The Effects of Human Activity on the Occupancy of *Tamias striatus* in the University of Michigan Biostation

Lauren Hacias
Cailey Miller
Sulgiye Park
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Anne Axel

Abstract:

The occupancy of *Tamias striatus,* the eastern chipmunk, was measured in an area dominated by human structures as well as in a less-traversed deciduous forest at the University of Michigan Biostation on Douglas Lake. Habitat variables such as tree species composition, downed woody debris, above ground biomass, canopy coverage, leaf litter, and basal area were measured in fourteen locations at two chosen sites in order to test the assumption of no difference in forest conditions. It was found that chipmunk occupancy was higher in the area dominated by human structures while occupancy was lower in the less-traversed deciduous forest. However, as some aspects of the environment were significantly different, it was unclear whether the difference in occupancy was the result of physical environment or man-made structures

Introduction:

The eastern chipmunk (*Tamias striatus)* is a commonly spotted species at the University of Michigan Biological Station (UMBS) located around Douglas Lake in Northern Michigan. This small, burrowing rodent is distinguishable by its dark stripes that run along its back, as well as by its short furry tail (Anderson and Stephens 2002). Throughout the Eastern United States and Canada, *Tamias straitus* is predominately found in open deciduous forests and the edges of woodlands, but not in densely wooded forests (Anderson and Stephens 2002). Consequently, the eastern chipmunk utilizes rocky crevices, tree trunks, decaying logs, and fence posts to host burrow entrances. They create multiple entrances to their burrows and hide these entrances with leaves and rocks (Anderson and Stephens 2002). Burrows are used to store food, hide from predators, and as a safe place for seasonal torpor. Chipmunks remain active throughout the winter and do not hibernate (Anderson and Stephens 2002, Snyder 1982).

Tamias straitus is an omnivorous mammal that depends on a variety of foods like acorns, nuts, seeds, insects, fruit, corn, bird eggs, and occasionally small vertebrates such as young mice (Anderson and Stephens 2002, Snyder 1982). Dispersed throughout Northern Michigan, hawks, owls, falcons, weasels, snakes, and fox are the main predators of the eastern chipmunk (Anderson and Stephens 2002). *Tamias straitus* is a solitary, territorial mammal that devotedly defends its home range or small foraging area (Michael et al 1982). As a defense mechanism, the chipmunks bite intruders, make chipping or chirping sounds, or chase them away (Michael et al 1982). Even though they spend most of their day underground in their burrows, eastern chipmunks do spend time foraging for food on the forest floor (Anderson and Stephens 2002).

The omnipresence of the eastern chipmunk in the student residential areas at UMBS led us to question the relationship between the occupancy of the eastern chipmunk population and man-made structures in the camp area such as cabins, paths, stairs, trashcans, and woodpiles. From our initial observations of the student camp area known as Manville, we inferred that chipmunks are active in this area despite the presence of humans (which they might otherwise perceive as threatening), because man-made structures offer easy site burrows and provide safety when compared to less-traversed wooded areas like the surrounding woods near the Grapevine Nature Trail. For this reason, we hypothesize that human structures have a positive effect on the occupancy of the eastern chipmunk; we expect chipmunk occupancy will be higher in Manville than in a wooded area near Grapevine Nature Trail.

Methods:

Study Area:

The study sites included the Grapevine Nature Trail as our control site and the Manville even numbered cabins of Upper Drive West as our treatment site (Figure 1). The Grapevine Nature Trail represented an undisturbed deciduous forest while the Manville camp area was a human modified deciduous forest. We chose these two sites based on their similar distance from the Douglas Lake (~105m) and their nearly identical elevations. The area of each site was 150m^2 (Figure 2). Trees species in the Grapevine Nature Trail and Manville sites included sugar maple (*Acer saccharum)*, red oak (*Quercus rubra),* beech (*Fagus grandifolia),* white pine (*Pinus strobus)*, red maple (*Acer rubrum)*, big-tooth aspen (*Populus grandidentata)* and paper birch (*Betula papyrifera).*

Study Design:

To test whether chipmunk occupancy differed between a site dominated by man-made structures and a site relatively unmodified by humans, we set up a grid system and measured chipmunk presence for each site over 5 visits. We characterized the environments of the two sites by measuring the following environmental variables: temperature, canopy cover, downed woody debris, and leaf litter. We controlled for the distance from Douglas Lake and area and shape for both the Manville and Grapevine sites. We selected two sites of comparable size and divided the sites into 14 stations based on the size of student cabins. We used a Garmin GPS to locate the end points of the sampling sites and then measured and marked out a grid of fourteen sample stations in the two sites using a 50-m tape. The area of the fourteen sample stations in Manville and Grapevine was dictated by the spacing of the Manville student cabins with identical dimensions and equidistance from Douglas Lake. Because both the Manville and Grapevine Nature Trail sites were in close proximity to one another and were equidistant to Douglas Lake, we assumed that the sites had similar climatic conditions.

We used a one-meter radius to sample for tree composition and growth, downed woody debris, and leaf litter (Figure 3). This was repeated at the north and its diagonal corner of each station for both sites. Diameter at breast height (DBH) measurements were converted to above ground biomass using specific allometric equations (Monteith 1979, Bitterlich 1948). Downed woody debris, collected as the volume of fallen trees, was measured in each of the one-meter radii at the fourteen stations for the two sites. This allowed us to discover whether each site had similar living space for chipmunks, which remain close to the ground and use logs to cover burrow entrances (Moore and Swihart 2005). We measured leaf litter depth by inserting a pointed stick into the litter in three spots within each sample radius, measuring the corresponding depth, and averaging the measurements per station. Tree basal area was measured using a 10-factor prism to determine tree density from the middle of each station in both sites (Moore and Swihart 2005).

We used the densiometer to measure the canopy coverage and then averaged readings from the north, south, east, and west for a single value per sample site (Strickler 1959). By using the basal area and canopy coverage, we tested for possible differences in light intensity and temperature between the two sites. We expected tree basal area and canopy coverage may differ between the sites given that cabins consumed a large portion of the sampling unit in Manville site.

For each of the fourteen Manville stations, we positioned ourselves at the corners to view one whole station around the cabins (three people monitoring one station) and waited five minutes for the chipmunks to acclimate to our presence (Figure 4). Then we sampled chipmunk occupancy for one minute as either “present” or “not present”. We sampled all 14 Manville stations during a single session. This procedure was the same at the Grapevine stations except one person monitored the entire station to avoid frightening the chipmunks. This strategy was possible because there were no structures to compromise visibility in Grapevine (Figure 5). The Manville and Grapevine sites were visited twice a day for one week in the mid-morning and mid-afternoon for a total for 5 visits. Data was organized into Microsoft Excel and analyzed using t-tests to compare the means of the two sites.

Results

The Manville site has a mean percent occupancy of 47.1429%, while Grapevine has a mean of 1.4286% (Table 1). The average presence of the chipmunks between the two sites is statistically different (F=0.001, df=26, p<0.000). The Grapevine site had only two chipmunk sightings although chipping was frequently heard and burrows observed (Figure 7).

Tree species richness of the Manville and Grapevine sites is different (Figure 6) with Manville consisting of white pine, beech, birch, red oak, and red pine, and Grapevine consisting of sugar maple, red maple, aspen, beech, and red oak. The only tree species that appear in both sites are beech and red oak. On average, there is three times the amount of biomass above the ground in Manville (0.0039515 m^3) compared to Grapevine (0.0012942 m^3) (Monteith 1979), but the t-test reveals that the tree biomass is not significantly different between the two sites (F=0.098, df=54, p<0.001) (Table 2).

The mean basal area for Manville is 3.3 trees/hectare, and 4.8 trees/hectare for Grapevine (Table 3) (Bitterlich 1948). A significant difference between the two sites was found (F=0.021, df=26, p<0.387). The area occupied by the cross-sectional area of the trees at breast height is higher in Grapevine. Manville site has a mean canopy coverage of 90.51%, while Grapevine has a mean of 96.2486% (Table 4) (Strickler 1959). There is a statistically different relationship of canopy coverage between the two sites, with Grapevine having higher canopy coverage (F=0.000, df=26, p<0.010).

The mean for the downed woody debris in Manville is 0.005086 m^3 and 0.008296 m^3 in Grapevine (Table 5). There is no statistically significant difference between the measured downed woody debris found between the two sites ($F=0.309$, $df=26$, $p<0.733$). The mean for the leaf litter in the Manville site is 2.7 cm and 3.9 cm in Grapevine (Table 6). There is a significant difference in leaf litter for the two sites ($F=0.004$, $df=54$, $p<0.001$) There is more leaf litter in the Grapevine site.

Discussion

The lower chipmunk occupancy in Grapevine can be explained by the physical factors we measured considering the evidence that Grapevine has a different tree composition, canopy coverage and basal area than the Manville site. For instance, the greater canopy coverage in Grapevine could have reduced light reaching the ground to an unfavorable point (Anderson and Stephens 2002). Although we do not feel that Grapevine is a "dark" area, it did not include the wide-open, cleared spaces that border each student cabin in Manville. Even though we recorded more chipmunks at Manville than at Grapevine, we do not doubt that there is a higher occupancy at Grapevine Nature Trail than we observed during this study. Chipping was frequently heard and burrows were noted at both sites although they were not recorded.

The different tree types at Grapevine could have made for a less ideal environment if they did not produce as much food as the trees in Manville. Maple and oak species of trees are considered a preferred food source for chipmunks (Chervenak 2008). This conflicts with our data, as we did not observe maple species in our Manville sample sites, where we found a higher occupancy of chipmunks. We did observe maples throughout the Manville site, but there were not many in the sampling station; the present trees are large enough to occupy most of our sampling radius.

We believe that other food sources and safety created by the man-made structures could influence the chipmunks' preference of home range (Bowers1995). Furthermore, we noted that there is increasing number of students feeding the chipmunks in the Manville site. This could have affected our results by drawing more chipmunks to the feeding sties (Mares et al 1976). Other researchers found that chipmunks' home ranges are strongly affected by food availability, as their home ranges decrease with increased chipmunk density around food sources (Mares et al 1976). Distance travelled from burrow entrances have also been found to affect chipmunk foraging behavior. Individuals attempt to maximize foraging efficiency by choosing areas where food availability is greatest within the least distance from their burrows (Bowers 1995). It could be possible that the burrows are closer to food sources in Manville or the home ranges are larger in Grapevine Nature Trail.

Our measurements on the ground coverage include the downed woody debris and leaf litter, each of which reveals different information. Downed woody debris is the same between the two sites, indicating that although the Manville site is inherently clearer, the amount of ground coverage is comparable between the two sites. This infers that there are similar amounts of open space for chipmunks in both areas to inhabit. On the other hand, leaf litter is deeper in Grapevine compared to the Manville site. The deeper leaf litter in Grapevine might not be preferred by chipmunks as they have to dig deeper to reach the ground for burrows and foraging, making them more preoccupied and susceptible to predators. On the other hand, the leaf litter could be beneficial providing greater protection from predators while foraging.

The limitations to our research are the result of daily weather conditions and a lack of allotted experimental time. Weather influenced our data collection heavily as the first data collection occurred during high winds and few wild animals were noted at both sites. The number of opportunities to collect samples was decreased with increasingly damp and rainy days. We believe that more sampling sessions could have improved our data, especially at the Grapevine site. Also, human presence is uncommon at the Grapevine site, which influenced their behavioral instinct to avoid the intrusion. It’s important to note that there was another experiment taking place on the same site we used in Grapevine; therefore, other researchers could have negatively impacted chipmunk behavior by frightening them.

Considering these complications, future research could be more effective if trappings or other variables such as burrow entrance counts, call counts, or scat collections are recorded. To better understand chipmunk occupancy and distribution, actual population counts and location of food sources could be mapped. Utilizing the occupancy and ecology of the chipmunks could influence pest management. Man-made structures and landscaping could be altered to minimize the populations of chipmunks by decreasing possible burrow sites. Also, understanding their occupancy could reduce accidental deaths of chipmunks by vehicles in camp. It remains unclear whether the Grapevine site is not suitable for chipmunk occupancy or the Manville site is preferred because of the presence of man-made structures. Despite this, we believe that our data supports a higher occupancy of chipmunks at the Manville site, and future research about their environment is needed to further support our findings.

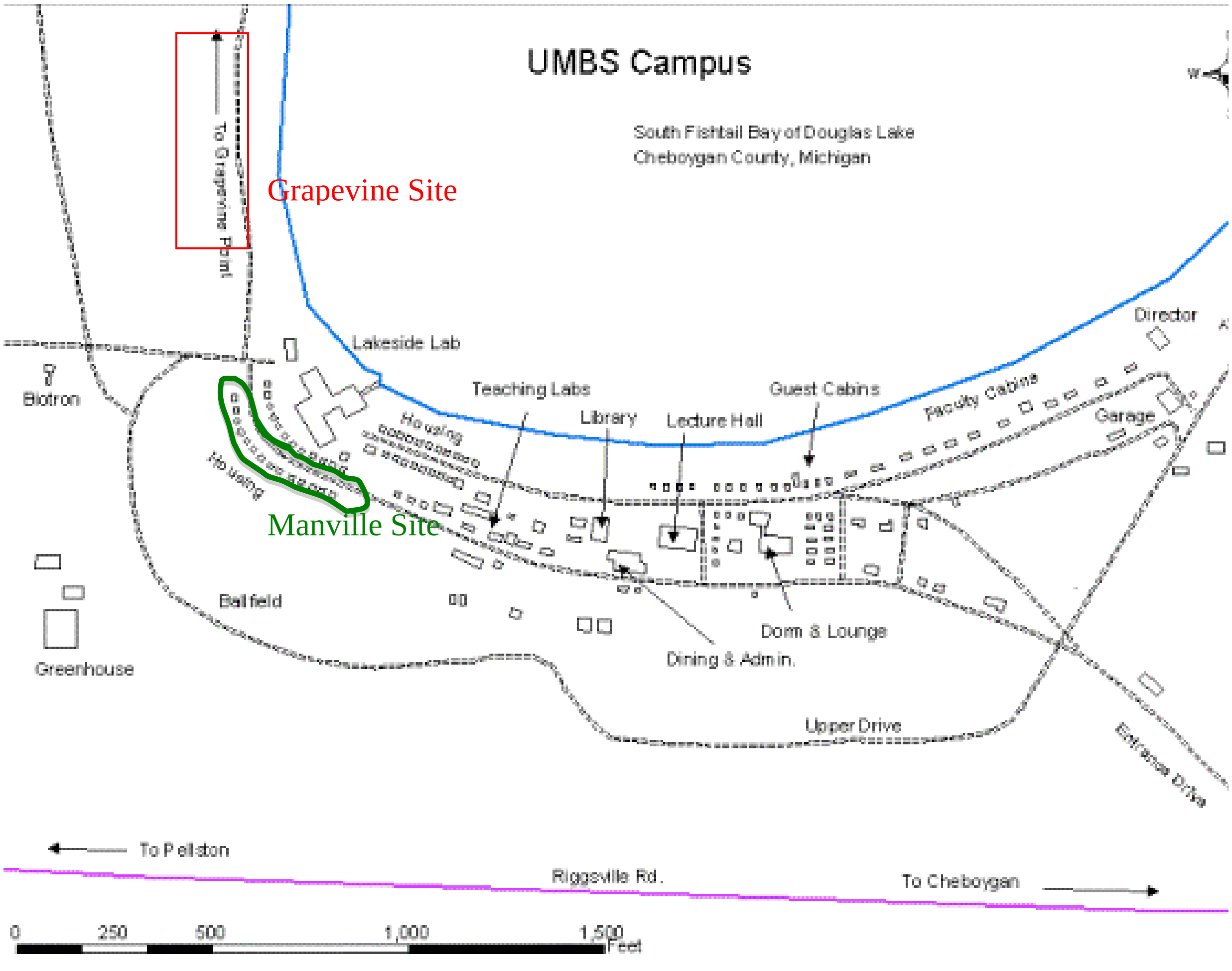

Figure 1: Study Areas

Figure 2: Distance from Douglas Lake and Area Size

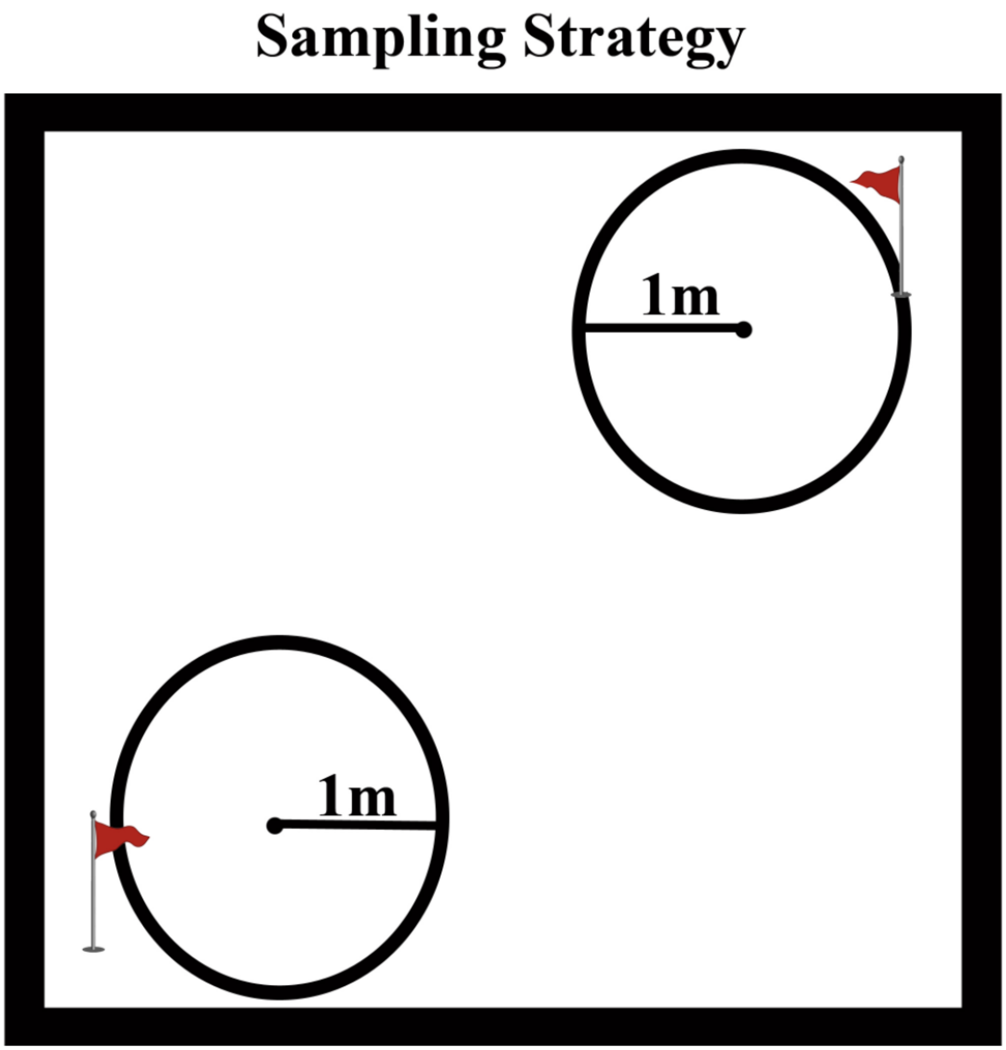

Figure 3: Sampling Strategy

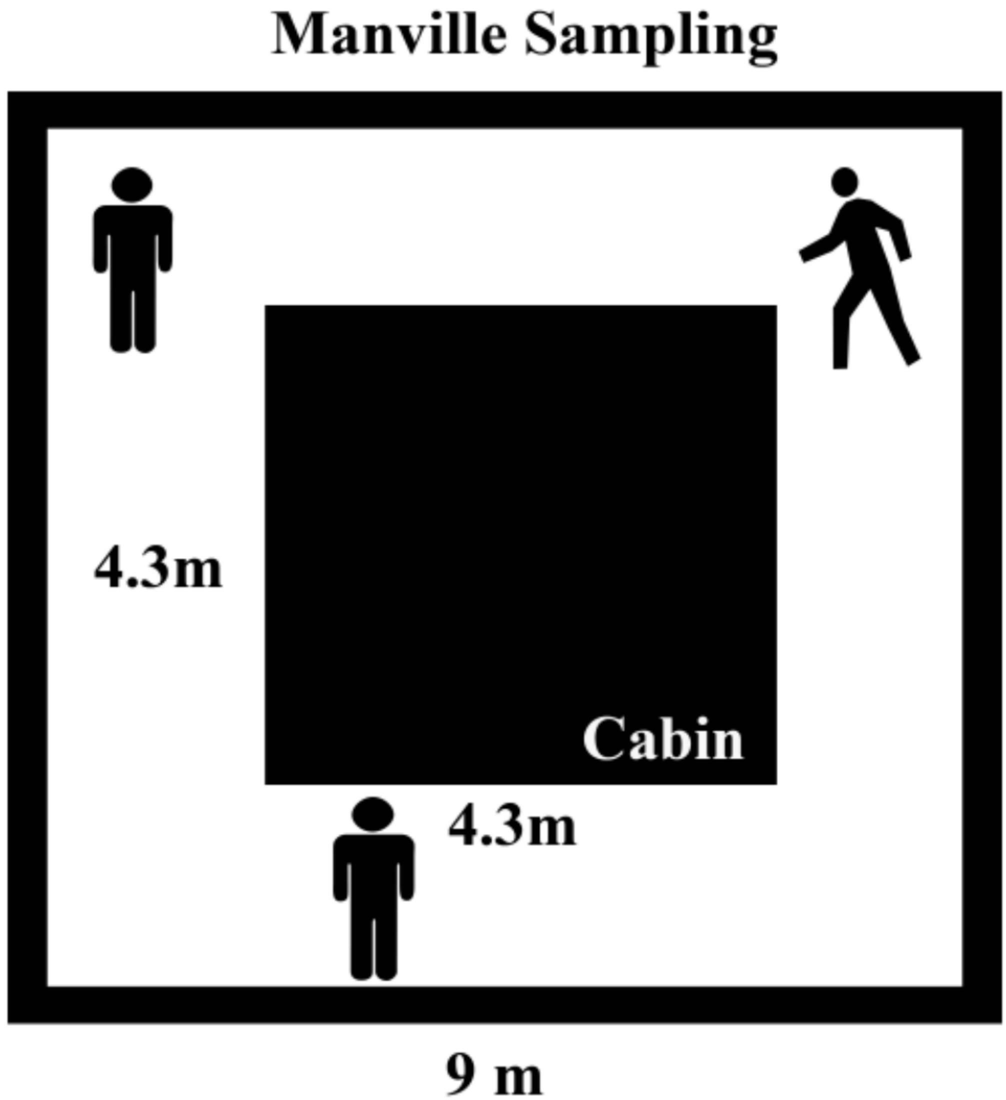

Figure 4: Manville Strategy

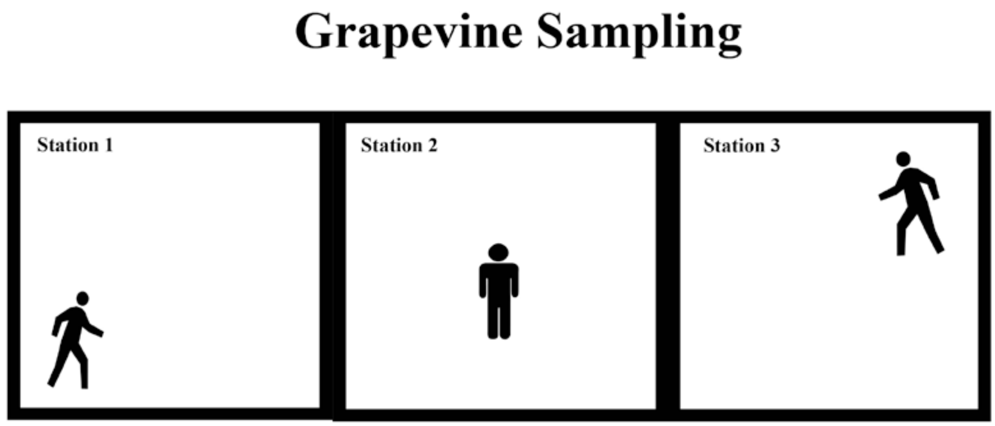

Figure 5: Grapevine Nature Trail Strategy

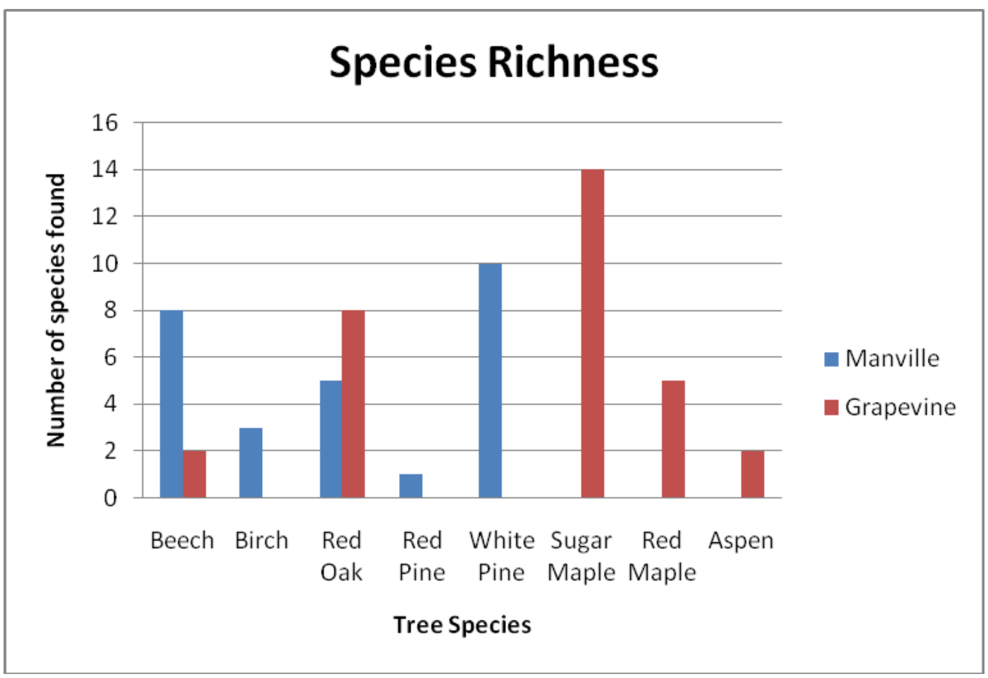

Figure 6: Tree Species Composition and Richness in Manville Site vs. Grapevine Nature Trail

Table 1: Percent Occupancy of Chipmunks

Percent Occupancy of Chipmunks	**Mean (%)**	**Levene's test for equal variances**	**df**	**Independent t-test p value (α=0.05)**
Manville	47.1429	0.000	26	0.000
Grapevine	1.4286			

Table 2: Biomass from DBH

Biomass from DBH	**Mean (cm^3)**	**Levene's test for equal variances**	**df**	**Independent t-test p value (α=0.05)**
Manville	3951.487633	0.001	54	0.098
Grapevine	1294.204726			

Table 3: Basal Area

Basal Area	**Mean (Hectare)**	**Levene's test for equal variances**	**df**	**Independent t-test p value (α=0.05)**
Manville	3.3179	0.387	26	0.021
Grapevine	4.8441			

Table 4: Canopy Coverage

Canopy Coverage	**Mean (%)**	**Levene's test for equal variances**	**df**	**Independent t-test p value (α=0.05)**
Manville	90.51	0.010	26	0.000
Grapevine	96.2486			

Table 5: Downed Woody Debris

Downed Woody Debris	Mean (cm^3)	Levene's test for equal variances	df	Independent t-test p value (α=0.05)
Manville	5089.0989	0.733	54	0.309
Grapevine	8295.7571			

Table 6: Leaf Litter

Leaf Litter	Mean (cm)	Levene's test for equal variances	df	Independent t-test p value (α=0.05)
Manville	2.6536	0.001	54	0.004
Grapevine	3.9942			

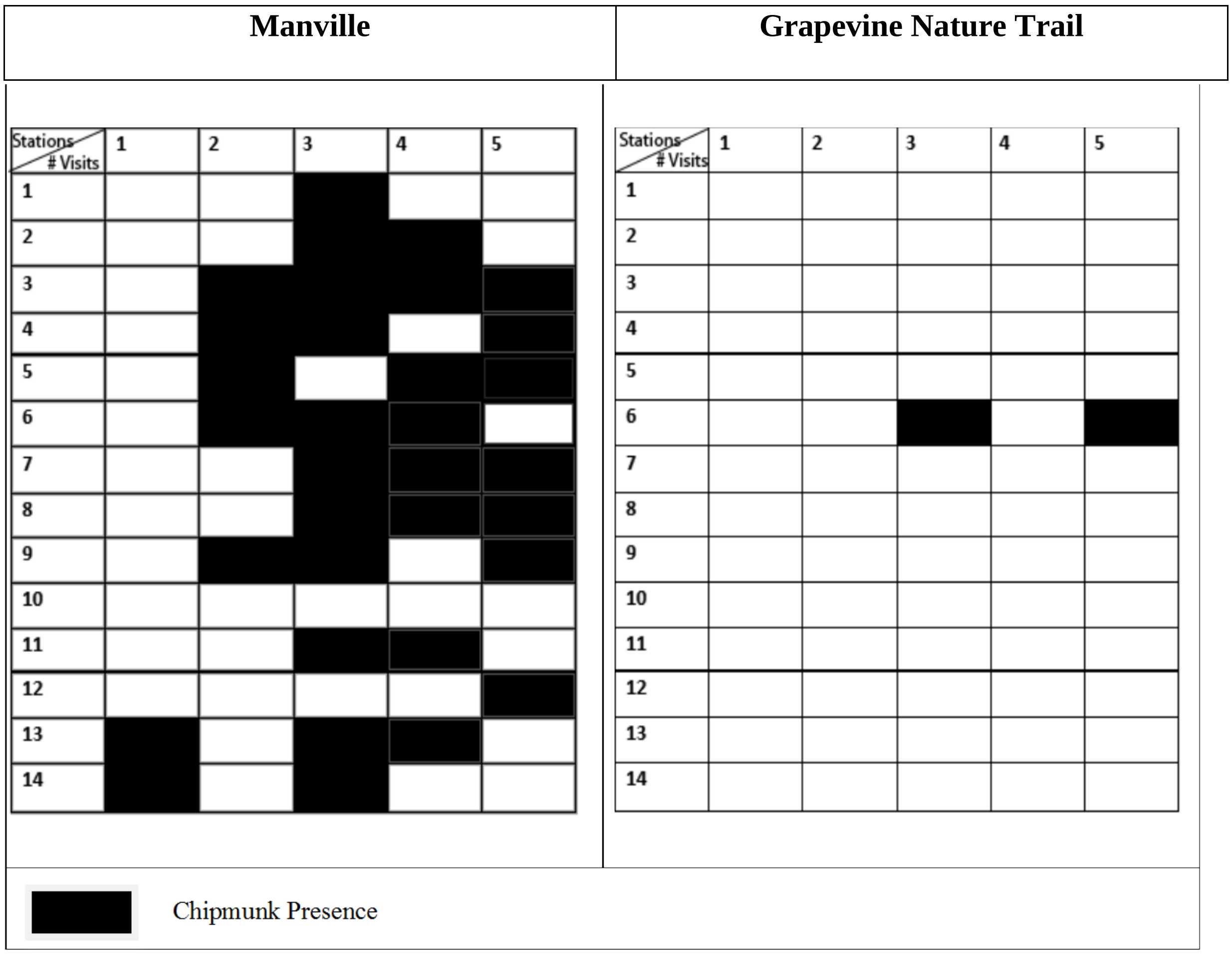

Figure 7: Chipmunk Occupancy for 5 visits

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