

Time budget of yellow-bellied marmots at high and low elevations

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Abstract

Time budgets of the yellow-bellied marmot (*Marmota flaviventris*) were created observing two different localities within the Rocky Mountains of Colorado at different elevations (Cement Creek, 2641m and North Picnic, 2900m). Six behaviors (foraging, sitting/lying, locomotion (moving from place to place), fighting, grooming, and being alert/vigilant) were observed and recorded. Marmots at both elevations spent the majority of their time sitting/lying (47-54%). There were no significant differences between time spent foraging at North Picnic and Cement Creek. However, there was a 9% difference in time spent foraging between the sites, with Cement Creek having the greater percentage of foraging time. No agonistic behavior was observed at Cement Creek, while marmots at North Picnic were observed to spend 4% of their time behaving antagonistically. An absence of agonistic behavior could explain the increase in the percent of time spent foraging.

Introduction

The yellow-bellied marmot (*Marmota flaviventris*) is a diurnal mammal that lives in an environment with harsh weather conditions in mountainous areas, such as the Rocky Mountains in Colorado. It typically hibernates up to eight months out of the year and spends up to 80% of its life in a burrow (Svendsen 1976). Yellow-bellied marmots in the East River Valley of Gunnison County usually emerge from hibernation in early May and their young are born in early June, with a short gestation period of about 30 days (Armitage and Downhower 1974). During the summer, it is necessary for the marmot to accumulate enough fat to sustain itself during winter hibernation, as food is not stored.

Marmots at higher elevations experience shorter active periods and growth periods due to greater length of snow cover compared to lower elevations (Van Vuren and Armitage 1991). It is known that food availability limits the growth of marmots, so the marmots at higher altitudes potentially have to forage more in order to store enough fat for the winter (Woods and Armitage 2003). Johns (1978) studied yellow-bellied marmots at an elevation of 3400 m and found that foraging peaked in mid-July, just before juveniles emerge. Marmots do not spend much time in an active state, so how they spend their time above ground is important. When above ground, the yellow-bellied marmot spends a significant amount of time either sitting or lying (Armitage *et al.* 1996). Populations of yellow-bellied marmots in the East River Valley have been studied since 1962. Armitage *et al.* (1996) has created a time budget for populations in the East River Valley, documenting 17 different behaviors, but time budgets for populations of marmots at higher elevations may give insight into the role of elevation on marmot behavior. I observed yellow-bellied marmots at high and low elevations in order to create a time budget that describes six behaviors: their time spent foraging, sitting/lying, locomotion (moving from place to place), fighting, grooming, and being alert/vigilant. Six behaviors were observed instead of the 17 used by Armitage (1996) because there were some that were similar and could be combined to fit into one category such as the behaviors vigilant and alert. Also, Armitage observed that of the 17, only five behaviors were major. The six behaviors that are documented in this study include the five major behaviors that are combined to create three categories with three other behaviors that describe the activities a marmot does on a daily basis (Armitage *et al.* 1996).

I wanted to see if there were changes in behavior due to the altitudinal and environmental differences. I tested the following hypotheses:

- 1) Marmots at higher elevation will spend a greater proportion of their time foraging to compensate for the shorter growing season.
- 2) Marmots at both high and low elevations will spend the majority of their time sitting/lying, because it has been proposed that energy budgets of marmots are not constrained by time (Armitage *et al.* 1996).

Methods and Materials

Yellow-Bellied Marmots were studied at three localities within the Elk Mountains of Gunnison County, Colorado, USA, one at low elevation and two at higher elevations. The low elevation locality is Cement Creek (2641 m), private property located near the National Forest and a residential community. The higher elevation localities are Cliff, a steep mountain side with a couple of large rock groups, and North Picnic, a steep slope with a large meadow and large rocks, are both about 2900 m (Armitage 1974). Marmots were live trapped using Tomahawk live wire traps that were baited with oats soaked in salt water. Marmots were then weighed using a 5k spring scale, tagged with metal ear tags, and sexed using a caliper to measure the distance between the anal and genital orifices (Armitage 1974). Reproductive status was determined by looking at the belly of the marmot for teats or testes, and hair samples were collected and placed in marked, sealed envelopes. The marmots were also given a unique mark with Nyanzol fur dye in order to identify individuals during observations.

Six behaviors of the yellow-bellied marmot were observed and the time (seconds) spent on a behavior was recorded (Armitage *et al.* 1996, Altmann 1974). The six observed behaviors were derived from Armitage's (1996) study. We chose to use 6 behaviors instead of 17 because there were many behaviors that were similar and could

be combined into one category, such as sitting and lying or alert and vigilance (Armitage *et al.* 1996). The behaviors were defined similarly to those in Armitage's (1996) study (Table 1).

<i>Foraging</i>	Animal eating with its head down
<i>Sitting/Lying</i>	Stationary, weight supported over the haunches and front legs or reclined (weight not supported by legs)
<i>Antagonistic</i>	Chase/flee, hide/seek, grapple, and mouthspar
<i>Grooming</i>	Chewing at fur, scratching the body with the hind feet, one grooming another
<i>Vigilant/Alert</i>	Looking around or sitting upright with front legs held in front of chest looking around the area
<i>Locomotion</i>	Movement from place to place

Table 1- Description of the six observed behaviors

Observations began before the marmots emerged from their burrows in the morning and afternoon and ended when marmots immersed to their burrows, the time of which varied depending on the weather. All observations were made from a distance using a 60 x 60 mm scope. Scan and focal sampling was used when observing the populations (Altmann 1974). There were two observers at each site who took hourly shifts observing. The locality was scanned in order to take a census of which marmots were above ground and active and then individuals were focused on. A census of active marmots was taken at the beginning of the observation period, and then every 30 minutes after the last census was taken. Individual marmots were observed every 2 minutes for 30 minutes. All sites were not observed for the same number of hours, North Picnic was observed for 16 and Cement Creek was observed for 9, due to weather conditions and the late approval of the Cement Creek site. Total seconds spent on each behavior will be made into a percentage. Data from Cliff was excluded from statistical analysis because animals were unable to be seen when they were foraging. There were also much fewer

hours of observations at Cliff. I ran a one-factor ANOVA to test for differences between behaviors by site. A one-factor ANOVA was ran to test for differences in foraging behavior between North Picnic and Cliff.

Results

Site had a significant effect on behavior ($F_{5,11}=43.3633$, $p=0.0001$), so a Tukey HSD test was ran to see which behaviors were different from each other. Sitting/lying was significantly different than foraging which was significantly different than the other four behaviors.

At North Picnic, 54% of the time was spent sitting/lying, while they spent 25% of their time foraging, 4% acting on antagonistic behavior, 3% grooming, 9% vigilant/alert, and the remaining 5% of their time was spent moving from place to place. At the lower elevation site, Cement Creek, 47% of time marmots were active was spent sitting/lying, 34% was spent foraging, 0% was acting on antagonistic behavior, 2% was spent grooming, 15% vigilant/alert, and 2% was spent moving from place to place (fig. 1).

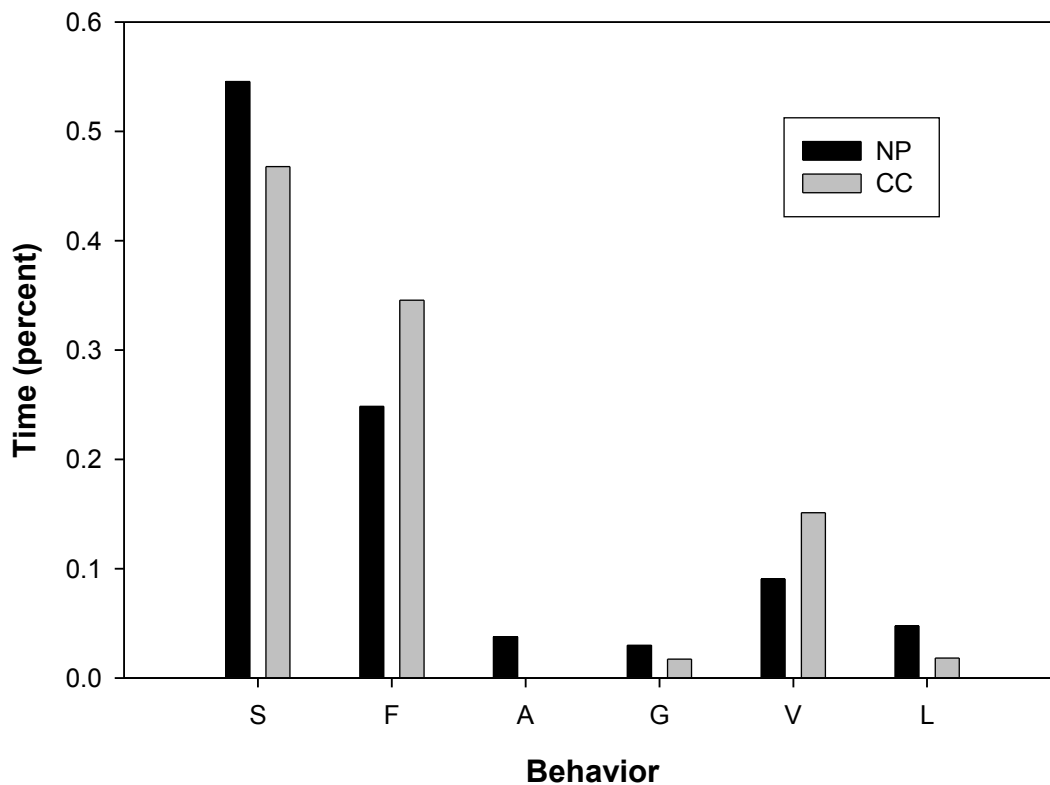


Figure 1- Comparison of behavior using percentages from both North Picnic and Cement Creek

There was no significant difference between time spent foraging at high and low elevations ($F_{1,51} = 0.7782$, $p = 0.3818$).

Discussion

The results of this study regarding time spent sitting/lying and foraging are similar to those of the Armitage study where marmots spent 40-60% of their time sitting/lying and 12-23% of their time foraging (Armitage *et al.* 1996). This indicates that marmots at high and low elevations spend the greatest proportion of their time doing the same major activities. I was expecting to find a significant difference between times spent foraging at North Picnic and Cement Creek, however no differences were found. If one looks at the percentages only, the marmots at Cement Creek spent a greater 9% of

their time foraging; however there was no significant difference. One reason for this is because I had less observational hours at Cement Creek. Another reason could be because I did not divide the day into different periods, like Armitage did, instead I analyzed data from an entire day period. However, the colony at Cement Creek is an unusual one because people who live near the private property trap marmots and let them free on the property; I observed this one evening after I was done observing in July. These marmots are forced to join a new colony and have to adjust to living in what is possibly a different environmental setting, so they may have to forage in order to increase their chances of surviving.

I found it interesting that no agonistic behavior was observed at Cement Creek, while marmots at North Picnic were observed to spend 4% of their time behaving antagonistically. This could mean that marmots at Cement Creek are able to spend more time foraging because they do not partake in nearly as much agonistic behavior, if they partake in any at all. It has been found that more than half of agonistic behavior is directed to yearlings by adults (Armitage and Downhower 1974) and that in 1965 agonistic behavior was related to territorial males, which is relatively uncommon (Armitage 1973). There may have been little or no yearlings present when I was observing, I do not know for sure because the majority of the marmots were unmarked.

The marmots at North Picnic showed more agonistic behavior is because adult females who have produced a litter are more aggressive at the time their young emerge from their burrows (Armitage and Downhower 1974). The later date of permission to use Cement Creek could be another reason why I observed less social interactions between

marmots because social interactions are generally at a higher rate in June (Armitage 1973).

I would next like to survey the vegetation that is present at both sites that marmots use as food sources to see if there are differences and what those differences are. Studies have been conducted by Carey (1985) as well as Stallman and Holmes (2002) in the White Mountains of California and by Armitage (1979) in the Rocky Mountains of Colorado to discover the use of foraging areas and food selectivity by the yellow-bellied marmot. I would also like observe marmots at North Pole Basin (3400m) because I was unable to do so this summer due to the long lasting snow cover, which only allowed time for trapping but not for observing. Differences in time allocation based on sex would be another thing I would like to test, because I was unable to for this study because I could only observe two marked marmots at Cement Creek of the ten marmots I was able to observe.

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