

The Effects of Slope Orientation and Temperature upon
Activity of the North American Pika, *Ochotona princeps*

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Abstract

In the face of global climate change, it is important to know how ecosystems will be affected so that conservation efforts may be more successful. In mountainous regions, effects of climate change may be especially pronounced due to steep elevation gradients and specific habitat requirements. The North American pika, *Ochotona princeps*, is highly sensitive to warming climates and may be a keystone species in many of the areas it is found. I asked how temperature affected the activity of pikas and how the orientation of the talus slopes they live in affected temperature. I found that more pikas are active in cooler temperatures of early morning than later in the day when it is warmer. Also, north facing study sites started out cooler in the morning than south facing study sites but became warmer than the south facing sites later in the morning. These results suggest that pikas are sensitive to warmer temperatures and also show how effects other than direct solar radiation, such as air currents, can result in heterogeneous heating of mountainous landscapes.

Introduction

As global climate change continues, mountainous regions may be one of the many biomes that are greatly affected. Plant community composition in the mountains can vary greatly over very short distances due to the rapid elevation changes, in turn creating a variety of habitats for animals (Fisher and Fule 2004). It is therefore important to understand the temporal dynamics of such systems because minor changes in any environmental factor may broadly alter animal distributions.

North American pikas, *Ochotona princeps*, are small mammals that may be important in maintaining healthy plant and animal populations within the Rocky Mountains, where they live on talus fields, or rock slides. Little is known about how temperature and orientation of a slope affect pika activity. Pikas (Order Lagomorpha) currently are found exclusively at elevations at least 2,533 meters above sea level (Grayson 2005). Historical work has shown that *O. princeps* once lived at lower elevations but that climatic warming has likely forced them to move to higher elevations

and also further north in latitude (Mead, 1987; Beever et al. 2003; Grayson 2005). Pikas typically live in burrows on mountainside talus fields (Kawamichi 1982). These mammals are philopatric and rarely disperse from their natal sites (Smith and Ivins 1983). This pattern has been supported by analysis of genetic variability; mean heterozygosity was very low, ranging from 0.5-1.4% within a population (Tolliver et al. 1985). Pikas are also territorial, especially with the same sex, but usually live adjacent to a member of the opposite sex (Smith and Ivins 1983; Smith and Ivins 1984; Peacock 1997). Despite this pattern, pikas are highly social animals, much more social than other lagomorphs, having at least nine different calls, which they use to maintain territories and issue warnings (Conner 1984; Conner 1985). Pikas are very temperature sensitive and cannot survive in hot temperatures for long; it has been predicted that if global temperature increased 3°C, only three other montane species would face faster extinction than pikas (McDonald and Brown 1992).

Pikas are thought by some to be keystone species because they serve as food for predators and alter the environments they live in (Smith and Foggin 1999). Herbivory by pikas often encourages and is sometimes necessary for plant growth (Travina et al. 2000; McIntire and Hilk 2002). Also, the haypiles that pikas collect for food in the winter contribute carbon and nitrogen to the talus fields, especially important on the nutrient-poor talus fields, allowing plants to grow in places they otherwise (Dearing, 1996; Aho et al. 1998).

As warming trends continue globally, it is important to understand how pika activity is being affected so that successful conservation efforts may be made. It is possible that if warming trends continue, many north-facing talus fields may soon come

to resemble present-day south-facing talus fields, which naturally receive more solar radiation. It is therefore important to acknowledge how slope orientation may affect the temperature of a slope. The degree to which pikas are active, including grazing, haypiling, and calling, may all be affected by temperature change. In my study I will investigate how orientation of talus fields and variation in temperature influence the activity of pikas on talus fields in Colorado.

The objective of my study is to determine what influences the activity of pikas at similar elevations. I ask two questions. First, does orientation of a talus field affect the activity? To answer this question, I compared the activity of pikas on two north facing talus fields and two south facing talus fields. I hypothesized that pikas would be more active on north facing slopes due to these areas receiving less solar radiation and possibly having more moderate temperatures than south facing slopes. Second, does orientation affect the temperature of a slope? I compared temperatures on north and facing slopes and hypothesized that south facing slopes would become warmer earlier than north facing talus slopes and stay warmer throughout the day.

Methods and Materials

I studied pikas at four sites in the Elk Mountain range of Gunnison County, Colorado. Data were collected from July 17-July 29, 2006. Two study sites were at Copper Lake; one north facing and one south facing, and two study sites were in the valley north of White Rock Mountain, one north facing and one south facing. A geologic compass

was used to obtain the orientation of talus fields. I used a Trimble GeoXT GPS unit to record talus field locations.

Observation sites were 30 x 30 m on a talus field and I watched an individual talus field for three days, rotating between sites. Each site was observed for four days. The observation periods were 06:00-10:00. I camped nearby so could arrive at sites prior to the observation period and observed from at least 4 m from the sites. I chose to do only morning observations because weather in the area can be highly variable in the afternoons. I recorded observations in 5-min blocks and recorded how many total pikas I saw out of their burrows in the observation site during the first two minutes of an observation block, considering these pikas to be active. A HOBO logger was placed within the observed talus field ten minutes prior to the time I began recording pikas and recorded the temperature in 15-min intervals, beginning on the hour. I used the non-parametric test Spearman's Rho and regression tests in JMP IN 5.1 (SAS Institute Inc.) to determine if temperature and time affected pikas activity.

Results

Temperature and time were highly correlated (Spearman's $\rho = 0.7728$; $P < 0.01$). The influence of temperature on pika activity varied across sites. The number of active pikas decreased as temperature increased at the north facing Copper Lake and White Rock Mountain sites and the south-facing Copper Lake site, though the relationship for the latter site was not significant (Table 1). At the south facing site White Rock Mountain site, the number of active pikas weakly increased as temperature increased (Table 1).

Combining all the data, however, I saw a significant decrease in the total number of active pikas as temperature increased (Figure 1)

Table 1: Pika Activity and Temperature		
Site	Equation of Line	<i>P</i>
Copper Lake South Facing	$-0.0163641x + 0.4922252$	0.348
Copper Lake North Facing	$-0.0889894x + 1.8566485$	0.0002
White Rock North Facing	$-0.0277267x + 1.0062388$	0.0317
White Rock South Facing	$0.0176849x + 0.5346659$	0.5163

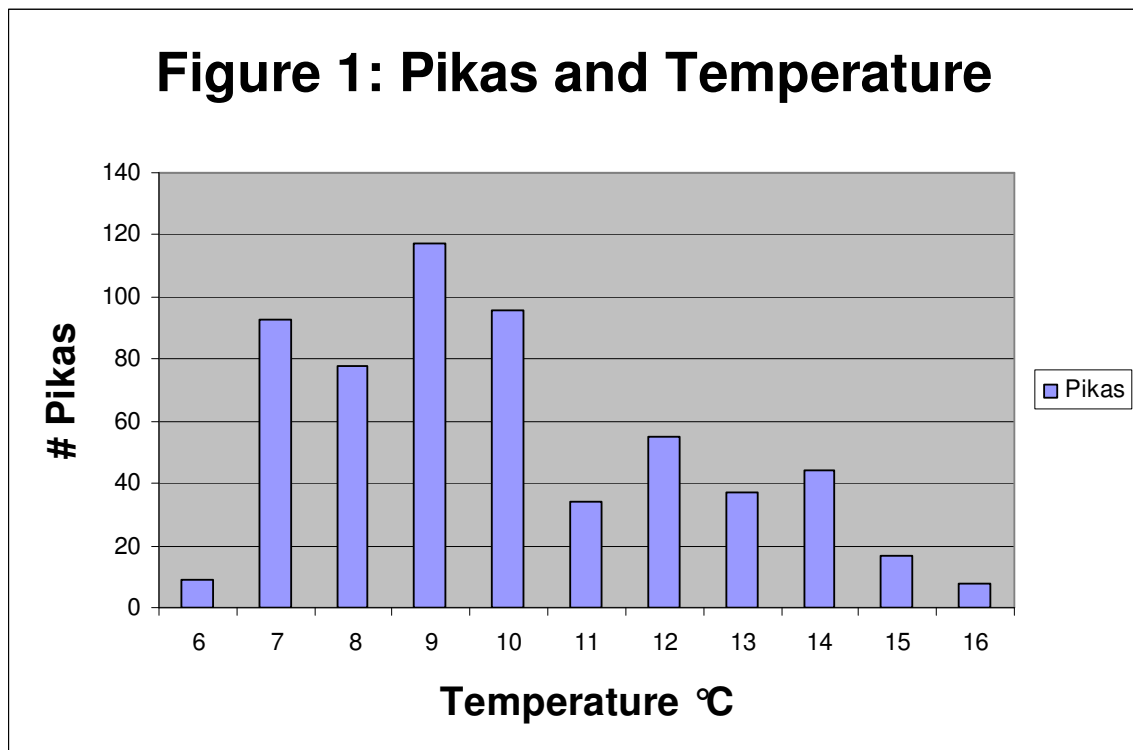


Figure 1: More pikas were active at temperatures between 7° and 10° Celsius. The number of pikas after that time declined.

Using separate regressions for time, I found that pika activity decreased as the day progressed in both Copper Lake sites and at the north facing White Rock Mountain site, though the relationship was not significant at the south facing Copper Lake site (Table 2). Pika activity actually significantly increased over time at the south facing White Rock site (Table 2). In terms of total numbers, there were more pikas active between 6 and 7 AM with activity then dropping off but remaining fairly constant for the rest of the observation period.

Table 2: Pika Activity and Time		
Site	Equation of Line	P
Copper Lake South Facing	$-0.0000099x + 0.6106122$	0.3360
Copper Lake North Facing	$-0.0000662x + 2.852517$	<0.0001
White Rock North Facing	$-0.0000205x + 1.2985034$	0.0246
White Rock South Facing	$0.0000179x + 0.2051701$	0.0471

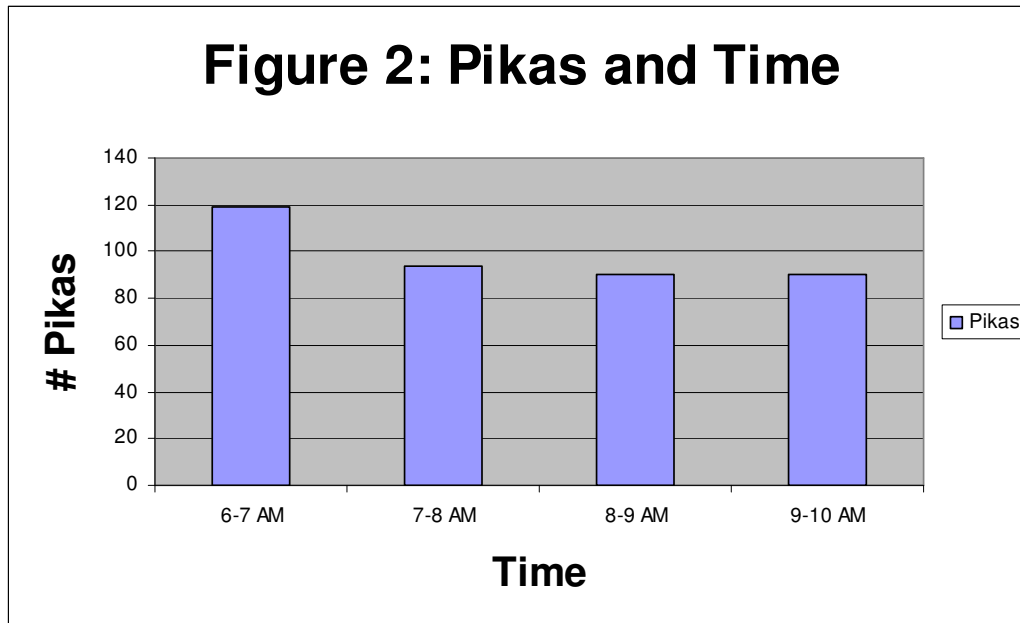


Figure 2: More pikas were active in the time interval between 6 and 7 AM but thereafter the total number of active pikas remained fairly stable.

All observation sites became warmer as the day progressed (Figure 3). South facing slopes were initially warmer than north facing slopes, but north facing slopes became warmer than south facing slopes as the day progressed.

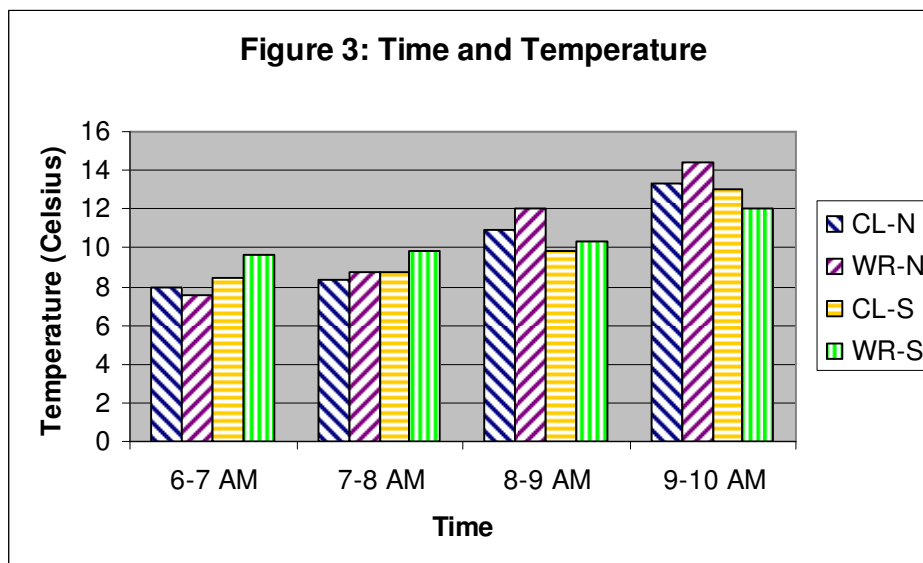


Figure 3: CL=Copper Lake. WR=White Rock Valley. N=North facing. S=South facing. Bars represent average temperature of three days at each site for the specified time interval. South facing slopes were initially warmer than north facing slopes but north facing slopes became warmer as the day progressed.

Discussion

I found that pika activity seems to be related to temperature. Pikas appear to be able to forage as long as temperatures remain favorable, therefore the fact that their activity is correlated with time of day is probably because as the time progresses to midday it naturally gets hotter in fair weather. All observation sites became warmer as the day progressed and experienced a decrease in number of active pikas, which supports my hypothesis that temperature is affecting pika activity. The only site that went against trend this was my site at the south facing White Rock Mountain site; I can explain this because one morning I did not see a pika until about 8:00, perhaps due to the presence of a predator, and I often saw this pika foraging in the forest outside of the observation site. This may have been due to the presence of a predator at that site, because the other days which I watched the site I would see at least one active pika much earlier in the morning.

I did not expect to find that north facing slopes would get warmer faster than south facing slopes. The south-facing Copper Lake site had a mountain to the east which caused direct sunlight to reach it later than at the Copper Lake north facing site. However, the White Rock north and south facing slopes are still a conundrum; sunlight did reach the south facing slope earlier, so perhaps air currents in the basin are somehow directed so that the north facing slope becomes warmer faster, despite starting out cooler at 6:00 AM. My hypothesis that orientation of a slope affects temperature of a slope was not statistically testable due to the small number of slopes I used in my study, but my results for temperatures on slopes oriented north and south were not as I anticipated. At

least in my study sites, something not entirely expected, based on my data, is occurring with temperature as the day progresses.

More research should be done which looks at how slope orientation affects the distribution of pikas. Slope orientation is also just one of many variables that can affect pikas; other studies that could be done could look at the plant species near talus fields to see how community ecology affects pikas' activity and distribution. Precipitation and soil type and composition may also affect pikas' activity and distribution. Pika distribution and density would be interesting to study; only my site which faced north at Copper Lake ever had three pikas active in it. What caused this higher than normal number is currently unknown. Much more work should be done with pikas and activity, distribution, and density before we can say how global warming is currently affecting pikas. I suggest comparing precipitation patterns and pika distribution and density. I would also suggest looking more closely at what plants are in the diets of pika populations that are doing well and comparing the plants to with those found in the diets of pika populations that seem to be in the process of extirpation. Plants in mountainous regions are often very sensitive to temperatures. As temperatures rise, these plants will either be forced to move to new areas or go be extirpated. Pika populations will likely do the same since they need the plants in their diet to survive.

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