TREE HABITAT CHARACTERISTICS OF

RED SQUIRRELS (*TAMIASCIURUS HUDSONICUS*) AND EASTERN

CHIPMUNKS (*TAMIAS STRIATUS*) IN NORTHERN HARDWOOD FORESTS

BIOS 569: Practicum in Field Biology

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Abstract

Red squirrels (*Tamiasciurus hudsonicus*) and eastern chipmunks (*Tamias striatus*) can have economic impacts on humans through their influences on tree species populations, use as part of the fur industry, and control of insect populations. The densities of red squirrels and eastern chipmunks in different forest types at UNDERC (balsam-fir dominated, sugar maple-dominated, and a mix of the two) were estimated to determine species-specific habitat preferences. Because previous research suggested red squirrels prefer nesting in coniferous stands, I hypothesized that they would prefer balsam fir (*Abies balsamea*) and eastern hemlock (*Tsuga canadensis*) stands. Because previous research suggested eastern chipmunks prefer sugar maple (*Acer saccharum*) seeds and the dry areas where sugar maple is found, I hypothesized that they would prefer sugar maple stands. Eastern chipmunks were captured least often in sugar maple-dominated forests and approximately equally in balsam fir-dominated forests and in mixed stands. Both the relative abundance and density of sugar maple appeared to have inverse relationships on eastern chipmunk density. Because few red squirrels were captured, the preferences of the most commonly captured rodent, the deer mouse (*Peromyscus maniculatus*), were examined. Although deer mouse densities did not differ among the three forest types, their densities were lower in forests with greater relative abundances of trembling aspen (*Populus tremuloides*) and eastern hemlock. Furthermore, eastern hemlock density and deer mouse density appeared to be inversely related and balsam fir density and deer mouse density appeared to be directly related. These trends could be due to the thicker understory of the balsam fir-dominated sites. Further research could involve the effect of the thickness of the understory on sciurid and deer mouse densities.

Introduction

The growing economic importance of the timber industry has increased the need for effective ways to survey the growth and mortality of different tree species populations. Because chipmunks and squirrels, henceforth referred to as sciurids, can be predators and dispersers of tree seeds, they can affect tree species populations by consuming many seeds of certain tree species and few of other tree species (Peters 2003, Janzen 1971). Therefore, the seed preferences of squirrels and chipmunks can potentially increase or decrease the populations of specific tree species.

Two sciurids found on the UNDERC property are red squirrels (*Tamiasciurus hudsonicus*) and eastern chipmunks (*Tamias striatus*). In addition to the repercussions of sciurid preferences on the timber industry, red squirrel populations are also economically important to humans because 1-3 million red squirrels are harvested annually in Canada for their fur and are considered the foundation of the fur trade in Alberta (Rusch 1978). Red squirrels have also been known to destroy crops and young trees (Ellis 1999). Therefore, knowledge of which tree species red squirrels prefer can make it easier for farmers to be mindful of whether red squirrels are likely to pose a threat to their crops in storage or young trees on plantations. Eastern chipmunk populations are also economically important to humans because they help control certain insect populations (Anderson 2002). Therefore, knowledge of which tree species eastern chipmunks prefer as habitat can enable humans to deal with pest problems in a more efficient manner.

In this study, I measured the densities of red squirrels and eastern chipmunks in different forest types to examine where both are most likely to be found. Previous research suggests that red squirrels prefer coniferous habitats and nest in conifer stands, often of grass and shredded bark (Kurta 1995, Rusch 1978, Whitaker 1998). Therefore, I expected the highest red squirrel densities to be found where balsam fir (*Abies balsamea*) and eastern hemlock (*Tsuga canadensis*) are the dominant tree species and the lowest densities to be found where sugar maple (*Acer saccharum*) and trembling aspen are (*Populus tremuloides)* dominant.

Eastern chipmunks prefer sugar maple seeds to those of other tree species in this region (Humphries et al. 2002, Whitaker 1998). Furthermore, sugar maple is found in dry, upland areas conducive for burrowing (Barnes and Wagner 2002). Therefore, I expected the highest eastern chipmunk densities where sugar maple and trembling aspen are the dominant tree species and the lowest densities where balsam fir and eastern hemlock are dominant.

Materials and Methods

Trapping

Data was collected at 15 different trapping sites over three separate weeks in the summer of 2005. Five sites were examined each week. Each site consisted of a 4500 m^2 (ca. 45 m x 100 m) plot on the UNDERC property. The sites were selected based on dominant tree species, with particular emphasis on balsam fir, eastern hemlock, sugar maple, and trembling aspen to ensure there was a gradient of relative tree species abundances. Five sugar maple-dominated stands, five balsam fir-dominated stands, and five mixed stands were chosen. For each trapping area, red squirrel and eastern chipmunk densities were compared to the relative abundance and density of each tree species. The 4500 m^2 plot size should have been a large enough area to obtain accurate densities because red squirrel territories average 6200 m^2 (Kurta 1995) and up to 10 squirrels can inhabit an area that is approximately 4100 m^2 (Whitaker 1998). Eastern chipmunk territories are smaller and average 700 m^2 (Kurta 1995, Whitaker 1998). I established four 100-m transects at 15 m intervals within each plot (0, 15, 30, 45 m). For each transect, 10 Sherman traps were placed on the forest floor every 10 m and three Tomahawk traps were evenly distributed along the 100-m transect lines. All traps were baited with rolled oats and peanut butter.

Squirrels and chipmunks were marked by a numbered metal ear tag (No. 1, National Band and Tag Co., Newport, KY). The date, time, location, weather conditions, species, gender, age, reproductive condition, weight, tag number, measurements, trap type, and a detailed description of the surrounding microhabitat were recorded. Trapping was conducted at each site for five consecutive trap nights (Vander Wall 1992). The five specific days used for trapping were selected based on weather conditions (drier, warmer weather is ideal). Because eastern chipmunks and red squirrels are diurnal, traps were checked at dawn and then checked again nine hours later (Mahan and Yahner 1998). If any other small mammals were captured, all the aforementioned data would be collected; however, the animal would not be tagged. If a large number of another species was captured, its preferred habitat would also be examined.

Vegetation Surveys

Tree surveys were conducted to estimate the relative abundance and density of the four common tree species (balsam fir, eastern hemlock, sugar maple, and trembling aspen) in each trapping area. Trees with a DBH of 5 cm or larger were included. Relative abundances and densities were estimated using 5-m circular plots at 0, 50 and 100 m along odd transects and at 33 and 67 m along even transects. Trees with at least half of their area in each 5 m plot were recorded.

Statistical Analysis

Linear regressions were used to compare the densities of captured small mammals to the relative abundance of the four common tree species in each trapping site. Linear regressions were also used to compare small mammal and tree species densities. ANOVA was used to compare small mammal densities between the three different forest types.

Results

Because only two red squirrels were captured, the sample size was not large enough to merit any statistical testing. However, 64 deer mice (*Peromyscus maniculatus*), 12 chipmunks, six southern red-backed voles (*Clethrionomys gapperi*), one northern flying squirrel (*Glaucomys sabrinus*), and one masked shrew (*Sorex cinereus*) were captured in trapping (Table 1). The number of deer mice and eastern chipmunks captured allowed statistical tests to be conducted to determine tree habitat characteristics of these species.

Tree Species Relative Abundance

The highest densities of eastern chipmunks were found at balsam fir-dominated sites (Table 2). Furthermore, sites that were predominantly balsam fir contained significantly higher chipmunk densities than sites that were predominantly sugar maple ($t = 2.806$, $df = 4$, $p = 0.0485$, Fig. 1). However, mixed sites did not contain significantly different chipmunk densities from that of balsam fir ($t = 2.436$, $df = 4$, $p = 0.0915$, Fig. 1) or sugar maple sites ($t = 1$, $df = 4$, $p = 0.3739$, Fig. 1). A marginally significant inverse relationship was found between sugar maple relative abundance and chipmunk density ($t = -1.781$, $df = 1$, $p = 0.098$, Table 3). Chipmunk densities were not significantly affected by the relative abundance of eastern hemlock ($t = 0.749$, $df = 1$, $p = 0.948$, Table 3), balsam fir ($t = 1.711$, $df = 1$, $p = 0.558$, Table 3), or trembling aspen ($t = -0.388$, $df = 1$, $p = 0.383$, Table 3).

Deer mouse densities did not differ significantly among forest types ($t = 0.4768$, $df = 4$, $p = 0.6584$, Fig 2). Marginally significant inverse relationships were found between trembling aspen relative abundance and deer mouse density ($t = -1.869$, $df = 1$, $p = 0.084$, Table 4) and between eastern hemlock relative abundance and deer mouse density ($t = -1.65$, $df = 1$, $p = 0.123$, Table 4). Deer mouse densities were not significantly affected by the relative abundance of balsam fir ($t = 0.863$, $df = 1$, $p = 0.404$, Table 4) or sugar maple ($t = 0.497$, $df = 1$, $p = 0.628$, Table 4).

Tree Species Density

Chipmunk densities were lowest at sites containing the greatest density of sugar maple (Table 2). A marginally significant inverse relationship was found between sugar maple and chipmunk densities ($t = -1.63$, $df = 1$, $p = 0.127$, Table 5). Chipmunk densities were not significantly affected by the total density of eastern hemlock ($df = 1$, $p = 0.822$, Table 5), balsam fir ($df = 1$, $p = 0.409$, Table 5), or trembling aspen ($df = 1$, $p = 0.450$, Table 5).

A strong relationship was found between an increase in balsam fir density and an increase in deer mouse density ($t = 3.135$, $df = 1$, $p = 0.009$, Table 6). A significant inverse relationship was also found between eastern hemlock and deer mouse densities ($t = -2.187$, $df = 1$, $p = 0.049$, Table 6). No significant relationship could be found between deer mouse density and trembling aspen density ($df = 1$, $p = 0.619$, Table 6) or between deer mouse density and sugar maple density ($df = 1$, $p = 0.188$, Table 6).

Discussion

The finding that sugar maple-dominated forests do not support higher eastern chipmunk densities than mixed or balsam fir-dominated forests is unexpected. Previous research indicates that sugar maple-dominated stands contain the highest chipmunk densities (Humphries et al. 2002, Whitaker 1998).

These studies concluded that sugar maple seeds are the preferred food source of eastern chipmunks throughout northern hardwood forests such as those found on the UNDERC property. However, the balsam fir sites tended to have a thicker understory than the sugar maple sites. This could provide chipmunks with more protection from predators and thus permit a greater density of chipmunks in balsam fir stands relative to their density in sugar maple stands, which tended to be much more open.

Furthermore, trapping error could have played a large part in the unexpected results due to the small number of chipmunks captured. Also, if eastern chipmunks prefer sugar maple seeds, they could have had such a readily available preferred food source in the sugar maple stands that they had little reason to enter the traps in the sugar maple stands (Whitaker 1998). They had more reason to enter the traps in the balsam fir-dominated stands, however, due to a limited preferred food source (Humphries 2002).

The greater density of deer mice in balsam fir-dominated stands could also be due to the thickness of the understory in these sites. These sites tended to have more downed logs, snags, and other forms of habitation for deer mice (Mara Irby and Kathleen McAvoy, personal communication). The finding that there appears to be a smaller density of deer mice in areas with a lower density of eastern hemlock could be due to the tendency of eastern hemlock to be found in very wet areas. Deer mice would have trouble burrowing underground in such areas. Deer mice were not marked; therefore, their actual densities may be lower than is suggested by the results of this project.

The small number of red squirrels captured could be due to the relatively large territory size of the species, a low population density on the UNDERC property, and/or the plentiful amount of alternate food supplies during the summer months. Because food was readily available for red squirrels during the time of trapping, they might not have had to search for food in unusual places such as traps. Furthermore, 40 of the 52 traps at every site were Sherman traps with doors barely large enough for a red squirrel to climb inside.

If eastern chipmunks do indeed prefer balsam fir, eastern hemlock, and trembling aspen to sugar maple, the increasing number of forests that are predominantly composed of sugar maple could decrease the area of preferred habitat of the eastern chipmunk (Doudrick 2005). Furthermore, a decrease in the number of non-sugar maple dominated forests could lead to increased number of insect pests because eastern chipmunks are a natural predator of these insects.

Future research into which forest types are preferred by red squirrels and eastern chipmunks would be more successful with larger trapping plots and longer trapping periods. Eastern chipmunks, and especially red squirrels, have large territories; therefore, a trapping area of more than 4500 m^2 could have made a difference in the number of small mammals captured. The red squirrels and eastern chipmunks tended to be caught later in the trapping period, perhaps as the mammals became less weary of the traps and time had passed since a new disturbance was added to the forest. Therefore, possibly more sciurids would have been captured if the traps had been pre-baited. Sciurids could have entered and left the traps for four to five days and then the traps would have been set to close. Finally, the majority of the red squirrels and eastern chipmunks captured were caught in Tomahawk traps. Therefore, the use of more than 12 Tomahawks per trapping site could have increased the number of sciurids captured. Further research could involve a comparison of Tomahawk and Sherman trap success at catching sciurids. Other research could be conducted to determine whether or not understory density has a direct effect on small mammal density as is suggested by the findings of this research.

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Tables

Table 1. Small mammals captured in trapping.

Site Number	CLGA	PEMA	SOCI	TAHU	TAST	GLSA
1	0	6	0	0	0	0
2	1	13	0	1	5	0
3	0	4	0	0	3	0
4	0	4	0	0	0	0
5	0	4	0	0	1	0
6	0	2	0	0	0	0
7	0	1	0	0	0	0
8	2	3	0	0	1	1
9	0	4	0	0	0	0
10	0	0	0	0	1	0
11	3	2	1	0	0	0
12	0	6	0	0	1	0
13	0	10	0	0	0	0
14	0	0	0	0	0	0
15	0	5	0	1	0	0

Table 2. Relative abundances and densities (number of trees/100 m^2) of tree species compared with number of chipmunks and deer mice captured per trap night.

Site Number	Stand Type	Eastern Hemlock Rel. Ab.	Balsam Fir Rel. Ab.	Trembling Aspen Rel. Ab.	Sugar Maple Rel. Ab.	Eastern Hemlock Density	Balsam Fir Density	Trembling Aspen Density	Sugar Maple Density	Chipmunks Caught/Trap Night	Deer Mice Caught/Trap Night
1	Sugar Maple	0.01	0	0	0.83	0.12733	0	0	10.5682	0	0.023077
2	Balsam Fir	0.016949	0.584746	0	0.177966	0.25466	8.02164	0	2.67388	0.019231	0.046154
3	Mixed	0	0.377049	0.147541	0.442623	0	2.92854	1.14594	3.43784	0.014423	0.019231
4	Mixed	0	0.326923	0.019231	0.596154	0	2.16457	0.12732	3.94715	0	0.015385
5	Sugar Maple	0	0.014706	0.014706	0.926471	0	0.25465	0.12732	8.02164	0.003846	0.015385
6	Sugar Maple	0	0.028986	0	0.956522	0	0.25465	0	8.40362	0	0.009615
7	Mixed	0	0.364865	0.013514	0.527027	0	3.18319	0.12732	4.96578	0	0.009615
8	Balsam Fir	0.054054	0.45045	0	0.378378	0.76397	6.36638	0	5.34776	0.003846	0.011539
9	Sugar Maple	0	0.039474	0.381579	0.460526	0	1.52793	3.69250	4.45647	0	0.015385
10	Balsam Fir	0.504065	0.227642	0.203252	0.04065	7.89432	3.56517	3.18319	0.63663	0.01	0
11	Balsam Fir	0.238532	0.284404	0.082569	0.293578	3.31052	3.94715	1.14594	4.07448	0	0.007692
12	Balsam Fir	0.011765	0.952941	0.011765	0.023529	0.12733	10.31354	0.12732	0.25465	0.003846	0.023077
13	Sugar Maple	0	0	0.025316	0.974684	0	9.80423	0.25465	9.80423	0	0.038462
14	Mixed	0	0.057143	0.414286	0.485714	0	0.50931	2.03724	3.94715	0	0
15	Mixed	0.044118	0.282353	0.191176	0.279412	0.38198	2.03724	1.65526	2.41922	0	0.009615

Table 3. "P" values of the linear regression of eastern chipmunk density vs. tree species relative abundance.

	Effect	Std Error	Std Coef	df	F	'P'
In						
1	Constant					
5	MAPLE REL. ABUNDANCE	0.005	-0.443	1	3.171	0.098
Out						
2	HEMLOCK REL. ABUNDANCE	.	.	1	0.004	0.948
3	FIR REL. ABUNDANCE	.	.	1	0.364	0.558
4	ASPEN REL. ABUNDANCE	.	.	1	0.819	0.383

N: 15   Multiple R: 0.443   Squared multiple R: 0.196

Adjusted squared multiple R: 0.134   Standard error of estimate: 0.006

Effect	Std Error	Std Coef	T	P(2 Tail)
CONSTANT	0.003	0.000	2.836	0.014
MAPLE REL. ABUNDANCE	0.005	-0.443	-1.781	0.098

Table 4. “P” values of the linear regression of deer mouse density vs. tree species relative abundance.

	Effect	Std Error	Std Coef	df	F	'P'
In						
1	Constant					
4	ASPEN REL. ABUNDANCE	0.022	-0.460	1	3.493	0.084
Out						
2	HEMLOCK REL. ABUNDANCE	.	.	1	2.178	0.166
3	FIR REL. ABUNDANCE	.	.	1	0.143	0.712
5	MAPLE REL. ABUNDANCE	.	.	1	0.006	0.938

N: 15   Multiple R: 0.460   Squared multiple R: 0.212

Adjusted squared multiple R: 0.151   Standard error of estimate: 0.012

Effect	Std Error	Std Coef	T	P(2 Tail)
CONSTANT	0.004	0.000	5.452	0.000
ASPEN REL. ABUNDANCE	0.022	-0.460	-1.869	0.084

Table 5. "P" values of the linear regression of eastern chipmunk density vs. tree species densities.

	Effect	Std Error	Std Coef	df	F	'P'
In						
1	Constant					
5	MAPLE DENSITY	0.000	-0.412	1	2.657	0.127
Out						
2	HEMLOCK DENSITY	.	.	1	0.053	0.822
3	FIR DENSITY	.	.	1	0.731	0.409
4	ASPEN DENSITY	.	.	1	0.610	0.450

N: 15 Multiple R: 0.412 Squared multiple R: 0.170

Adjusted squared multiple R: 0.106 Standard error of estimate: 0.006

Effect	Std Error	Std Coef	T	P(2 Tail)
CONSTANT	0.003	0.000	2.685	0.019
MAPLE DENSITY	0.000	-0.412	-1.630	0.127

Table 6. "P" values of the linear regression of deer mouse density vs. tree species density.

	Effect	Std Error	Std Coef	df	F	'P'
In						
1	Constant					
2	HEMLOCK DENSITY	0.000	-0.427	1	4.783	0.049
3	FIR DENSITY	0.000	0.613	1	9.831	0.009
Out						
4	ASPEN DENSITY	.	.	1	0.262	0.619
5	MAPLE DENSITY	.	.	1	1.966	0.188

N: 15   Multiple R: 0.736   Squared multiple R: 0.542

Adjusted squared multiple R: 0.466   Standard error of estimate: 0.009

Effect	Std Error	Std Coef	t	P(2 Tail)
CONSTANT	0.004	0.000	2.774	0.017
HEMLOCK DENSITY	0.000	-0.427	-2.187	0.049
FIR DENSITY	0.000	0.613	3.135	0.009

Figures

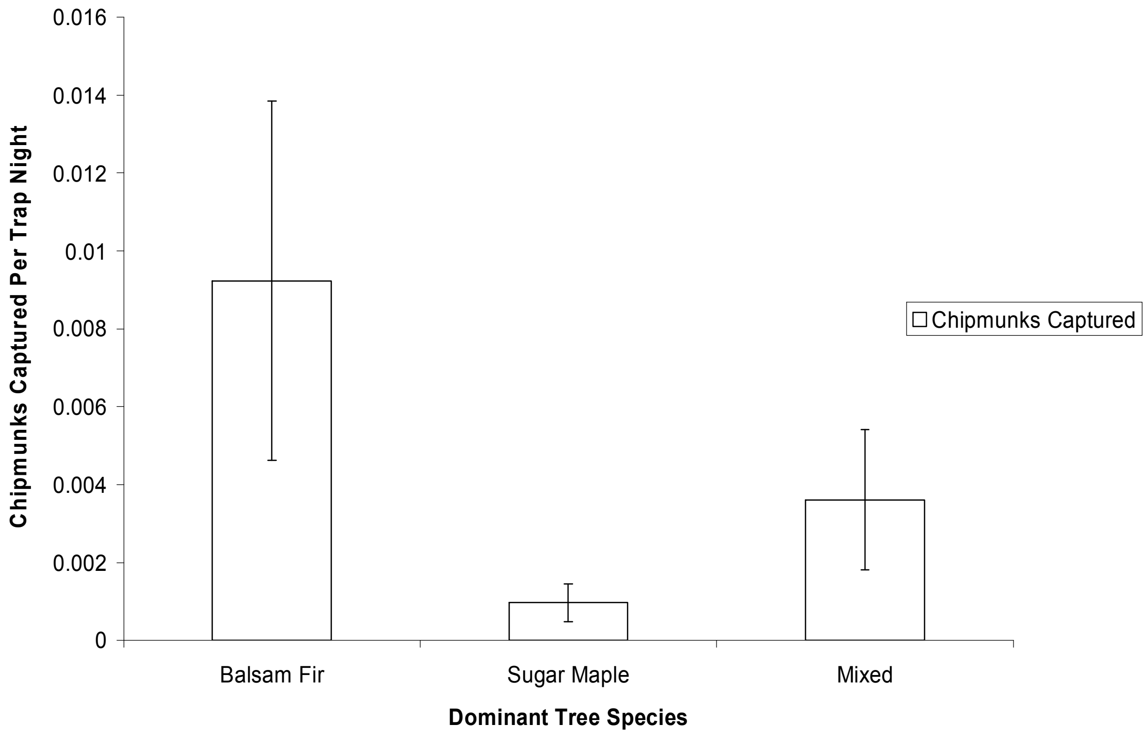

Figure 1. Chipmunk densities based on predominant tree species of trapping site. The balsam fir sites contained significantly greater densities of chipmunks than did the sugar maple sites ($p<0.05$). Mixed sites did not significantly differ from balsam fir or sugar maple sites in chipmunk density.

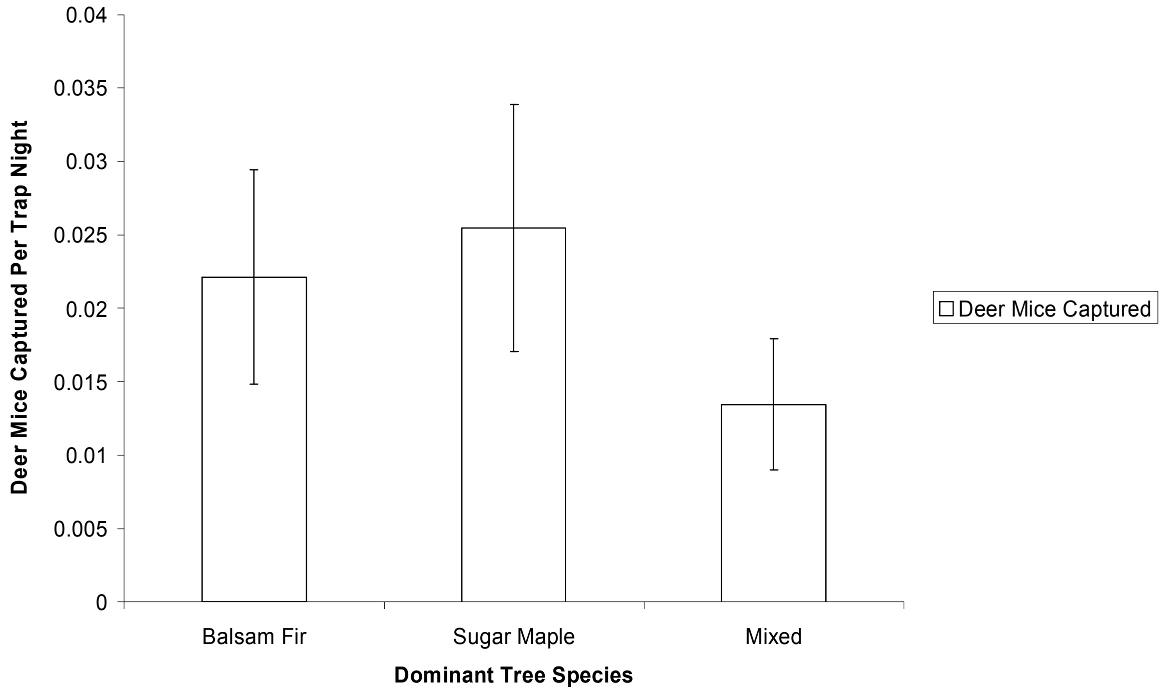

Figure 2. Deer mouse densities based on predominant tree species of trapping site. All three forest types contained roughly the same density of deer mice. None of the forest types differed significantly in deer mouse densities ($p>0.05$).