

Golden-Mantled Ground Squirrel (*Spermophilus lateralis*) and Yellow-Bellied Marmot (*Marmota flaviventris*) Intraspecific and Interspecific Perch Use and Interaction Dynamics in Gothic, Colorado.

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ABSTRACT:

Golden-mantled ground squirrels (*Spermophilus lateralis*) and yellow-bellied marmots (*Marmota flaviventris*) can both be found in abundance at high elevation meadows in the Rocky Mountains. Though different in behavior, both species inhabit and utilize the open meadows of Gothic in very similar ways. Both species utilize perches and respond to each other's alarm calls. Additionally, here in the Gothic town site, both species' have been studied and recorded for many years. This research project aims to examine how golden-mantled ground squirrels share habitat features and interact with yellow-bellied marmots in the Gothic town site. This was done by collecting observational data during the summer of 2022 in Gothic, Colorado. Using the methods from the GMGS (golden-mantled ground squirrels) long term study, I collected data by observing and recording marmot and GMGS individuals interactions and perch use. With this data I was able to create histograms that display perch use frequency and total number of perches used. With this same data I was able to run a Chi-squared test which displayed that GMGS share perches with yellow bellied marmots significantly more than with their own species. Potentially indicating that GMGS are less social with their own species than yellow-bellied marmots.

INTRODUCTION AND GENERAL PLAN OF STUDY:

How species share the landscape has been a question asked and answered by scientists for some time. Do they displace one another through competition or do they inhabit different niches which allow them to coexist? Or are they attracted to one another by the benefit of protection from predators and the use of similar land features?

Interesting trends in interactions and habata sharings between has been observed in marsh nesting avian species such as the little crake (*Zapornia parva*) and water rail (*Rallus aquaticus*), preferring the same habitat for nest selection (Jedlikowski, 2017). An example of spatial displacement was found between Asiatic black bears (*Ursus thibetanus*) and brown bears (*Ursus arctos*) in northeastern China. The study found that Asiatic black bears avoided brown bears by occupying higher elevations and being more diurnal where they coexisted (Ji, 2022).

Interspecific and intraspecific forms of competition greatly affect species interactions and use of important habitat features shared between different species. These competition trends are important in understanding the dynamics among species that will cause spatial preference trends. For example, a paper published in 2017 found that due to inter-species competition

between the little bustard (*Tetrax tetrax*) and the great bustard (*Otis tarda*) caused a displacement of the little bustard's niche preferences (Tarjuelo, 2017). This paper found that in areas where great bustard populations were high, the little bustard populations were at a much lower density due to niche displacement from competition between the species (Tarjuelo, 2017).

Golden-mantled ground squirrels (*Spermophilus lateralis*) and yellow-bellied marmots (*Marmota flaviventris*) can both be found in abundance in high-elevation meadows in the Rocky Mountains. Though different in behavior, both species inhabit and utilize the open meadows in very similar ways. Both these species are ground-dwelling sciurids that live in high-elevation mountainous areas (Shriner, 1998). They are herbivores and consume large amounts of leaves of forbs that make up as much as 87% of their diet (Carleton, 1966) (Shriner, 1998). Although they differ in size, both species share similar predators, such as golden eagles (*Aquila chrysaetos*), coyotes (*Canis latrans*), red foxes (*Vulpes vulpes*), and the American badger (*Taxidea taxus*) (Shriner, 1998). As a result, both species respond to each other's alarm calls by becoming alert, looking for the potential threat, and running to safety (Shriner, 1998).

Both species highly depend on perches consisting of large rocks and boulders, fallen trees and tree stumps, and mounds of soil to gain a vantage point so that they can see predators approaching from afar (Shriner, 1998). However, golden-mantled ground squirrels and yellow-bellied marmots are quite different in physical characteristics and behavior. Both species are very different in body mass. Yellow-bellied marmots range from 5220g - 1590g, and golden-mantled ground squirrels range from 120g - 394 g, which translates to a significant difference in size (Frase, 1980, Bartels, 1993). Additionally, both species live in very different social organizations. Golden-mantled ground squirrels are asocial, meaning they live most of their lives alone, defending their territory from individuals of the same species (Bartels, 1993). However, golden malted ground squirrels have been able to tolerate their related kin by allowing them to overlap with their home ranges (Wells, 2017). While quite opposites to the golden-mantled ground squirrels, yellow-bellied marmots are social creatures that live in colonies consisting of one or more males and a harem of several females that share one large natal burrow (Frase, 1980).

Marmots, as the larger species, may have a more dominant presence, excluding ground squirrels from lookout perches. In contrast, ground squirrels may benefit from heeding the marmot's alarm calls. This odd relationship of costs and benefits may directly result in trends in habitat feature sharing and interactions with one another. This research project aims to examine how golden-mantled ground squirrels share perches and interact with one another due to cost and benefit dynamics between yellow-bellied marmots.

Questions:

1. Is intraspecific use preceded by interspecific use for perches by golden-mantled ground squirrels and yellow-bellied marmots?
2. Are interactions of tolerance preceded by negative interactions between golden-mantled ground squirrels and yellow-bellied marmots?

Hypotheses:

1. Golden-mantled ground squirrels (*Callospermophilus lateralis*) and yellow-bellied marmots (*Marmota flaviventris*) will utilize the same perches because they are a vital habitat feature for both species.
2. If golden-mantled ground squirrels and yellow-bellied marmots utilize the same perches, then interactions between both species will be negative (i.e., avoidance and chase interactions).

SPECIFIC METHODOLOGIES:

This study took place at the Gothic town site of the Rocky Mountain Biological Laboratory in Colorado. The study area was the same as the current golden-mantled ground squirrel long-term project. In addition, this site overlaps with one of the yellow-bellied marmot colonies in the long-term marmot research project. The data for this project was collected from July 7th to July 24, 2022.

To answer both hypotheses, I collected observational data, following the same protocol as the golden-mantled ground squirrel (GMGS) long-term research project. This protocol is to walk around the town site from 8:30 am-5:00 pm when ground squirrels are most active, at least four times a week. While walking around the town site, I will observe as many ground squirrels and marmots as possible. When I see a GMGS or marmot individual while walking, I will first identify the individual using the dye marks on its back and its location using data from both long-term studies. Unfortunately, due to the marmot molting, I could not identify all of the marmots I observed because their dye marks were not visible. When observing an individual, I recorded perching activities that I defined as: A marmot or GMGS in an alert position (alert on all fours, alert on two fours) perching on a habitat feature that is, from my observation, above the average height of the vegetation in the surrounding area. When I observe a marmot or a GMGS using a perch as I defined, I will record the date, time, place and individual using the perch.

The location was recorded in this study using a 7 by 7 meter gridded map of the town site and identifying which gridded square the individual was in. Additionally, I would write reference notes of which specific feature within the 7 by 7 meter grid square the individual was using. For example, T10 (grid square), the rock by the corner of Bellevue cabin looking towards the parking lot and dining hall.

To answer my second hypothesis, while walking around the research site, I would take special note of any interaction between GMGS and marmots that I observed. I record the date, time, location, individuals in the interaction, and at the description of the interaction. I have defined interaction as any behavior of both individuals in a meter or less from one another. The interaction will be defined as either tolerance (both individuals behave calmly in each other's presence as if each other were not there), avoidance (one or both individuals move or run away from being close to one another), and chase (an individual chases the other individual away).

After collecting data for three weeks, I analyzed the number of perches used, the frequency of perch use, and a chi-squared test using R. I created a Chi-squared test to test whether the number of perches used by marmots and ground squirrels that I observed was greater than expected. I calculated the number of perches not used by either marmots or GMGS by counting the grid squares on the 7 by 7 meter gridded map Gothic that I did not record perch use in. I counted each grid square as one perch. This gave me a rough estimate of the number of perches used.

Additionally with this data I created dark grapes displaying the frequency and number of prechs used. I did this by looking over my observational data and organizing it into two different data sets. I created the frequency data by recording the number of times each perch was used by a ground squirrel. The second data set I made by counting the numbers of perches used by marmots and GMGS. These two datasets not only show the numbers of perches that are used by each species, but also how frequently they are used.

RESULTS:

Figure 1:

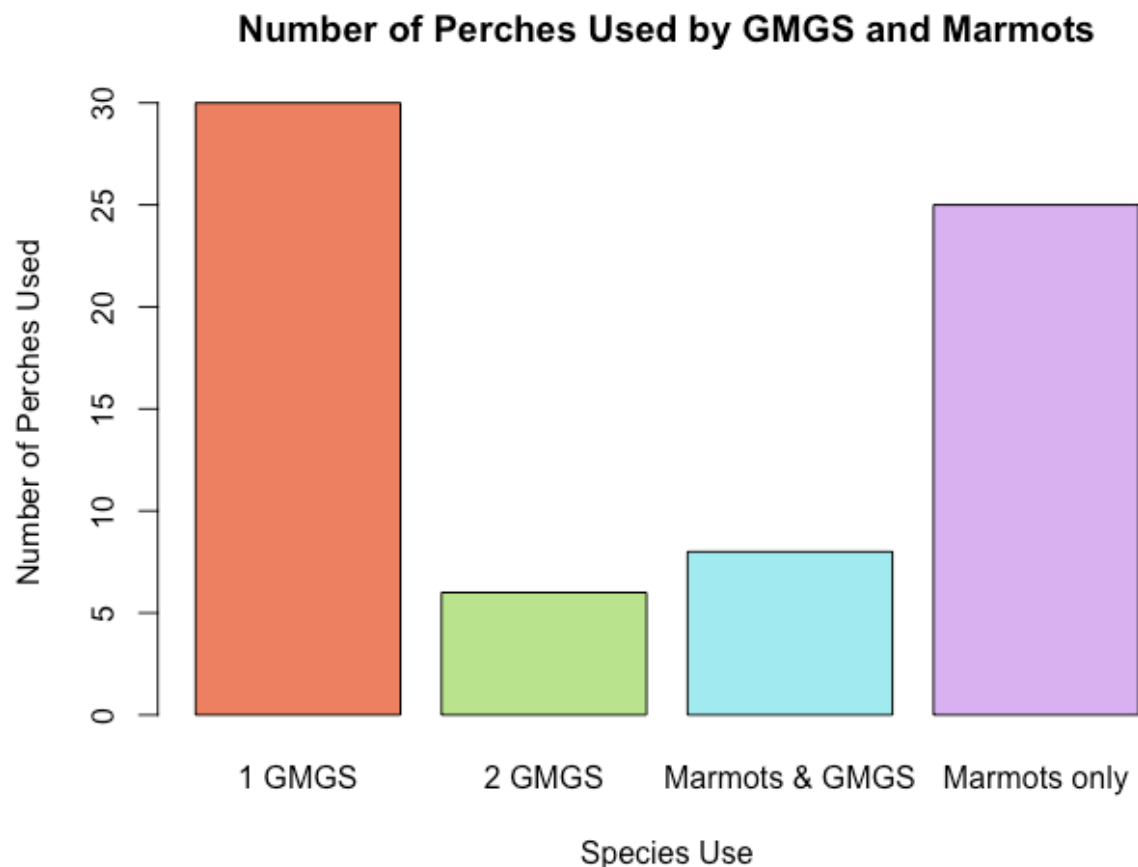


Figure 1: this figure depicts a bar graph of the total number of perches used by one golden mantled ground squirrel individuals(1 GMGS), Two golden mantled ground squirrels(2 GMGS), golden mantled ground squirrels and yellow bellied marmots (Marmots and GMGS) and the by marmots (Marmots only).

More perches were used by one GMGS individual or marmot individual (Figure 1). Secondly, the number of perches used by both marmots and GMGS (8 perches) was greater than the number of perches used by two GMGS individuals (6 perches, sometimes shared simultaneously or at different times by each individual). GMGS use more perches with marmots than they do each other.

Figure 2:

	Marmot	No Marmot	Marginal Row Totals
GMGS	8 (2.55) [11.63]	36 (41.45) [0.72]	44
No GMGS	25 (30.45) [0.97]	500 (494.55) [0.06]	525
Marginal Column Totals	33	536	569 (Grand Total)

The chi-square statistic is 13.3827. The p -value is .000254. Significant at $p < .05$.

Figure 2 depicts the results of the Chi-squared test. The first numbers that are in parentheses repent the number of perches observed, the numbers in the () represent the number of expected perches (statistically), and the numbers in the [] repent the test statistic value or “p-value.”

The results from the Chi-squared test demonstrated that the number of perches used by both GMGS and marmots was significant. I observed a total of 8 different perches being used by both species. The expected value calculated by the Chi-squared test was 2.55, which is noticeably much lower than what I observed. In summary, the chi-squared test showed that the marmots and GMGS are using the same perches *more* than expected by chance, which is a very interesting result.

Figure 3:

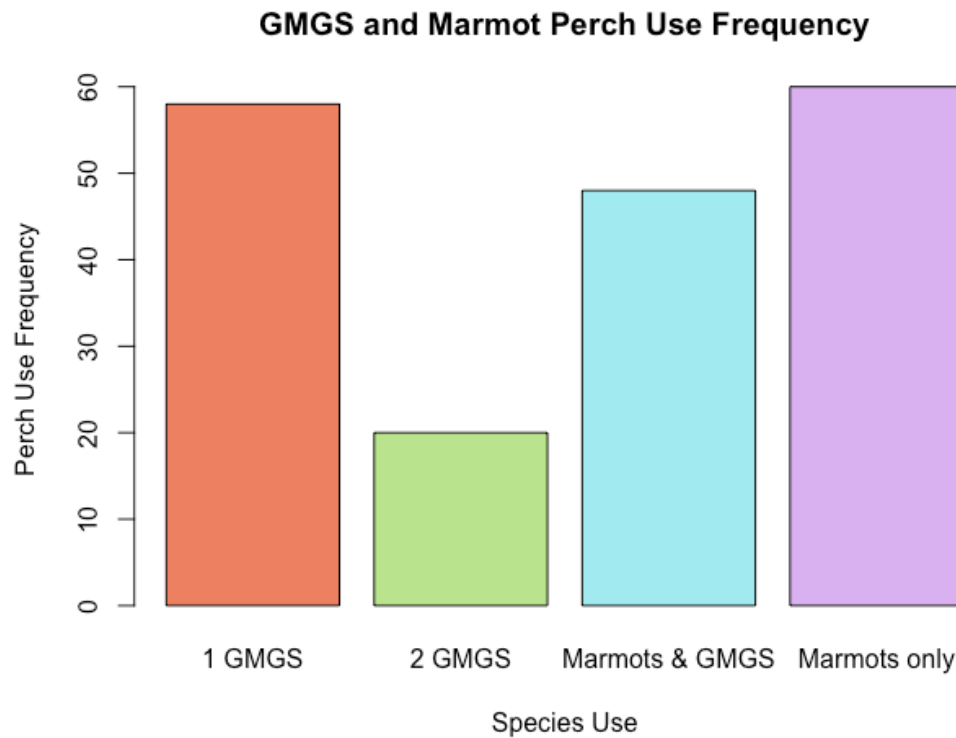


Figure 3 depicts the frequency of perch use by, one golden-mantled ground squirrel individual (1 GMGS), Two golden-mantled ground squirrels (2 GMGS), and golden-mantled ground squirrels and yellow-bellied marmots (Marmots and GMGS) and the by marmots (Marmots only).

Individual perch use frequencies were similar between “Marmots only” (60 perch use frequency) and “1 GMGS” (58 perch use frequency). Additionally, marmots and GMGS shared perch use frequency (48) is much higher than the number of perches (8). This means that these 8 perches are very frequently used by both species. Lastly, the use frequency of perches used by 2 GMGS is quite low (20), showing that these perches are less frequently used.

Finally, during the three weeks of data collection, I was only able to record data on 9 GMGS and marmot interactions. Unfortunately, this is an insufficient amount of data. However, an interesting trend in this data was that all nine interactions were of tolerance (Figure 4).

Figure 4:

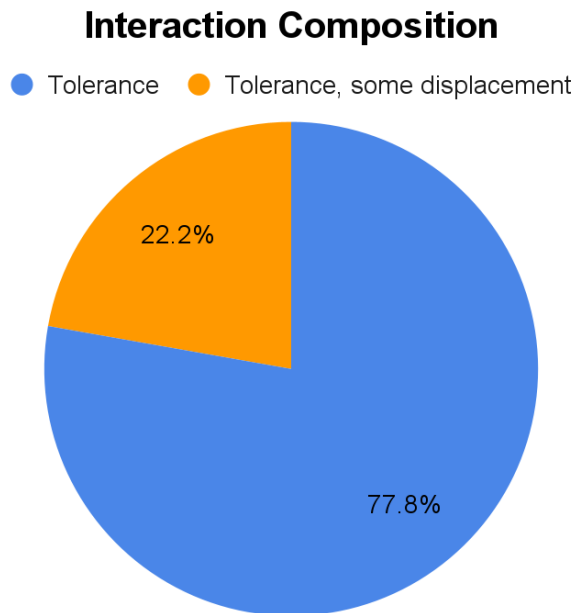


Figure 4 depicts the composition of the 9 interactions I observed. In orange is depicted the interactions where the marmot's presence slightly displaced the GMGS individual. While depicted in blue, the other interactions were purely of tolerance.

All marmot and GMGS interactions were of tolerance (tolerance is when both individuals behave as if each other were not there, behaving calmly and behaving normally). However, in two (22.2%) of the observations, the GMGS did avoid/was slightly displaced by the marmot by moving away from the marmot but then, once further away, relaxed and continued to tolerate the marmot's presence from a farther distance. Although not having enough data for significant results, I think that it is biologically important that all interactions were of the same composition.

DISCUSSION:

The results of my project supported my hypothesis which was "Golden-mantled ground squirrels (*Callospermophilus lateralis*) and yellow-bellied marmots (*Marmota flaviventris*) will utilize the same perches because they are a vital habitat feature." My results displayed that perch sharing did occur between golden-mantled ground squirrels and yellow-bellied marmots. Additionally, my results showed that GMGS shared more perches with marmots and used these perches more frequently than with other GMGS. Additionally, the Chi-squared test results supported this trend: GMGS and Marmots were sharing perches significantly more than expected.

The results of my project may hint at an interesting dynamics occurring between GMGS and marmots. One of the potential reasons for this outcome could be due to GMGS asocial nature. GMGS strictly defined their home ranges from one another, and simply because a yellow-bellied marmot is a different species, they may be less inclined to behave asocially towards them. This behavior could be potentially supported by the results of a previous study which found that interspecific aggression could predict body size, meaning the larger the

rodent's body size, the more significant the role of dominance the species would have in interspecific interactions (Chock, 2018). This phenomenon could potentially have a role to play in the results of my project. The marmots, which are much larger bodied than the ground squirrels, could have the role of dominance in determining the form of relationship between the perch sharing GMGS. Additionally, the GMGS may be hesitant to interact negatively with a marmot due to its large body size.

This may additionally explain my results from the interactions part of my project. My second hypothesis is that “ If golden-mantled ground squirrels and yellow-bellied marmots utilize the same perches, then interactions between both species will be negative i.e., avoidance and chase interactions.” My data did not support this hypothesis. All interactions that I recorded were positive. My hypothesis assumed that interactions between GMGS and marmots would be negative due to the potential for interspecific competition because the two species would both utilize a vital habitat feature. A review published in 2010 found that heterospecific aggression was higher with increased resource overlap (Peiman, 2010). However, contrary to my expectation, all of the interactions between the marmots and GMGS were positive.

These positive interactions could be because when GMGS is interacting with a marmot, they may take the submissive role in the interaction, and the interaction outcome is mostly dependent on the marmot's behavior towards the GMGS. If this theory is true, I am curious how marmots and GMGS interactions could potentially change as both populations' densities change over time. Dr. Caitlin Wells, who has been working on the GMGS project for several years, said that she had recorded severe negative interactions that occurred between the marmots and GMGS when both species populations were high in the Gothic town site. When both marmot and GMGS populations are high, marmots could feel more threatened by a GMGS presence due to an overall heightened competition potential (Peiman, 2010).

CONCLUSION:

In conclusion, the results from my research project revealed an interesting trend between marmots and GMGS. Although this study was small and somewhat informal, I think the results revealed the potential for some significant results if a larger and more study was conducted on the interactions and perch use of GMGS and marmots. Additionally, a longer-term study could reveal how both species' population size could affect interactions and perch sharing. This research project is significant because it shows a significant relationship between well-studied and understudied populations of ground-dwelling squirrel species here at the Rocky Mountain Biological Laboratory. Studies on interspecific relationships and competition are significantly less frequent than studies on intraspecific competition, making the research important in itself (Peiman, 2010). Lastly, this research project gave me valuable experience in the field, improving my observational skills and field skills. Additionally, the experience gave me familiarity with the process of creating a scientific paper. Overall I really enjoyed this summer and had a really wonderful experience at RMBL.

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