Color Preference by the Eastern Chipmunk, *Tamias striatus*, in Populations Exposed to Humans Compared to Populations from the Wild

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Animals use color vision for a variety of things, but one of the most important is food location. The purpose of this study is to determine if color preference varies in different populations of the Eastern Chipmunk (*Tamias striatus*), which has not been well studied. We will focus on chipmunks habituated to human contact and those relatively isolated from humans. Using feeding trays with differently colored bottoms, we observed variations in color choice based on factors such as net foraging rate, number of visits, and food taken per visit. Though there was a significant difference in foraging rates for one color (i.e. orange), no other significant differences in foraging data were obtained. Additionally, no significant differences were observed in habituated versus non-habituated chipmunk habitats. Ultimately, our results did not indicate a color preference either in general or by location; however, further studies with a larger sample size may yield stronger results.

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Introduction

Color vision is important for many animal species to identify food sources, mates, predators, and/or other important aspects of their environment (Freeman 2005). Various primates use trichromatic color vision to find ripe fruits (Dominy et al. 2003) and numerous birds use color vision to choose mates (Doucet et al. 2007). In addition white-tailed deer use color vision to enhance predator detection abilities (VerCauteren and Pipas 2003).

The *Sciurus* (squirrel) family, a close relative to chipmunks, can discern a variety of colors (MacDonald 1992). Past studies, including a study conducted at the University of Michigan Biological Station (UMBS), have noticed trends that may suggest that Eastern Chipmunks can also discriminate between colors, specifically red and green (Ulbrich et al. 1992). However, the experimental methods implemented were questionable due to multiple response variables (i.e. different foods for different colors), which may have skewed the data. Furthermore, the results of this past study were inconclusive in that they were not statistically significant. Thus, the potential for discrimination between colors by chipmunks merits further study.

Additional research strongly suggests that habituation (the process of a wild animal becoming familiarized to the presence of humans) can affect an animal's behavior in regards to predator discrimination, poaching, and home range and mortality rates (Coleman et al. 2008, Kasereka et al. 2006, Mattson et al. 1992). Generally, habituated animals (e.g. dik-diks, grizzly bears, and gorillas) were less sensitive to human activity and therefore were more susceptible to adverse human effects (i.e. predator discrimination, hunting, and poaching, respectively) (Coleman et al. 2008, Kasereka et al. 2006, Mattson et al. 1992). Furthermore, the foraging behavior of the Olympic Marmot (another member of the rodent family) is negatively affected by habituation, with habituated marmots reflecting a decrease in predator awareness (Griffin et al. 2007). The effects habituation may have on behavior of Eastern Chipmunk populations, however, have been under studied.

Therefore, the study proposed here further delves into chipmunk behavior by testing color preference in different chipmunk groups (habituated versus non-habituated) in a population. Our study will specifically look at how *Tamias striatus*, the Eastern Chipmunk, relies on sight (i.e. the ability to differentiate colors) to determine appropriate food sources by having them choose food placed on top of naturally and unnaturally colored paper. Natural colors, for example brown, are those that are often colors of organic matter and commonly found in the landscape at UMBS. Unnatural colors, for example certain shades of pink or blue, are not commonly found in the forest at UMBS but are more likely observed in camp due to human development (i.e. garbage, deforestation, housing). Our results may not only support the previous UMBS study that chipmunks can distinguish colors (Ulbrich et al. 1992), but may also suggest that they have a color preference. Color preferences may also vary depending on whether chipmunks are habituated or non-habituated (i.e. from camp or off camp).

We hypothesize that chipmunks living in close proximity to humans ("habituated chipmunks") will exhibit less color preference than their less habituated counterparts, due primarily to more frequent contact with unnaturally colored food sources. Furthermore, the non-habituated chipmunks are expected to prefer the natural color over the alien colors. We also hypothesize that habituated chipmunks will have a higher foraging rate (consume larger quantities of proffered food items over time) because of a greater familiarity to humans and their manmade materials.

Methods

This study will be conducted at the University of Michigan Biological Station (UMBS), located near Pellston, Michigan, United States. The approximate latitude of the study area is 45° 33' 10" N. The approximate longitude of the area is 84° 47' 2" W. This area falls well within the bounds of the temperate forest biome, with temperatures ranging from 12 to 30 degrees Celsius (295 to 303 K) and average rainfall between 75 and 150 centimeters per year. The forested locations are a mix of both deciduous and coniferous native trees, with neutral to slightly acidic soils (Ballard 2004).

At UMBS, four observational sites were in camp (sites C, D, E, and F) and four were away from camp (sites A, B, G, and H) for a total of eight observational sites (Table 1). We expected that the chipmunks at the camp sites would be habituated to humans and the chipmunks in the forest would be less habituated to humans. Away from camp sites were located in the forest, at a distance of 0.8 hectares from UMBS and ready human access. The forest sites were also placed at least 0.8 hectares apart from each other. These distances are in accordance with a study showing that chipmunks rarely venture more than this distance away from their burrow (Blair 1942).

We used 30x30x5 cm wooden trays at the observational sites. We covered the bottom of the control variable tray with a natural color of construction paper (a light shade of brown) that is frequently encountered during foraging and closely resembles local soil and leaf litter. The bottom of each experimental tray was covered with an alien color of construction paper (blue, orange, yellow, or pink) that is not commonly found on the ground at the UMBS. Approximately 156 grams of food (the metric equivalent of our 6oz measuring cup) were placed on each tray and chipmunk consumption was monitored, including color preference and time spent at tray. Seeds were only placed in trays - not on the ground - because the study was designed to test for color preference and not aversion to trays. Our food choice was sunflower seeds, based upon the UMBS study performed by Thomson (1996), which suggests that chipmunks prefer to forage for high fat foods such as the sunflower seed.

At each observational site, located in or away from camp, trays were placed 1 m apart with the observer recording from 3 m away. The trays always consisted of a brown tray and one of the unnatural-colored trays. The observer recorded the color of the tray that the chipmunks chose, duration of time spent at the chosen tray (via stopwatch), and the weight of seeds consumed in each different colored tray (calculated by weighing the number of seeds removed). Each session lasted 90 minutes and was conducted between 8:00-11:00 am, as that is the primary chipmunk foraging time (Freivalds 1978). Sessions were conducted on four different days, with paired natural and unnatural colored trays, in a randomized design (Table 1). The four observers were randomly assigned to different sites at and away from camp to avoid observer bias.

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Table 1- Method of randomization of trays and observers

	5/23/2009	5/24/2009	5/30/2009	5/31/2009
8:00 a.m. 8:30 a.m. 9:00 a.m.	Individual observation of sites A, C, E, G	Individual observation of sites A, C, E, G	Individual observation of sites A, C, E, G	Individual observation of sites A, C, E, G
9:30 a.m. 10:00 a.m. 10:30 a.m.	Individual observation of sites B, D, F, H	Individual observation of sites B, D, F, H	Individual observation of sites B, D, F, H	Individual observation of sites B, D, F, H
11:00 a.m.				

Data Analysis

Because our data were not normal, our primary statistical analysis was a Kruskal-Wallis test to determine if there was any significant difference between visit time, number of visits, average visit time, total food taken, and foraging rate for each tray color. Then, we conducted a series of paired t-tests comparing foraging rate between tray colors (a paired design between natural [brown] and unnatural colors [orange, pink, blue, and yellow]), habitats (habituated and non-habituated animal zones), colors by habitat, and average quantity of food taken.

Results

We found no significant difference between the foraging rates of chipmunks for sunflower seeds placed on brown or colored trays in the habituated and non-habituated groups. There was also no significant difference between foraging rates on pink and yellow trays compared with foraging rates on brown trays in all habituated and non-habituated populations. Additionally, no significant difference in behavior towards the natural color (brown) was discovered in the non-habituated population, compared with the habituated population. However, there was a significant difference between brown and orange foraging rates, with all individuals (habituated and non-habituated combined) showing a higher average foraging rate at brown trays (Figures 1 & 2). The blue data could not be statistically considered due to a small sample size. All other variables compared had non-significant results.

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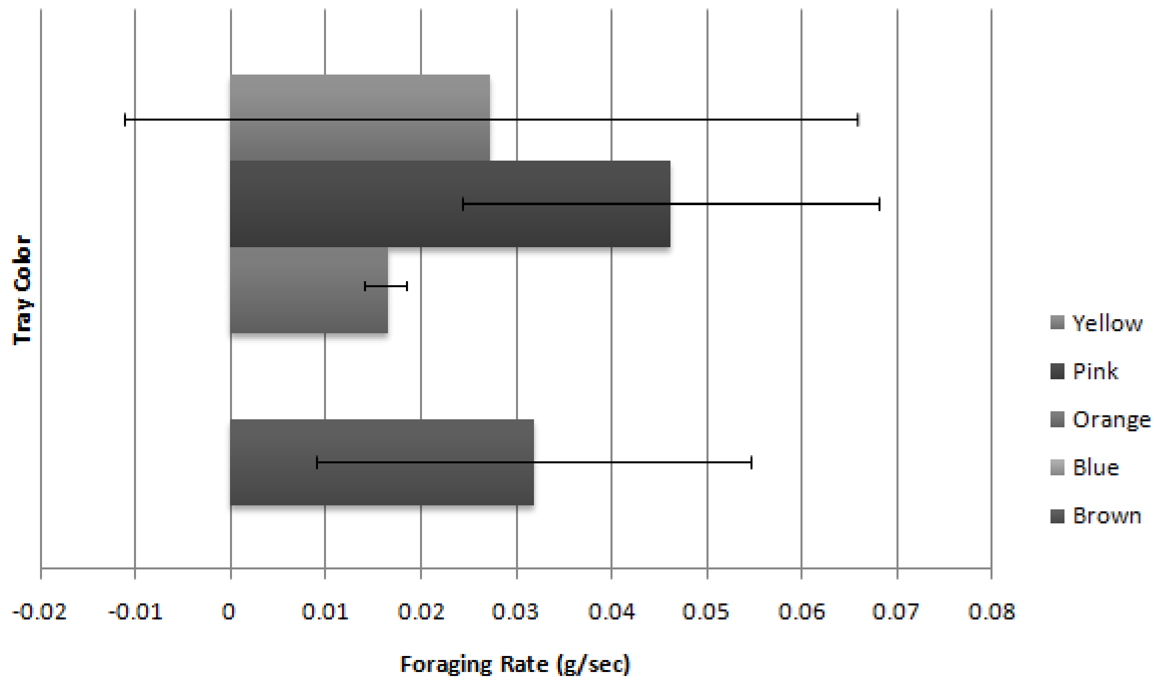

Figure 1
Average foraging rate by color in the non-habituated population (Kruskal-Wallis)

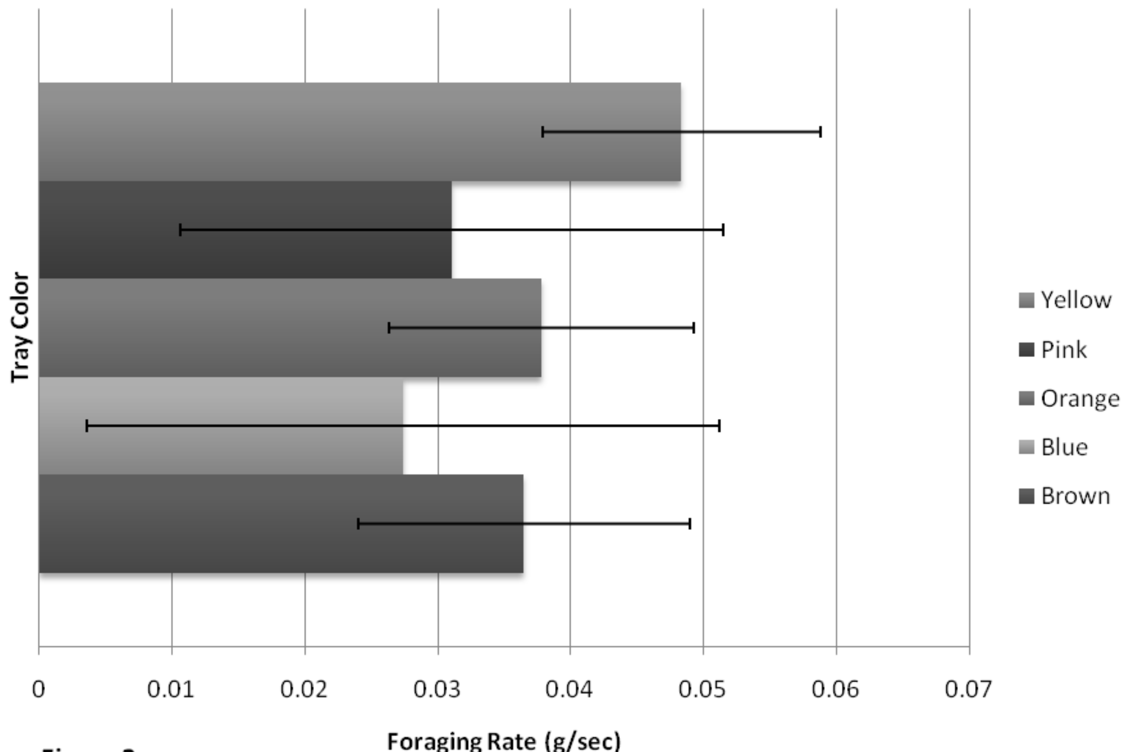

Figure 2
Average foraging rate by color for habituated populations (Kruskal-Wallis)

When comparing the average amount of food taken per visit between habituated and non-habituated chipmunk populations, we found that the habituated individuals took much less food than the non-habituated individuals did, with 1.3 grams versus 2.3 grams, respectively, per visit (Figure 3). Habituated chipmunks took 1 gram more per tray from brown trays than did non-habituated chipmunks, but that difference was not significant (Figure 3).

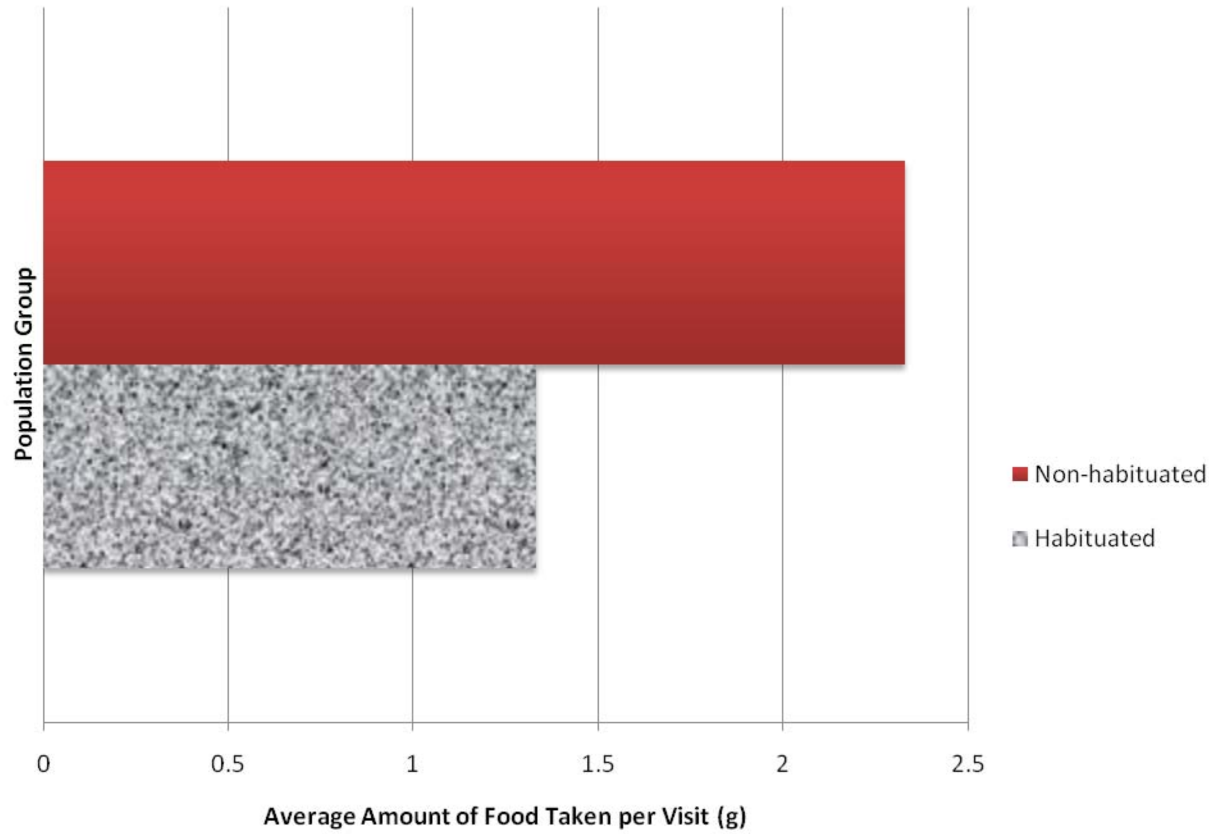

Figure 3
Average Amount of Food Taken per Visit for Habituated vs. Non-habituated Populations (T-Test)

Our data also showed that chipmunks took 3.75 more grams of seeds from brown trays than from colored trays when data from habituated and non-habituated chipmunk populations were combined. Brown trays were favored by 6.7 g for the non-habituated chipmunks alone and 2.37 g for the habituated chipmunks, possibly representing a small trend (Figure 4).

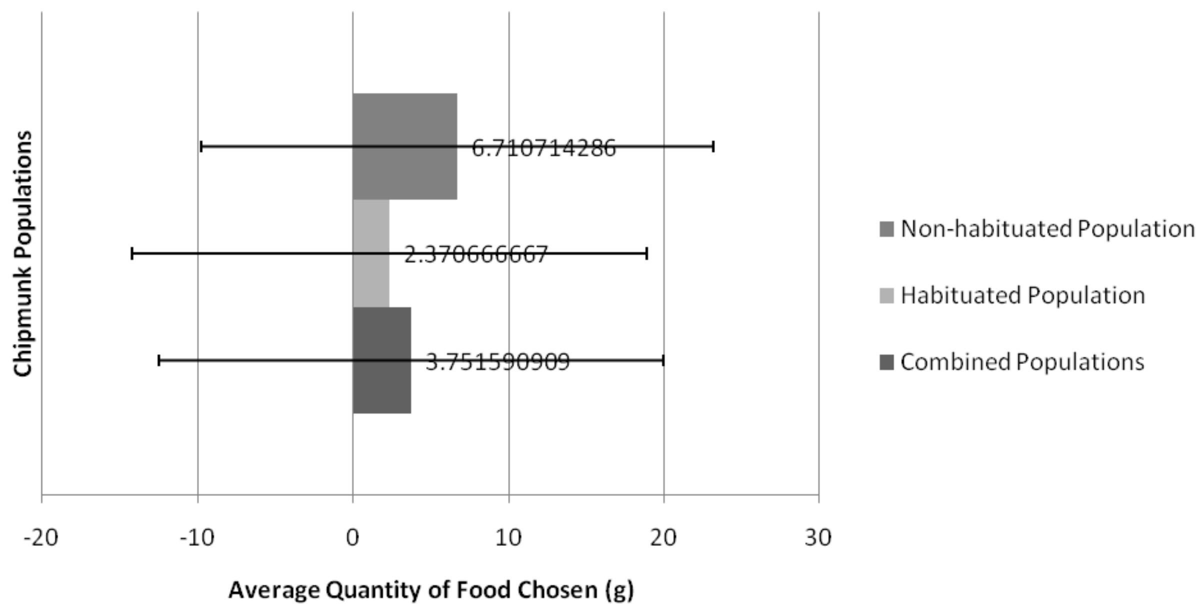

Figure 4
Average quantity of food chosen at brown trays in relation to other colors (T-Test)

Discussion

Contrary to what we hypothesized, the Eastern Chipmunk did not demonstrate a great deal of color preference. Although we observed a significant preference for brown over orange trays in both groups, the majority of our comparisons found no significant color preference. We believe that further tests with larger sample sizes need to be conducted for more significant results to be found. Unfortunately, directly comparable past studies do not exist.

Our second hypothesis, that habituated chipmunks will consume larger quantities of proffered food items per visit, was not supported by our data. In fact, our data seems to suggest quite the opposite; non-habituated chipmunks consume more food per unit time than their habituated counterparts. We did notice that the totals for means total food taken seemed to reflect a trend however this was not significant. We speculate, based on our own observations, that this trend could be due to the increased population density (which would thereby increase scarcity and competition [Smith 1776]) of the habituated population. Once again, directly comparable past studies were not conducted and further study would be required to support this. However, we believe that important information could be garnered by focusing on chipmunk territoriality. The chipmunks at UMBS exhibited a variety of territorial behaviors towards our trays and each other, and we believe that further study could reveal more information regarding their feeding habits as they relate to territoriality, as suggested by Yerger (1953).

This study had several limitations, the greatest of which was sample size. With a larger sample size, the results may have been more significant. There were also a few confounding variables involving chipmunk choice that may not have been accounted for. Specifically, chipmunk choice may have been influenced by proximity to their burrow and territoriality (e.g. other chipmunks dominating a certain tray and desire to return to their first tray choice). Further studies on chipmunk color preference could shift focus towards individual preference (via adding distinguishing marks) rather than merely recording total visits of an undocumented number of chipmunks. Yet another limitation may have been the lack of randomization in pairing sites with observation times (sites A, C, E, and G were always observed before sites B, D, F, H on a given day). Chipmunks may have varied their foraging rate based on time of day. Also, according to Van Arsdel and Loop (2004) chipmunks have dichromatic color vision. This means that they can distinguish between colors, but may be limited to some degree, which may render some of our color choices irrelevant.

We believe with further testing and a larger sample size, this study could have a number of impacts. In particular, with urban development reaching unseen heights, many foraging species are being forced to adapt to the presence of human products within their foraging range, especially considering a study conducted by Martin and Reale (2008), which found that chipmunks have distinctly different behavioral patterns in response to human frequentation.

Taking the color preference theme a step further, it may also be important to show how the presence of human refuse (e.g. a colored cup, discarded food) alters foraging behavior. Glennon and Porter (2007) suggest human modifications of landscape (e.g. building gardens) can create a larger habitat for rodents including the Eastern Chipmunk. Considering this, if *Tamias striatus* are present in larger numbers, but they actively avoid a particular color (e.g. orange), people who wish to keep chipmunks out of an area such as a garden could then use this color as a deterrent.

Literature Cited

Ballard, S. (2004). The forest biome. Web site: http://www.ucmp.berkeley.edu/exhibits/biomes/forests.php#temperate

Blair, F. 1942. Size of home range and notes on the life history of the Woodland Deer-Mouse and Eastern Chipmunk in northern Michigan. Journal of Mammalogy 23: 27-36.

Coleman, A., D. Richardson, R. Schechter, D. Blumstein. 2008. Does habituation to humans influence predator discrimination in Gunther's dik-diks (*Madoqua guentheri*)? Biology Letters 4(2): 250-252.

Dominy, NJ., PA. Garber, JC. Bicca-Marques, MADO. Azevedo-Lopes. 2003. Do female tamarins use visual cues to detect fruit rewards more successfully than do males? Animal Behavior 66: 829-837.

Doucet, SM., DJ. Mennill, GE. Hill. 2007. The evolution of signal design in manakin plumage ornaments. American Naturalist 169: S62-S80.

Freeman, S. 2005. Biological science. Pearson Prentice Hall, Upper Saddle River, New Jersey, USA.

Freivalds, Z. 1978. Time of day effects on feeding strategies for the Eastern Chipmunk, *Tamias striatus*. Animal Behavior. UMBS.

Glennon, M. G., and W. F. Porter. 2007. Impacts of land-use management on small mammals in the Adirondack Park, New York. Northeastern Naturalist 14: 323-342.

Griffin, S.C., T. Valois, M.L. Taper, L.S. Mills. 2007. Effects of tourists on behavior and demography of olympic marmots. Conservation Biology 31: 1070-1081.

Kasereka, B., JB. Muhigwa, C. Shalukoma, J. Kanekwa. 2006. Vulnerability of habituated Grauer's Gorilla to poaching in the Kahuzi-Biega National Park, DRC. African Study Monographs 27(1): 15-26.

MacDonald, I. M. V. 1992. Grey Squirrels discriminate red from green in a foraging situation. Animal Behavior 43: 694-695.

Martin, J. G. A., and D. Reale. 2008. Animal temperament and human disturbance: Implications for the response of wildlife to tourism. Behavioral Processes 77: 66-72.

Mattson, D., B. Blanchard, R. Knight. 1992. Yellowstone Grizzly Bear mortality, human habituation, and Whitebark Pine seed crops. The Journal of Wildlife Management 56(3): 432-442.

Smith, A. 1776. An inquiry into the nature and causes of the wealth of nations. W.Strahan and T. Cadell, London, England, United Kingdom.

Thomsen, T. 1996. Food selection of the Eastern Chipmunk (*Tamias striatus*): a test of optimal foraging theory. Behavioral Ecology. UMBS.

Ulbrich, J., L. Reffigee, E. Cadena. 1992. Color discrimination in *Tamias striatus*. Introduction to Field Research. UMBS.

Van Arsdel, R. E., and M. S. Loop. 2004. Color vision sensitivity in normally dichromatic species and humans. Visual Neuroscience 21: 685-692.

VerCauteren, KC., and MJ. Pipa. 2003. A review of color vision in white-tailed deer. Wildlife Society Bulletin 31: 684-691.

Yerger, R. 1953. Home range, territoriality, and populations of the chipmunk in central New York. Journal of Mammology 34: 448-458.