THE ROLE OF FOREST STRUCTURES ON HABITAT SELECTION BY RED SQUIRRELS (*TAMIASCIURUS HUDSONICUS*) AND EASTERN CHIPMUNKS (*TAMIAS STRIATUS*)

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Abstract

Small mammals use forest structures such as snags and logs for nesting sites, food hoarding, and shelter from predators. In this study, red squirrel (*Tamiasciurus hudsonicus*) and eastern chipmunk (*Tamias striatus*) densities were studied as a function of physical habitat characteristics. Red squirrels and eastern chipmunks were surveyed at 15 sites for five consecutive nights. Due to low capture success, red squirrel density could not be determined. However, deer mice (*Peromyscus maniculatus*) were frequently caught and their densities were determined. Eastern chipmunk density increased with increasing average snag DBH and log diameter at the trapping sites. Deer mouse density increased significantly with increasing snag DBH, but deceased significantly with increasing snag height. Deer mice may use shorter snags with larger diameters for nesting and food caching sites, however taller snags can cause canopy gaps, which may allow predators to detect their movement more effectively. Future studies should determine the significance of other habitat characteristics such as canopy cover and soil type, which would lead to better forest management of small mammals.

Introduction

Red squirrels (*Tamiasciurus hudsonicus*) and eastern chipmunks (*Tamias striatus*) are among the most widely distributed small mammals of the northeastern United States forests (Kurta, 2003). These mammals reside in similar areas but have different specific habitat preferences. Red squirrels are territorial, with average territory sizes of 7600 m^2 (Steury and Murray, 2003). They tend to prefer coniferous forests over deciduous and will often nest and store food in snags or fallen trees (Rusch and Reeder, 1978). Snags are dead standing trees which often have cavities from decay or from animals such as woodpeckers. If no suitable nesting site is present, the red squirrel will make tree nests out of grass, shredded bark, twigs, and leaves (Whitaker, 2000). Eastern chipmunks are also territorial, with average territory sizes of 800 m^2 (Steury and Murray, 2003). They prefer open, deciduous forest types to conifer stands. Eastern chipmunks burrow and store food in woody slopes, stumps, forest edges, and areas with brush cover. Unlike the red squirrel, the eastern chipmunk prefers the ground, only climbing trees if no food is available at ground level (Kurta, 2003). Chipmunks thus prefer to nest and cache their food in or under fallen trees or at the base of stumps.

In this study, relationships between habitat characteristics and densities of red squirrels and eastern chipmunks were analyzed. I hypothesized that red squirrel density would be higher in plots where more conifers are present because red squirrels prefer to nest in and feed on the cones of conifers. In addition, I predicted that areas with higher densities of snags would have higher red squirrel density. I also hypothesized that areas with more fallen trees (coarse woody debris) will support higher eastern chipmunk densities. These hypotheses provide the red squirrel high nesting sites while providing the eastern chipmunk cover to burrow and search for food closer to the ground. Lastly, I hypothesized that areas with higher sapling density would favor higher densities of eastern chipmunks. A higher sapling density would once again provide cover close to the ground for the eastern chipmunk.

Methods

Trapping

Fifteen sites (45 m x 100 m) were surveyed throughout the UNDERC property in the Upper Peninsula of Michigan. These sites were separated into three forest types: coniferous, deciduous, and mixed coniferous/deciduous. Within a plot, one 100-m transect was established every 15 m. The transects at each site were placed parallel to the road and at least 5 m from the forest edge. Ten Sherman traps were placed every 10 m along the length of each transect along with three evenly spaced Tomahawk traps. The traps were placed near microhabitat features such as tree trunks, fallen trees, or large rocks to increase the probability of capturing the target species of red squirrels and eastern chipmunks (Schmid-Holmes and Drickamer, 2000). Bait for each trap consisted of an even mixture of peanut butter and rolled oats. The traps were opened the first day of each research week and were kept open for five consecutive nights (Vander Wall, 1992). They were checked and rebaited each morning between 700 and 900 h and again between 1500 and 1700 h. The traps were open when both the red squirrels and the eastern chipmunks are most active—at dawn, midmorning, and dusk (Burt and Grossenheider, 2003).

All small mammals that were trapped, including deer mice (*Peromyscus maniculatus*), shrews, or voles were weighed and gender, age, and reproductive activity was recorded. Red squirrels and eastern chipmunks were then marked with numbered metal ear tags (No. 1, National Band and Tag Co., Newport, KY) to determine recapture success. The microhabitat and weather conditions were also recorded at each site. Density per trapnight was calculated to eliminate any bias toward sites that had more trapnights than others due to trap damage by animals.

Habitat Analysis

The densities of snags, logs, and saplings in each trapping site were measured. A snag was considered any dead tree that was standing or leaning against another tree at an angle greater than a 30°. The minimum size for recording snags and logs was a DBH of 10 cm and a diameter of 10 cm, respectively (Butler et al., 2003). An area running the length of each transect and extending 2 m away from the road was used to count the number of snags and logs. Logs which fell across two transect lines were counted for each transect. For each snag and log, cavities and woodpecker holes (potential nesting or caching sites for small mammals) were documented. To measure sapling density, all woody plants within circular plots of 5 m radii were recorded. These plots were placed at 0m, 50m, and 100m along two of the four transects (Hackett and Pagels, 2003 and Shmid-Holmes and Drickamer, 2001). Plots were positioned at 33 m and 66 m on the remaining two transects. Only saplings under a DBH of 5 cm were used for analysis and each was identified to species.

Statistical Tests

Separate stepwise regressions related eastern chipmunk and red squirrel density to nine habitat characteristics: total sapling density, sugar maple sapling density, balsam fir sapling density, other sapling species density, snag density, mean snag height, snag DBH, log density, and log diameter (Table 1). All statistical tests were performed in SYSTAT 11 (SYSTAT Software, Inc. 2004).

Results

Twelve eastern chipmunks and two red squirrels were trapped along with four other species of small mammals (Appendix 1). Due to the low capture success of red squirrels, the relationship between red squirrel density and habitat characteristics was not determined. However, because of the abundance of deer mice (64), statistical tests were run to determine if habitat characteristics had any effect on their density.

As the mean diameter of the logs increased, eastern chipmunk density per trap night significantly increased ($R^2 = 0.619$, $t = 4.966$, $p < 0.001$; Table 1). No relationship was found between log density and eastern chipmunk density (linear regression, $p >> 0.05$; Table 1). As mean snag DBH increased, the eastern chipmunk density per trap night showed an increased trend which was marginally significant ($R^2 = 0.619$, $t = -1.900$, $P = 0.082$; Table 1). No significant relationship was found between chipmunk density and snag density or snag height (linear regression, all p-values >> 0.05; Table 1)

As snag height increased, the mice density per trap night decreased significantly ($R^2 = 0.718$, $t = -4.473$, $p = 0.001$; Table 2). However, as snag DBH increased, mice density per trap night significantly increased ($R^2 = 0.718$, $t = 4.431$, $p = 0.001$; Table 2). Snag density, log density, and log diameter had no significance with regard to deer mice density (linear regression, all p-values >> 0.05; Table 2). Increases in overall sapling density, or individual species of saplings had no significant impact on eastern chipmunk or deer mice densities (linear regression, all p-values >> 0.05; Table 1, 2).

Discussion

Due to the low number of red squirrels captured, no findings could be extrapolated from the data. It is possible that because red squirrels occupy very large territories (7600 m^2), it was unlikely that any one of the trapping areas of 4500m^2 fell into more than one or two red squirrel territories. In future studies, larger trapping sites should be used to overlap different squirrel territories.

Eastern chipmunk density was found to increase significantly with an increase in mean log diameter. Logs that are greater in diameter will have larger cavities, which provide more potential nesting and caching sites for the eastern chipmunks (Kurta, 2003). Larger logs may also provide the eastern chipmunk and other small mammals with foraging sites, travel routes, territorial markers, and refuge from potential predators (Zollner and Crane, 2003). Deer mice were found to travel along logs to reduce predation risks because logs speed their movements between locations and reduce detection by auditory predators.

Contrary to my hypothesis, a relationship between log density and eastern chipmunk density was not found. These results contrast those found by Zollner and Crane (2003), who found that eastern chipmunks traveled on coarse woody debris more in areas where more coarse woody debris was present. One explanation may be that there is a threshold for log density needed to sustain eastern chipmunk populations. Any further increases in the density of coarse woody debris would have no effect on eastern chipmunk density, however further research is needed on this topic.

Eastern chipmunk and deer mouse densities both increased as snag DBH increased. Snags of larger diameter potentially have larger cavities for the eastern chipmunk and deer mouse to nest and cache food in. Snags with a larger DBH also will provide more hiding spots for the small mammals.

Deer mice density was significantly lowered as snag height increased. This result was expected, as deer mice prefer to forage and live closer to the ground rather than climbing trees. Taller snags may result in larger gaps in the forest canopy, which may allow for birds of prey to detect small mammal movement more effectively (Zollner and Crane, 2003). However, shorter snags would provide the deer mice with optimal nesting and caching sites, while presenting no danger from predators.

The hypothesis that increased sapling cover would increase eastern chipmunk density was not supported. Eastern chipmunks may prefer more open and older forested areas. They have been shown to forage less and are more likely attacked by predators in sites with thick sapling layers (Zollner and Crane, 2003). An increase in sapling density also did not increase deer mouse density. Previous research has shown that deer mice prefer habitats with low woody stem densities (Kamler and Pennock, 1999 and Hadley and Wilson, 2004). Alike to the eastern chipmunks, deer mice prefer open, older forest areas without many saplings for easier foraging and more seed availability on the forest ground.

Many potential factors may have influenced the outcome of this study. First, the presence of bears and other predators at the three sites where traps were damaged could have led to lower numbers of small mammals caught. At those sites, we removed the Sherman traps before the five trapping nights were completed to avoid further damage. This discrepancy was accounted for by calculating capture density per trap night, however small mammals may have avoided the area before traps were removed. In addition, all red squirrel and eastern chipmunk captures were in the Tomahawk traps. This may be due to the small size of the Sherman traps, which could have dissuaded the red squirrels and eastern chipmunks from entering. Similarly, a study by Schmid-Holmes and Drickamer (2001) used only Sherman traps and was successful only in catching deer mice, shrews, and voles. Also, because deer mice were not one of our target species and were not ear-tagged, their densities may have been inflated due to capturing the same individuals repeatedly.

Based on personal observation, I found that more small mammals were caught later in each trapping week. In future studies, pre-baiting the traps would help to accustom the mammals to the traps. Research has shown that small mammals may avoid entering traps recently placed in their environment (Chitty and Kempson, 1949, as cited by Hilborn et al., 1975). Future studies should trap for longer periods of time and different bait should be experimented with to determine the most effective type for trapping different small mammals. Any small mammal captured must be ear-tagged or marked to determine recapture success. Future studies could also determine the effects of predators on small mammal trapping success. The execution of future experiments is essential to better understand habitat characteristics that influence small mammal population densities. This may in turn lead to a better understanding of how to manage forests to support small mammal populations and how their activity may affect forest growth and regeneration in different forest types.

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Table 1: Stepwise linear regression of eastern chipmunk density per trap night versus total sapling density, sugar maple sapling density, balsam fir sapling density, other sapling species density, snag density, mean snag height, snag DBH, log density, and log diameter.

		Effect	Coefficient	Std Error	Std Coef	Tol.	df	F	'P'
In									
	1	Constant							
	8	Snag DBH	-0.000	0.000	-0.333	0.88529	1	3.610	**0.082**
	10	Log Diameter	0.003	0.001	0.871	0.88529	1	24.662	**0.000**
Out			Part. Corr.						
	2	Sapling Density	-0.068	.	.	0.80243	1	0.051	0.826
	3	Sugar maple density	-0.082	.	.	0.89210	1	0.075	0.789
	4	Balsam fir density	0.081	.	.	0.66358	1	0.073	0.792
	5	Other sapling density	-0.373	.	.	0.88713	1	1.776	0.210
	6	Snag density	0.411	.	.	0.91396	1	2.237	0.163
	7	Snag height	-0.170	.	.	0.80079	1	0.328	0.578
	9	Log density	0.241	.	.	0.83267	1	0.679	0.427

R = 0.820 R-Square = 0.673

Table 2: Stepwise linear regression of deer mice density per trap night versus total sapling density, sugar maple sapling density, balsam fir sapling density, other sapling species density, snag density, mean snag height, snag DBH, log density, and log diameter.

		Effect	Coefficient	Std Error	Std Coef	Tol.	df	F	'P'
In									
	1	Constant							
	7	Snag height	-0.001	0.000	-0.636	0.99726	1	20.005	**0.001**
	8	Snag DBH	0.000	0.000	0.630	0.99726	1	19.633	**0.001**
Out			Part. Corr.						
	2	Sapling density	0.390	.	.	0.77660	1	1.968	0.188
	3	Sugar maple density	-0.017	.	.	0.93146	1	0.003	0.956
	4	Balsam fir density	0.410	.	.	0.85694	1	2.222	0.164
	5	Other sapling density	-0.281	.	.	0.62547	1	0.944	0.352
	6	Snag density	-0.054	.	.	0.58396	1	0.033	0.860
	9	Log density	-0.272	.	.	0.76701	1	0.880	0.368
	10	Log diameter	0.191	.	.	0.71088	1	0.416	0.532

$R = 0.871$ $R^2 = 0.758$

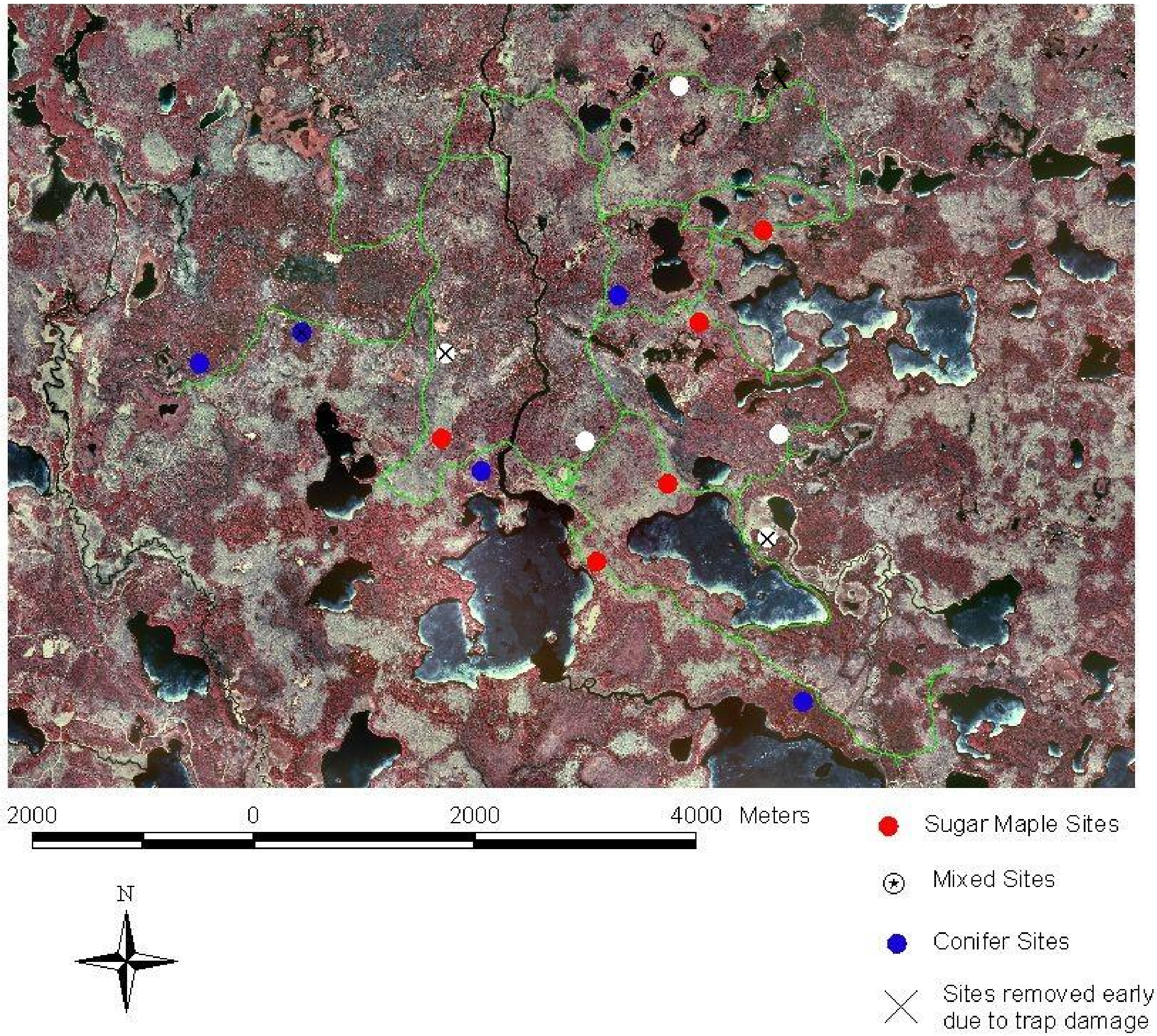

Figure 1: Map of UNDERC property with trapping sites marked. Red dots denote sugar maple as the dominant tree species, white represent mixed sites, and blue represent coniferous. Sites with X's over the dots had Sherman traps removed early due to trap damage from bears.

Appendix 1: Total number of captures of target and non-target species.

Species	No. of captures	% of all captures	Common Name
Target Species			
Tamias striatus	12	14.1	Eastern chipmunk
Tamiasciurus Hudsonicus	2	2.4	Red squirrel
Non-target Species			
Peromyscus maniculatus	64	75.3	Deer mouse
Clethryonomys gapperi	5	5.9	Southern red-backed vole
Glaucomys sabrinus	1	1.2	Northern flying squirrel
Sorex cinereus	1	1.2	Masked shrew