Highlighting the 2024 Colorado Mountain Club Foundation Fellowship and Grant Recipients

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The mission of the Colorado Mountain Club Foundation is to raise, manage, and distribute funds to support the stewardship, conservation, education, and other programs of the Colorado Mountain Club and other similar organizations. Since 1982 The Colorado Mountain Club Foundation has awarded fellowships and grants for research consistent with the statement of purpose adopted by the founders of the Colorado Mountain Club in 1912:

To unite the energy, interest and knowledge of the students, explorers, and lovers of the mountains of Colorado; to collect and disseminate information regarding the Rocky Mountains in behalf of science, literature, art and recreation; to stimulate public interest in the mountain area; to encourage the preservation of forests, flowers, fauna and natural scenery; and to render readily accessible the alpine attractions of this region.

Each year, the Foundation solicits applications from undergraduate and graduate students whose research is focused on the Rocky Mountain region. The Foundation awards grants ranging from approximately $500 to $2,000, in disciplines such as biology, chemistry, environmental studies, forestry, geography, geology, history, and law. The top three outstanding applicants are awarded a named fellowship: the ***Jim Gehres Fellowship***, in honor of the late Jim Gehres's long service and support of the CMC, the CMCF, and the CMCF Fellowship and Grant Committee as well as his establishment of the Gehres Fourteeners Fund; the ***Kurt Gerstle Fellowship***, in honor of the late Dr. Gerstle, professor of engineering at the University of Colorado, a long-time member of CMC, and the founder of the Foundation's Academic Fellowship program; the ***Neal B. Kindig Fellowship***, in honor of the late Dr. Kindig, a graduate of West Point and Stanford University and professor of electrical engineering at the University of Colorado, as well as an active member of The Colorado Mountain Club and The CMC Foundation; or the ***Al Ossinger Fellowship***, in honor of the late Dr. Ossinger, a graduate of Stanford University, a long-time member of CMC and the Foundation, and retired chair of the Academic Fellowship Committee.

In 2024, the CMCF Fellowship and Grant committee was able to support eleven worthy students. Below are highlights from these recipients' 2023 research.

Eva Anderson, MS student at Western Colorado University, was awarded the Gerstle Fellowship ($2,000) for the project, "An assessment of the macroinvertebrate community within the Burrows Creek fen complex before and after mining pollution mitigation in the San Juan Mountains of Colorado." I am incredibly grateful for the financial support provided to assist with the sampling process for my thesis project. This past June, I visited my field site outside of Animas Forks, Colorado for the pre-restoration sampling. With the help of my advisors, I sampled 19 fen ponds in the complex where the mining and restoration is and an additional 7 fens in a nearby reference fen complex. In addition to the macroinvertebrate sampling, in August, we collected water samples from each pond sampled and plan to conduct isotope analyses to determine if the water sources for the various fens are the same or different groundwater sources. We plan to repeat this sampling process in the summer of 2025 and compare the findings between pre- and post-restoration. I am currently spending time in the lab identifying the aquatic macroinvertebrates to family and genus when possible. Currently, the samples sorted have an assortment of aquatic beetles and their larvae, various caddisflies, and many midge larvae. So far, the mine-adjacent fen ponds house very few types of invertebrates compared to the ponds further away. Sorting is a slow process but seeing the insects under the scope is fascinating and illuminates how much life exists below the water's surface. The laboratory process further inspires me to investigate the impacts of mining on these valuable and fragile ecosystems and the organisms within.

Samuel Pierce, PhD student at the Standford University was awarded the Ossinger Fellowship ($2,000) for the project, "Beaver dam analog influence on floodplain hydro-biogeochemistry." Through the support of the Colorado Mountain Club Foundation, I was able to make several key findings for my project studying the biogeochemical influence of beaver ponds on wetland ecosystems. Prior to my work this summer, I was unaware of any other studies that have focused on understanding the mobilization/immobilization of heavy metals within beaver pond sediments across 24-hour timeframes. The 24-hour cycle is crucial to understand because under anoxic conditions it is thermodynamically favorable for iron hydroxide minerals, which are abundant in beaver pond sediments, to dissolve and release trace metals such as copper, cobalt, zinc, arsenic, and lead into mobile forms. Funding from CMCF and my home institution helped me purchase an autosampling unit (Teledyne ISCO 6712 Full-size portable sampler, Cat. No. 686710070) that I deployed in the field to collect beaver pond water samples across 24-hour periods. I ran two sampling campaigns in July 2024 pairing continuous dissolved oxygen measurements with hourly ISCO-collected pond water samples. I identified major swings in dissolved oxygen concentrations within beaver ponds, ranging from 18 mg/L during the day to 0.08 mg/L at night, that could induce dynamic dissolution of iron hydroxide minerals. I was also able to detect high concentrations of reduced iron in return flow pathways from beaver ponds, supporting the concept of mineral dissolution under anoxic conditions. Though my total metals data is still undergoing quality assessment, preliminary results suggest that anoxic conditions that occur overnight could be causing increased concentrations of mobile phase trace metals within beaver ponds. I am incredibly grateful for the generous support provided by CMCF that has helped advance my research project and the knowledge of our beautiful state.

Juliana on the right.

Juliana Ruef, MS student at University of Colorado, Boulder was awarded the Kindig Fellowship ($2,000) for the project, "Defining rock glacier dynamics to probe Colorado's Holocene climate." Thanks to the generous support of the Colorado Mountain Club Foundation, I've begun unraveling the mechanics of rock glaciers, ubiquitous, poorly understood, icy features slowly flowing downhill across Colorado's alpine landscapes. These unique landforms require three conditions for survival: 1) a rocky layer thick enough to reduce melt of the ice-rich core, 2) rapidly eroding headwalls to feed the rocky layer and 3) an avalanche cone funneling snow to the top of the rock glacier. With the support of a wonderful team, I've been exploring how Imogene Rock Glacier (near Ouray, CO) formed, moves, and might one day disintegrate. More broadly, I'm also working to understand Imogene valley's evolution, piecing together how the landscape transitioned from being covered in a massive glacier during the Last Glacial Maximum to the tiny rock glacier that now occupies the valley. To better understand the processes and conditions driving the formation and disintegration of Imogene Rock Glacier, we are in the process of collecting data to quantify its thermal dynamics, movement, and mass balance. I've collected: GPS points along Imogene's centerline to quantify velocity, water samples from its toe to study meltwater chemistry, Schmidt Hammer measurements to assess weathering of the rocky carapace, Beryllium-10 rock samples to determine when the surface rocks fell from the headwall, and temperature data (at various depths within the rock glacier). In addition to fieldwork, I built a coupled energy balance and thermal model of Imogene Rock Glacier that estimates yearly melt depths for any rocky layer thickness and mean annual temperature. Preliminary results suggest 2-3 centimeters of annual melt given a 2-meter rocky layer and a mean annual temperature of 0 C. I'm excited to use ground penetrating radar this coming spring to quantify rocky layer thickness and "tune" my model accordingly.

Stavi Tennenbaum, PhD student at Princeton University was awarded the Gehres Fellowship ($2,000) for the project, "Snowpack as an eco-evolutionary driver in a hibernating mammal." I am a PhD candidate at Princeton University and the Rocky Mountain Biological Laboratory (RMBL) in Gothic, Colorado, where I am studying yellow-bellied marmots for my dissertation. Marmots around RMBL have been individually trapped and monitored since 1962, providing valuable data on their behavior and population dynamics. However, little is known about their ability to survive climate change. My dissertation focuses on how mammals may adapt to climate change through genomic-level changes. Hibernating species like marmots are restricted to cold, high elevation ecosystems, so warmer temperatures and declining annual snowfall in Colorado uniquely threaten their survival. Genomic changes in DNA methylation and gene expression are key molecular tools marmots may use to survive warmer years with less snow. This summer, I gathered new samples to explore DNA methylation and gene expression in marmots living on subalpine slopes around RMBL. From June-September 2024, I collected marmot blood samples, and with support from the CMCF Gehres Fellowship, 14 marmot ear tissues, which I grew into millions of living skin cells in the lab. Since this approach had never been done before for marmots, I developed a new field protocol for this study. I now have marmot cells stored for future experiments on DNA methylation and gene expression changes in responses to different temperature conditions, which I can simulate in the lab to avoid disturbing these animals in the wild. Studying genomic variation allows me to build a comprehensive understanding of how hibernators may evolve under climate change, from the cellular to organismal level. At RMBL, I also engaged school groups from the Crested Butte community and beyond, including a local preschool class, and communicated my work to RMBL's broad scientific community, encouraging place-based research in Colorado's ecosystems.

Emily Burgess, PhD student at Utah State University, was awarded a $1,000 grant for the project, "Investigating plant adaptation to climate change through shifts in flower and seed microbiomes." The CMCF grant that I received supported my field research for my dissertation over the summer of 2024. My dissertation research is centered on investigating the impacts of climate change on floral microbiomes. Floral microbiomes can impact plant reproduction in several important ways, including by changing the way that flowers smell or taste, which can change which flowers pollinators choose to visit. Additionally, pollinators can be important in determining the composition of floral microbiomes by dispersing microbes among flowers as they pollinate. Different pollinators have been shown to disperse different microbes to flowers, and climate change is causing the timing of flowering to shift relative to the timing of pollinator activity. By changing how frequently flowers are visited, and by what pollinators, climate change is likely to shift floral microbiomes, though this has yet to be examined experimentally. My study aims to address this research gap by mimicking future climate scenarios, manipulating both the timing of spring snowmelt and air temperature in a wildflower meadow at the Utah State University Experimental Forest in Rich County, Utah. In montane systems, the timing of snowmelt is often the most important determinant of flowering time, especially for early season plants. Temperature can also impact flowering time and can alter floral microbiomes by influencing how quickly microbe populations are able to grow. This summer, I collected data to track the timing of flowering for plants in my climate manipulation, collected flower samples to determine the microbiome composition, and because of CMCF funding I was able to purchase 6 camera traps that will help me identify pollinators and quantify how frequently flowers are visited in each of my treatments. The data from these camera traps will provide valuable insight into how the timing of flowering and temperature conditions influence pollinator visitation, and whether it correlated with the composition of floral microbiomes.

Theodore Kuhn, MA student at University of Colorado, Boulder, was awarded a $500 grant for the project, "How streams are changing due to climate change across the western US." Water temperature is an important ecological variable that affects most ecosystem functions within mountain streams. For example, salmonids like the endangered Greenback Cutthroat Trout cannot survive when temperatures exceed a certain threshold. Stream temperature is sensitive to changes in climate, which may impact where cold-water species can live in the future. But how different streams will respond to climate change remains an open question. In addition to climate, stream temperature is controlled by a combination of landscape and hydrologic characteristics that make each river basin unique. As a result, predicting how streams will respond to changing future climate requires an understanding of how stream temperature relates to basin characteristics in the present and past. To help answer these questions, I analyzed long-term stream temperature records in Rocky Mountain National Park alongside publicly available climate and landscape datasets. I developed a series of statistical models to determine which climate and landscape variables were the best predictors of summer stream temperatures over the past 25 years. I found that certain variables were especially important; most notably, abundant lakes within a basin were associated with warmer stream temperatures, while higher basin elevation was associated with cooler stream temperatures. Warmer temperatures were also associated with higher exposure to sunlight, lower stream slopes, lower grass coverage (analogous to tundra in the park), and higher maximum basin elevations. This analysis showed that publicly available landscape data, alongside long-term stream temperature data, can be used to accurately characterize summer stream temperature variability in complex mountain topography. In the future, I plan to use this knowledge of the controls on summer stream temperature to predict future stream temperature response to climate change within the park.

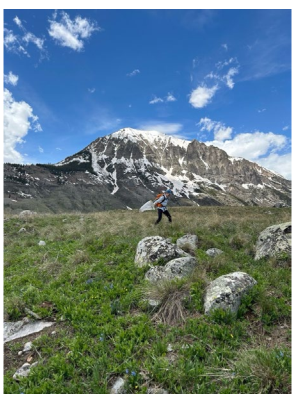
I greatly appreciate the support from CMCF for my research. In addition to the statistical analysis, this support allowed me to purchase additional stream and air temperature loggers, which I deployed throughout the park during the summer of 2024. While this data is still being analyzed, it will serve as the basis for additional field work and modelling in the coming years as I embark on a PhD.

Erika Lee, MS student at Colorado State University, was awarded a $500 grant for the project, "The effects of wildfire on snowpack: tree characters' influence on snow accumulation and melt rates in montane forests." My research is focused on how a wildfire impacts the energy budget of a snow-covered forest, and thus how the snow accumulation and melt rates change in a burned forest compared to an unburned forest. I am primarily focused on researching the longwave radiation component of the energy balance – the amount of energy retained and emitted in the form of heat from a tree, which in turn impacts snowmelt rates in a forest ecosystem. I have successfully collected snow accumulation and melt data, tree surface temperature data, and tree well development data throughout the 2023-2024 winter. I am now working on analyzing this data, as well as collecting a second winter's worth of data for the 2024-2025 season. The funds provided by the CMCF have been used to pay for travel to and from the field, as my field sites are about 1.5 hours outside of Fort Collins, in the Cameron Peak burn scar, near Cameron Pass, Colorado. These funds have allowed me to take monthly snow depth observations, as well as collect data from my tree surface temperature sensors and weather stations and fix some equipment issues we had during the 2023-2024 winter. I am now in the processing of synthesizing my findings and writing a thesis based on the data collected last winter, with the hope that my findings will be used in published papers co-authored by my advisor, Dr. Stephanie Kampf, and other faculty members at Colorado State University. I greatly appreciate the scholarship funds provided by CMCF and am excited to learn more about how my research findings can benefit the scientific community.

Kim Nichter, MS student at Colorado State University, was awarded a $500 grant for the project, "Ecological effects of stream restoration following wildfires in the Colorado Front Range." This past summer, with support from CMCF funding, I successfully completed fieldwork exploring the potential for beaver-based restoration to enhance stream ecology in post-fire areas. My study focuses on the Cameron Peak Fire burn scar and compares three distinct sites: one with simulated beaver structures, another with natural beaver activity, and a reference site. This funding enabled me to travel to my field sites, hire two undergraduate technicians, and obtain essential field supplies, all of which contributed to a successful field season. Together, my team and I collected a comprehensive dataset by measuring a variety of environmental variables, such as stream depth, pebble sizes, periphyton levels, and wood composition. Additionally, we assessed macroinvertebrate communities across the three sites and began laboratory processing to explore how these organisms indicate differences in stream function. Furthermore, we conducted two rounds of fish surveys—one in the spring and another in the fall—to evaluate how beaver-based restoration may influence fish populations, particularly during the growing season. These efforts have allowed us to build a robust comparison of the three study sites, all of which were impacted by Colorado's largest wildfire. This work helps further understand how beaver-based restoration may serve as a tool to mitigate wildfire impacts on stream ecosystems. Supporting the health of alpine ecosystems has become more pertinent as wildfire risk increases, and this work will provide valuable insight for future conservation efforts. As I finalize my data analysis, I look forward to sharing results that highlight the role of beaver-based restoration in enhancing post-fire stream resilience. This work will culminate in my master's thesis, which I plan to submit this summer.

Jake Slawson, PhD student at Colorado School of Mines, was awarded a $500 grant for the project, "The early Paleogene: a glimpse of extreme warming." Climate models used to predict the future are commonly tested with data from historical records. However, warming of greater than 1.5°C is expected by the end of the 21st century. This is rapidly pushing the Earth toward a state that humans have never experienced before. To realistically test these models and better predict the future, the collection of real-world data from high carbon dioxide climates is paramount. My research is focused on the response of the hydrological cycle to greenhouse gas-induced warming in the Rocky Mountain West during the Paleocene and early Eocene epochs, approximately 56-49 million years ago. By gaining information about how we can expect precipitation to change in the Rocky Mountain West in the coming centuries, I hope to provide information that will enable engineers, land managers, and policy makers to better mitigate the effects of climate change. In the last year, in part thanks to your funding, I have made significant strides in my research and have two papers in review at prominent scientific journals. Through the collection and chemical analysis of ancient soil samples at my field site in northeastern Utah, I have found that precipitation during extreme warm periods of the Paleocene and Eocene are not associated with a significant change in mean annual precipitation. However, they are associated with a shorter wet season and more intense precipitation connected to changes in the North American Monsoon. This information helps us to better understand how the North American Monsoon, a major control on precipitation in the southwest, may change in the future and think critically about how to manage water resources in an increasingly seasonal environment.

Kelly Tobin, MS student at University of Denver, was awarded a $500 grant for the project, "Impact and strength of top-down forces on the establishment of biocontrol beetles in the genus *Diorhabda*." Tamarisk beetles in the *Diorhabda* genus are specialist herbivores that were released across the western US as a biocontrol for invasive trees in the genus *Tamarix*. *Tamarix* have flourished in riparian areas across the West and sites with *Tamarix* have experienced varying levels of beetle establishment. Previous studies have suggested that predation could play an important role, but limited data are available on larval predation and the tri-trophic effects on *Tamarix*. This summer, our all-female field crew conducted two predation experiments to test whether larval *Diorhabda* are prey for birds and arthropods across 10 field sites in western Colorado and eastern Utah. We sampled vegetation at each site to record plant community composition. To measure predation, we glued plasticine models of beetle larvae to *Tamarix* trees. Birds and arthropods create unique bite marks that allow us to track predation pressure on beetle larvae. Using these bites, we could quantify the different levels of predation across sites using the number of bite marks. To study if different types of predators like ants were consuming beetles more or less than other types, we conducted predator exclusion experiments in which we placed white mesh bags on *Tamarix* trees and selectively allowed some predators to access the larvae inside. In the Upper Colorado River Basin, larval beetles are being consumed by birds and arthropod predators. However, it appears that this predation is not a driving factor in where new swarms establish. We also did not find evidence for significant predation by ants over other types of predators. Our research measuring trophic cascades will help better describe the ecology of this introduced species in a critical watershed. We aim to understand the impacts of predation on beetle populations to help determine which *Tamarix* control and removal methods are appropriate for a given site.



Lauren Weinstock, PhD student at Utah State University, was awarded a $500 grant for the project, "The impacts of climate change on bee behavior across socio-ecological contexts." This research studies the effect of increased temperature on three different populations of a wild bee, *Halictus rubicundus* (the orange legged furrow bee), to understand the resiliency of bees to climate change across different types of environments. In the summer of 2024, we collected *H. rubicundus* from Logan, Utah; Mount Crested Butte, Colorado; and Gothic, Colorado to understand how short (4-hour) and long (48-hour) exposure to increased temperature impacts bee behavior, physiology, and gene expression. Our data from 2022 in Logan, Utah suggest that increased temperature increases aggressive behavior in this species of bee, which may upset social dynamics in bee nests. Analyzing our behavior data from 2024 will tell us if bees from different environments are differently affected by climate change. Further, bee body condition may be more susceptible to environmental stress at different locations. Gene expression data will give us clues to the molecular processes that may cause these differences. So far, we have analyzed the size and wing wear of the bees collected in 2024. We found that *H. rubicundus* are larger in size at the lower elevation locations (Logan, Utah) than the higher elevation locations (Mt. Crested Butte and Gothic, CO). This is consistent with previous findings and may indicate that the environment is more ideal for bee development at these lower elevations. We also found that the bee wings had more wear and tear the later the date was when the bees were collected. This indicates that bees that were collected later were likely older than the bees that were collected earlier. This information about the bees will help us better understand the behavior, physiology, and gene expression data that we collect.