
Andrew Sánchez Meador, Northern Arizona University;
Wade Tinkham, Rocky Mountain Research Station;
Ethan Bucholz, Colorado State University;
Emily Francis, Colorado State Department of Forest and Rangeland Stewardship

Colorado forest managers require accurate forest structure estimates to maintain frequent-fire forests and reduce severe fire risk in areas with high ecological and social value. Accordingly, managers are seeking cost and resource efficient inventory techniques to supplement traditional field methods. Terrestrial laser scanning (TLS) is one such technique that offers the potential for an increased level of detail and accuracy with less cost and effort. However, current research has not reached a consensus on the number of scans needed for accurate estimations. While some studies found single-scan methods to be sufficient, others suggest multiple-scan methods may improve estimates by reducing occlusion levels. To date, no studies have assessed the accuracy of single- or multiple-scan forest structure estimates in Colorado Front Range frequent-fire forests. In this study, we evaluated the accuracy and bias of plot-level forest structure estimates from single- and multiple-scan methods at 74 plots in 9 sites across the Colorado Front Range. We found the error structure between scanning methods to be functionally identical, therefore the single-scan method is preferred, as aligning multi-scan data is labor intensive and provides no accuracy improvements. The single-scan method produced low median absolute errors for diameter at breast height (10%) and tree height (12%), however, errors were higher for canopy base height (CBH; 33%), basal area (38%), and stand density (32%). The greatest errors occurred in plots with significant occlusion (e.g., high shrub/regeneration abundance, low CBH) especially when stand density was also low. Consequently, TLS methods are best applied in stands with low shrub and regeneration abundance and high CBH. These findings benefit forest managers, as the single-scan method offers a parsimonious inventory approach when applied in appropriate forest structures, enabling increased sampling intensities and larger spatial coverage for the same resource inputs.

Keywords: *LiDAR, frequent-fire forest management, forest mensuration*

Long-term stream temperature trends, sensitivity, and the role of groundwater in RMNP streams

Theo Kuhn (Graduate Student, University of Colorado Boulder)
theodore.kuhn@colorado.edu

Andrew Birch, Colorado Department of Public Health and Environment;

E. William Schweiger, University of Colorado Boulder;

Holly Barnard, University of Colorado Boulder

Stream temperature is an important ecological variable, affecting which species can live in a stream, their reproductive success and timing, growth rates, and biogeochemical cycling. Climate change is driving changes in stream temperature, but stream temperatures are changing at highly variable rates across the National Park Service network and even between different stream segments within RMNP. One potential mechanism to explain these differences in stream temperature change is varying groundwater contributions to streamflow, as groundwater can buffer stream temperatures against rising air temperatures and diminishing flows. In this study, we compared long-term trends in stream temperature across RMNP to several metrics related to stream temperature sensitivity and groundwater contributions. We combine paired air, stream water and groundwater temperature measurements, stable water isotopes and ion chemistry to better understand how stream temperature sensitivity and groundwater contributions vary throughout the park and across the growing season. We sought to determine the landscape features associated with greater groundwater contributions and to identify potential relationships between long-term warming and groundwater connectivity metrics. Ultimately, this information will be used to inform projections of stream temperature change in the coming century.

Keywords: *Groundwater, stream temperature, climate change, hydrology*

A field survey of the preparedness of wilderness day hikers and trail runners in Rocky Mountain National Park

John Lambert (Boston University)
johntl@bu.edu

Introduction: Actively recreating in natural environments enhances physical and mental health, but also carries potential risk. This study aimed to characterize wilderness day hikers and trail runners, and examine factors that predict preparedness.

Methods: A cross-sectional survey in 4 distinct areas of Rocky Mountain National Park (RMNP) was conducted from June to August 2024. The survey was administered on trail via tablet. English-speaking adults returning from a day hike or trail run of more than 2 miles were invited to participate. The survey assessed self-reported wilderness experience, equipment carried, health status, medical education, demographics, residence, activity outcomes, altitude experience, and health problems or safety concerns encountered. We classified visitors as ‘prepared’ based on the gear they reported carrying. Logistic regression analysis and two-sample t-tests were performed to examine factors associated with preparedness.

Results: Of 801 potential participants approached, 586 (82.3%) day hikers and 68 (76.4%) trail runners agreed to participate. The overall average age was 40.7 years (range 18-82); 50.1% were female; and most common state of residence was Colorado (47.3%). Day hikers tended to be older, travel in larger groups, and spend fewer days in the wilderness per year while trail runners reported higher levels of experience and wilderness preparedness, and were more likely to experience ‘close calls’. A minority of participants met our definition of wilderness prepared, about half were altitude prepared, and approximately a quarter did not tell anyone where they were going and when they expected to return. Several measures of experience were associated with preparedness.

Conclusions: Equipment and knowledge are important for safely enjoying and leaving wilderness settings. Yet many wilderness users in RMNP did not meet our definition of adequate preparation, especially those with less experience. Additional efforts to increase the proportion of wilderness day-users who are prepared may help further improve visitor safety.

Keywords: *Preparedness, accident prevention, public health, preventive search and rescue, visitor use*

Arboreal Armageddon: Post-fire Plant Communities in Rocky Mountain National Park

Chris Maienza (Ph.D. Candidate, Idaho State University)
christophermaienz@isu.edu

Dr. Ken Aho, Idaho State University

The historical fire regime of subalpine forests in the southern and central Rocky Mountains has been characterized by infrequent, high severity fires. However, across the western United States, high elevation forests have seen the greatest increases in burned area in recent decades. Additionally, estimates of the fire rotation period in the Front Range of the Rocky Mountains indicate an approximate doubling of the rate of burning in the 21st century relative to historical estimates. Given this developing mismatch between current and historical disturbance regimes, my research aims to characterize the early post-fire plant community composition and diversity of montane to subalpine forests within Rocky Mountain National Park. In 2024, vegetation surveys were conducted in the areas of the Cameron Peak and East Troublesome fires which burned within the park in 2020. Plots were located in both burned and nearby unburned areas within lodgepole pine forest below an elevation of 9500 feet a.s.l., lodgepole pine forest above 9500 feet, and spruce-fir dominated forest. Based on results from permutational multivariate analysis of variance (PERMANOVA), burn condition and forest type were found to have a significant effect on understory vascular plant community composition. Indicator species analysis was used to identify species which are associated with combinations of plot types defined by the crossed factors of burn condition and forest type. Further preliminary results will be shared concerning patterns in beta diversity across burned and unburned areas as well as linear mixed-effects models of alpha diversity. From this research we can learn more about how subalpine plant communities and species of management interest respond to fire.

Keywords: *Plant community composition and diversity, fire ecology, subalpine forests*

Colorado Fires and Biodiversity

Leah McTigue (Colorado State University, Rocky Mountain Research Station)
leah.mctigue@colostate.edu

Zachary Steel (USDA Forest Service, Rocky Mountain Research Station)

The 2020 wildfire season was record-breaking across the world. In rocky mountain subalpine forests, large fires contributed to a near doubling of fire frequency relative to the past two millennium. While wildfire is an important factor in shaping ecosystems, the consequences of changing fire regimes and uncharacteristically large and severe “megafires” on wildlife and biodiversity is unclear. To evaluate the impacts of these atypical fires on wildlife communities in the Southern Rocky Mountains, we sampled three 2020 megafires in Colorado: the Cameron Peak fire (84,544 ha), the Mullin fire (71,565 ha), and the East Troublesome fire (78,465 ha). Together, Cameron Peak and East Troublesome fires burned 12,140 ha within Rocky Mountain National Park. These large fires spanned a range of elevation and forest types representing different historic fire regimes. For example, lower elevation ponderosa pine forests historically burned frequently with low-moderate severity effects while lodgepole pine and subalpine fir forests are adapted to infrequent but high-severity fire. During the summers of 2023, 2024, and 2025, we deployed camera traps to survey terrestrial mammal communities. Surveys were located across all three wildfires and unburned reference areas using a stratified random sampling design to encompass the range of fire effects and pre-fire conditions. Following a short 2023 pilot season, we observed 20 mammal species in 2024 and 16 mammal species in 2025. With surveys from these three seasons, we present results addressing the following primary questions: 1) How does species occurrence and community diversity vary across gradients of burn severity and pyrodiversity (variation in past fire history)? 2) How do these effects differ among fire regimes and surveyed taxa with contrasting life history characteristics? These findings advance our understanding of how continued shifts in western forest fire regimes are impacting wildlife communities and will inform adaptive management strategies in a changing world.

Keywords: *Wildfire, wildlife, biodiversity, pyrodiversity*

From Backlog to Action: Collaborative Data Management in the Rocky Mountain Network

Jennifer Nestler (NPS Rocky Mountain Inventory and Monitoring Network)
jennifer_nestler@nps.gov

Abigail Volk, NPS, Colorado State University; Katherine Zybko, NPS Rocky Mountain Inventory and Monitoring Network; Melina Kompella, NPS Rocky Mountain Inventory and Monitoring Network; Alexa Serrantes, NPS Rocky Mountain Inventory and Monitoring Network; Isaac Quevedo, NPS Rocky Mountain Inventory and Monitoring Network; Melina Takvorian, NPS Rocky Mountain Inventory and Monitoring Network; Claire Anderson, Rocky Mountain NPS Inventory and Monitoring Network; Judd Patterson, NPS Rocky Mountain Inventory and Monitoring Network; Liam Smith, NPS Rocky Mountain Inventory and Monitoring Network, Scientists In Parks; Claire Smith, NPS Rocky Mountain Inventory and Monitoring Network; Dana Witwicki, NPS Rocky Mountain Inventory and Monitoring Network

The Rocky Mountain Network (ROMN) is one of 32 National Park Service Inventory and Monitoring Networks across the United States, and works across six parks in Colorado and Montana, including Rocky Mountain National Park. In the park, ROMN conducts long-term monitoring on wetlands, streams, and alpine habitats, as well as snow chemistry, with the goal of providing relevant and timely information to park stakeholders and decision-makers. A critical—but often overlooked—part of long-term ecological monitoring is managing the large, complex datasets that the network collects; it is not unusual for datasets to span decades. As is often the case, ROMN developed a data management backlog that needed to be addressed. In 2025, we partnered with a group of data scientists in the NPS Inventory and Monitoring Division called the Data Strike Team. Together, we developed processes to perform quality control checks on our existing datasets; wrote documented, repeatable quality control scripts to run annually; and created extensive metadata documentation. We also wrote scripts to automate the creation of data packages for publication, allowing us to publish a significant amount of our backlogged data, with additional work ongoing. This is a complex, collaborative process that requires coordinating ecological and data management expertise. Moving forward, this will contribute significantly to completing our information lifecycle more quickly, putting information in the hands of decision-makers faster.

Keywords: *Data management, ecological monitoring, quality control*

Accounting for thermal refugia in American pika habitat in Rocky Mountain National Park

Airy Peralta (Graduate Student, University of Colorado Boulder)
aigo5934@colorado.edu

Chris Ray, University of Colorado Boulder

The American pika is one of many species experiencing increasing vulnerability due to climate change. Species distribution models provide essential forecasting tools to inform management efforts that sustain the ecosystem services species provide. But these models are only as good as the environmental data that drives them. In 2016, a species distribution model for pikas in Rocky Mountain National Park predicted extinction under both business-as-usual and moderate climate projections. However, this model relies on climate data at spatial scales too coarse to capture the thermal complexity created by rugged topography. Can this model accurately predict pika persistence? Can it identify the thermal refugia—often decoupled from regional climates—on which pika depend? Will some park landscapes offer pikas a refuge from climate change?

We address these questions by improving the climate data that underlie pika distribution models. From 2021 to 2024, we monitored microclimatic temperature in low and high-quality pika territories from a 30+ year study in Montana. Our preliminary results reveal that high-quality habitats exhibit distinct thermal buffering: they are warmer during winter and cooler during summer—conditions that allow pikas to avoid both cold stress and heat exposure. This suggests that suitable pika habitat cannot be identified using regional climate alone; local topographic complexity creates the thermal refugia that matter. To translate these insights into better predictive tools for Rocky Mountain National Park, we established a microclimate monitoring network at Niwot Ridge Long-Term Ecological Research Site, 15km south of the park. We found that regional climate products like ClimateNA—commonly used in SDMs—systematically overpredict mean and maximum temperatures and underpredict minimum temperatures in our mountain system. We developed correction models to address these biases for improved pika habitat predictions.

Keywords: *Small mammals, species distribution, forecasting, climate refugia*

Boreal Owl (*Aegolius funereus*) and Northern Saw-whet Owl (*Aegolius acadicus*) Research in RMNP

Scott Rashid (Director of The Colorado Avian Research and Rehabilitation Institute)
pygmyowl15@gmail.com

In 2011, we opened the first banding station within Rocky Mountain National Park (RMNP) to capture and band both Boreal Owls (*Aegolius funereus*) and Northern Saw-whet Owls (*Aegolius acadicus*) to determine the numbers of these species within the park and the health of each bird captured. Before dark we place three mist nets in a “U” shape and after dark broadcast the territorial call of the species we intend to capture. There are live video cameras on each net enabling us to monitor the nets live via a computer to see the instant an owl is captured. The captured owl is extracted and placed in a cloth bag and brought in to be processed. To process each bird, first we place a numbered aluminum leg band on each owl. The owl is then measured, weighed, its fat level is checked, its sex and age are determined before being released. The sex of each bird is determined by combining the wing length and weight. Females are larger and heavier than males. Before 2011, we would only hear a single advertising male Boreal Owl in the Hidden Valley area each spring. Therefore, we opened a banding station there to try and determine if the owls nest within the park boundary or simply move through. The first evening we set up a juvenile female Boreal Owl was captured. This proved that Boreal Owls nest within the boundary of the park. The number of juvenile owls captured each year gives us insight into the health of the forest. Since we began the project, we have been capturing more Northern Saw-whet Owls than Boreal Owls, averaging 14.5 owls captured per year. As for the Boreal Owls, we average 7.78 owls captured each year. In 2024 we began recapturing previously banded individuals, which suggests the birds may remain within Hidden Valley year-round, but this needs more study.

Keywords: *Boreal owl, Northern Saw-whet owl, banding*

Will pikas be lost from the park?

Chris Ray (Research Scientist, University of Colorado Boulder)
cray@colorado.edu

Jasmine Vidrio, University of Colorado Boulder

One decade ago, a prediction was published about the American pika, a small relative of rabbits and hares that lives in Rocky Mountain National Park and many other rocky areas across the western US: By the end of this century, pikas would be lost from many or all of the places they've long occupied in the park. This loss would mean fewer encounters with wildlife along park roads and trails, as the pika's iconic vocalizations and bustling activities disappear from these landscapes. But was this prediction valid? The specific mechanism proposed was that a warming climate would reduce the ability of pikas to move between habitat patches during the summer, when many young pikas search for territories to colonize. Lower colonization rates would reduce the number of occupied habitat patches in the park. To evaluate this prediction, we analyzed long-term data from historical and recent studies at the Niwot Ridge Long Term Ecological Research (NWT LTER) site, just 15 km south of the park. Previous studies of this population and others in the region suggest ample exchange of individuals in the past, and yet the number of unused territories has recently increased. Pikas were captured, weighed, and classified by stage annually from 1981 to 1990, in 2004, and from 2008 to 2020. Date of birth was estimated for each juvenile captured, using a growth curve developed for this population. The proportion of juveniles comprising this population declined by more than 50% over the 40-year study period, and this decline was well explained by a metric of warm-season temperature calculated from NWT LTER sensor data. This result suggests that young pikas are colonizing open territories at lower rates as the climate warms, and appears to support the prediction that pikas will decline in the park.

Keywords: *Small mammals, alpine ecology, long-term studies, climate change*

Archival Research, Document Analysis, and Database Development of Historic Irrigation Structures in Rocky Mountain National Park

Michael Welsh (Faculty Research Fellow, University of Northern Colorado)
michael.welsh@unco.edu

Darian Burns, University of Northern Colorado;

Chrisopher Muscato, University of Northern Colorado

As part of the project to identify and map the historic irrigation features of Rocky Mountain National Park, the Documents Analysis team, in collaboration with the Geospatial Mapping team, has undertaken a review of primary sources and secondary literature about the park's interaction with private landowners from the years prior to park creation through the Interior department's 1950s land-acquisition program of inholdings and their water rights. These sources augment and expand upon the General Land Office and Bureau of Land Management patents collected by the geospatial team. Sources from both teams will be housed on an open-access database, hosted by the University of Northern Colorado's library website. This database will allow park staff to consult these sources as they prepare nominations to the National Historic Landmark program. Among the sources to be discussed in our oral presentation would be files from a variety of federal and state agencies, such as the National Park Service, Bureau of Land Management, US Forest Service, US Geological Survey, US Bureau of Reclamation, Northern Water, U.S. District Courts and Colorado water courts.

Keywords: *Water rights, private landownership, land-acquisition, maps*

A management tool to visualize restoration treatments that achieve historical overstory structure from present-day forest structure

Kevin Willson (Postdoctoral Research Fellow, Rocky Mountain Research Station)
kevin.willson383@gmail.com

Paula Fornwalt, Rocky Mountain Research Station; Chuck Anderson, Colorado State University; Mike Battaglia, Rocky Mountain Research Station; Peter Brown, Rocky Mountain Tree-Ring Research; Tony Cheng, Colorado State University; Shannon Kay, Rocky Mountain Research Station; Wade Tinkham, Rocky Mountain Research Station

Over a century of fire exclusion has increased the risk of severe wildfire in dry conifer forests across the Colorado Front Range. Forest managers have aimed to mitigate this risk by implementing treatments that restore historical, fire-maintained forest structure. However, targets for achieving historical structure, and methods to visualize those targets, remain unclear. We addressed these shortcomings using a two-step approach. First, we reconstructed historical spatial and nonspatial forest structure using 172 stem-mapped plots with tree-ring data in the Front Range and determined how climate, soils, and topography affected forest structure before 1860. Then, we used those measured biophysical relationships to inform an analytical framework that blends forest reconstruction data, remotely-sensed forest structure, and artificial intelligence to visualize treatment options that recreate historically-relevant overstory structure. The proposed framework uses relationships between historical overstory structure and climate, soils, and topography data to identify the range of historically appropriate benchmarks for achieving desired structural characteristics in a treatment unit. Then, a deep learning algorithm uses maps of remotely-sensed trees to generate sets of viable arrangements of present-day trees in the treatment unit that meet those benchmarks. Once the manager selects the desired arrangement, the algorithm returns a map of trees to keep and cut, which managers can use to inform a prescription for the treatment unit. Once developed, this tool can help managers account for historical forest structure, forest heterogeneity, and the risk of severe wildfire in treatments designed to meet these or other management objectives.

Keywords: *Historical forest reconstruction, deep learning, dendroecology, forest treatment*

The Poudre Headwaters Project: A Cornerstone of Greenback Cutthroat Trout Recovery Efforts

Boyd Wright (Colorado Parks and Wildlife)
boyd.wright@state.co.us

Jen Williams, USFS/ARP;

Jonathan Lewis, Rocky Mountain National Park;

Chris Carroll, USFS/ARP

The Poudre Headwaters Project (PHP) will restore Colorado's state fish, the federally threatened greenback cutthroat trout (greenback; *Oncorhynchus clarkii stomias*), into its native range. This fish species will be returned to 37 miles of stream habitat and > 100 acres of lake habitat. Eighty-five percent of the project area occurs within Rocky Mountain National Park (RMNP) while the remainder is on the Roosevelt National Forest. Nonnative fish upstream of the restoration area need to be eradicated so that they cannot enter the area and outcompete or hybridize with greenbacks. In August 2025, an 85-member interagency team conducted a large scale and complex chemical reclamation of the 14.3-mile transbasin Grand Ditch and 18 of its tributaries. Rotenone is an organic compound derived from a member of the bean family, and it was used to disrupt cellular respiration of brook trout (*Salvelinus fontinalis*) and Colorado River cutthroat trout (*O. c. pleuriticus*) for this reclamation. Rotenone is carefully administered by fish managers following strict legal requirements. The compound breaks down naturally in sunlight and through aeration from water turbulence. In addition, detoxification stations were set up on large tributaries with a neutralizing agent to make sure that rotenone did not enter the Colorado River in the Kawuneeche Valley, as the river is not part of the treatment area. This same operation will be conducted in 2026 because two years of chemical reclamation are typically needed for full eradication of brook trout. Brook trout are not native to Colorado but were stocked to provide a recreational fishing opportunity to the public. Colorado River cutthroat trout are native to Colorado but only to the western side of the Continental Divide. Upon completion of the PHP, RMNP will be the only unit in the National Park system to host greenbacks.

Keywords: *Poudre Headwaters, cutthroat trout, Kawuneeche Valley, Colorado River*

Coming of Age... EVMP at 15 Years

Linda Zeigenfuss (Ecologist, NPS Partner, Colorado State University)
lzeology2@gmail.com

Nick Bartush, Rocky Mountain National Park;

Will Deacy, Rocky Mountain National Park

Seventeen years ago, Rocky Mountain National Park implemented a 20-year Elk and Vegetation Management Plan (EVMP) to reduce the impacts of elk on key winter range habitats. Vegetation condition data are monitored and analyzed regularly with results reported on a 5-year schedule so that managers can modify management actions as needed to improve vegetation condition on the elk winter range. The 15-year data collection and analysis were conducted in 2023, and the results are mixed. Progress toward improved habitat that was observed through the first 10 years appears to have plateaued in the last 5 years, likely due to several additional factors, namely an increasing moose population and large wildfires which affected EVMP aspen and willow sites. Aspen regeneration and recruitment has steadily increased since baseline and by 2023, was just short of reaching the 20-year EVMP objective, but most progress has been inside protective fences. Aspen stand structure has improved, but only inside fences and in unfenced, noncore winter range. Willow height increased by 43% relative to baseline conditions and willow cover nearly doubled over the entire winter range, however these increases were mostly limited to fenced areas. Noncore winter range showed only modest willow height and cover gains, while no significant change was observed on unfenced core winter range despite a ~50% reduction in browse intensity. Although many EVMP objectives have been met after 15 years, the habitat fences are key to maintaining patches of high-quality habitat and we advise against removing them until other components of the system (beaver communities, restoration of hydrologic regimes, willow recruitment, stable elk and moose populations) are functioning.

Keywords: *Elk management, willow, aspen, Rocky Mountain National Park*

Poster Presentations

Who colonizes and who persists? American pika territory occupancy in the current Rocky Mountain climate

Van Baronofsky (University of Colorado Boulder)
vaba4392@colorado.edu

Chris Ray, University of Colorado Boulder

Many species are experiencing reductions in habitat due to human caused climate change. The American pika (*Ochotona princeps*) is a small territorial mammal related to rabbits that is currently facing a reduction in range at lower elevations. Based on climate projections, the range of pikas in Rocky Mountain National Park is predicted to shrink by over 50% by 2100, but the mechanisms linking climate to pika losses are largely unknown. To study these mechanisms, we used existing data from a large pika population in the central Rocky Mountains. We used annual data from the years 2018-2024 to project the occupancy of pika territories and the stage (juvenile or adult pika) structure of territory owners. To suggest the mechanisms by which a territory may change ownership, we modeled the effect of mean summer temperature and mean winter precipitation on territory colonization and owner mortality. We also modeled how different stages of pikas were affected by both mean summer temperature and mean winter precipitation. We found that higher temperatures and lower snowfall predicted lower territory colonization and higher owner mortality. Also, juveniles were slightly more susceptible to climate conditions than adults. Projections of occupancy under 2018-2024 climatic conditions suggested long-term stability of this pika population, perhaps due to the above-average snowfall at this study site which might offset the negative effects of higher summer temperatures. By modeling occupancy transition rates as functions of climate, our approach can better inform conservation management strategies. The next step is to study whether these results from the central Rockies apply to Colorado pikas.

Keywords: *Pikas, demographic modeling, mammals*

Not just Bears in the Woods: Managing Human Waste in the Wilderness of Rocky Mountain National Park

Danny Basch (Rocky Mountain National Park)
danny_basch@nps.gov

Tara Vessella, Rocky Mountain National Park;

Cheri Yost, Rocky Mountain National Park;

Eron Early, Rocky Mountain National Park;

Aubry Andreas, Rocky Mountain National Park;

Hilary Rollins, Rocky Mountain National Park;

Kyle Patterson, Rocky Mountain National Park

Join members of the Park's recently formed Human Waste Management Interdisciplinary Team (HWM IDT) to learn about what the park has done and is currently doing to manage Human Waste in the woods. This team has been formed to summarize activity to date, survey and compile information on best practices, technology and trends, determine types of installations/ systems and locations, communications/messaging, coordinate with partners and other land managing agencies and support the implementation of human waste management practices over the next 3 to 5 years.

Keywords: *Human waste management, wilderness management, water quality, backcountry sanitation*

Plains to the Park: Community Science in the Rocky Mountains

Dan Cribby (Westview Middle School, St. Vrain Valley Schools)

cribby_dan@swsd.org

Westview Middle Schoolers

Plains to the Park program, is a hands-on, long-term STEM initiative established by Westview Middle School (St. Vrain Valley Schools) in 2014. The program was created to provide students with consistent, immersive field research opportunities in Rocky Mountain National Park (RMNP). The core objectives of the program are to:

- Foster understanding of the scientific process through contributory research.
- Instill appreciation for the ecological and historical value of RMNP and all public lands.
- Encourage stewardship and potentially inspire pursuit of natural resource education and STEM careers.

Students conduct fieldwork within the Fall River corridor (Horseshoe Park), utilizing camera traps as the primary research tool. The central research questions driving the initiative are: "Who lives in this place?" and "How is that changing over time?" Through ongoing data collection, the program has documented diverse RMNP wildlife, including deer, elk, bears, coyotes, bobcats, mountain lions, and foxes. Noteworthy trends observed within the research area include an increasing presence of moose and heightened fox activity. The educational impact extends beyond simple animal identification. Students make 10-15 trips annually, experiencing the park across all seasons. This exposure facilitates a deeper comprehension of complex ecosystem dynamics by observing how dramatic seasonal changes in the geosphere, hydrosphere, and atmosphere (abiotic factors) influence animal distribution and behavior (biotic factors). It is our goal that involvement in this program helps students develop the sense of appreciation that helps grow into a stewardship mindset about RMNP and all public lands. We hope to see students pursue further natural resource education, and possibly pursue a STEM related career. Many past Plains to the Park participants already have.

Keywords: *Stewardship, STEM, Community Science, Middle School*

A National Park for Whom? Why Browns Bears Could Not Find Refuge in the Colorado Rocky Mountains

Alexandra Ertel (Graduate Student, University of Colorado Denver)
alexandra.ertel@ucdenver.edu

This paper, delivered as a poster presentation, compares Rocky Mountain National Park and Glacier National Park's ability to serve as a refuge for brown bears at the time of the parks' respective founding. Comparisons are made based on state policies and the public perception of brown bears between Colorado and Montana. Rocky Mountain National Park was founded in 1915. At the time the park was founded, brown bears had been extirpated from the Southern Rocky Mountain region. The Federal Government did not start its funding of predator extermination until 1915, making the discrepancy in brown bear populations between what would become Rocky Mountain National Park and Glacier National Park established five years prior in 1910, worthy of examining. Federal laws and oversight served significantly different purposes in the regulations and establishments of Rocky Mountain National Park and Glacier National Park. However, the differences in policies and public opinion between Colorado and Montana allowed for one National Park to help conserve a species, while only five years later in a new park, that same species was all but gone.

Keywords: *Brown bears, conservation, public perception, state policy*

Hidden History Revealed: Sharing the Story of Yaye and Ryoji Kato as a Means of Stewardship

Jessica Foster (Rocky Mountain National Park)
jessica_foster@nps.gov

Cheri Yost, Rocky Mountain National Park

Park stewardship means caring for and uncovering the history and stories contained within park boundaries. Rocky Mountain National Park is often interpreted from an environmental and biological perspective. However, there are historical figures and narratives just begging to be uncovered and shared. What can we learn about human behavior and society from those who have gone before us? Who are some of these hidden figures with stories to be told? What are the management implications when we find significant cultural connections?

If I asked if you know about a woman who owned a tea house in the park, you would probably think of Anna Wolfram and the Wigwam Tea House. But do you know of Yaye Kato, a Japanese woman who operated Kato's Tea House along the Bear Lake Road near Tuxedo Park? One of these hidden histories is that of the Kato family. Their story broadens our cultural perspective of both Estes Park and Rocky Mountain National Park. It also highlights the importance of interdisciplinary collaboration in the fields of historical research, archaeological research, park management, and park interpretation.

Keywords: *Hidden history, Kato's Tea House, Japanese heritage, cultural resources, Yaye and Ryoji Kato*

Rocky Mountain National Park Hazard Tree Program Overview

Wade Frisbey (Rocky Mountain National Park)
wade_frisbey@nps.gov

Doug Parker, Rocky Mountain National Park;

Max Miller, Rocky Mountain National Park

The Hazard Tree Program in Rocky Mountain National Park has been re-established in recent years to address increasing visitor safety and infrastructure risk associated with aging forests, disturbance events, and changing environmental conditions. The program uses data-driven GIS inventories and standardized field assessments to evaluate tree health, identify hazard conditions, and prioritize work across high-use visitor areas, developed sites, and critical infrastructure.

Results from this approach have improved consistency in hazard identification, strengthened defensible decision-making, and allowed park managers to strategically allocate limited resources based on risk, use patterns, and ecological context. By translating field observations into actionable spatial data, the program supports proactive park stewardship, enhances visitor protection, and demonstrates how applied research and technology can directly inform management decisions within a complex and dynamic park landscape.

Keywords: *Hazard trees, spatial data, park stewardship*

American pika call complexity across sites, possibly suggesting hybridisation of Colorado subspecies

Jules Hamlin (Undergraduate Student, University of Colorado Boulder)
jules.hamlin@colorado.edu

Rachel Billings, University of Colorado Boulder;

Chris Ray, University of Colorado Boulder

Pikas are the resident lagomorphs of alpine talus, though much more vocal than their rabbit and hare cousins. Their distinct squeaks can be heard loud and clear over the otherwise bird-dominated soundscape. Colorado has two subspecies of *Ochotona princeps*: *Ochotona princeps princeps* and *Ochotona princeps saxatillis*. Although the subspecies don't appear to differ physically, a study from the 1970s found that they do differ in their alarm calls; the *saxatillis* subspecies consistently made shorter alarm calls with a higher pitch. Conversely, *princeps* made longer alarm calls with lower frequencies. A previous genetic study found that the two subspecies hybridise in boundary zones, which are areas where the two populations meet. Calls from these hybrids have not yet been definitively identified. Understanding the differences between the subspecies as well as the extent and consequences of hybridisation will allow us to help identify pikas, their conservation needs, and maintain their levels of diversity.

Keywords: *Pika, hybrids, alarm calls*

Using Next Generation Sequencing to Address Taxonomic Uncertainties Surrounding *Potentilla rupincola*

Natalie Hieber (Master's Student, University of Northern Colorado)
natalie.hieber@unco.edu

Dr. Mitchell McGlaughlin, University of Northern Colorado

Landscape stewardship is an integral role for land managers. This role becomes more important when rare or endangered species occur within managed areas. Conserving these organisms across the landscape is a primary concern for land managers, but resources allocated for conservation can be limited with many competing goals. The taxonomic uncertainty that can surround rare and endangered taxa, particularly plant taxa, that have historically been classified solely using morphological features further complicates conservation planning. One such taxon is *Potentilla rupincola*, a rare plant endemic to the eastern Rocky Mountains in Colorado. For over a century, botanists have debated whether *P. rupincola* is a distinct species or a morphological variant of the more widespread *Potentilla effusa*. Using next generation DNA sequencing (NGS), this study seeks to address this debate through the analysis of genetic relationships. This project focuses on the collection and use of genetic, morphology, and ploidy (chromosome count) data to investigate the taxonomic status of *P. rupincola*. Field collections cover the entire range of *P. rupincola*, including populations located within Rocky Mountain National Park. Analyses employed in this study include genetic relatedness between sampled populations, phylogenetic relationships between sampled individuals, morphological comparisons, and ploidy counts. Analyses incorporate a third closely related species, *Potentilla hippiana*, as well as outgroup taxa to strengthen phylogenetic resolution. Results indicate little genetic differentiation between *P. rupincola* and *P. effusa*, with all genetic data collection to be completed by the end of 2025. Morphological analyses confirm consistent differences between *P. rupincola* and *P. effusa*, aligning with previous recognition of two morphologically distinct species. Preliminary analyses of ploidy documents variability among populations, which could be a driver of morphological differences. Resolving the taxonomy of *P. rupincola* will support evidence-based conservation and resource management, enabling land managers to prioritize actions and allocate resources appropriately within their landscapes.

Keywords: *Genetics, conservation, taxonomy*

Mapping Historic Landownership Prior to the Creation of Rocky Mountain National Park

Madelyn Hill (University of Northern Colorado)
hill1090@bears.unco.edu

Madison Tucker, University of Northern Colorado;

Jessica Salo, University of Northern Colorado;

Michael Welsh, University of Northern Colorado

As part of a larger effort to map historic agricultural water-conveyance features in Rocky Mountain National Park, we created a census and spatial dataset of landowners in the area between approximately 1870 and 1920. Because these conveyance systems are widespread in Colorado and may qualify as historic properties, this research served as an initial step toward identifying locations that may contain irrigation-related features. To develop the dataset, we compiled and mapped landownership from General Land Office land patents and integrated additional archival sources, including water-rights records and files at the Denver National Archives. The outcome was a spatial representation of landownership within the area that would later become Rocky Mountain National Park, providing a foundation for identifying parcels with potential irrigation features.

Keywords: *Cultural resources, GIS, Historic Landownership Mapping*

Managing no-shows in public resource allocation: The economics of campground reservations

Jonathan Hughes (Associate Professor, University of Colorado Boulder)
jonathan.e.hughes@colorado.edu

Low prices, limited capacity and increased interest in outdoor recreation contribute to intense competition for public campsites in the United States. Yet, users and park managers report high vacancy rates due to unused reservations or “no-shows.” I develop a simple model for the campground reservation, cancellation and no-show decisions. I numerically simulate pricing policies at a hypothetical but representative park. When capacity constraints are binding, the cancellation fees charged by many parks increase no-shows and decrease consumer surplus. In contrast, modestly higher prices and no-show fees dramatically reduce no-shows and increase social surplus by 8 to 15 percent. However, these policies create different distributional effects. Higher prices raise revenue but decrease consumer surplus and discourage reservations from lower income users when income is positively correlated with trip utility. No-show fees increase consumer surplus and do not materially affect the income distribution of users. The optimal no-show fee, equal to the lost consumer surplus from the marginal no-show, maximizes consumer surplus and increases social surplus by 8.5 percent.

Keywords: *Public lands, outdoor recreation, congestion externalities*

Landscape-Scale Assessment of Forest Composition and Regeneration Following Bark Beetle Outbreaks and Wildfire Disturbances

Christopher Jones (Graduate Student, Colorado State University)
chrjones@colostate.edu

Dr. Camille Stevens-Rumann, Colorado State University;
Kevin Gaalaas, Rocky Mountain National Park

Bark beetle outbreaks and wildfires affect millions of hectares of forests each year, raising concerns about recovery and management strategies in these disturbed landscapes. As the size and scope of these disturbances increase, so does the likelihood of compounding effects that can reshape post-disturbance trajectories and challenge forest management. In Rocky Mountain National Park, an early-2000s mountain pine beetle epidemic caused widespread mortality in single-aged lodgepole pine (*Pinus contorta*) stands on the west side of the park. Perovich and Sibold (2016) investigated these impacts by establishing 218 plots to measure post-epidemic regeneration and fuel conditions. Their results showed a shift in forest composition and structure from lodgepole pine dominance to more diverse stands dominated by spruce and fir. In 2020, approximately half of the original study area burned in the East Troublesome Fire, burning through 111 of the 218 plots and creating a rare opportunity to evaluate how repeated disturbances—mountain pine beetle followed by wildfire—shape forest composition and structure. This proposed project would examine these changes in Rocky Mountain National Park by replicating the methods of Perovich and Sibold (2016) and comparing burned and unburned plots and testing the hypothesis that the East Troublesome Fire initiated another shift in forest composition and structure. This repeated-measures design across sequential disturbances will clarify how fuels and forest structures change over time and provide management recommendations for post-disturbance reforestation in Rocky Mountain National Park.

Keywords: *Bark beetle, wildfire, compounding disturbances, post-disturbance forest dynamics*

Investigating the impact of wildfire on high-elevation lake water quality

Adeline Kelly (PhD Student, University of Colorado Boulder)
adeline.kelly@colorado.edu

Dr. Isabella Oleksy, University of Colorado Boulder

Wildfires are increasing in the Western United States in response to a build up of fuels from wildfire suppression and climate change, exposing more lakes to wildfire within their watersheds. Between 1984 and 2021 roughly 1,000 lakes in the region were exposed to wildfire that consumed >20% of the watershed, a threshold suggested to have negative water quality impacts. In 2020, the East Troublesome and Cameron Peak fires burned ~400,000 acres, impacting several lakes and high-elevation reservoirs and burning 30,000 acres within the boundaries of Rocky Mountain National Park (RMNP). Currently, the impact of wildfire on lake water quality remains poorly understood. Studies are biased towards streams and rivers, where short-term increases in nitrogen, phosphorus, and turbidity are well-documented. In lakes, there is high variability in water quality responses, particularly in the magnitude and duration of biogeochemical impacts and primary productivity; this along with a paucity of pre-fire data on fire-impacted lakes makes it difficult to generalize and predict future wildfire impacts to water resources. In my doctoral work, I propose the use of both remote sensing and paleolimnological methods to better understand lake biogeochemical and ecosystem productivity responses to wildfire. Remote sensing imagery will be used to quantify lake productivity responses across the Landsat record (1984-present). I am proposing to collect sediment cores from Fern and Odessa Lake in RMNP to pilot paleolimnological methods to determine whether we can reconstruct the timing of fire events and the subsequent biogeochemical impact. These methods may be expanded to other lakes in RMNP or throughout Colorado in order to better understand heterogeneity of lake responses. A better understanding of lake responses to fire will allow for more proactive management decisions and focused restoration efforts

Keywords: *Wildfire, lakes, biogeochemistry*

The Epidemiology of Search and Rescue in Rocky Mountain National Park, 2018-2025

John Lambert (Boston University)
johntl@bu.edu

Davidson Hamer, Boston University;
Gregory Wellenius, Boston University

Introduction: This study sought to describe search and rescue (SAR) incidents in Rocky Mountain National Park (RMNP) and identify opportunities for proactive action to reduce SARs and adverse outcomes.

Methods: A retrospective review of SAR incidents in RMNP between January 1, 2018 and December 31, 2025 was conducted to characterize the circumstances of incidents and park visitors involved. SAR patterns before and after April 2020 were compared, coincident with the onset of the COVID-19 pandemic and subsequent introduction of a timed entry reservation system.

Results: There were 1,034 SAR incidents and 41 fatalities during this 8-year period. Individuals receiving assistance were aged 1-90 years (42.5 ± 20 years, mean \pm SD) and 53.0% were male. The most common activity resulting in SAR was day hiking (66.1%) and common primary contributing factors included ground level fall (23.7%), fatigue/physical condition (23.1%), and insufficient information/error in judgement (14.6%). During this study period 65.5% of SARs involved visitors who were ill or injured. The most common medical problems were lower body/lower extremity trauma (40.4%), upper body/upper extremity trauma (13.6%), and adult major trauma (9.3%). SAR incidents were concentrated during time periods and areas of highest park use. Searches are decreasing as a proportion of SAR incidents, while the proportion involving injuries has increased post-2020.

Conclusions: Mountainous SAR and injury trends have changed over time in RMNP. To reduce injuries and SAR incidents in national parks and beyond, there is a critical need to improve reporting and facilitate evidence-based prevention strategies. New methods to reduce falls in wilderness environments are warranted. Effective advice focused on age-sex and activity specific risks could reduce risk among visitors.

Keywords: *Visitor Use, Public Health, Wilderness Medicine, Preventive Search and Rescue*

Tracking Alpine Plant Communities: Creating Phenological Datasets Through Community Science

Cynthia Langguth (Rocky Mountain National Park)
cynthia_langguth@nps.gov

Beverly Fry, Rocky Mountain National Park

Rocky Mountain National Park is home to extensive alpine plant communities with unique phenological characteristics and relationships potentially affected by challenges from a changing climate. The purpose of this presentation is twofold: 1) to share preliminary findings from the pilot and year one data collection efforts by the trained volunteer experts of the Alpine Bloom Crew (ABC), and 2) to describe the implementation process used for the community science component with park visitors that resulted in additional phenological data and increased stewardship awareness for the alpine. Methodological issues will be addressed in the presentation including refinement of the 2025 data collection tools for both the ABC group and the community science participants, the implementation of the improved grid system on the alpine plot, and the development of the community science visitor engagement component. Data collection for 2025 occurred from June through most of September. Weekly observations were completed by the ABC team. Preliminary analyses of these data are underway and include observations of each individual species in the four phenological phases (early leaves, budding, flowers, senescence), timing/duration of each primary phenological phase, correlations with climate data (i.e., air and ground temps, wind speed), and comparison of all identified species in the varied phenological phases across the entire observation time. Additional pilot data collected by park visitors that participated in the community science engagement component will aid in exploring collection mechanisms for future summers. Refinements for future research may include defining additional nuances within the phenological phases, the addition of grasses versus forbs in data collection, tracking individual plants of select species in various microclimates, and expanding study areas.

Keywords: *Phenology, community science, alpine plants, climate change, stewardship*

Merging Vegetation Plot Datasets

Katie Marascio (MS Student, University of Northern Colorado)
katie.marascio@unco.edu

Noah Estrada, University of Northern Colorado;

Scott Franklin, University of Northern Colorado

Data sets have been collected over the past century to classify vegetation. Usually, these collections are specific to political boundaries like National Parks, but emerging management strategies look outside political boundaries to understand more landscape- or ecosystem-level patterns and processes. In addition, with the release of Version 3.0 of the US National Vegetation Classification, there is a need to develop more regional analyses of vegetation for mapping and management. Unfortunately, numerous datasets were collected using different methodologies and thus strategies are needed to guide combining these datasets for large-scale analyses. We tackle this with three datasets from the Rocky Mountain Front Range, each resampling an original dataset of over 300 plots established from 1972 to 1974. The three resamples occurred between 2012 and 2016 with different objectives in mind and thus different methodologies. Here, we examine the decisions that went into merging the three datasets and using a type of quality control through overlapping plots, i.e., those plots sampled by at least two of the resample projects. We conformed the data through cutoffs of seedling, sapling, and overstory categories of woody vegetation, and produced both density and basal area values for comparison. We examined over 50 ‘overlap’ plots and found that plot data were roughly comparable and most showed an 80% overlap of species and counts, as would be expected. The merging of these data now provides a full dataset to compare to the original data. We generally discuss options for decision-making for other datasets that could be merged and the opportunities that may provide to answer larger-scale ecological questions.

Keywords: *Data, vegetation plot, analysis*

Wildfire severity filters dragonfly assemblages by mating-related traits

Sarah Nalley (PhD Candidate, University of Colorado Denver)
sarah.nalley@ucdenver.edu

Michael Moore, University of Colorado Denver

Wildfires are reshaping the American West, destabilizing habitat structure and composition and creating more open, warmer, and drier conditions. Although animal growth and survival in the aftermath of wildfires are increasingly well-documented, we know far less about how fire shapes mating and reproduction, or whether species require specific reproductive traits to successfully breed in burned habitats. We are currently investigating the species assemblages of dragonflies breeding at wetlands that have been burned by recent wildfires in Colorado and Wyoming, including in Rocky Mountain National Park. We are testing if breeding assemblages are less diverse and tend to support species with only certain reproductive phenotypes. Based on standardized surveys we have been conducting since 2023, we are characterizing species assemblages to estimate coverage-based species richness, calculate the community-weighted mean value of reproductive traits in dragonfly assemblages, and construct generalized linear mixed-effects models to assess how wildfire burn severity (unburned, low, moderate, and high) influences the average reproductive phenotype in these communities. Our analyses from data collected between 2023-2025 indicate that breeding assemblages at wetlands burned by high-severity fires are the least speciose, while assemblages did not differ in richness between unburned and low-severity sites. Community-weighted means for melanin wing ornamentation further show that moderate to high-severity burns shifted dragonfly assemblages toward species with little to no melanin wing ornaments, while unburned and low-severity sites maintained higher average representation of highly ornamented species. Continuing through summer 2027, our research will quantify how wildfire burn severity gradients filter dragonfly communities by their reproductive traits in lentic ecosystems, where wildfire effects remain poorly understood. Park management can use our findings to assess habitats where post-fire conditions may constrain mating and identify species whose traits make them especially vulnerable to wildfire.

Keywords: *Wildfire, reproductive ecology, community assembly, odonates*

Leveraging an Earth System Model to Understand Rain-on-Snow Flooding Events in National Parks and Gateway Communities

Dr. Kyle Nardi (NSF National Center for Atmospheric Research)
knardi@ucar.edu

Christine Shields, NSF NCAR; Dr. Adam Herrington, NSF NCAR; Dr. Will Wieder, NSF NCAR;
Dr. Andy Newman, NSF NCAR; Dr. Andy Wood, NSF NCAR

National parks serve our nation in multiple ways, preserving cherished natural and cultural resources for future generations, while also facilitating public enjoyment and use today. However, extreme weather events can impact the natural environment and visitor experience within the parks. Rain-on-snow (ROS) flooding events, which occur when heavy rainfall and warm temperatures induce snowmelt and surface water runoff, pose a significant threat to national parks and their neighboring communities. Therefore, it is critical to understand the physical mechanisms driving ROS flooding events.

In this study, we apply an Earth System Model (ESM) to understand the processes driving ROS flooding events in national parks. ESMs provide a coupled modeling framework that aims to simulate the interaction of processes within different components of the Earth System: atmosphere, land, rivers, sea and land ice, and oceans. We specifically leverage the Community Earth System Model (CESM) to understand the physical mechanisms driving the November 2006 ROS flooding event in Glacier National Park (GLAC). We first initialize CESM with observed atmosphere, land, and ocean conditions in November 2006, and we then simulate the evolution of the ROS event in GLAC. We determine the “adequacy-for-purpose” of CESM by comparing modeled precipitation, snowmelt, and river runoff to observed conditions. After confirming CESM’s adequacy, we then re-create the same ROS event in GLAC, but with a variety of background conditions for the Earth’s atmosphere.

We highlight pathways for calibrating CESM to adequately depict the physical processes driving ROS flooding in GLAC. We further provide a range of possible outcomes for how future flooding events could impact GLAC and surrounding communities. We will also share how this work can benefit other units such as Rocky Mountain National Park. This presentation aims to stimulate discussion with local partners about how ESMs can inform resource management, disaster preparedness, and evacuation planning.

Keywords: *Earth system modeling, rain-on-snow flooding, extreme weather, disaster preparedness*

Bridging the Gap Between Research and Action - A Front Range Mountain Consortium

Dr. Megan Oldfather (USGS North Central Climate Adaptation Science Center)
moldfather@usgs.gov

Anne Marie Panetta, Nancy Emery, Katharine Suding, Eve-Lyn Hinckley, Sarah Elmendorf, Chris Ray, University of Colorado Boulder; Rebecca Hufft, Jennifer Neale, Alexandra Seglias, Denver Botanic Gardens; Laila Parker, Kate Dunlap, City of Boulder Utilities; Sarah Hart, Marin Chambers, Colorado State University; Alexandra Rose, CU Science Discovery

The mountains of the Front Range provide many services to our local communities, from drinking water to recreation, while also supporting iconic and biodiverse ecosystems. They are also home to some of the world's longest-running and impactful scientific research programs investigating high-elevation ecosystems. These synergies provide unique opportunities to build data-driven, evidence-based stewardship plans for mountain resources. Effective science-management partnerships require collaboration between researchers and practitioners to ensure that the relevant data sets are collected, interpreted, and shared among scientists and resource stewards. In 2021, representatives from several local groups formed a Mountain Consortium to communicate research needs and progress about the state of local mountain ecosystems in the context of the rapid environmental changes currently unfolding in the Denver-Boulder region. Consortium members represent the Niwot Ridge Long Term Ecological Research (NWT LTER) program, Rocky Mountain National Park, Denver Botanic Gardens, City of Boulder Utilities, the Colorado Forest Restoration Institute, and the USGS North Central Climate Adaptation Science Center. The collaboration has identified shared goals of data sharing, improving science communication, and co-producing knowledge critical to sustaining various ecosystem services. Our first product was a "Data Dashboard" summarizing long-term trends in decadal monitoring programs collected and curated by the NWT LTER. The Data Dashboard was designed to provide Consortium partners with easily accessible visualizations of long-term trends in local mountain climate, chemistry, and ecology. The Consortium has also facilitated the co-production of research projects between academic and non-academic organizations. Looking forward, this group is interested in collaborating to identify management practices that will conserve valuable biodiversity and infrastructure at higher elevations within the context of post-fire restoration, increased timber extraction, and climate adaptation across Front Range Mountain ecosystems.

Keywords: *Mountain science, co-production of knowledge, resource management, data synthesis*

On thin ice- implications of shorter winters for the future of freshwater phytoplankton phenology and function in Loch Vale and beyond

Dr. Isabella Oleksy (University of Colorado Boulder)
isabella.oleksy@colorado.edu

Charlie Dougherty, University of Colorado Boulder;

Katie Gannon, University of Colorado Boulder;

Adeline Kelly, University of Colorado Boulder;

Abigail Ross, University of Colorado Boulder

Lakes around the world face rapidly warming temperatures coupled with shorter winters, which affects ice cover, and can alter phytoplankton dynamics. Increased phytoplankton blooms threaten water quality, drinking water supplies, recreation, and energy flow through food webs. Despite the risks, current ecological theory and field sampling methods are not well equipped to predict alterations to phytoplankton structure and function over the entire year, including winter. We present a project overview for our new NSF Macrosystems grant, where our main objective is to study the transition from ice covered to ice free winters and assess the effects on freshwater ecosystem structure and function. Our study will compare lakes across a latitudinal gradient (Ontario to Florida) to span a variety of ice cover conditions, ranging from long ice cover to intermittent to ice-free. Our gradient includes The Loch in Rocky Mountain National Park and Green Lake 4 in the Indian Peaks Wilderness, two Colorado lakes that serve as extreme endmembers in ice cover but have evidence for changes in primary producers associated with climate change. We are studying how ecosystem memory of winter conditions may result in altered spring and summer ecosystem conditions, including changes in cyanobacteria biomass, toxin production, and lake metabolism. We present plans for field surveys, experiments, and predictive modeling using high-frequency environmental sensors and share early results from the first year of monitoring in The Loch. This project assesses how changes in climate will ultimately affect basal ecosystem structure and function.

Keywords: *Lakes, ecology, climate change, algae, winter*

Mapping Water Histories: Archival Reconstruction of Historic Ditches in Rocky Mountain National Park

Madison Tucker (University of Northern Colorado)
tuck5285@bears.unco.edu

Madelyn Hill, University of Northern Colorado;

Jessica Salo, University of Northern Colorado;

Michael Welsh, University of Northern Colorado

As part of a larger project assessing the historical significance and integrity of agricultural features, particularly irrigation and drainage ditches, we mapped historic irrigation systems using a variety of archival records. These water conveyance structures are ubiquitous in Colorado and may qualify as historic properties, yet they pose several challenges for resource managers. Project areas often encompass only a small segment of a much longer linear feature, and funding or scheduling limitations typically prevent surveys from extending beyond project boundaries. In addition, determining the historical significance of these systems can be difficult when archival documentation and surviving physical evidence provide limited information about their original function, historical associations, or subsequent modifications. To create map the ditches, we utilized water-appropriation documents, water-management reports, and other historical sources. We interpreted and mapped the legal descriptions of irrigation ditches located within and around what is now Rocky Mountain National Park. This research advances a park-specific, resource-informed framework for identifying and assessing the historical significance and integrity of irrigation features, while also providing a model workflow for integrating archival research with spatial analysis in protected landscapes.

Keywords: *Cultural resource management, archival mapping, Historic Water Conveyance Systems, GIS*

The First Synthesis of North American Alpine Environments

Abigail Volk (NPS Partner, Colorado State University)
abigail_volk@partner.nps.gov

Dr. Meagan Oldfather, USGS; Kaleb Goff, North Carolina State University; Dr. Seema Sheth, North Carolina State University; Alexandra Cisneros Carey, University of California Los Angeles; Dana Witwicki, National Park Service; Kristin Legg, National Park Service; Dr. Brian Smithers, Montana State University

Global Observation Research Initiative in Alpine Environments (GLORIA) is an international long term monitoring program for assessing alpine vegetation response to climate change. At GLORIA target (study) regions, species composition, richness, cover, and continuous soil temperature are collected worldwide. A North American synthesis project in collaboration with the National Park Service, GLORIA Great Basin non-profit, USGS North Central Climate Adaptation Science Center, Bureau of Land Management, US Forest Service, US Fish & Wildlife Service National Wildlife Refuge System, and the GLORIA Coordination team in Vienna, Austria will assess how mountain ecosystems are changing across North America. This research is connected to draft DOI Strategic Plan Objective 3.4 "Species and Natural Resources are Protected" which includes sharing "data and science with partners to make informed management decisions". For this synthesis, data are being managed, quality checked, and harmonized at over 27 GLORIA target regions and over 100 summits from Alaska to Arizona, including at Rocky Mountain National Park. This collaborative project will increase collaboration among GLORIA sites in North America, increase partnership with the GLORIA Coordination team in Vienna, and analyze trends in vegetation community change observed over the last twenty years. Some focal research questions of interest include: 1) Can we assess vulnerability of specific species in a way that is applicable to management? 2) Do certain drivers lead to variation in vegetation changes across summits? 3) Do certain North American mountainous regions cluster in their response to changing climate? And 4) Over the last two decades, have alpine species shifted across microclimate gradients within the summit survey areas (Ie. across aspects.)? This project will be the first North American synthesis of GLORIA mountain summits, complementing syntheses in other continents and a current global GLORIA synthesis.

Keywords: *Alpine, vegetation, climate, management implications*

Rocky Mountain Fire Effects Data Dashboard for Decision Support

Nate Williamson (Rocky Mountain National Park)
nathan_williamson@nps.gov

Kate Jones, North Carolina State University;

Melissa Gold, North Carolina State University;

Hilary Rollins, Rocky Mountain National Park;

Jelena Vukomanovic, North Carolina State University

Adaptive forest and fire management in parks and protected areas is becoming increasingly complex as climate change alters the frequency and intensity of disturbances (wildfires, pest and disease outbreaks, etc.), while park visitation and the number of people living adjacent to publicly managed lands continues to increase. The Colorado Front Range attracts an ever-growing number of people to its gateway communities, which emphasizes the need for public land stewardship and the development of complimentary decision support tools to facilitate land management. Evidence-based, adaptive forest and fire management practices are critical for the responsible stewardship of public resources and require the continued availability of long-term ecological monitoring data. The US National Park Service has been collecting long-term fire monitoring plot data since 1998, and has continued to add monitoring plots through time, but these data are housed in databases with limited access and minimal analytic capabilities. To improve the accessibility and decision-support capabilities of this monitoring dataset at Rocky Mountain National Park, we created the Trends in Forest Fuels Dashboard (TFFD), which provides an implementation framework from data collection to web visualization. This easy-to-use and updatable tool incorporates data from multiple years, plot types, and locations. We used the ArcGIS Online (AGOL) software platform, which hosts TFFD and allows for efficient data visualizations and analyses customized for the end user. Adopting interactive, web-hosted tools such as TFFD allows the National Park Service to more readily leverage insights from long-term forest monitoring data to support decision-making and resource allocation in the context of environmental change.

Keywords: *Dashboard, decision support, fire management, fuels*