

The effect of human activity on the vigilance rates of *Spermophilis  
lateralis* and *Tamias minimus*

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## ABSTRACT

With human population on the rise, human presence in wildlife areas will rise along side it. The study of how human activity is affecting wild animals in any and all aspects is of vast importance. This growing overlap is due to effect both sides of the issue, the humans and the animals. My study focuses on how human activity affects vigilance rates in golden-mantled ground squirrels and least chipmunks. I conducted observations in six different locations that were grouped in to 3 categories based on predicted human activity levels; high, medium and low. Here I observed the rate of vigilance by recording what individual squirrels and chipmunks were doing every 10 seconds. My study showed that human activity does have an effect on the vigilance rates of squirrels and chipmunks. As the level of human activity increases the rate of vigilance in the squirrels and chipmunks decrease and foraging rates increase. If increased human activity also decreases the predator densities in the area then the fitness of the squirrel populations in the area will increase. This information gathered on such common species as the Golden mantled ground squirrel and the least chipmunk could be used to make predictions on how human activity will affect the vigilance and foraging rates of more illusive nonsocial species of mammals.

## INTRODUCTION

Vigilance is the state of being aware of one's surroundings, most often to evade predators and locate food (Quenette, 1990). Thus, vigilance is a critical component of an animal's behavior and has important fitness consequences to the individual. As for all behaviors, there is a tradeoff (Werner and Anholt, 1993): an individual increases vigilance to detect predators at the cost of decreased foraging activity. Animals feeding with their head down (i.e. animals in a non-vigilant state) have a highly reduced ability to detect approaching predators (Lima and Bednekoff, 1999). Hence, in many animals there is a suggested optimal balance between being in a vigilant state and foraging (Lima, 1999). Vigilance fluctuates depending on the environmental context, e.g., location of food resources, perceived predation risk, and the presence of other organisms (Manor and Saltz, 2003). Thus, the optimal balance between vigilance and foraging can be dependent on the environmental context (Bachman, 2002).

The presence of human activity is an example of an environmental factor that may influence vigilance in animals. Humans make quick movements and loud noises but do not necessarily pose a threat as a predator. Thus, an animal may become accustomed to this particular activity and decrease its vigilance and forage more. Also, humans may scare off potential predators, and the presence of any predators may be an important factor in maintaining functional anti-predator behavior (Blumstein, 2002). Furthermore, the vigilance of animals may be affected in areas that involve seasonal human activity, such that when people leave, then the predators return to the area. This may change how animals budget time to vigilance behavior over the course of a season.

Different species can perceive different amounts of risk in the same environment. For example, chipmunks are smaller and slower than golden-mantled ground squirrels and may spend more time being vigilant in order to be able to escape a predator. In comparison, the larger and faster Golden-mantled ground squirrel may perceive lower risk in the same habitat, (Smith, 1995; Blumstein 2004). Differences in foraging rates could influence vigilance rates between the two species (Smith, 1995). As the chipmunk is much smaller and forages in tall grasses, it may spend less time being vigilant as it is not easily detectable by predators (Kotler, 1988).

I studied the Golden mantled ground squirrel, *Spermophilus lateralis* and the Least chipmunk, *Tamias minimus* in the area surrounding Gothic, Colorado. Both the squirrel and the chipmunk need to increase their fat percentage during warmer months in order to survive the winter (Murie and Boag, 1984). So, foraging is a significant activity in determining individual fitness. However, too much foraging results in decreased vigilance, which then would also decrease fitness if it increases mortality. In sciurids, vigilance is defined as when the animal is standing up on its hind legs and monitoring its surroundings (Lima and Bednekoff, 1999). The East River Valley, in the area surrounding Gothic, has high levels of human activity during the summer months, and lower activity during the rest of the year. During the active season predators are warded off by humans (Woodroffe, 2000), which may lower anti-predator mechanisms of the squirrels and the chipmunk. This study tested whether the presence of humans decreased perceived predation risk, thus decreasing the sciurid's levels of vigilance. To measure the levels of vigilance, I compared the percentage of time the sciurids

spend in a vigilant state in six different sites that differed in the amount of human activity. The use of multiple sites that are far enough away from each other so that the territories are non-overlapping avoided the need to trap and mark the squirrels, since the probability of the squirrels dispersing to another one of the test sites was minimal.

## METHODS

### *Locations*

I conducted my research within the East River Valley near the Rocky Mountain Biological Laboratory in Gothic, Colorado during the summer of 2012. I selected six different locations that differed in human activity and had populations of golden-mantled squirrels and chipmunks: two with high levels of human impact, two with low levels of human impact and two medium. The two high human impact locations were located in the Gothic town site, one by the Barclay classroom and parking lot and the other by Enders Dining hall; both of these sites are highly frequented by humans and have almost constant human presence. The two medium human impact sites were Judd Falls trail and the Bellview parking area (see map). The low human activity sites were adjacent to the lower 401 trail and the Kettle Ponds.

### *Study Species*

*Spermophilis lateralis* and *Tamias minimus* both forage a variety of plants, seeds, and insects in open areas. Both species utilize large rocks to burrow under, sit on and watch for predators, and look for food (Carleton, 1996; Haufler and Nagy, 1984 Bihr and Smith 1998). Both species are diurnal and easily observable during the morning and afternoon hours.

### *Measuring human activity*

During each observation session, I counted the number of people, dogs and cars that passed by the observation site during observations and then normalized the numbers to get the number of people, dogs and cars that pass by every 3 hours.

### *Flight initiation distances*

Flight initiation distances (FID) were conducted to test the habituation levels of the squirrels to humans (Rodriguez-Prieto and

Fernández-Juricic, 2008). These tests were done during observational periods by walking towards a ground squirrel or chipmunk at a controlled pace and measuring the distance between the squirrel and the observer when it began to flee. I dropped a flag where I was standing when the animal fled, observed the location of the squirrel at that moment, and then measured the distance between the two points. I measured FIDs for 25-29 animals at each location: 17-20 ground squirrels and 5-9 chipmunks. The FID distances were compared among species and sites, as was their relationship to human activity and vigilance behaviors.

### *Behavioral observations*

The Golden-mantled ground squirrels and the Least chipmunks were observed using binoculars. Each observation session was preceded by a 5-minute period in which no behavioral data were recorded, to allow the animals to adjust to the observer's presence. During an observation session, an individual's behavior was recorded every 10 seconds in three categories: foraging, vigilant, and other. Each session lasted 5 minutes, or until the animal could no longer be seen. I collected 5 observations from each of the six sites; 3 observations in the morning beginning at 8:30 am until 11:30 am, along with 2 observations in the afternoon beginning at 3:00 until 5:30 pm.

### *Data Analysis*

To determine how behavior varied among sites with different level of human impact, I compared Vigilance between levels of human activity using a bivariate linear and a linear regression model. In order to determine the mean differences among sites an ANOVA test was used.

## RESULTS

The original predictions on levels of human activity of each site were determined to be different than the actual levels of human activity. The medium human activity sites were determined to be high human activity sites and the high human activity sites were determined to have medium human activity, in relation to the other sites (Figure 1). Only the site with highest human activity was significantly different from the others (ANOVA test,  $F=59.47$ ,  $p=0.004$ )

Flight initiation distances were more strongly associated with human impact levels in both chipmunks,  $p < .01$ , and ground squirrels,  $p = .02$  (low-medium-high) than by the observed human activity (people/time). As predicted, the Golden mantled ground squirrel and the Least chipmunk both showed significantly higher flight initiation distances at the sites with the lowest predicted level of human activity (ANOVA, Figure 2 and 3). The greater the human impact level, the closer the squirrels and chipmunks would allow someone to approach them, as the FIDs for the medium and high human activity sites were much lower. In the bivariate linear fit of the FID by number of people, there was not a significant correlation between the number of people that passed by and the FID for either squirrels or chipmunks (Figures 6 and 7).

Vigilance was influenced by both human impact levels and the number of people at a site. The ground squirrels exhibited the highest percentage of vigilance in the area of low human activity, while at the high human activity site the ground squirrels spent the lowest percentage of the time being vigilant. Equivalently, the higher the number of people that passed a site, the lower the vigilance, and the lower the number of people that passed a site, the higher the vigilance (figure 4). Using a linear fit, we were able show that the chipmunks follow a similar trend, but the data is not significant (figure 5).

## DISCUSSION

My initial assumption about the relative rankings of the level of human activity at each site was not supported. I discovered the difference between actual human activity and human impact. The Gothic town site (which I designated as the two high level sites) has a higher human impact with permanent buildings and other constant human pressures. However, the two sites that I designated as medium human activity sites that were along trails and popular tourist sites actually had higher levels of human activity even though there are no permanent structures. The low human activity sites fit my initial assumptions of a minimal human presence. These results influenced my data analysis, as I compared FIDs and Vigilance behaviors to both the initial site rankings as well as to the measured human activity levels.

The FID's did hold true to my predictions in both the ground squirrels and chipmunks, with the lowest FIDs being at the sites that

were predicted to have high human disturbance, and the highest FIDs being at the low human disturbance sites. This suggests that individuals of both species can habituate to the presence of humans, which would allow them to spend more time in foraging areas and less time fleeing.

There were differences in the rankings of FID in the analysis of # of people (human activity) versus the levels of human impact. In the sites with high human activity, many people that passed through brought with them dogs, and often times these dogs were off leash and were free to chase off all of the squirrels if they so pleased, and they often did. While in the sites that had the median number of people come through were in the Gothic town site, which is the site of Rocky Mountain Biological Laboratory. In the town site dogs are not allowed, even on leash, so the squirrels and chipmunks in town may associate approaching humans less with being chased by a dog than the ground squirrels. Also the squirrels and chipmunks in the town site even though they are frequented by fewer people on a daily basis, they are under a more constant presence with the same people walking around during all hours of the day. Whereas at the sites with the high number of people, the presence of people is generally restricted to several hours in the morning and several more in the afternoon because people are less inclined to come out in the midday heat, early in the morning or late at night to these sites. When people do come to these sites, which are tourist attractions, they tend to come in large groups as opposed one or two at a time in the town site. This difference in frequency could be a cause for the ground squirrels and chipmunks to be more habituated to people walking towards them in the Gothic town site (High sites) than in the tourist areas (Medium sites). In turn reducing the FID distances in the higher sites even though the number of people that walk by is lower.

The prediction on the association of vigilance and human activity level was upheld in ground squirrels: as the number of humans that passes through a site increased, the percentage of time spent being vigilant decreased. So if the predator density decreases in same way, then the fitness of the ground squirrels in the areas of high human activity will be greater than the others since they are spending less time looking for predators and more time stocking up calories for winter. The analysis of the chipmunks was not significant, but this may be due to not having enough data due to the difficulty of

observing chipmunks when foraging or doing anything much longer than ten seconds at best.

Some of the other factors that may affect the vigilance rates of my test subjects are age, and gender and body weight (Bachman, 2002). These should not play a role in my analysis as the presence of these factors are about equal in every study site and were all averaged together. The time of year also plays an important role in the proportion of time a Least chipmunk or a Golden mantled ground squirrel spends being vigilant. Early in the summer as the chipmunk or ground squirrel comes out of hibernation they will probably spend more time foraging and less time looking for predators as they are trying to begin stocking up for the next winter. Later in the summer the squirrels tend to spend more time foraging as they have much of the fat storage that they need to survive the winter and will spend more time making sure that they aren't predated. As my study was conducted in the middle of the summer and the 5 observations at each site were spread out though the research period, the effect of time of year should not play a role in my analysis.

Similar studies with different focal species have shown opposite results. A study on piping plovers showed that there was a direct relationship between vigilance rates and the number of people in an area (Burger 1994). Another study with mountain gazelle in Israel showed a similar trend, the higher the number of people in an area the higher the vigilance rates and the less time spent foraging (Manor and Saltz, 2003). Both of these studies differed from this one in there approach to quantify human activity. The other studies merely used a population density estimate of the area where as in this study actual counts of the numbers of people that came by were taken along with the number of dogs on leash and off leash. By using this method to determine the presence of humans gives the study the exact number of people that were present during the time of behavioral observations. The mountain gazelle was also formerly hunted, before being listed as a threatened species. This would make humans a primary predator and would lead to increase vigilance in areas where there are higher human population densities (Joel and Laundre, 1999).

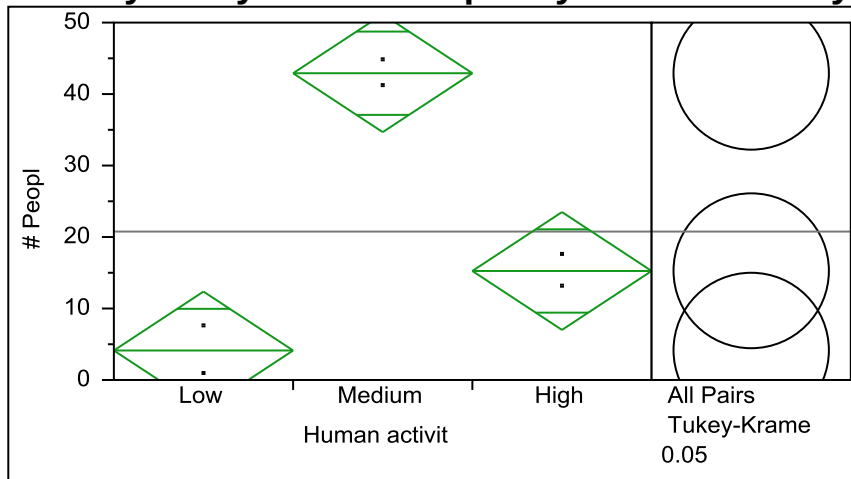
This study has shown that the effect of habituation to humans on the behaviors of foraging and predator detection is more strongly related to the numbers of people that come through as opposed to the number of buildings or the constant presence of humans. So, by

increasing the human traffic to an area, if the predator density is reduced then the fitness of the ground squirrels and chipmunks will be greater than that of a more developed area with less people, and greater than an area with minimal human impact. This shows that ecotourism may be beneficial for the ground squirrel and chipmunk populations. However, since there is obviously no current problem with the decline of chipmunk and ground squirrel populations, if populations of the chipmunks and ground squirrels reached a level where they were becoming a problem for the ecosystem as deer often do, management systems could reduce the number of people that are allowed to visit those areas and potentially reduce the fitness of those populations of ground squirrels.

## FIGURES AND GRAPHS

Figure 1

### Oneway Analysis of # People By Human activity

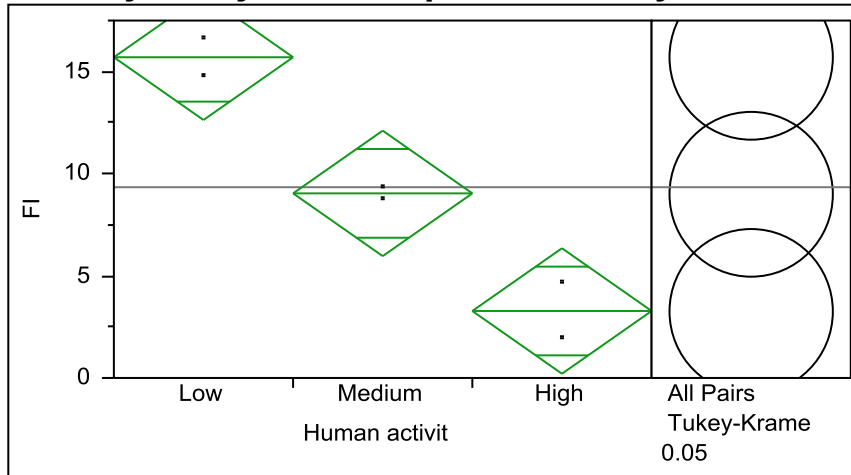


ANOVA;  $F=59.47$ ,  $p=0.004$   $n=6$  (means)

| Level  |   | Mean      |
|--------|---|-----------|
| Medium | A | 42.916667 |
| High   | B | 15.250000 |
| Low    | B | 4.125000  |

Figure 2

### Oneway Analysis of Chipmunk FID By Human activity

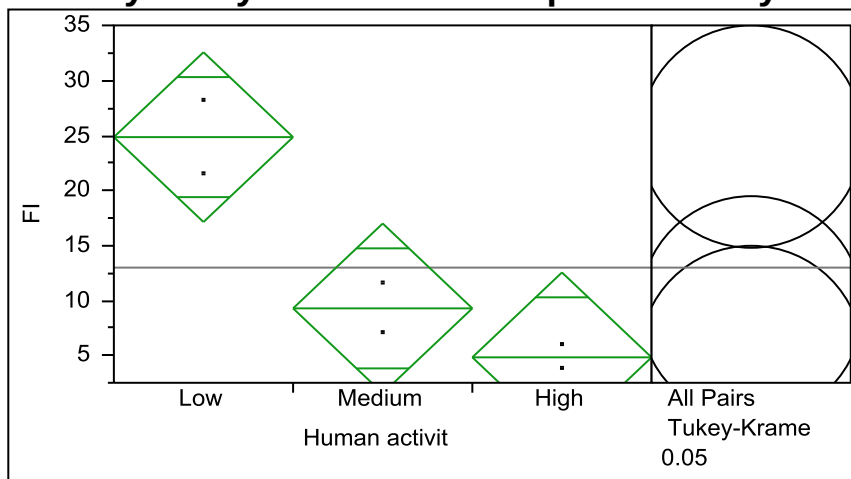


ANOVA;  $F = 41.49$ ,  $p < 0.01$   $n = 6$  (means)

| Level  |   | Mean      |
|--------|---|-----------|
| Low    | A | 15.703100 |
| Medium | B | 9.038150  |
| High   | C | 3.279145  |

Figure 3

### Oneway Analysis of Ground Squirrel FID By Human activity

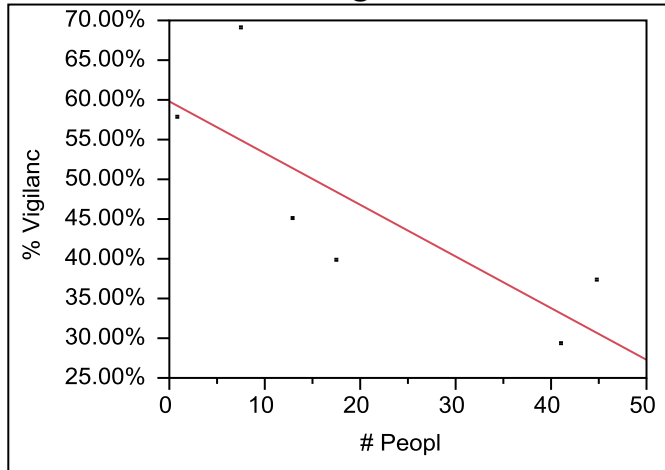


ANOVA;  $F = 18.79$ ,  $p = 0.020$   $n = 6$  (means)

| Level  |   | Mean      |
|--------|---|-----------|
| Low    | A | 24.868750 |
| Medium | B | 9.276144  |
| High   | B | 4.817692  |

Figure 4

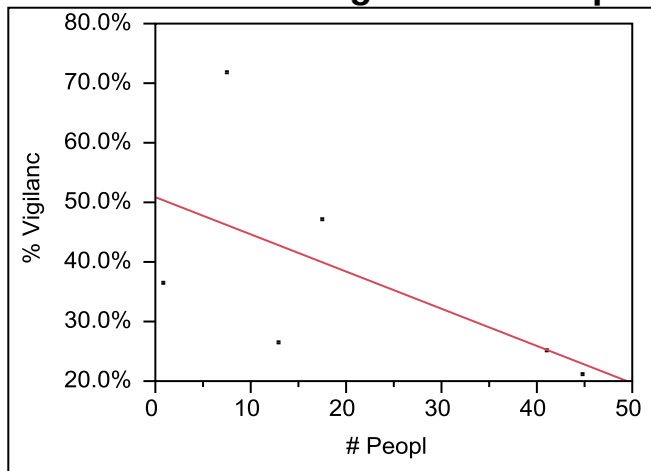
**Bivariate Fit of % Vigilance in Ground Squirrels By # People**



ANOVA;  $F=7.45$ ,  $p=0.052$   
 $n=6$  (means)

Figure 5

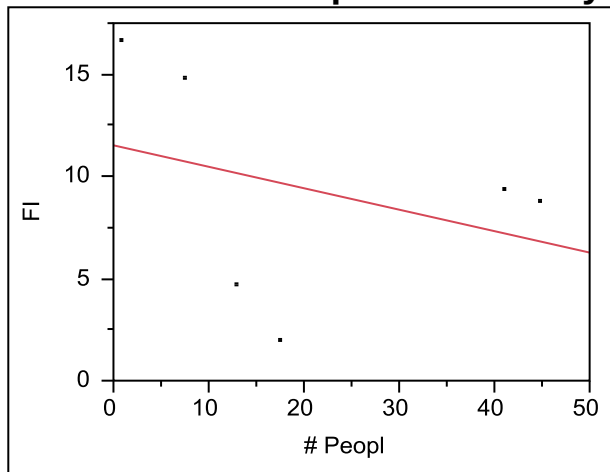
**Bivariate Fit of % Vigilance in Chipmunks By # People**



ANOVA;  $F=2.17$ ,  $p=0.215$   
 $n=6$  (means)

Figure 6

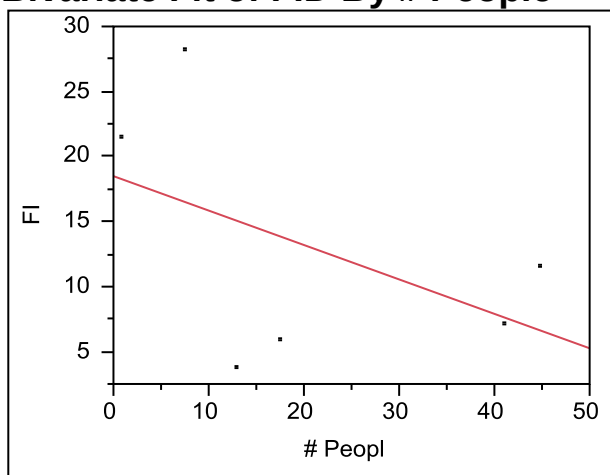
**Bivariate Fit of Chipmunk FIDs By # People**



ANOVA;  $F=.508$ ,  $p=0.516$   
 $n=6$  (means)

Figure 7

**Bivariate Fit of FID By # People**



ANOVA;  $F=1.26$ ,  $p=.324$   
 $n=6$  (means)

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