Ecological interactions between American pikas and mountain goats in the La Sal mountains

In partnership with the United States Forest Service

Discovery Pool Grant: Final Report 2026

Mallory Sandoval Lambert

08/31/2026

Statement of research need and questions/aims addressed

Canyonlands Natural History Association's Discovery Pool grant, project in partnership with the US Forest Service, supported the 2022, 2023, and 2024 seasons of fieldwork for my Ph.D. I am conducting a multi-level, field-based study to document potential ecological interactions between mountain goats and American pikas: two mammalian herbivores that are specialists in alpine habitats. There are no previous studies in the peer-reviewed literature on ecological interactions between mountain goats and pikas. Understanding these interactions will have important implications for the conservation of each species. Such data will be particularly useful for both pika conservation and agencies tasked with managing the land that introduced mountain goat herds inhabit.

The Specific Aims of my research were to:

1) Evaluate mountain goat use of pika-occupied talus habitat using GPS telemetry data from multiple subpopulations for habitat selection function analysis.

2) Assess risk-sensitive foraging by pikas by testing whether pika giving up distance varies with (a) mountain goat pellet density and (b) vegetation coverage of soil.

3) Compare forage utilization between goats and pikas. Test for evidence of competition or facilitation using a replicated three-plot semipermeable exclosure design. Additionally, test for ecosystem-level feedback loops in herbivore-plant interactions that might influence forage quality for both species around pika-inhabited talus slopes. I also added a DNA metabarcoding component to my research under this third aim to elucidate the plants in the diets of both species.

4) Review the ecological interactions between pikas and mountain goats, and the management options for both, in the context of conserving the biodiversity of alpine habitats of the Colorado Plateau.

Methodology

Funding from CNHA for all three field seasons allowed me to provide living wages to 6 field technicians: Elena Borges, Katelyn Sanchez, Collette Webb, Ellie Kaiser, James Irza-Leggat, and Moth Deppe. I analyzed data, wrote a manuscript and submitted it to Journal of Mammalogy for *Specific Aim* 1. It has been accepted by an Associate Editor and is awaiting final approval from the Editor-in-Chief. Throughout all field seasons, we collected pika behavioral data (*Specific Aim 2*) and vegetation and goat sign data (*Specific Aim 2*). We collected over 1,000 observations of pika foraging distances, I have analyzed this data and am writing a manuscript for Specific Aim 2, which I plan to submit to a peer-reviewed journal by the end of the year. We collected pika and goat scat in 2023 and 2024 to contribute to my collaboration with Princeton University in our analysis of plants in the diets of both species (*Specific Aim 3*). We used radio telemetry to track mountain goats in the north group of the La Sal mountains to collect over scat samples from mountain goats and visited pika latrine sites. We collected over 50 scat samples from each species. The samples were sent to Dr. Rob Pringle's lab at Princeton to be analyzed, I received the results last year and they are being written in my final manuscript. At the end of each summer field season, my team and I clipped the vegetation in all of our experimental plots and sampled two soil samples at each site (*Specific Aim 3*). A laboratory technician dried, weighed, and sorted the clipped vegetation. The soil samples were processed by the Soil Lab at USU to be tested for soil nutrients such as nitrogen, phosphorous, sodium, and ph. I have analyzed these data for *Specific Aim 3.* To monitor visitation rates to our experimental plots by pikas and goats, we deployed two camera traps at each site, a laboratory technician processed ~500,000 images to be included in the analysis for *Specific Aim 3*.

Personnel

- Mallory Sandoval Lambert. PhD candidate and principal investigator
- Jackie Joya graduated with her Bachelor's degree in animal science from Cornell University. Jackie was supported by a grant from the Rocky Mountain Goat Alliance.
- Elena Borges graduated with her Bachelor's degree in wildlife biology from the University of Montana.
- Ellie Kaiser graduated with her Bachelor's degree in wildlife biology from California Polytechnic State University. Ellie was supported by funds from the Discovery Pool grant.
- James Irza-Leggat recently graduated with his Bachelor's degree in Environmental Science from University of Vermont. This was James' first wildlife technician position! James was supported by funds from the Discovery Pool grant.
- Moth Deppe graduated with his Bachelor's degree in Biology from Northern Arizona University. Moth was supported by funds from the Discovery Pool grant.
- Collette Webb recently graduated with her Bachelor's degree in wildlife biology from Western Washington University. Collette was supported by funds from the Discovery Pool grant.
- Katelyn Sanchez graduated with her Bachelor's degree in Ecology and Conservation Biology from Texas A&M University. Katelyn was supported by funds from the Discovery Pool grant.
- Eliza Wesemann is a student at Utah Sate University and helped sort photos and vegetation. They are supported by funds from the Discovery Pool grant.
- Karli Weatherill graduated with her Bachelor's at Colorado Mesa University. She was supported by funds from the Saccomanno Institute Program for Biological Research fellowship and was co-mentored by Dr. Varner.
- Dr. Johanna Varner is a professor at Colorado Mesa University. Dr. Varner volunteered her time for field work several times throughout the project and provided advice and guidance on study design.
- Yoni Argov works for the Moab BLM office as a wildlife biologist. Yoni volunteered and helped to collect mountain goat scat.
- Paul Frank is a desert tortoise biologist and Moab local. He volunteered to help clip vegetation in August.
- Holly Nelson graduated with her Bachelor's degree in biology-organismal ecology from Colorado Mesa University and her Master's degree in biology from Colorado State University - Pueblo . Holly was supported by funds from the Saccomanno Institute Program for Biological Research fellowship.
- Molly Parent has her bachelor's degree in Veterinary Technology from The State University of New York – Canton. Molly worked with us for three days to help clip vegetation and was supported by a Graduate Student Research Award from the Ecology Center at USU.
- Emily Gelzer and Marie-Pier Poulin are wildlife ecologists. They volunteered to help clip vegetation one summer.

Specific Aim 1 results.

In the first chapter (*Specific Aim 1*) of my dissertation, I analyzed mountain goat GPS collar data to assess spatial overlap between mountain goat space-use and pika habitat at the talus edge. I used a Resource Selection Function (RSF) to compare resources at mountain goat used GPS points with randomly generated, available points within mountain goat home ranges. To understand whether mountain goats are selecting or avoiding pika habitat, I included a variable for distance to pika habitat in the model. I also included variables that previous studies have been shown to be important for mountain goat resource selection, they include: distance-to-escape terrain, biomass, slope angle, elevation, and heat load.

Mountain goats avoided distance to pika habitat (β=-0.8, 95% CI [-1.0, -0.6]). In other words, mountain goats selected for areas near to pika habitat and avoided areas which were farther from pika habitat (Fig. 1). This demonstrates that shared habitat use exists between mountain goats and pikas, establishing a basis for potential interactions between the two species.

Additionally, mountain goats avoided distance to escape terrain (β=-1.01, *P*=0.001), selected for elevation (β=0.81, *P*=0.001) and forage biomass (β=0.50, *P*=0.001), and they neither selected nor avoided slope (β=0.03, *P*=0.54) or heat load (β=0.06, *P*=0.11).

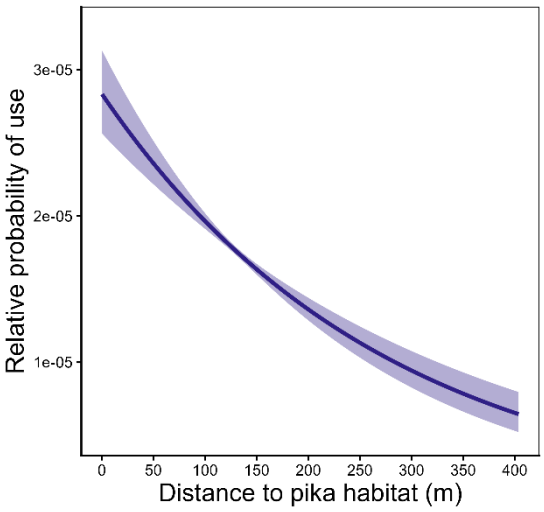


Figure 1. Relative probability of use for distance to pika habitat by mountain goats within their home ranges in the La Sal Mountains during the summers of 2020-2023. Mountain goats selected for areas near to pika habitat and avoided those far from pika habitat.

Specific Aim 2 results.

In the second chapter (*Specific Aim 2*) of my dissertation, I analyzed whether pika foraging distances were influenced by varying levels of mountain goat use across a range of vegetation cover. In addition to an interaction term between average vegetation cover and total goat pellet counts, we included variables that are known to influence pika foraging distances: julian day and behavior (grazing vs. haying). We found statistically significant relationships between pika foraging distances, average vegetation, and total goat pellet counts. In general, pikas foraged farther from the talus at sites with low average vegetation when compared to sites with high average vegetation. This response was even stronger at sites with high mountain goat pellet counts. Specifically, pikas at sites with high vegetation foraged closer to the talus if the site had high goat pellet counts compared to sites with high vegetation but low goat pellet counts. We are working through what this change in behavior might mean for pikas in areas with low-high mountain goat use. I am almost done writing up this chapter for submission to a peer-reviewed journal.

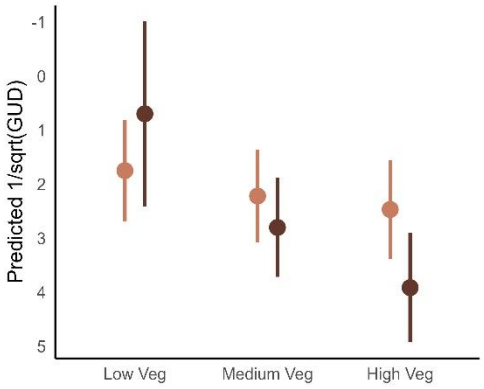


Figure 2. Dot and whisker plots of pika foraging distances across low, medium, and high average vegetation cover, and at sites with low vs. high mountain goat pellet counts. We had to transform the response variable (GUD, which represents pika foraging distances) for the analysis. Negative numbers represent farther foraging distances while positive numbers represent shorter foraging distances.

Specific Aim 3 results

In the third chapter (*Specific Aim 3*) of my dissertation, I analyzed vegetation collected from our experimental grazing exclosures to understand the impacts to above ground biomass by small- and large-bodied herbivores. To separate out the pika and mountain goat effects from other herbivores (i.e., chipmunks, marmots, elk, and deer) I analyzed camera trap data to estimate visitation to the partial (small-bodied herbivores) and open (large-bodied herbivores) plots. In collaboration with researchers at Princeton University, we analyzed mountain goat and pika scat to identify areas of dietary overlap

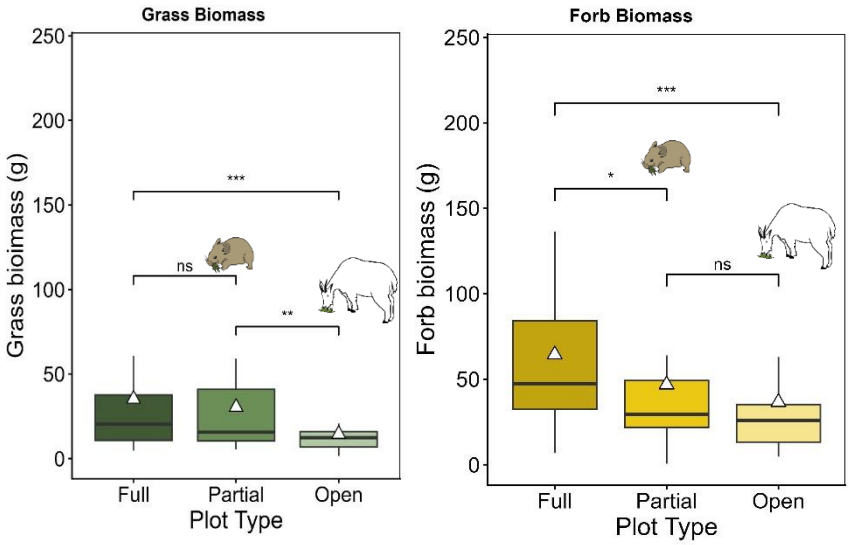


Figure 3. Boxplots with medians (crossbar) and means (triangle) of the absolute values of dried aboveground grass (a) and forb (b) biomass. Plot type is indicated on the x axis from full exclosure (no herbivores in or out) to partial exclosure (allows access by small herbivores) to open, control plot (allows access by all herbivore classes). Whiskers extend to the largest (top) and smallest (bottom) values. Significant differences from estimated marginal means comparisons after fitting GLMM are indicated with asterisks (ns = not significant, *p<= 0.05, **p<= 0.01, ***p<= 0.001).

First, we found that small- and large-bodied herbivores differed in their impact to above ground grass and forb biomass. For grasses (Fig. 3a) there was no statistically significant impact from small-bodied herbivores on the removal of above ground grass biomass, however, there was a statistically significant impact of large-bodied herbivores on aboveground grass biomass. Moreover, large-bodied herbivores have a greater impact on the removal of grasses on the landscape than do small-bodied herbivores. We found the opposite result when we looked at forbs (Fig. 3b): small-bodied herbivores had a statistically significant impact on the removal of above ground forb biomass, but large-bodied herbivores did not.

We then analyzed camera trap data to understand which herbivores visited the partial and open plots the most. For small-bodied herbivores, although we did not have enough power in our data to detect a statistical difference, pikas visited the partial plot more so than either chipmunks or marmots. For large bodied herbivores, we estimated mountain goat visitation the open plot to be 20 times higher than that of elk, and six times higher than that of deer.

Our DNA metabarcoding analysis of plant families in the diets of mountain goats and pikas revealed interesting results. In general, mountain goats and pikas have mostly separate diets, meaning to a large extent, they partition their resources. However, there is still some dietary overlap. Grasses made up ~13% of the pika's diet and only 1% of the mountain goat's diet. This is interesting because, above in figure 3a, we showed that pikas have a negligible impact on the removal on above ground biomass while mountain goats have a significant impact, yet the pika's diet has more grass than the mountain goat's. This can be explained due to differences in body size and the gregarious nature of mountain goats. Specifically, pikas are about the size of a russet potato and are territorial, meaning there were likely 1-2 individuals feeding from our grazing exclosure plots, whereas the mountain goat is much larger and moves as a herd, sometimes numbering up to 30 individuals. Thus, grass may make up a decent amount of the diets of 1-2 individual pikas, yet compared to a herd of mountain goats whose individual diets may only consist of 1% grass, the pika's impact on the removal of grasses on the landscape is negligible. This focus on grasses will be important to keep an eye on as this mountain goat population increases because another study in the middle group of the La Sal Mountains found that, as grass cover decreased, pika stress levels increased (Weatherill et al., 2026).

Specific Aim 4

The conclusion for this study and what it might mean for the conservation of alpine wilderness areas and its wildlife species, including pikas and mountain goats, with a particular focus on areas with introduced mountain goats, will be writing up as the introduction and discussion of my dissertation.

Conclusions and application of research results to future educational or interpretive efforts

I am grateful to the CNHA for supporting my project for three years. Without financial support from the Discovery Pool grant, completing the fieldwork portion of my dissertation would have been even more challenging. I will continue to update the US Forest Service on the progress of my dissertation and would be happy to participate in CNHA's free lecture series next summer.

References

Weatherill, K. P., Whipple, A. L., Sandoval Lambert, M., Ozsoy, A. Z., Nelson, H. M., Mcfarland, T. R., King, J. L., Muzzio, T., Ray, C., & Varner, J. (2026). Climatic stressors and habitat quality explain individual stress metrics in an isolated population of small mammals. *Western North American Naturalist*, *86*(2), 171–192.