

## **Effect of food manipulation on home range size in *Tamias striatus***

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### **Abstract**

The home range of an individual represents the spatial component of its overall fitness (Bowers, 1989). As the distribution of resources such as food changes, an animal must adjust its home range in order to maximize its fitness. Home range sizes of *Tamias striatus* (eastern chipmunks) were measured before and during a feeding manipulation. We hypothesized that home ranges would expand in response to the introduction of a new and rich food source outside of their original home ranges. Home ranges of chipmunks within 63 meters of the feeding site shifted and increased in size by 876 m<sup>2</sup> on average, while the home range of a chipmunk 143 meters from the feeding site did not change. Burrow locations remained unchanged throughout the study, while overlap among home ranges of different chipmunks increased greatly. Conspecific aggression increased sharply.

### **Introduction**

In 1943 William Burt defined home range as “the area, usually around a home site, over which the animal normally travels in search of food” (Burt, 1943). Since this first definition, the meaning of home range has evolved; in a more recent publication, home range is described as the “part of an animal's cognitive map of its environment that it chooses to keep updated” (Powell and Mitchell, 2012). Many factors influence home range sizes, but food availability is considered

a primary influence on the delineation of home ranges (Schoepf, 2015). Various ecological events can affect food availability and distribution in the habitat of an animal, and understanding the response of the animal to changes in its food sources is critical to the understanding of its ecosystem as a whole. Manipulating key resources such as food while monitoring changes in home range size allows researchers to better understand the role of those resources in the ecology of the animal (Bowers et al., 1989). Access to space and resources directly affects the fitness of individuals, and decisions made regarding occupying spaces and obtaining resources influence reproductive success (Lacher and Mares, 1996).

*Tamias striatus* (eastern chipmunk) is found in various habitats but prefers open deciduous forests. Eastern chipmunks spend much of their time foraging for food on the ground and use food caches to store seeds and nuts. They guard their home ranges, which vary in size from 800 to 6000 m<sup>2</sup> and include an underground burrow used for nesting and food storage (Kurta, 1995). Eastern chipmunks are solitary and territorial animals often acting aggressively toward other chipmunks and squirrels. The population of *T. striatus* that inhabits the campus of the University of Michigan Biological Station (UMBS) is easily observable; their home ranges extend among the classrooms, cabins, and other buildings. The animals are fairly habituated to human presence and can often be seen foraging and fighting. Their burrows are typically close to roads, pathways, and buildings on the campus.

Because eastern chipmunks do not hibernate but rather cache large amounts of food underground for winter use, it is critical that the animals use their forage time efficiently. While their foraging is typically limited to their home ranges, we investigated how eastern chipmunks respond when a new and rich food source becomes available outside of their home ranges in order to understand whether the animals can shift their home ranges. We hypothesized that

eastern chipmunks would expand their home ranges following the introduction of a food source outside of their current home ranges.

### **Materials and methods**

*Study area:* This study was conducted at the University of Michigan Biological Station in Cheboygan County, MI (45.563 °N, 84.697 °W). The area used for the study is a fraction of the campus, consisting of open deciduous forests and scattered cabins and classrooms. Pedestrians frequent the area and chipmunks are habituated to human presence.

*Unmanipulated home range mapping:* Four chipmunks were captured and various sections of their fur were shaved to allow for identification of individuals. Chipmunks were then released. Between 7/20/16 and 7/25/16, observers walked through the area inhabited by the chipmunks and mapped each sighting of each chipmunk. The location of the burrow of each chipmunk was also noted. Observations were made between 9 AM and 4 PM.

*Manipulation of home range:* Between 7/26/16 and 7/31/16, 2 cups of sunflower seeds were placed in a 3 meter line in a location outside of the home ranges of the observed chipmunks. The sunflower seeds were replenished as needed to maintain a large seed pile. The feeding site was located in an open area near a road frequented by pedestrians and cars. During this time, observers continued to note the coordinates of each sighting of the marked chipmunks.

*Data analysis:* ArcGIS (Esri, Redlands, CA) was used to map the home range of each chipmunk prior to the food manipulation and during the food manipulation. The convex hull function, which visualizes the boundary of a set of finite, planar points in the form of a simple closed polygon, was used to create each map.

### **Results**

Animals with home ranges within 63 meters of the feeding site expanded their home ranges to include the new food source, but one individual whose burrow was located 143 meters away from the feeding site did not expand its range. The three chipmunks whose burrows were located within 63 meters of the feeding site expanded and shifted their burrows in response to the food manipulation. On average, their home ranges increased in size by 876 m<sup>2</sup>, more than doubling the average size of the pre-food manipulation home ranges (Table 1). Additionally, the home ranges shifted to include more area closer to the feeding site than was previously included in the home ranges (Figure 1). Chipmunks with home ranges within 63 meters of the feeding site expanded and shifted the boundaries of their home ranges, but the burrow of each chipmunk remained the same.

Commented [DH1]: home ranges

Before the feeding manipulation, each of the home ranges of the four chipmunks was discrete and did not overlap with the home range of any other chipmunk. However, during the food manipulation, the home ranges of the three chipmunks within 63 meters of the feeding site expanded toward the same point and overlapped greatly (Figure 1). This increased contact between chipmunks and increased aggression was observed. Chipmunks frequently fought at the feeding site, and often chased each other away from the feeding site. In particular, the chipmunk whose home range was initially closest to the feeding site was observed to behave especially aggressively towards other chipmunks (Figure 1; yellow).

### Discussion

Due to the small sample size in this study (n=4), statistical tests were not performed. However, the home range map indicates that for the three chipmunks within 63 meters of the feeding source, home ranges expanded and shifted (Figure 1). Burrows did not change in

location throughout the study. Eastern chipmunks use their burrows as nest sites as well as food storage, and recreating their burrows would require a great deal of time and effort.

The feeding site was placed outside of the home ranges of the three nearest chipmunks and caused the home ranges to more than double in size (Table 1). The chipmunks expended more energy traveling between their burrows and the feeding site than they would typically expend while foraging. Despite the additional energy invested by the chipmunks in foraging at a distant food source, the benefits of an abundant food source apparently outweighed the costs associated with accessing the food source. Additionally, and perhaps more importantly, the chipmunks risked predation while foraging at the feeding site, which was located in an open area. Home range is a reflection of this tradeoff between costs and benefits of occupying a particular area at a particular time (Bowers et al., 1989). The results of this study demonstrate the importance of a plentiful food source relative to other factors affecting home range such as risk of predation and additional energy spent traveling to the food source.

However, the most important risk associated with accessing the food source during the feeding manipulation was conspecific aggression. Chipmunks were frequently observed behaving aggressively towards each other during the feeding manipulation, especially within approximately 10 meters of the feeding site and at the feeding site. Chipmunks feeding outside of their established home ranges risk injury, wasted energy, exposure to predators, and lost foraging time while fighting with other chipmunks. Chipmunks are known to fight conspicuously and often; one study calculated agonistic encounters in chipmunks at a rate of approximately 1.7 encounters/h (Getty, 1981). However, the movement of individual chipmunks typically minimizes conspecific contact, which also minimizes fighting (Getty, 1981). The frequency of conspecific encounters was not recorded in this study but multiple encounters were observed

within a 15 minute period several times, suggesting sharply increased aggression. Thus, not only were the chipmunks willing to expend additional energy to travel to the distant food source, but they were also willing to engage in conspecific aggressive behaviors sacrificing their safety, energy, and foraging time.

The chipmunk whose burrow was located 143 meters from the feeding site did not change its home range throughout the feeding manipulation. It either did not detect the feeding site, or the dangers of traveling 143 meters to the feeding site outweighed the benefits provided by the rich food source. In this instance, the difficulty of accessing the food source prevented the animal from benefitting from the advantages of doing so.

A significant limitation of this study was the small sample size, and future studies with increased sample size are necessary to verify the findings of this study. In addition to being located much further from the feeding site, the chipmunk whose burrow was 143 meters from the feeding site was also observed to benefit from human feeding, which also may have confounded the results. Another limitation of this study is the short time period over which it was conducted, which limited the amount of data that could be collected.

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**Tables and Figures**

Figure 1: Home ranges of *Tamias sciurus*.



Outlines represent pre-feeding manipulation home ranges; shaded areas represent home ranges during feeding manipulation. White dots indicate burrows and the white star marks the feeding site.

Table 1: Measurements of *Tamias sciurus* home ranges.

Symbol in fur	Distance from feeding site to Burrow (m)	Area pre-manipulation (m <sup>2</sup> )	Area during manipulation (m <sup>2</sup> )	(Area during)-(Area pre) (m <sup>2</sup> )	Color on map
MS	63	375	1266	891	Red
MR	49.5	637	1524	887	Yellow
RS, RH	62	193	1042	849	Pink
<b>Averages</b>	<b>58.17</b>	<b>401.66</b>	<b>1277.33</b>	<b>875.67</b>	
RM, RH	143	1016	536	-480	Blue