Pilot:
A Long-Term Grasshopper Monitoring Program in the Cascade-Siskiyou National Monument 2023

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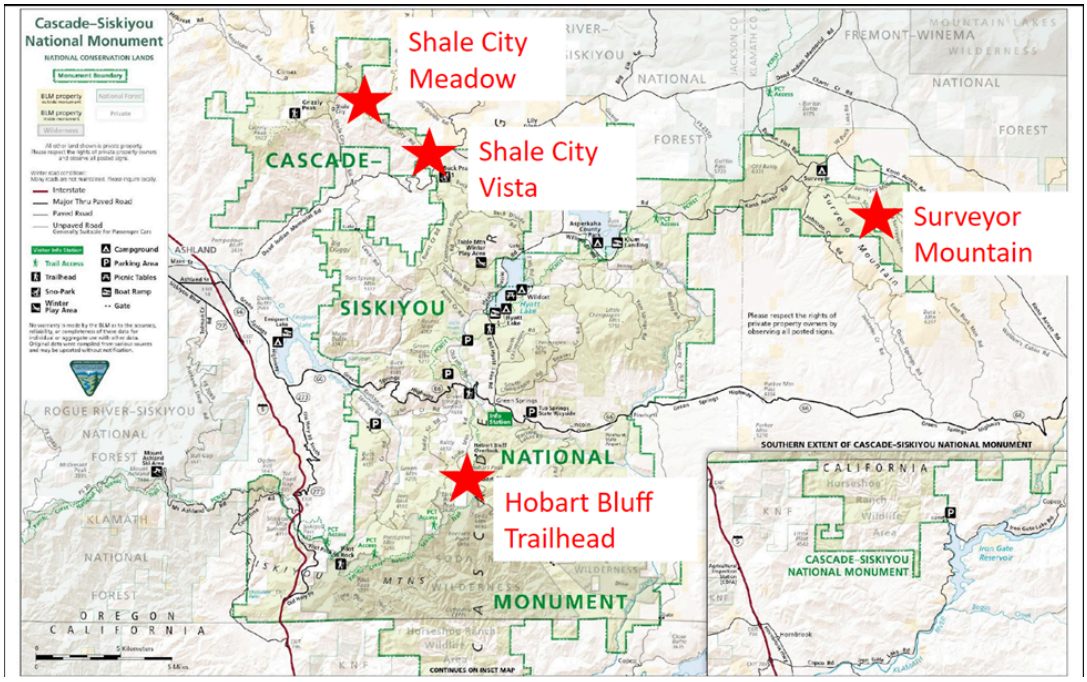


Figure Map. Cascade-Siskiyou National Monument and sites monitored.

Methods

This project aims to establish a baseline for long-term monitoring of grasshopper biodiversity in the Cascade-Siskiyou National Monument. Four distinct sites were chosen, ranging in elevation from 4500 to 6500 feet: Hobart Bluff Trailhead (HBT), Shale City Vista (SCV), Shale City Meadow (SCM), and Surveyor Mountain (SM). These locations offer diverse habitats due to variations in temperature, vegetation, and shade

IButton temperature loggers were strategically placed at each site to capture microclimatic variations. Loggers were deployed in various microhabitats, including open areas, shaded areas, and at different heights above the ground. They recorded hourly temperature data over a three-month period, generating a comprehensive dataset for analysis.

Weekly surveys were conducted at each site for 12 weeks, during which 200 sweeps were made using insect nets. The collected grasshoppers were carefully transported to Southern Oregon University (SOU) for identification, documentation, and preservation. The species abundance and thermal data was processed and analyzed with R.

Outcomes and Findings

Over the course of this year's project, 19 distinct grasshopper species (Orthoptera: Acrididae) were identified, with over 1,200 individuals collected. This sample included multiple individuals of the endemic Siskiyou short-horned grasshopper (*Chloealtis aspasma*), highlighting the Monument's unique biodiversity.

A preliminary catalog of grasshopper species in the Monument has been drafted, which includes photographs of representative individuals and their distinguishing characteristics. This catalog will serve as a foundation for a future publication, enhancing public understanding and identification of these insects within the Monument.

During field surveys, previously undocumented mating behaviors were observed in several species, including *Melanoplus ascensus* and *Bradynotes obesa*. These observations were recorded on video and may provide valuable insights for future research on grasshopper behavior and ecology.

The collected temperature data has been processed but is currently being analyzed to determine the relationship between grasshopper diversity, abundance, and temperature variations across the sites. To properly make any correlations, more years of monitoring are necessary. This analysis will inform future monitoring efforts and contribute to a deeper understanding of how climate change may impact grasshopper populations.

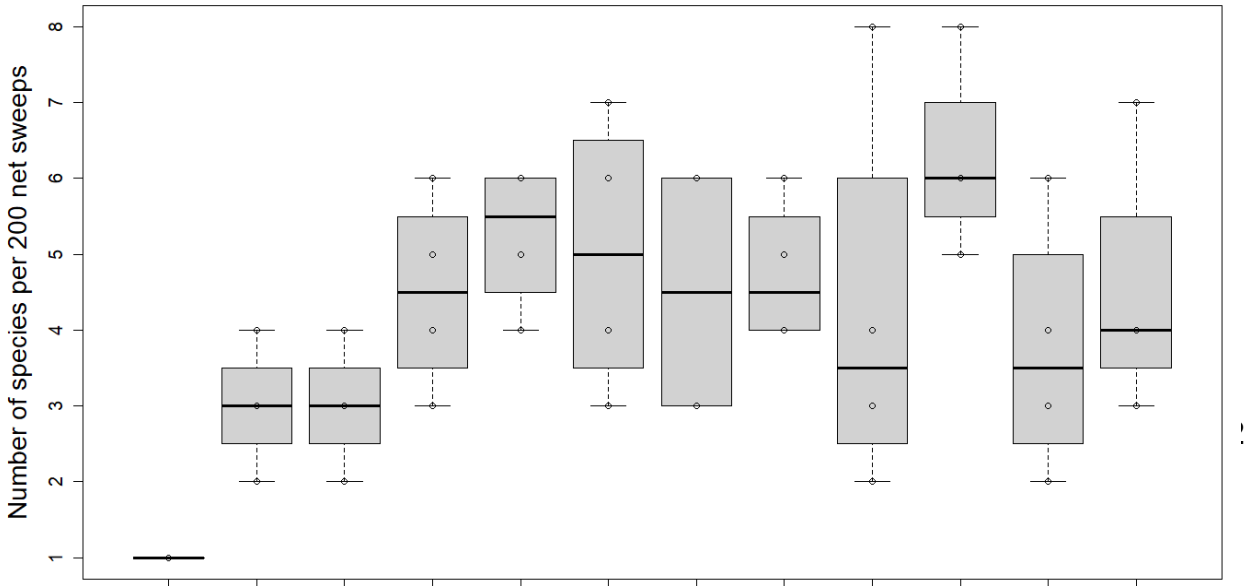


Figure 1. Average adult grasshopper diversity across the CSNM varied over time, peaking in August and September.

Figure 2. Grasshopper diversity varied over each site. Hobart Bluff Trailhead had the highest species richness. Shale City Meadow had the lowest species richness.

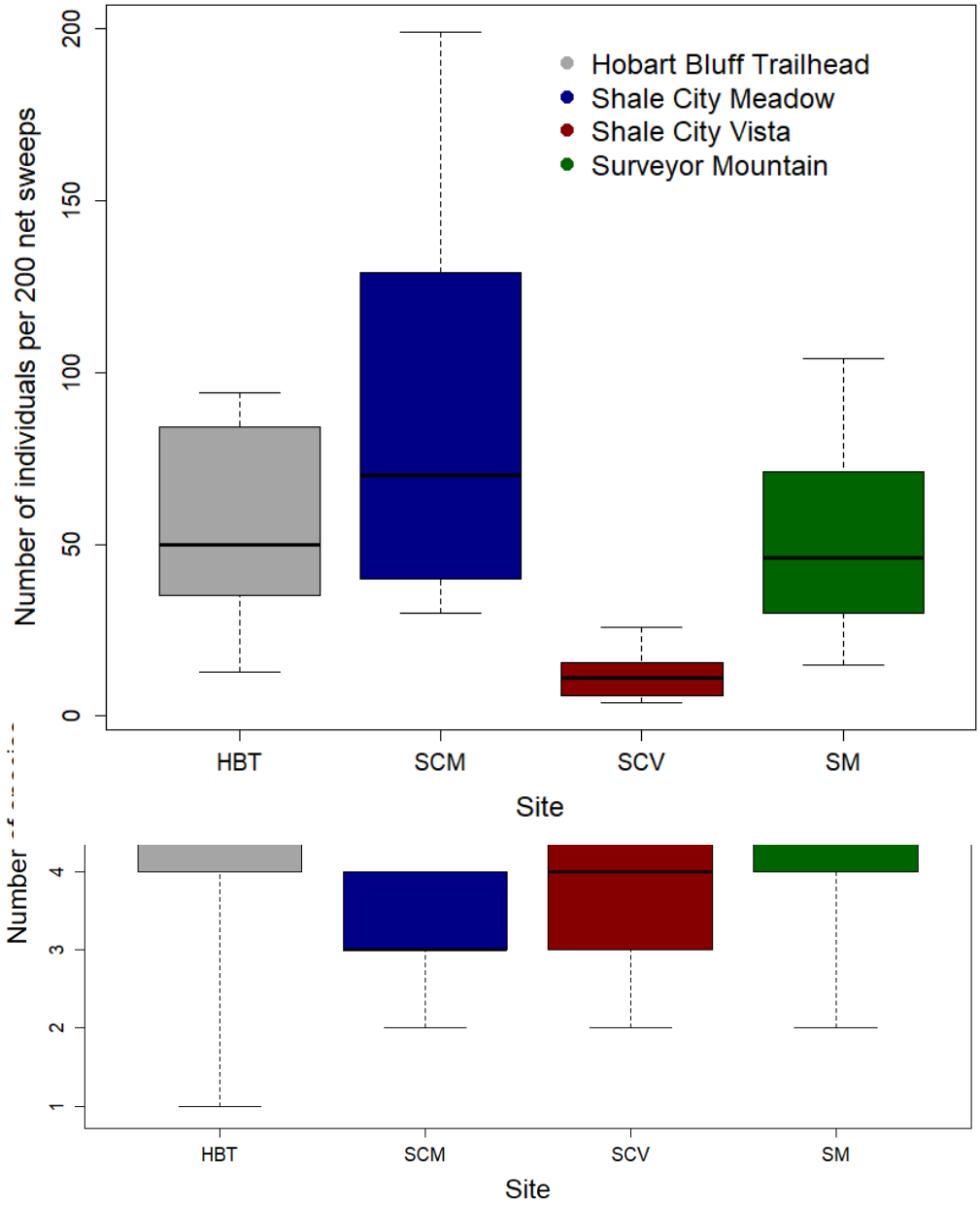


Figure 3. Abundance during the average day at each site. Shale City Meadow had the highest abundance. Shale City Vista had the lowest abundance.

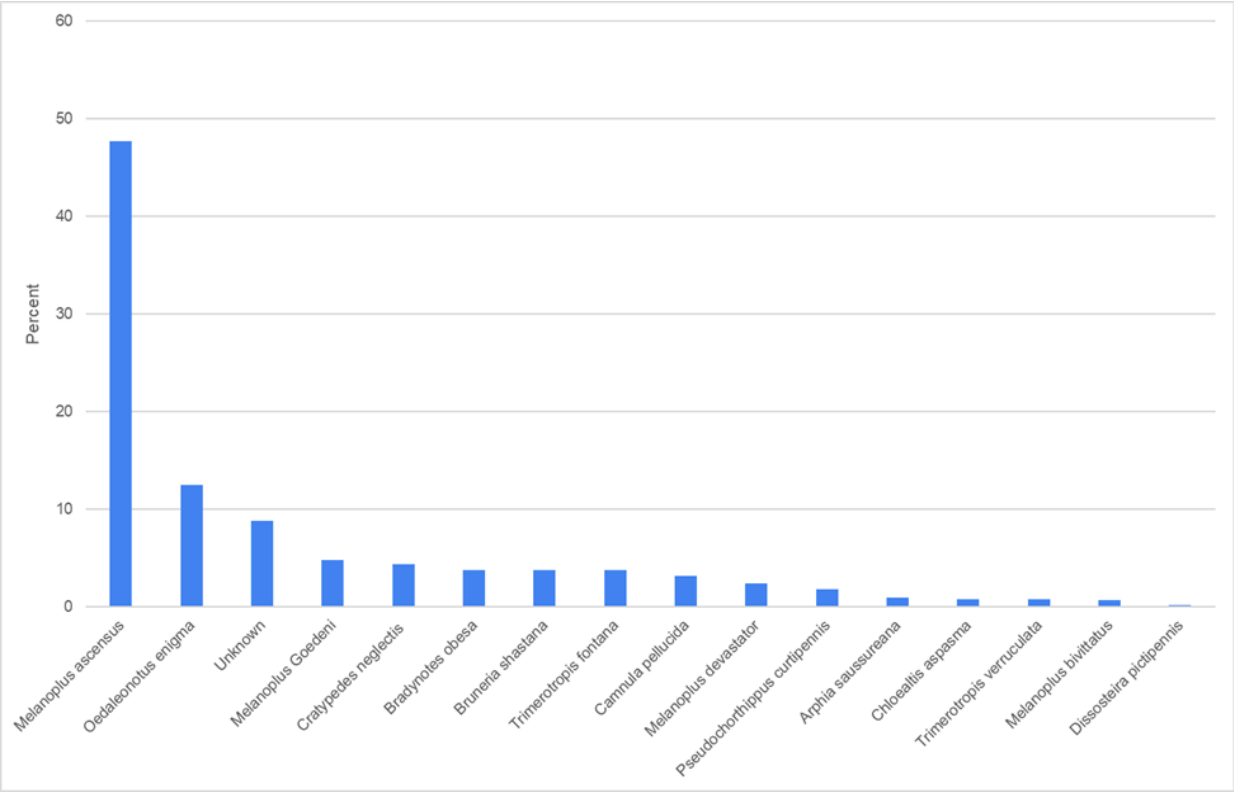


Figure 4. Species abundance across all four sites. *Melanoplus ascensus* had the highest observances in the Monument and at each of the sites. Southern Oregon's endemic Grasshopper, *Chloealtis aspasma* has a low abundance but was present at every site except Surveyor Mountain though it was most prevalent at Hobart Bluff Trailhead.

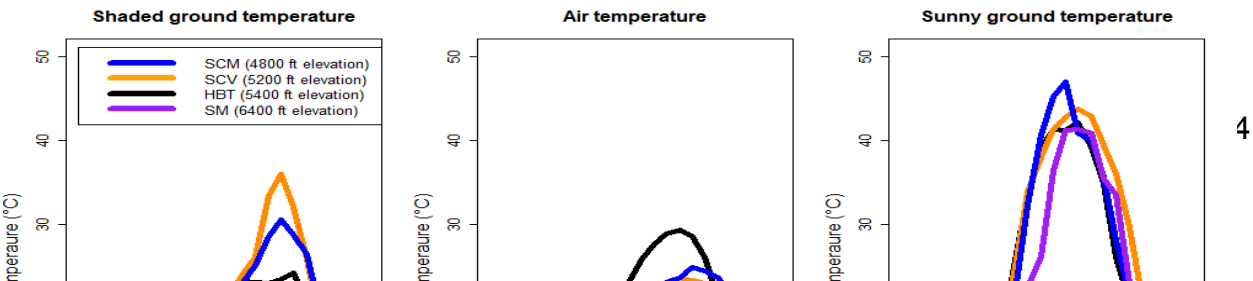


Figure 5. The microclimate data of each of the sites roughly follows the general trend of higher elevation having lower temperatures. There are significant differences between the temperatures of the microclimates at each of the sites.

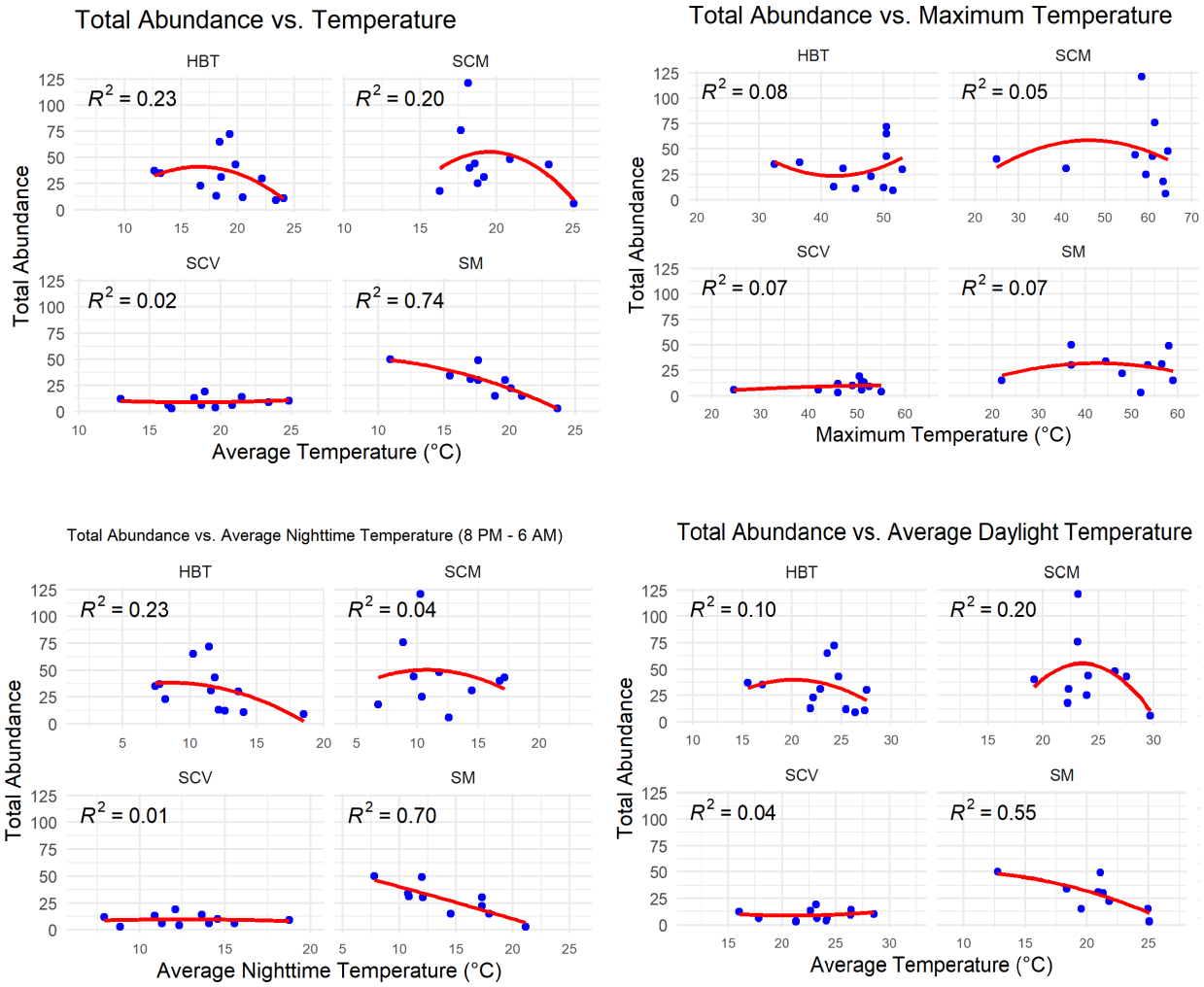


Figure 6. The polynomial regression models indicate that temperature does not explain a large proportion of the variation in total grasshopper abundance across most sites within the observed temperature range. However, Surveyor Mountain grasshoppers exhibit a moderate negative correlation with temperature, suggesting higher abundance at cooler temperatures.

Discussion:

Hobart Bluff Trailhead experienced the greatest species richness among all the sites (Figure 2). This may have been sufficiently aided by human activity as powerlines work their way right through the trailhead. Beneath the powerlines lies the perfect grassland

habitat that might function as a highway allowing grasshoppers and other organisms to graze into and out of the Monument.

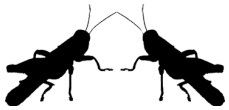
There may be many reasons why Shale City Vista experienced a low abundance of grasshoppers (Figure 3). The site was more exposed and the types of grass and shrubs there died off very early. This potentially caused grasshoppers to migrate while another site nearby, Shale City Meadow, was teaming with *Melanoplus ascensus*, perhaps because of the site's lush vegetation that was present throughout the summer and till the very end. The two sites are along the same road and rather close together. The two sites are along the same road and rather close together. Tall conifers encompassed the small grassy plane of SCM, potentially isolating it from many species.

SCM experienced low species richness (Figure 2). The site was less exposed, possibly peaking the interests of one of the CSNM's generalists, M. ascensus, which happens to be the most abundant grasshopper across the monitored sites (Figure 4). Future studies should investigate whether this species is outcompeting other species.

Other species seem to drop in for short, isolated periods (check catalogue) as their overall range likely fluctuates through the season and from year to year. Many of these briefly appearing grasshoppers were strong fliers such as the beautiful California Red Winged grasshopper (Arphia saussureana). Such a species likely dispersed to the sites after developing elsewhere because these species were not detected until the end of the season. Further cataloging in the years to come will be necessary to affirm whether the drop-in species observed this year uses the Monument as a frequent extension of their range or if they are just passing through.

Temperature is undoubtedly a factor in the population dynamics of ectotherms like grasshoppers; however, temperature was weakly correlated with the abundance of grasshoppers (Figure 6). Surveyor Mountain may have had a higher correlation, but and that could be due to the grasshoppers there being adapted to higher elevation and thus perform better at colder climates, however the correlation is still low, and more investigation is needed.

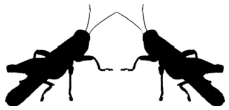
While temperature might not be as strong of a factor in with this year's abundance, it could still influence the size of grasshopper populations in subsequent years. Warmer temperatures can lead to increased metabolic rates in grasshoppers, prompting them to consume more food and be active for longer durations. This heightened activity might expose them to greater predation risk, potentially reducing the number of individuals that survive to lay eggs for the following year. However, additional research is needed to quantify the precise impact of temperature on the physiology and ecology of grasshoppers within the Monument.



The microclimate data indicates a large range of temperatures available to grasshoppers and other heat sensitive organisms at the sites (Figure 4). This microclimatic variation could explain the weak relationship between environmental temperature and grasshopper abundance. They can always hop to the plethora of shaded areas throughout the Monument if they cannot handle the heat. Further research is needed to determine the specific nature of the temperature-abundance relationship and to identify the other contributing factors. It is important to note that just because the temperature grasshoppers experienced this year did not correlate to their abundance, that does not mean it will not in years to come. If this year is representative of a typical climate they would otherwise experience or does not exceed these organisms' ability to thermoregulate, then temperature should not make much of an impact on a species that has adapted to that climate.

Promoting Understanding, Appreciation, Preservation, and Protection

- **Expanding Knowledge:** Establishing baseline data on grasshopper biodiversity provides a critical foundation for future monitoring efforts, enabling researchers to detect changes over time and assess the impacts of environmental factors.
- **Informing Management:** Understanding the relationship between grasshopper populations and temperature variations can help land managers make informed decisions about habitat restoration, fire management, and other activities that may affect these insects.
- **Engaging the Public:** The creation of a comprehensive grasshopper catalog will provide a valuable resource for the public, fostering appreciation for the Monument's biodiversity and encouraging citizen science initiatives.
- **Highlighting Endemic Species:** Documenting the presence and behavior of the endemic Siskiyou short-horned grasshopper underscores the unique ecological value of the Monument and the importance of protecting its sensitive habitats.
- **Scientific Collaboration:** The microclimate data can be used by other researchers studying the Monument's thriving ecosystem.



MATERIALS AND SUPPLIES

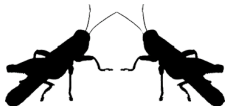
Item	Quantity	Cost per Unit	Matching Funds	FRF Funds	Total Funding
Gemplers Sweep Nets	**1**	**$99.99/net**	**$0.00**	**$99.99**	**$99.99**
Replacement Nets	**5**	**$32.99/unit**	**$0.00**	**$164.95**	**$164.95**
Student Stipend	**1**	**$750.00**	**$0.00**	**$750.00**	**$750.00**
Thermochron iButton	**12**	**$88.99/unit**	**$166.58**	**$901.30**	**$1067.88**
Rite in the Rain Notebook	**1**	**$13.95/unit**	**$0.00**	**$13.95**	**$13.95**
3-L Water Reservoir	**1**	**$36.81**	**$0.00**	**$36.81**	**$36.81**
Total: Materials and Supplies			**$166.58**	**$2967.00**	**$2133.58**

Gemplers Sweep Nets: These nets were used to collect grasshoppers at all field sites. This specific net and handle are sturdy enough to withstand a field season of intensive sampling diverse terrain.

Replacement nets: Replacement nets were necessary because sweep netting through thic of thorns and occasional barb wire can pierce the nets.

Thermochron iButton: iButtons were deployed at four sites to document the range of environmental temperatures available to the grasshoppers and to determine the relationship between temperature and behaviors such as feeding, thermoregulating, and mating. 36 iBut were necessary to capture an average range of microclimate data across four sites: several full sun on the ground, several in full shade on the ground, and several in full shade two met off the ground to estimate air temperature. These data enabled us to begin correlating insect development with temperature.

Rite in the Rain Notebook: This waterproof, high-quality notebook ensured that our field no were recorded and preserved regardless of the weather or local conditions.



3-L Water Reservoir: This water reservoir enabled hands-free access to water so that I cou
stay hydrated and safe throughout all field work.

Budget

Acknowledgements

This research was funded by the Friends of Cascade-Siskiyou National Monument, with facilities and support provided by Southern Oregon University.

(See Attach Catalog)