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RH: Macias • Effects of trails on small mammals

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**Effects of recreational trails on small mammal communities in north-central Gunnison County, Colorado (USA)**

### **Abstract**

Human recreation can lead to changes in behavior and distribution patterns of wildlife populations. This project aims to (1) evaluate the effectiveness of the Hunt trap, a novel non-invasive technique used to estimate small mammal abundance (2) determine the distance from trails at which we see an effect on small mammal activity and (3) assess the impact of non-motorized recreational activities on rodent species abundance. We investigated these objectives at areas of high utilization using a non-invasive camera trap method at a series of locations throughout July and August 2019. Heavily used recreational trails did not show a significant impact on habitat utilization by several small mammal species. Nocturnal species including deer mice (*Peromyscus maniculatus*) activity was higher, however not significant, in proximity to trails. Diurnal rodents including golden-mantled ground squirrels (*Callospermophilus lateralis*) and least chipmunks (*Tamias minimus*) did not exhibit a negative trail effect. Quantifying the impacts of human recreational disturbance on wildlife is essential for a functional ecosystem and establishing management policies regarding use of recreational trails.

### **Introduction**

Outdoor non-consumptive recreation activities have increased over the last 20 years. Recent trends show a 7.1 percent growth in the number of participants in outdoor recreation between

1999 and 2009 in the United States alone (White et al. 2016). Individuals engaged in hiking is projected to expand to over 100 million participants through 2030 (White et al. 2016). Effects of recreation on wildlife have demonstrated changes in behavior, spatial use, community composition and richness, and declines in abundance and reproductive success (George and Crooks 2006, Naylor et al. 2009).

Humans can have a different influence on wildlife depending on land-use management. Elevated heart rates were reported in mountain sheep disturbed by non-motorized activities, like hiking, than disturbances caused by motorized activity (road traffic, helicopters, fixed-winged aircrafts) (McArthur et al. 1982). Motorized activities tend to be more predictable and rarely leave roads and trails, whereas, non-motorized activities are less predictable and take more time to cover the same distance (Ciuti et al. 2012).

In some cases, animals may benefit from human presence in natural areas, such as female brown bears (*Ursus arctos*). Mother bears and cubs sharing a closer association with humans are able to forage for an extended period and evade aggressive males, which tend to avoid humans (Nevin and Gilbert 2004). Lenth et al. (2006) deployed camera traps, pellet plots, track plates, and scat surveys to measure wildlife activity along trails with and without the presence of dogs. There was a significant reduction of activity in small mammals, including mice (*Peromyscus spp.*), squirrels (*Sciurus spp.*), chipmunks (*Eutamias spp.*), and rabbits (*Sylvilagus spp.*), while red fox (*Vulpes vulpes*) detections were higher in areas that allowed dogs. Understanding responses to recreational activities across taxa can help implement strategies for managing wildlife and natural areas.

The primary objective of this study is to test the hypothesis that non-consumptive human recreation has a negative impact on small mammal communities species abundance and

composition. If small mammals are affected by human trail-use, we predict that sites with higher human use will have a reduced number of rodent species and relative species abundance than sites with low human use. To test these predictions, we used a novel method to census small mammals at three sites of contrasting human use throughout the East River Valley region of Colorado.

## **Methods**

### *Study Site and Species*

This study was conducted at three sites including Belleview Bench, Maxfield Meadow, and the Judd Falls trail in the East River Valley near Gothic, Colorado, USA. Each site features consistent habitats of subalpine meadows. The Judd Falls trail is heavily trafficked and restricted to hiking only, dogs are also permissible on-leash. This allowed us to narrow down human disturbance primarily to hiking alone. Temperatures can range from 29°C during the day and 19°C at night throughout the summer months (NOAA).

Species examined include both diurnal species, golden-mantled ground squirrels (*Callospermophilus lateralis*) and least chipmunks (*Tamias minimus*), and nocturnal species, deer mice (*Peromyscus maniculatus*), Western jumping mice (*Zapus princeps*), and montane vole (*Microtus montanus*).

### *Traps*

We used a modified version of the Hunt trap to index small mammals. The Hunt trap is used to estimate small mammal abundance in tidal environments (McCleery et al. 2014). The design of the modified Hunt trap consists of a 26.5 L (7 gallon, 50 cm tall) bucket and fitted lid. Two entryways were cut out to allow access. Camouflage cloth was placed over the buckets to

conceal the traps. A camera is housed inside the bucket and attached to the lid, facing downward towards the bait. The bait consists of a mix of sweet horse feed (omolene) and peanut butter. We used Bushnell NatureView HD Essential, Bushnell Natureview HD Live View trail camera with an adjusted focal distance (46 cm) (Bushnell Outdoor Products, 9200 Cody, Overland Park, Kansas 66214), and Browning Strike Force 850 Extreme BTC-5HDX trail camera (Browning Arms Company, Morgan, UT, USA). We programmed the cameras to capture three consecutive infrared images when triggered, with a 10-s delay between sets. Cameras remained continuously activated (except when malfunctions occurred); date and time were automatically stamped on each image. Cameras were visited in alternating days intervals to check batteries and re-bait.

### *Experimental Design*

To compare the modified Hunt trap to standard small mammal live-traps, I placed two Hunt traps within established trapping grids in Bellevue and Maxfield Meadow and compared species composition and abundance. Cameras were located ~50 m apart.

To compare small mammal diversity and abundance in areas of high human usage, we laid a transect perpendicular to the established trail. We set a 100 m transect line with four traps at every 30 m, beginning with 5 m. Camera traps were deployed at all sites for 6 consecutive nights, from July until early August 2019. After each survey, we recorded the number of individuals and the species detected.

We obtained a measure of utilization in the established trail from data collected by RMBL docents. This included the count of people utilizing the Judd Falls trail at a given day between the hours of 10:00 and 14:00.

### *Data Analysis*

We classified photographs as belonging to independent records if more than 2 min elapsed between consecutive photographs of the same species at a given location. If the image captured an individual exiting the trap and another entering within the 2 min period, it was counted as an independent record. We indexed activity in terms of number of photographs/numbers of trap days. We calculated number of trap days for each trap location as the time the camera was placed in operation until the traps were removed or the last photograph was taken if batteries had failed or other malfunctions had occurred. The average number of diurnal, nocturnal, and total rodents at each distance was analyzed using a one-way ANOVA.

## RESULTS

### *Livetrapping comparison*

An index of relative abundance was estimated for each site by calculating the number of images of a species detected in a photograph divided by the number of nights the camera operated at that station. If multiple individuals were captured within a single photograph, each individual was counted independently. All species captured in the Longworth traps were also represented in the Hunt trap. Capture rates of *P. maniculatus* and *M. montanus* were higher in the Hunt traps (**Fig. 1**). *Zapus princeps* was the only species underrepresented in the Hunt trap.

### *Trail effect on rodents*

Our analysis of total small-mammal abundance relative to trail distance showed no significant impact on rodent abundance but show a slight downward trend ( $F = 2.26$ ,  $df = 3$ ,  $p = 0.09$ ) (**Fig. 2**). No evidence of negative effects on diurnal species in relation to trail distance ( $F = 2.43$ ,  $df = 3$ ,  $p = 0.07$ ) (**Fig. 3**). Similarly, nocturnal species did not show a strong effect in relation to trail distance ( $F = 3.95$ ,  $df = 3$ ,  $p = 0.01$ ) (**Fig. 4**).

## **DISCUSSION**

Human activity along heavily trafficked trails appear to have had little impact on either diurnal or nocturnal rodent species. Nocturnal species appeared to show a reasonably positive reaction to being near trails. The overall lack of apparent impact on small mammal relative abundance might indicate that human activity, although common, was not sufficiently intense to produce negative responses for most species.

Rodents may elicit short-term responses (temporarily fleeing) rather than long-term avoidance of areas with human presence (Kays et al. 2016). Depending on the degree of human disturbance through recreation, human activity could deter predators from these areas (Muhly et al. 2011). Predator displacement by human disturbance could then indirectly benefit prey species by reducing predation risk. Nocturnal species may also show no response to increased human activity because of the temporal components, with hiking occurring during the day hours and nocturnal rodent activity remaining primarily throughout the night (Gaynor et al. 2018).

In this study, we only examined effects on rodents in terms of their presence. Their presence or absence may not reflect other impacts non-motorized recreational activity such as behavioral changes. For example, individuals may spend more time being vigilant, resulting in a decrease of foraging time and possibly reducing reproductive success (Green and Giese 2004).

Further monitoring of impacts non-motorized recreational human disturbance on wildlife is needed to ensure that interactions between humans and wildlife are managed properly. If negative effects of human activity increase over time, recreational areas may require further temporal and spatial restrictions.

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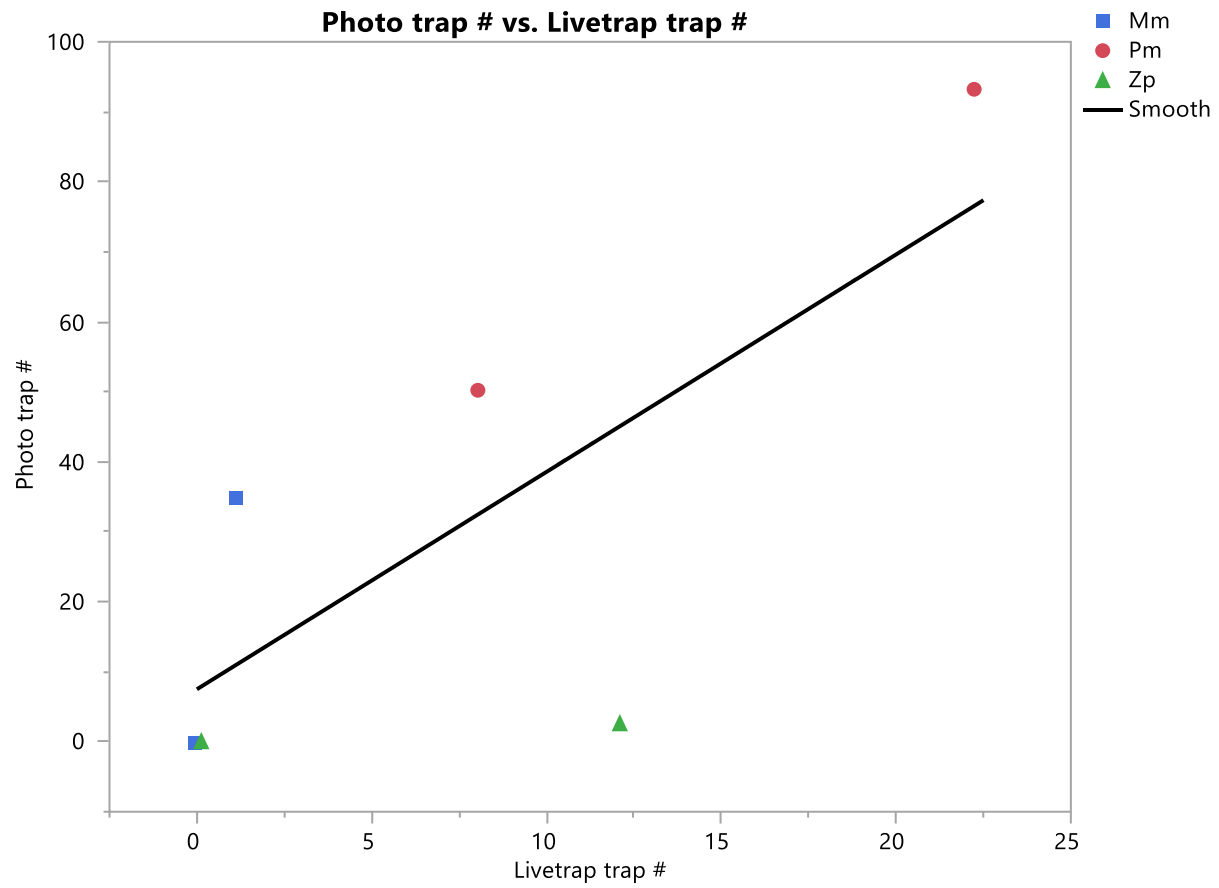


Figure 1. Comparison of mean rodents captured between Hunt traps and Longworth traps at established live-trapping grids in Gunnison County, Colorado, USA, 2019.

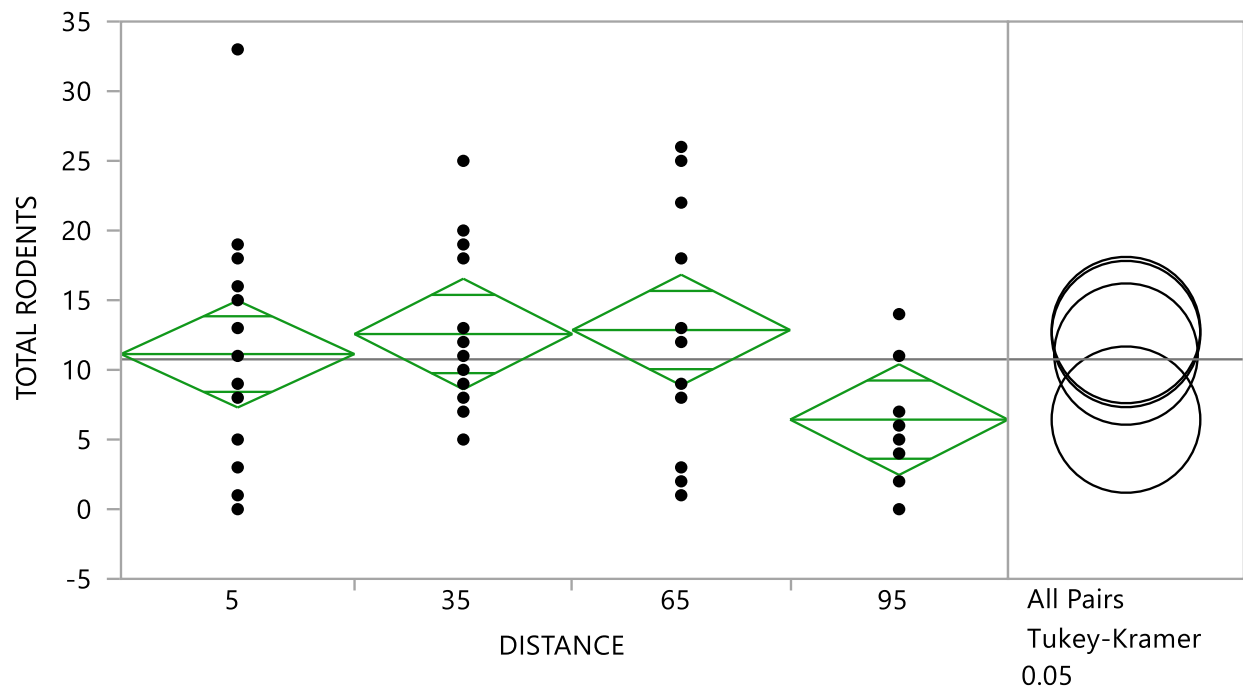


Figure 2. Mean rodent abundance across four distances from the Judd Falls trail in Gunnison County, Colorado, USA, 2019.

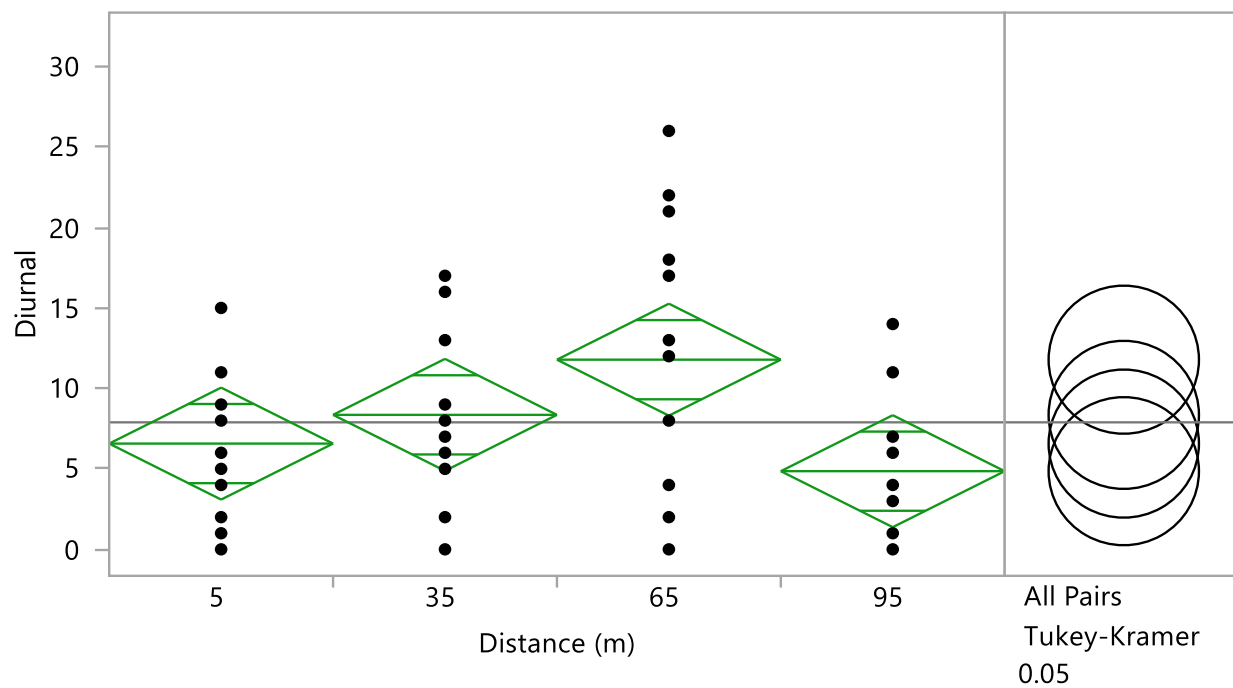


Figure 3. Mean diurnal rodent abundance across four distances from the Judd Falls trail in Gunnison County, Colorado, USA, 2019.

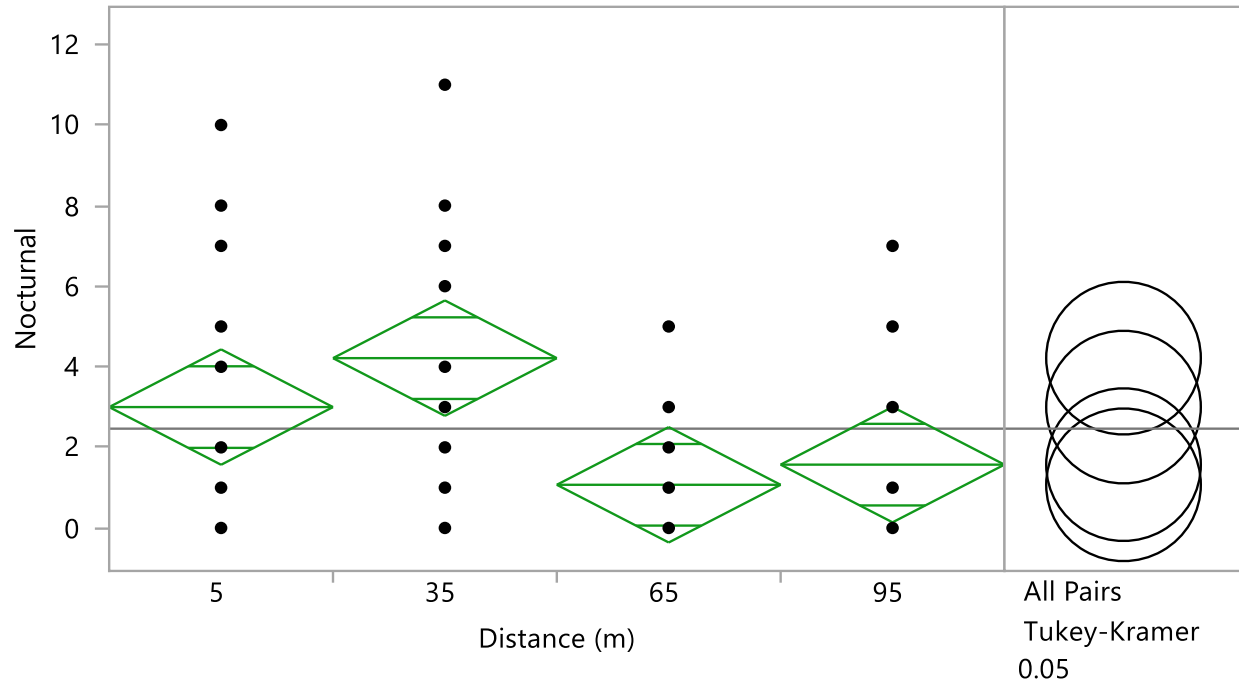


Figure 4. Mean nocturnal rodent abundance across four distances from the Judd Falls trail in Gunnison County, Colorado, USA, 2019.

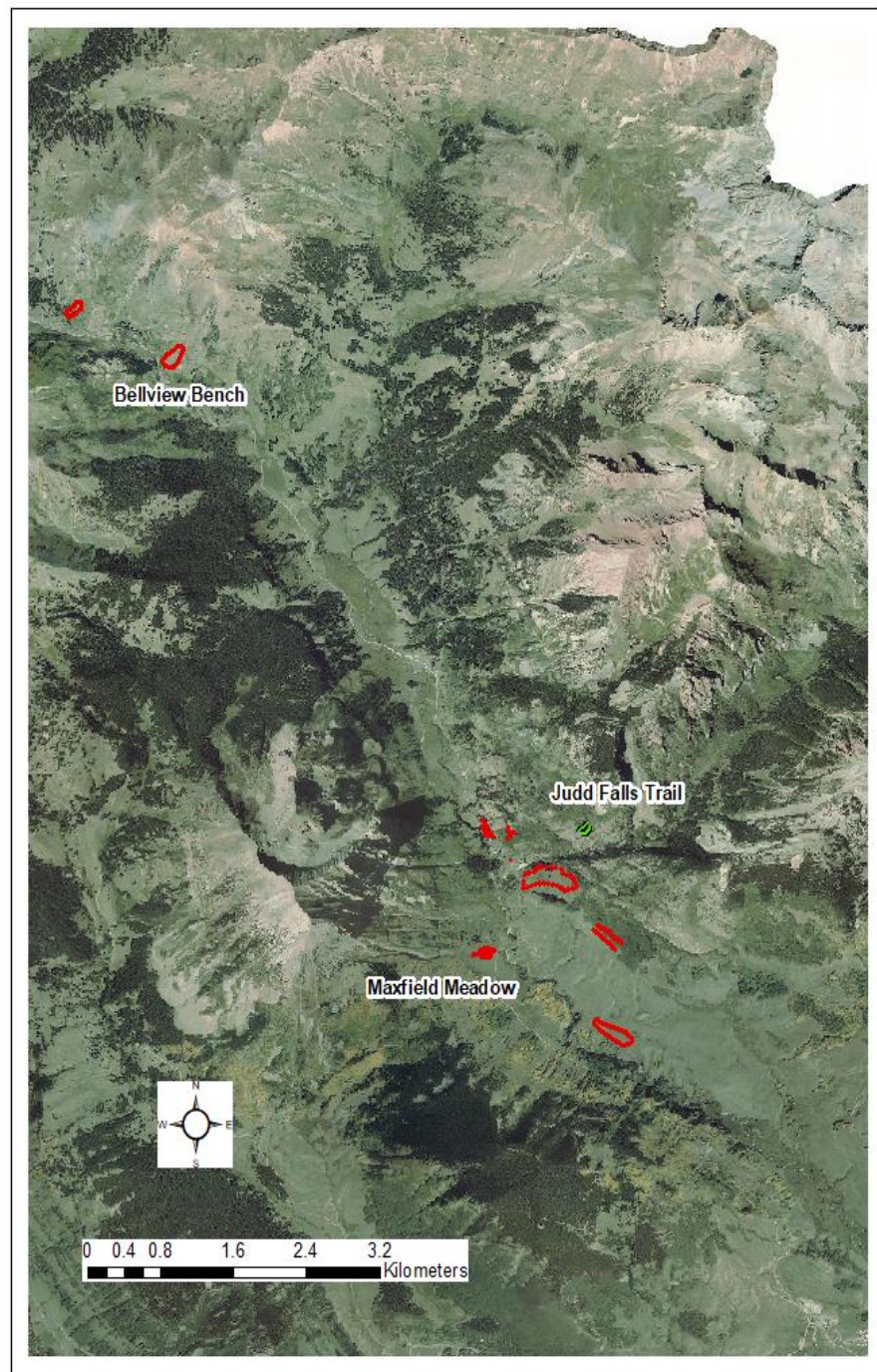


Figure 4. Map of small mammal study in the East River Valley area of Colorado, USA.