

The effects of recreational trail use on small mammal species richness and abundance

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Abstract

RMBL is a prominent field station in Colorado containing native plants and animals of Western Colorado. The recreational trails near the Rocky Mountain Biological Laboratory (RMBL) are an important resource for the community. They generate touristic income for the surrounding cities and are an important place for scientific research and education. However, human activity can lead to behavioral and ecological changes in wildlife and communities. Knowing whether the regulations currently being implemented to regulate the trails are sufficient to protect the wildlife is imperative. Utilizing triggered camera traps for small mammals implemented from a study conducted in 2019 and trail cameras, we looked into the effects of recreational trails on small mammals. This three-part study compared rodent activity from bucket camera trapping to the live trapping census; measured human activity by trail game cameras on trails with different levels of pedestrian and biker activity; and, determined there were no significant negative impacts of high trail use on rodent species richness and abundance.

Introduction

Recreational trails are essential for connecting people with nature, creating public support for protected areas, and generating \$80 billion in revenue in the U.S (USDA 2019). In particular, trails provide public access to lands and wilderness in a safe way and allows for a greater understanding of the environment. The public are able to take advantage of all the benefits that recreational trails provide, however, trail usage can promote or cause trail proliferation, off-road vehicle use, vegetation trampling, and habitat alteration (Muter et al. 2005, Suavajot et al. 1998). These factors can lead to ecological impacts on species abundance and biodiversity (Muter et al. 2005). Although conservation efforts have implemented mandates to prevent habitat damage and strategies to reduce these threats, such as limited access for bikes and off-road vehicles, there are still impacts such as vegetation trampling and habitat alteration caused by hikers.

Hikers might expect to interact with nature such as sight-seeing, interacting with animals, and plant collecting. Although people wish to see scenic nature on their hike, high foot traffic causes vegetation damage and alters animal behaviors. Research has shown that trails through meadows have less vegetation, more exposed soil and rock, and greater soil loss (Barros et al. 2013). In addition, biodiversity is potentially reduced by major disturbances in which counters regulations and mandates such as hiking. (Kays et al. 2017). A study in California showed disturbed sites in the chaparral had lower mammal richness and a reduced mammal abundance (Suavajot et al. 1998). Habitat destruction can have direct effects of reducing food resources for animals. In addition the presence of humans can affect foraging behaviors, antipredator behaviors, habitat selection, and time budgets of wildlife, in particular these effects are less studied in small mammals (Uetrecht 2020). These indirect effects can also influence the abundance of both large and small mammals near trails.

Through these studies, it is imperative we gain a better understanding of how the presence of humans in nature affects the organisms that inhabit the wilderness near trails. At Gothic, Colorado it has not been studied yet on how recreational usage can affect wildlife by negatively or positively impacting animal population and biodiversity. Leslie Macias, a former

Rocky Mountain Biological Laboratory (RMBL) student, suggested that human activity may create a safe environment from predators for some mammals (Macias 2019). A similar study mentions that small mammal prey species can be more attracted to busier trails as they might use humans as shields against predators and potentially show no decrease in biodiversity (Kays et al. 2017). For example, a study found that a bear and her cubs stayed near humans to avoid aggressive males. (Nevin and Gilbert 2005) These studies show that human presence can cause predator displacement which indirectly benefits prey species, as prey species may not be displaced by humans (Muhly et al. 2011). Even though the bear and her cubs are predators, it goes to show that people might have an effect on wildlife when there is recreational trail usage. The effect hikers can have on wildlife can be direct and indirect. Small mammals that may never see a human can also be affected by the change's humans bring. In addition, there can be cascading effects through ecosystems- many carnivores depend on small mammal populations for their own food sources. For these reasons, we are interested in seeing how small mammals are affected by human activity to better manage human use of recreational trails.

To observe the effects of recreational trails on small mammals (and other wildlife), we conducted a three-part study. The first part of the study was to compare rodent activity from bucket-cam trapping to the live-trapping census. Because bucket-camera trapping is a new technique, we tested its effectiveness in measuring small mammal diversity and abundance by comparing the results with the well-studied and established technique of live-trapping. Longworth live-traps were used on established long-term research grids (used by Dr. Rosemary Smith for many years) to obtain data of small mammal activity. The Longworth live-traps are designed to minimize discomfort without endangering or having a large impact on the animal. Comparing these two methods increases our understanding of small mammal communities and the best methods to study them. The second part of the study consisted of measuring human activity by camera-trapping on four trails that we expected differed in levels of pedestrian and biker activity. With camera-trapping, the technology of infrared sensors and digital photography leads to cost-effective and noninvasive means of generating reliable counts of wildlife and their activity (Burton et al 2015). The final and third part of the study was to determine if recreational use influences rodent species and abundance. Comparing the data collected from the trail cameras of human activity to the data collected from the bucket-trap cameras on the same trail sections, we could determine if there was any effect on small mammals from different types and levels of recreational usage.

The aim of this study was to investigate the species diversity and abundance of small mammals among trails with different levels of human recreational activity. We measured both human activity and small mammal activity at four sites that varied in human usage (foot, foot+bike, low and high use). Our null hypothesis was: There are no differences in species abundance and diversity among trails with varying levels of human activity. It's possible that biker or hiker activity might not affect small mammals, especially the nocturnal ones, and therefore there would be no differences among the four trails. Alternatively, trails with higher human activity might have the same diversity (species richness) of small mammals, but might have lower or higher abundance. This is hypothesized as higher levels of foot-traffic or biker traffic might cause vegetation damage, disrupt foraging activity, and/or avoidance behavior for small rodents, which would decrease abundance, or trails may decrease predators, and thus pose

a safe-haven for small rodents, so their abundance would be higher. Finally, another alternative is that trails with higher human activity will have lower diversity of small mammals, but a similar abundance of those species compared with trails with varying levels of human activity. This is hypothesized as some species may be negatively affected, while others may be positively affected by different types of human recreation.

Methods

Study Site and Species

The study site is located in the Upper East River Valley (UERV), on both private and USFS land near Gothic, Colorado, USA. The camera traps (trail and small mammal) were deployed at four trails sections that differed in their designated (signed) allowable use: USFS Trail 401 (horseback, hiking, biking), USFS Deer Creek Trail (horseback, hiking, and biking), and RMBL/private: Judd Falls and Avery Mine (designated for horseback, hiking use only). These trail sections were selected to provide a range of expected levels of recreational usage (Dr. Rosemary Smith, Maddy Uetrecht, and Dr. Dan Blumstein, personal observations). To determine the effectiveness of the bucket camera traps, these were deployed on existing long-term small mammal trapping grids at Bellview, Maxfield, and Kettle Ponds, also located within the UERV. Expected small mammals that would enter the live and/or bucket traps were the diurnal golden-mantled ground squirrels (*Callospermophilus lateralis*) and least chipmunks (*Tamias minimus*) and the nocturnal deer mice (*Peromyscus maniculatus*), Western jumping mice (*Zapus princeps*), and montane voles (*Microtus montanus*).

Camera Traps

To measure human activity on trails, we collaborated with Dr. Dan Blumstein and Maddy Uetrecht (RMBL and UCLA), who provided some of the equipment, camera placement maps, and image organization and storage. We provided all the fieldwork setting up the cameras and collecting the SD cards each week. We deployed six cameras per trail. The trail was divided into six zones and each zone had six subsections (See Figure 8). The trail cameras were moved to a new random location within each subsection every week for 5 weeks (June 29-August 7, 2020). We used Trimble Geo 7x to find the new coordinates for the camera placement, the cameras were placed on either a 1 m tall wooden stake or a tree. At each new location we measured vegetation type and height. See Table 1 for description of Trail Cameras and settings. The cameras were set with a photographic rate of 3 shots per trigger with an interval of 10-30 seconds between each set of shots. In addition, the cameras were set to low sensitivity to decrease the risk of false positives and an image size of 4 MP to increase image space on the SD cards. Each week at each site we checked each camera's battery percentage, recorded the number of pictures taken, and changed the SD cards. The SD cards were mailed to Maddy Uetrecht, who downloaded the pictures and created shared folders for the camera images we used in our study. For this study, we used images from just one of the trail segments closest to our small mammal camera traps, usually the first segment, except for Judd and Avery, which we used images from segments 5 and 6 of the Judd trail (see Maps). We sorted the pictures by human activity into different folders: one biker, two bikers, one pedestrian, two pedestrians, etc. Once the pictures

were sorted we added or multiplied the totals to obtain different measures of human activity per trail. We focused on 3 measurements: Total bikers, total pedestrians and total activity. For total bikers, it equaled the total number of all bikers, which was derived by counting multiple bikers in one photo. Total pedestrians equaled the total number of pedestrians which also counted multiple pedestrians in one photo. For the final measurement, the total activity equaled the total number of walking and biking events. Each photo was counted as an event, regardless of the number of people in the photo.

We totaled the number of bikers, pedestrians, and total events for each week and calculated the average and standard error across all weeks for each trail. The pictures were sorted into different folders. For example, Judd week four had 200 pictures in the 2 Pedestrian folder. We were able to determine that there were 400 pedestrians in that folder. When we finished the calculations for each folder per trail we were able to determine the total number of pedestrians and bikers. With our totals from each trail we calculated the weekly average activity per trail. See Figures 2,3, and 4 for the averages and standard error per trail.

Note: Because we looked at all of the trail camera images, we also generated a list of larger mammals that used the trails (see Results, Table 5.)

Bucket Camera-Traps

Using a similar approach to a method used in Macias (2019), a modified version of the Hunt trap, involving camera-trapping, was deployed on the trails and measured the relative abundance and richness of small wildlife. The 14 modified bucket-traps were built with a 26.6 L (7 gallon US) bucket with a fitted lid. Each bucket had two ~4 cm round holes cut out of the sides of the bucket near the bottom to allow small mammals access. A ruler was drawn on the bottom to provide a scale for the images. The camera was attached to the lid using two small holes threaded with wire, and placed facing the bottom of the bucket. Care was taken to level the camera using foam padding so that the image would be of the bottom of the bucket. A small amount of bait was added when the buckets were deployed. A camouflage cloth was placed on top of the bucket with a tight mosquito net to keep the fabric in place. The purpose of the camouflage cloth was to conceal the bucket from humans using the trails. Five different cameras were used for the bucket traps (Table 1), but the ApeManMini proved to take the highest quality images due to its short focal distance. The Browning, Bushnell, and Wildview cameras had to have part of their flash covered by cardboard and tape to prevent picture overexposure. (Figure 9) For future studies we highly recommend using a darker cardboard and tape to prevent overexposure especially when the buckets are in an open meadow.

The camera trap pictures were counted by rodent visits. Table 2 shows which species were captured by the bucket traps. If the rodent visibly exited the trap then it would be the end of that visit. Also, if the pictures jumped more than four minutes to another rodent in another location then it was counted as a separate visit. We calculated the total number of visits per species per trail section, averaged over the three weeks (see Table 4).

The bucket-trap surveys were conducted in July and August 2020. Two bucket traps were paired with a single trail camera, within one subsection of a trail, in the zones established in collaboration with Uetrecht and Blumstein's study. The two bucket traps were positioned 25 meters on either side of the trail cameras, within five meter of the trail. Each week, the bucket traps were relocated based on the new location of their paired trail camera. Bait consisting of oats, horse feed, and peanut butter was placed directly in the camera's field of view. We visited the traps each week to move to a new location, check on the camera's battery life, record vegetation type, exchange SD cards, and replenish the bait. The new coordinates of the bucket traps were also taken using the Trimble Geo 7x GPS unit. The images were viewed and the number of unique visits (> 4 minute lag between pictures) were counted for each species. Because different species were observed in the pair of buckets, the number of visits for both buckets in the pair was combined into one total activity measure per trail camera location.

Live Traps vs. Bucket camera traps

A live-trapping mark-recapture study using Longworth live-traps was conducted to estimate population sizes of nocturnal small mammals species. The live-traps were set out in grids, consisting of 49 trap stations arranged in 7x7 configuration and with each being set 10 meters apart. Traps were baited with a mixture of oats, horse feed, and peanut butter and bedding was placed in the nesting-chamber box. Each individual captured was identified by species, weighed, sexed and marked before their release. Traps were opened at dusk and revisited early in the morning after dawn. One site was set and revisited per evening and aimed to obtain five to eight trap nights per site. The Schnabel multiple mark-recapture method was used to estimate population sizes for each species at each site. If fewer than 10 animals were trapped, then we reported MKA (minimum known alive).

This estimate was then compared to small mammal activity based on images from the bucket camera traps placed on the same trapping grid. The bucket traps were set out for one week in each of the trapping grids in July and early August 2020. The images were viewed and the number of unique visits (> 2 minute lag between pictures) were counted for each species.

Results

We found that on the established rodent census grids that the live trapping and bucket trap camera images detected the presence of the same rodent species (Table 2). We also counted the number of rodent visits from the bucket traps and compared it to the Schnabel estimated number of rodents of each species from the live trapping grid. There was a positive relationship between the number of pictures (unique visits) from the bucket traps and the live-trapping estimates of abundance of the species for both *Peromyscus maniculatus* and *Zapus princeps*, but not for *Microtus*, where there were many fewer camera images/visits than expected (Figure 1). We only trapped a few *Tamias* in the live-traps, so we could not compare their numbers with the camera traps.

To detect differences in trail use and to quantify the usage patterns by activity type (pedestrians, bikers, horses, etc.) time (diurnal/nocturnal, day of year, etc.) we categorized over x thousand trail camera images. We calculated the average number of bikers, pedestrians, and total activity on all of the trails per week. As expected, there were significantly higher numbers of bikers on the 401 trail than any other trail. Deer Creek had a moderate number of bikers. Both of these trails had significantly higher numbers of bikers than Judd and Avery (Figure 2). In contrast the Judd trail had a significantly higher average number of pedestrians per week. The 401 and Deer Creek had similar numbers of average pedestrians per week and Avery had the lowest number of pedestrians. (Figure 3). When looking at the average total activity (= humans passing on a trail, any activity type or group size), we found that the Judd and 401 trails did not have a significant difference in total human activity. Deer Creek had a moderate amount of activity and Avery had the lowest amount of activity (Figure 4). To summarize, when we compared all four trail sections, we found that we had two trails with no biker activity, but vastly different hiker activity and two trails that had similar pedestrian activity but vastly different biker activity (Table 3). These differences formed the basis of our comparison with small mammal activity along trails of different usage patterns.

We combined the bucket camera and trail camera data across study weeks 2, 3, and 4. We collected images in Week 5, but have not included them (yet!) in this study. We found that each trail section had a species richness of three to four species, but not all of the sites had the same species of rodent (Table 4). We selected two species that were common or abundant on 3 or 4 of the trails and that differed in their activity time (nocturnal v. diurnal). For *Peromyscus maniculatus*, the average total activity had a non-significant slight positive effect as total human activity increased ($F = 3.452$, $p = 0.204$). We also found a significant positive effect on *Peromyscus* as total pedestrians increased ($F = 27.199$, $p = 0.035$). There was no significant effect on *Peromyscus* by bikers on trails ($F = 0.309$, $p = 0.634$) (Figure 5). There was no effect on *Tamias* as average total activity increased ($F = 0.0003$, $p = 0.989$). We can also see that there was no significant increase of *Tamias* with higher average pedestrian activity ($F = 0.467$, $p = 0.698$). In contrast with *Peromyscus*, there was a significant decrease of *Tamias* activity with higher average biker activity ($F = 47.819$, $p = 0.091$) (Figure 6).

When we combined all rodent species activity and all human activity, we found that there was a marginally significant increase of rodent activity on trails with higher human activity ($F = 5.664$, $p = 0.140$) (Figure 7).

Discussion

Overall our studies showed that there were no significant negative impacts of high trail use on rodent species richness and abundance, and if anything, there was a marginally significant positive relationship between small mammal activity and human recreational activity. This result is consistent with studies that show that small mammal species can be more abundant on busier trails as they might use humans as shields against predators (Kays et al. 2017) or there may be decreased abundance of their predators on trails. Our results contrast from studies that show human activity can lead to negative ecological impacts on species abundance and

biodiversity (Muter et al. 2005). We think that this difference is because studies of human impact on mammals tend to be on larger mammals (deer, elk, etc.) and we expected that smaller mammals might never even encounter a human if they are nocturnal, and they may also have a much easier time of hiding from or avoiding humans. We expected bikers to have a negative effect on diurnal small mammals because bikers have higher noise and speed. We only found a negative effect of bikers on chipmunks, an animal that is diurnal and would likely show avoidance of bikers, but not necessarily hikers. While researching pedestrian affect on small mammals, we were unclear on how pedestrians would affect the small mammals because of the contradicting studies. Interestingly, we found a positive effect of hikers on *Peromyscus*, a species that is nocturnal so would not encounter humans directly. That suggests an indirect effect, perhaps hikers provide a predator-free space for deer mice.

At the beginning of our study we were unsure if the bucket traps images would be a reliable way to capture the species in our study area. Table 2 shows that the bucket traps and the camera traps captured the same species of rodents. This allowed us to further confirm that the bucket traps were an effective way to determine the species diversity in an area, similar to the results found by Leslie Macias in 2019. Only one of the species captured in both the live traps and bucket traps was diurnal, this was because the live traps are not designed to capture diurnal species. On the trails, the bucket traps captured images of the two diurnal species, chipmunks and golden-mantled ground squirrels. Figure 1 shows that *Peromyscus* was captured in high amounts in both the bucket traps and the live traps, and that the captures were correlated. This was also the case for *Zapus*, the jumping mouse. However, there were not high *Microtus* images, even on sites where *Microtus* were known to be abundant. This could be for various reasons. One reason that *Microtus* failed to be reliably captured may be because the high number of *Peromyscus* might make them the dominant rodent in the area, and they kept the *Microtus* out of the bucket traps. Another reason we believe had a significant effect was the cattle that graced the Kettle Ponds and Deer Creek areas. Because of the cattle our bucket traps were toppled over multiple times which gave us incomplete data of the areas where *Microtus* were known to be most abundant (data from the live trap data). Because we did capture many images of *Microtus* in the bucket traps on the trails without cows, we think that the decreased time of useful camera deployment when the cows were grazing was a likely contributor.

A critical piece of this project was to establish how the recreational trail sections we chose had different levels and types of human activity. Figures 2, 3, & 4 show the significant differences among the trails in average biker, pedestrian, and total activity per week. This allowed us to confirm that the trails we chose to compare varied in their recreational use. The different types and levels of human activity (summarized in Table 3) allowed us to compare low versus high biker and pedestrian trails and measure how these activities affected the rodents. These data will also be utilized in the future by Maddy Uetrecht as she studies the effects of trail use on larger animal activity on the trails. Another future study that could be beneficial to look at is the changes over seasonal changes of human activity as human activity increases at the beginning of the summer, peaks and starts slowing down as the summer comes to an end. See Table 5 for the larger mammals captured.

Five small mammal species were captured in images in the bucket traps, and each trail had 3-4 of the species (Table 4). Each trail section differed in which species were present and common or abundant. We think that the most likely explanation for species presence or absence is habitat and vegetation type, not trail use patterns. Future studies where habitat variables were controlled and replicated across trail type would be very informative.

Because they occurred on nearly all the trails, and because they differed in their activity periods and therefore their direct interactions with humans, we focused our analyses on two species, the diurnal chipmunk (*Tamias*) and the nocturnal deer mouse (*Peromyscus*). For *Peromyscus* abundance we compared the four trails and for *Tamias* abundance we compared three of the trails, excluding Deer Creek. We found that there was a significant positive effect on *Peromyscus* as total pedestrians increased, but there was no effect on *Tamias* as total pedestrians increased. This may be evidence that humans provide a safe haven for prey animals from predators (Kays et al. 2017). We also found that higher numbers of bikers had a significant negative effect on *Tamias* while *Peromyscus* had no significant decrease associated with bikers. We think that this is the case because *Tamias* are diurnal which gives them a higher chance to see and be disturbed by a biker while the nocturnal *Peromyscus* is unlikely to directly encounter a biker.

In summary, we found that a great benefit to using the bucket traps was that we were able to capture not only nocturnal species, but also the diurnal species (*Tamias* and *Callospermophilus*). We also found that trail cameras can be used to quantify differences in trail use patterns. This gives us the ability to study trails and wildlife over longer periods of time while reducing the amount of time needed to spend in the field. The bucket camera traps showed that rodent species richness was not influenced by the type of recreational trail use. Consistently in all the trails we had a variety of species. The bucket traps also showed that rodent abundance was marginally higher on trails with more use.

Even in our highest used trails, the mammals seem to be thriving. From general observation while executing this study, the general public using the recreational trails near RMBL have been doing a good job at keeping the trails clean and undamaged. This needs to continue being the status quo and the general public needs to continue to be aware of the possibility of the negative effect that may come to the wildlife that lives near the recreational trails if things change. While our data indicated overall there were no significant negative impacts of high trail use on rodent species richness and abundance, the USFS should still be aware that biker activity tended to have a higher negative effect on rodent species, especially diurnal species. Pedestrian activity seems to have a positive effect on rodent species but if this is due to a decrease in their predators, this could show that there are indirect effects of trails that need further study. The USFS should also keep track of any significant increase of bikers on the trails because of the negative effect it has on the diurnal rodent species. There are several factors that our study could not account for. One was the vegetation types of the trails and camera bucket placements. In future analysis, consideration of the effects the different vegetation types could change how we see human activity affecting rodent species. Future counts of predators and larger diurnal and nocturnal mammals and influence of seasonal changes could also help us understand how the whole ecosystem is affected by human activity.

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Tables and Figures

Table 1: Camera settings for cameras used on trails and in buckets.

Camera	Photographic rate	Interval	Resolution	SD Card
Apeman H40	3 shots per trigger	30 seconds	5M	San Disk Ultra Micro SD 16GB
Browning Strike Force HD Pro X	3 shots per trigger	10 Seconds	4MP	Ultra San Disk
Bushnell Natureview HD Live View Trail Camera	3 shots per trigger	10 seconds	4MP	Ultra San Disk
Bushnell Natureview HD Essential Trail Camera	3 shots per trigger	10 seconds	4MP	Ultra San Disk
Wildview TK 30 8.0 Trail Camera	3 shots per trigger	20 seconds	High	Ultra San Disk

Table 2: Species present in live trapping and bucket camera comparison.

Species	Activity	Live Traps	Bucket Traps
<i>Peromyscus maniculatus</i>	Nocturnal	Present	Present
<i>Microtus montanus</i>	Nocturnal	Present	Present
<i>Zapus princeps</i>	Nocturnal	Present	Present
<i>Tamias minimus</i>	Diurnal	Present	Present

Table 3: Summary of biker and pedestrian levels in each trail section.

Trails	Bikers	Pedestrians
Avery	None	Low
Judd	None	High
Deer Creek	Medium	Medium
401	High	Medium

Table 4: Species presence and level in each trail studied.

Species	Avery	Deer Creek	401	Judd
<i>Peromyscus maniculatus</i>	Abundant	Common	Abundant	Abundant
<i>Microtus montanus</i>	Absent	Common	Abundant	Rare
<i>Zapus princeps</i>	Absent	Rare	Absent	Absent
<i>Tamias minimus</i>	Common	Absent	Common	Common
<i>Callospermophilus lateralis</i>	Common	Rare	Rare	Abundant

Table 5: Species list of the species seen on the Trail cameras.

Species	Avery/ Judd	Deer Creek	401
<i>Alces alces</i> (moose)		☐	
<i>Bos taurus</i> (domestic cattle)		☐	
<i>Callospermophilus lateralis</i> (golden-mantled ground squirrel)	☐		
<i>Canis latrans</i> (coyote)	☐	☐	☐
<i>Colaptes auratus</i> (Northern flicker)	☐	☐	
<i>Equus caballus</i> (domestic horse)		☐	
<i>Lepus Americanus</i> (Snowshoe Hare)			☐
<i>Martes americana</i> (pine marten)	☐		
<i>Odocoileus hemionus</i> (mule deer)	☐		☐
<i>Puma concolor</i> (mountain lion)			☐
<i>Tamias minimus</i> (least chipmunk)		☐	
<i>Taxidea taxus</i> (american badger)			☐
<i>Ursus americanus</i> (American Black Bear)			☐
<i>Vulpes vulpes</i> (red fox)	☐		☐

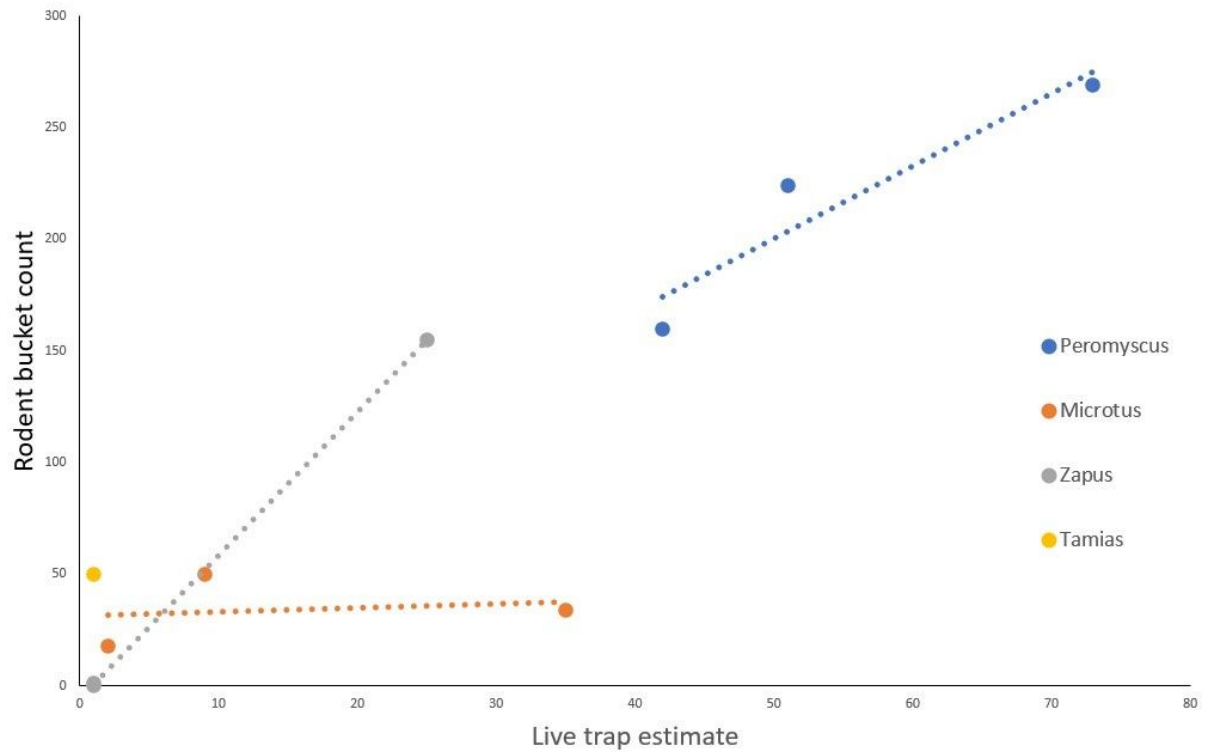


Figure 1: Relationship between number of rodents estimated from live trapping and number of rodents counted in the camera bucket traps.

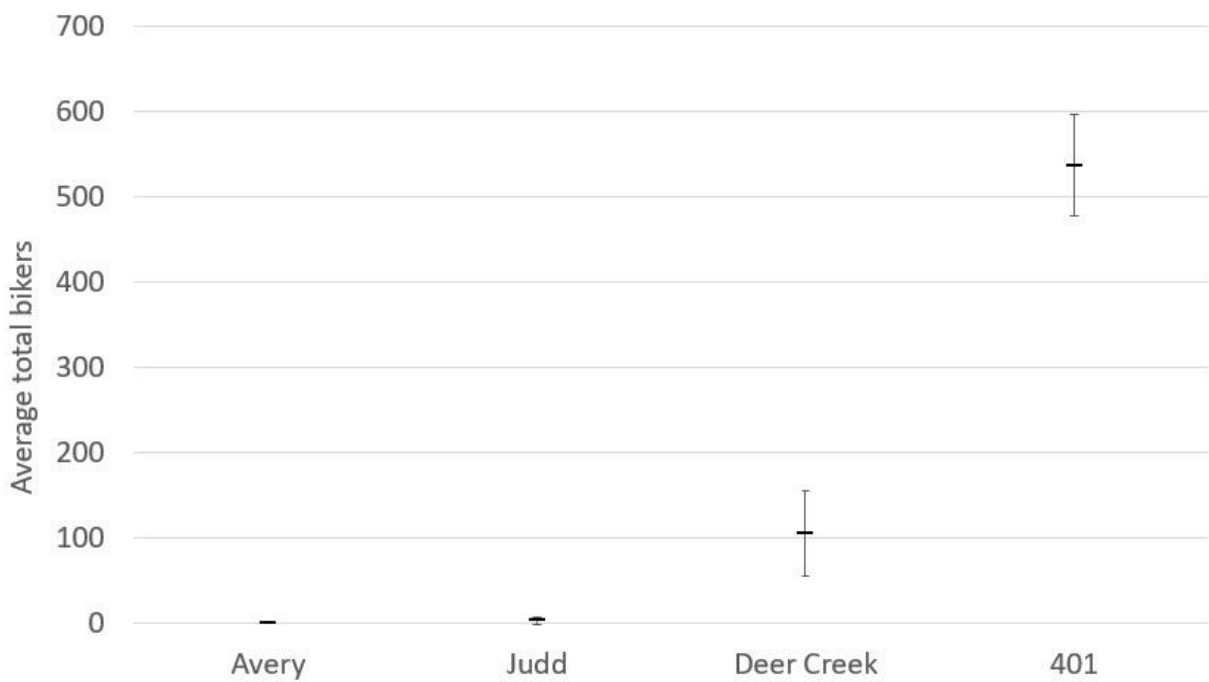


Figure 2: Average total bikers per week on each trail studied with ± 2 standard error bars.

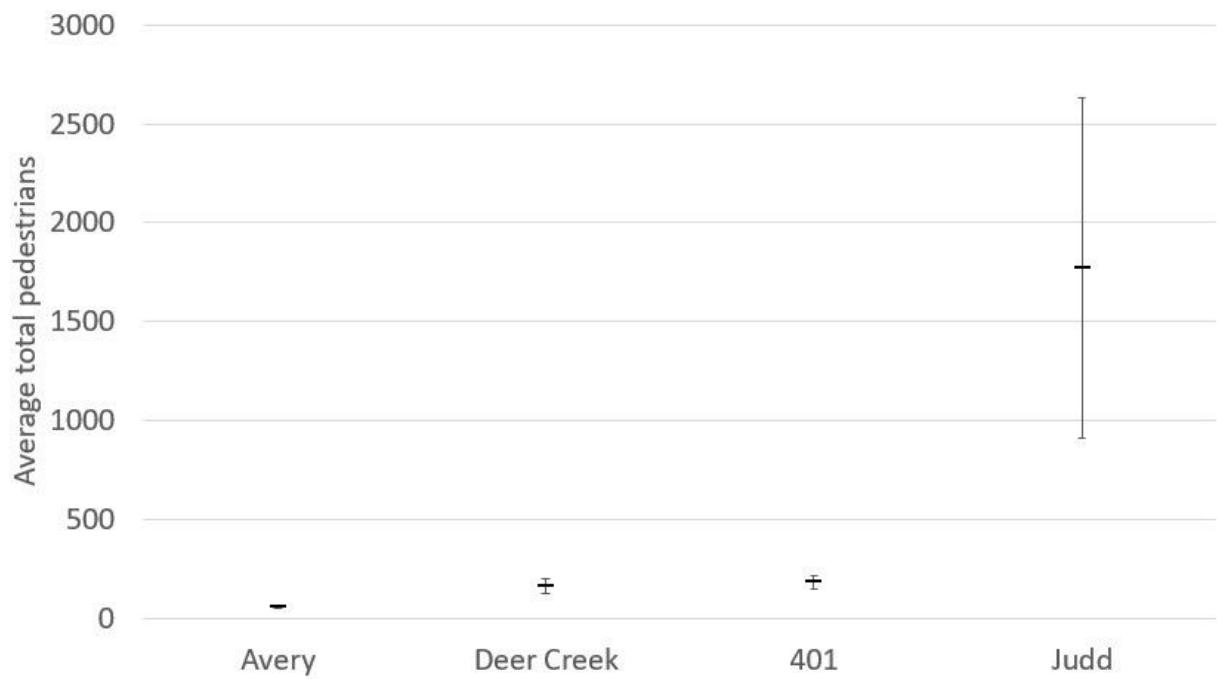


Figure 3: Average total pedestrians per week on each trail studied with ± 2 standard error bars.

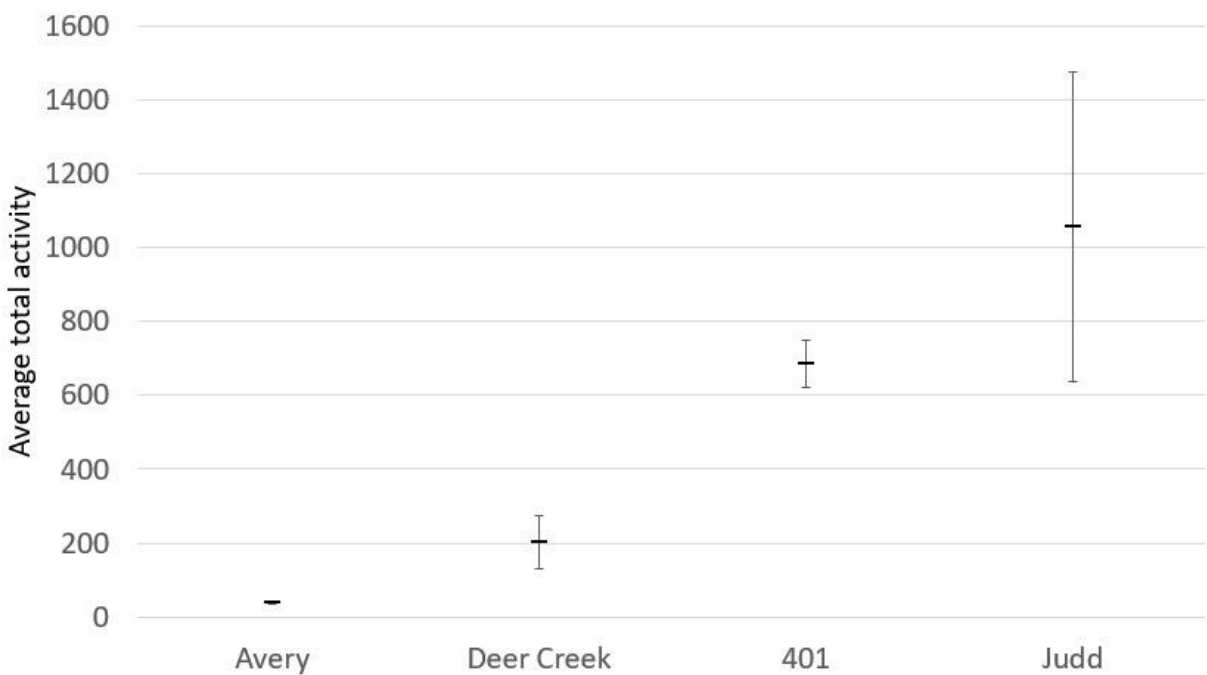


Figure 4: Average total activity per week on each trail studied with ± 2 standard error bars.

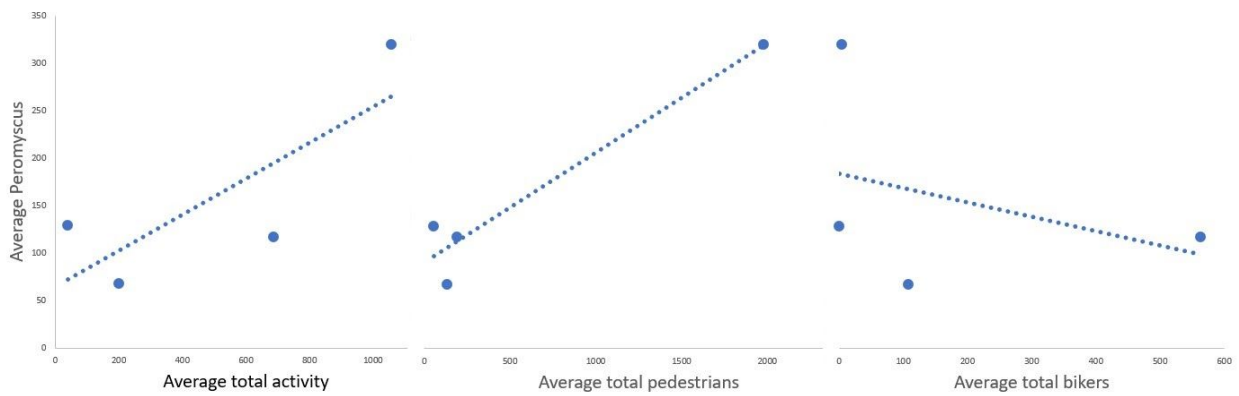


Figure 5: Average *Peromyscus* in a trail vs. average total activity, total pedestrians, and total bikers per trail studied.

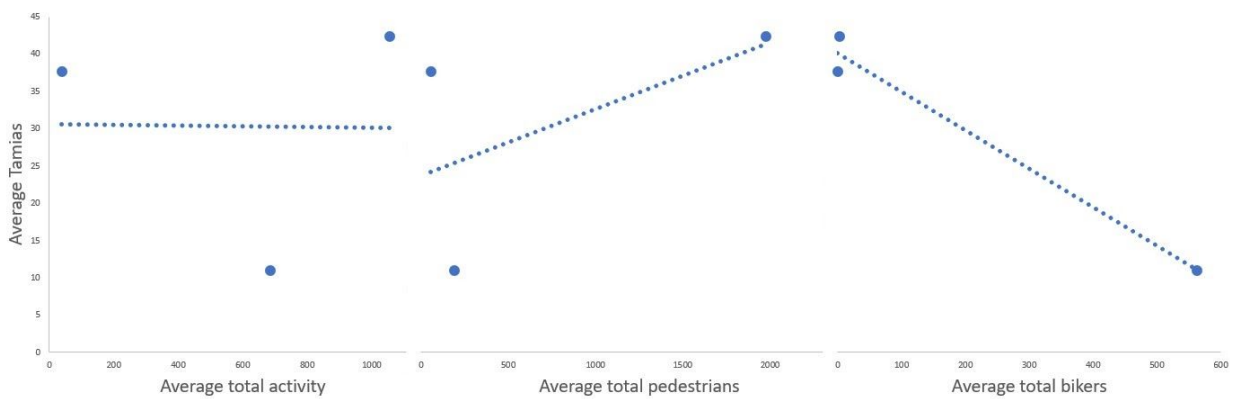


Figure 6: Average *Tamias* in a trail vs. average total activity, total pedestrians, and total bikers per trail studied.

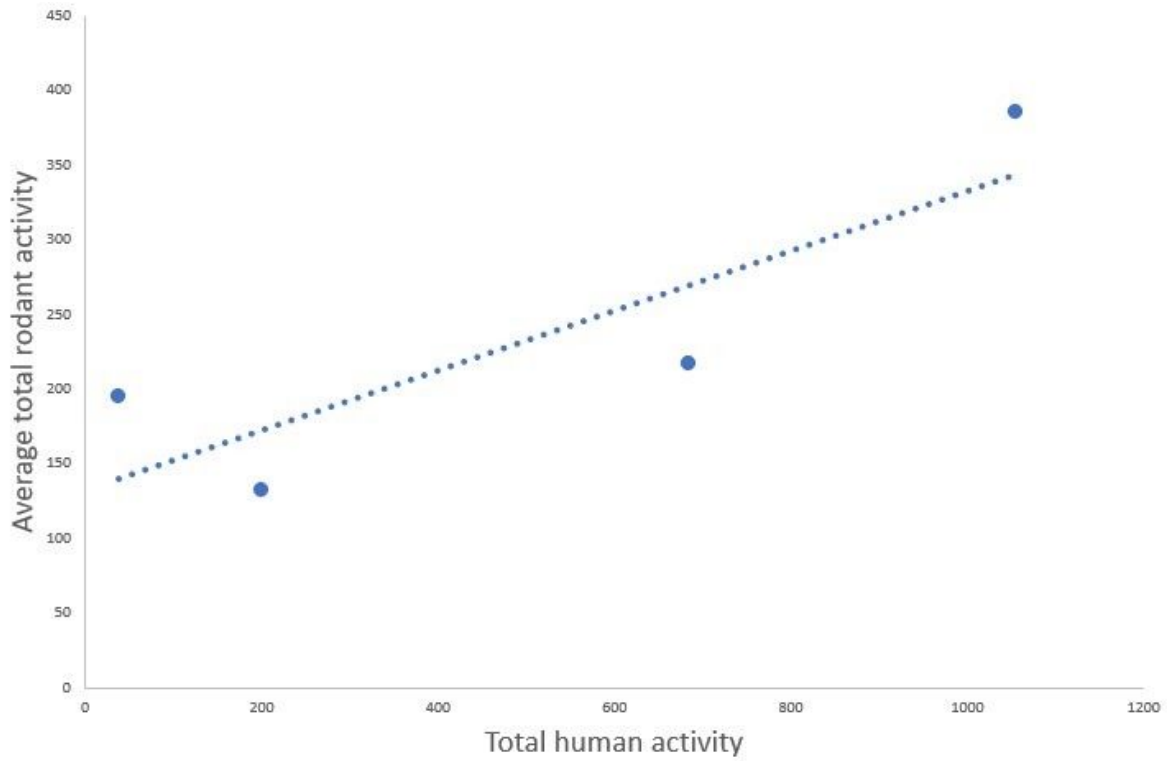


Figure 7: Combined totals of all types of human activity vs. combined number of all species of rodents studied.

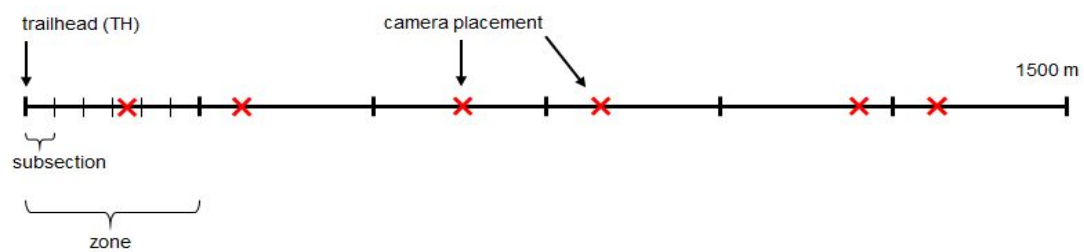


Figure 8: Trail Logistics



Figure 9: Examples of how to cover camera flash.

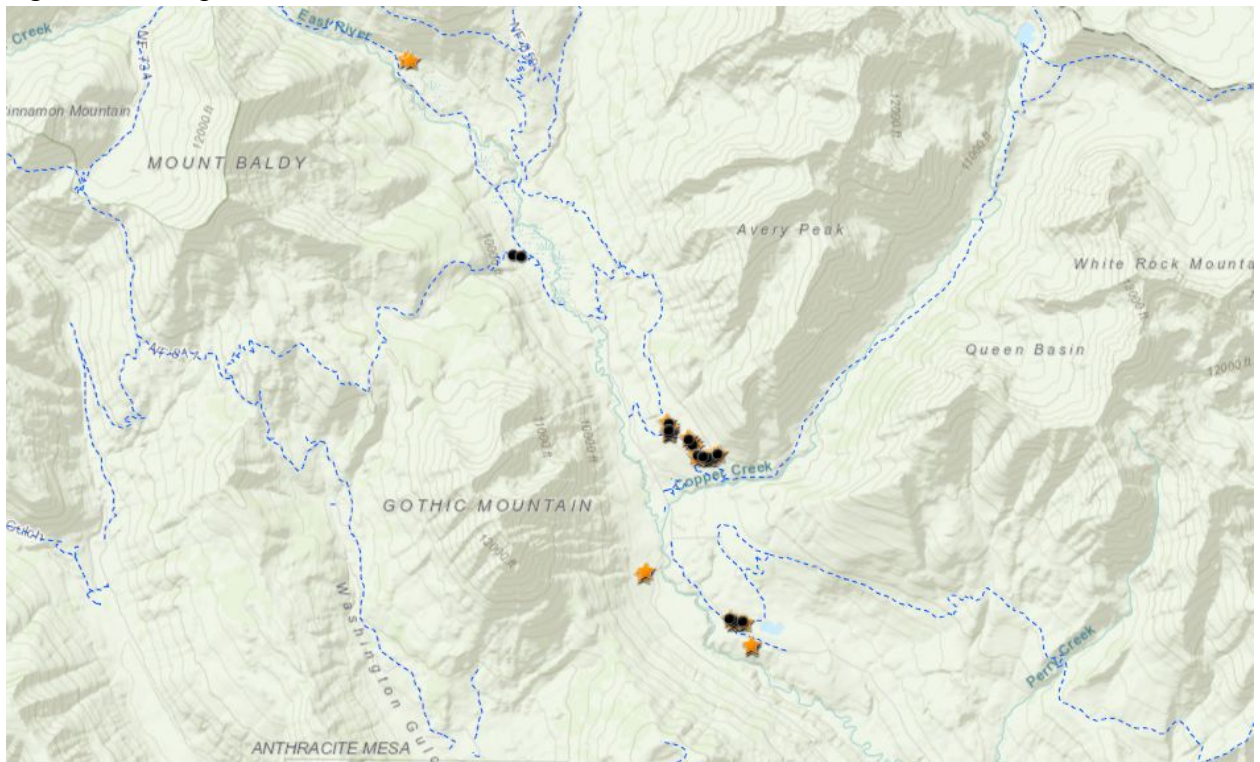


Figure 10: Map of trail sections, bucket camera placements (orange) and game camera placements (black). (Map has a 401 game camera placement error).