THE EFFECT OF FOREST COMPOSITION AND CANOPY COVER ON SMALL MAMMAL SPECIES COMPOSITION

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Abstract

The succession of a forest from mature big-tooth aspen stands to mixed coniferous-deciduous woodland may have many effects on species composition in the area. To accelerate the maturation of a forest over time, the Forest Accelerated Succession Experiment (FASET) research group at the University of Michigan Biological Station (UMBS) girdled over 6700 big-tooth aspen and birch trees within an approximately 39 hectare area. We trapped small mammals between the FASET plot and an unmanipulated control plot on UMBS property to measure differences in species composition, animal weight, reproductive activity, age group proportions, and gender proportions between plots. We found only one statistically significant result; we trapped significantly more *P. leucopus* in the FASET plot than in the control plot ($p<0.05$). Increased *P. leucopus* population may increase seed predation thus decreasing future forest recruitment and decreasing forest density over time. Increased *P. leucopus* may also provide the predator population the opportunity to expand. Overall we concluded that as a forest changes, it can influence changes in the mammal populations already inhabiting it, and this process has the capability to alter the predator-prey dynamics and structure of the forest in the future.

Introduction

Succession of forest ecosystems not only exhibits a change in the plant species composition but also a change in the composition of animal species inhabiting them. Forest succession is most clearly observed after a natural disturbance such as fire. In temperate regions, cleared landscape is first re-established by grasses and sedges, followed by pioneer species such as *Populus grandidentata* (big-tooth aspen) and *Betula papyrifera* (white birch; Barnes et al., 2004). As the aspen-birch forest ages, pines such as *Pinus resinosa* (red pine) and *Pinus strobus* (white pine) outcompete shade-intolerant pioneer species in competition for light (Barnes et al., 1998). Early successional forests thereby transition into mixed coniferous-deciduous forests that are preferred by many different animal species. Certain species may inhabit particular forest types more frequently than others, and by evaluating the type of and the successional stage of the forests that we see, we can infer the animal, particularly mammal, species composition and dynamics within these forests.

To understand the effects of forest succession on canopy structure and carbon cycles, researchers at the University of Michigan Biological Station (UMBS; 45.560, -84.672) in Cheboygan County, MI, USA are manipulating the forests around the UMBS property in an experiment called Forest Accelerated Succession Experiment (FASET, University of Michigan). FASET researchers girdled more than 6700 aspen and birch trees and approximately 35% of the canopy LAI (leaf area index) within a 39 ha area on UMBS property (University of Michigan). The purpose of this project is to compare these variables between non-altered control plots and altered FASET plots (University of Michigan).

In this study, we focused on the dynamics of species composition of small mammals between control plots and FASET plots on UMBS property. We investigated the effect of changes in the canopy cover on the species of small mammals present. We hypothesized that the FASET manipulated plots would show differences in species composition and demographic characteristics such as relative abundance, gender composition, community age structure, reproductive activity, and weight of species present. Changes in these characteristics suggest the possibility that changing dynamics of the species we see in forests today will have long-term effects on plant recruitment and animal species composition of forests in the future.

Methods

Study Sites

Big-tooth aspen, birch trees, red pine, and white pine dominated the control plot. Within the control plot, we placed eight transects approximately ten meters apart in the control plot (45.560, -84.696). Along each transect, we set large Sherman traps (Trap-LFA; 3" x 3.5" x 9"; Tallahassee FL): a single trap approximately every 10 meters apart for 80 meters (Fig. 1). The FASET plot contained girdled birch and girdled big-tooth aspen trees, allowing red pines and white pines to dominate the plot. In the FASET plot, we four transects (A, C, E, and G) radiated out from one starting location at (45.563, -84.697; Fig. 2). Along each transect, we set large Sherman traps: a single trap approximately every 10 meters for 200 meters. Using a densiometer, we measured coverage density at each trap and found the average percentage of canopy cover per plot.

The animal species that we had the potential to catch in these areas using Sherman traps included soricomorphs *Sorex hoyi* (pygmy shrew), *Sorex cinereus* (masked shrew), *Blarina brevicauda* (short-tail shrew); rodents *Peromyscus leucopus* (white-footed mouse), *P. maniculatus gracilis* (woodland deer mouse), *Napaeozapus hudsonius* (woodland jumping mouse), *Microtus pennsylvanicus* (meadow vole), *M. pinetorum* (woodland vole), *Myodes gapperi* (red-backed vole), *Synaptomys cooperi* (southern bog lemming); sciurids *Tamias striatus* (eastern chipmunk), *Glaucomys volans* (southern flying squirrel), *G. sabrinus* (northern flying squirrel); and carnivores *Mustela erminea* and *Mustela frenata* (ermine and long-tailed weasel; Kurta, 1995; Dr. Phil Myers, pers. comm.).

Trapping and Processing Protocol

Students trapped small mammals between 28 July 2014 and 31 July 2014 using 144 large Sherman traps, baited with oats (1 tablespoon). Students opened the traps at 0900 h, checked the traps at 1300 h, and closed the traps at 1900 h. We immediately released every caught *Blarina brevicauda* after recording its location. Every other trapped mammal was brought back to the classroom. We caught *P. leucopus, T. striatus,* and *S. cinereus.* We kept *S. cinereus* in captivity for several hours for observation, but recorded no measurements on them because the animals would have become stressed and died. We recorded the species, sex, age, reproductive condition, and weight of all *T. striatus* and *P. leucopus*. We marked these animals by trimming off an approximately 1 cm x 1 cm patch of their outer coats in order that we be able to recognize recaptured animals. After measurement, all animals were released into the plots in which we found them.

Data analysis

Using GraphPad Software ® Quick Calcs, we analyzed data using chi-squared (χ^2) tests without Yates' correction to compare the following species dynamics between FASET and control plots: the proportion of *T. striatus* to *P. leucopus*; the number of *P. leucopus* caught on each plot; the proportion of male to female *P. leucopus*; the proportion of immature to adult *P. leucopus*; and the proportion of reproductively active to reproductively not active *P. leucopus*. We used Student's t-test to compare the average weight (in grams) of *P. leucopus* between FASET and control plots. For each test, we used an alpha (α) value of significance of 0.05. We corrected for the greater number of traps in the FASET plot; fractional values were rounded to the next highest integer.

Results

We caught a total of 53 *P. leucopus* and 17 *T. striatus* individuals in the FASET plot (Fig. 3) and 19 *P. leucopus,* 5 *T. striatus*, and 2 *S. cinereus* in the control plot (Fig. 4). The ratio of *P. leucopus* to *T. striatus* did not differ between FASET and control plots (χ^2= 1.22; p=0.2690; Table 1). For demographic characteristics, we examined only *P. leucopus* populations because we did not trap enough individuals from either *T. striatus* or *S. cinereus* for comparisons to be meaningful. We caught significantly more white-footed mice in the FASET plot than in control (n=53, n=24, respectively; χ^2=10.922; d.f.=1; p=0.001; Table 2). The proportion of male to female *P. leucopus* did not differ significantly between the FASET and control plot (χ^2 =3.79; d.f=1; p= 0.0516; Table 3). The proportion of juvenile to adult *P. leucopus* individuals did not differ significantly between the FASET and control plots (χ^2 =0.278; d.f.=1 p=0.5978; Table 4). *P. leucopus* individuals did not exhibit significantly more reproductive activity between FASET and control plots (χ^2 =0.743; d.f.=1; p=0.3887; Table 5). *P. leucopus* did not have significantly different weights between the FASET and control plot (t=0.5468; d.f.=18; p=0.5912; Table 6).

Discussion

Conclusion of the Hypotheses

The difference in structure of the forests did not have as much of an effect on animal biology or species interactions as we had expected. We did not find significant differences in the proportion of male to female, juvenile to adult, or reproductively active to reproductively not active *P. leucopus* between the FASET and control plots. Additionally, we did not find a significant difference in the average weight of *P. leucopus*. We also did not find a significant difference between the proportion of *P. leucopus* to *T. striatus* between the FASET and control plots. These results indicate that the structural differences of these two forest plots did not affect these biological characteristics of the white-footed mouse.

We caught significantly more *P. leucopus* in the FASET plot than control plot. White-footed mice commonly inhabit deciduous woodlands (Baker, 1983), especially in areas where there is moderate herbaceous cover but abundant ground cover such as rocks and fallen logs (Kurta, 1995). Many of the big-tooth aspen and birch trees girdled by the FASET researchers have fallen. This process has created large amounts of downed woody debris, which is a more favorable environment for *P. leucopus* than the comparatively more open ground cover of the control plot.

An increase in the *P. leucopus* population in the FASET plot due to the understory composition may increase seed predation within the ecosystem. Understory community structure can affect the habitats that small mammals select (Schnurr et al., 2004), and in this case, appears to favor *Peromyscus leucopus*. *Peromyscus leucopus* is known as a seed predator (Baker, 1983), and increased *P. leucopus* populations may have the capability of altering the entire structure of the forests which they inhabit.

The white-footed mouse is preyed upon by *Mustela spp.* (weasels), *Vulpes vulpes* (red fox), *Urocyon cinereoargenteus* (gray fox), *Felis catus* (domesticated cat), *Procyon lotor* (raccoon), *Mephitis mephitis* (striped skunk), owls (order Strigiformes), and snakes (order Squamata), also native to these areas (Baker, 1983). An increase in the prey base in the FASET plot may lead to an increase in populations of these predators as well.

Study Limitations

This study has several limitations. We trapped animals for only three days. Initially, we attempted to measure the soricid species within each plot (*S. hoyi* and *S. cinereus* in particular). These animals are caught by pitfall traps (Kurta, 1995). However, the pitfall traps we set out at one trapping session were disturbed, probably by *Procyon lotor* (raccoons), and we were forced to end pitfall trapping prematurely and recorded no data.

Future Research

Because we were unable to study the potential differences in shrew concentration between the FASET and control plot, future research should be dedicated to refining our trapping tactics so that the complications we encountered do not occur. A large portion of the analysis of our study involved *P. leucopus*, however gaining more understanding of the dynamics of other small mammal species in these areas would provide a greater depth of knowledge of the system as a whole. Understanding how many different species interact with each other is critical to understanding how our forest ecosystems will fare in the future.

Acknowledgments

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Literature Cited

Baker, R. H. 1983. Thirteen-Lined Ground Squirrel: *Spermophilus tridecemlineatus* (Mitchell). In: Michigan Mammals (193-200). Wayne State University Press, Detroit.

Barnes, Burton V., Zak, Donald R., Denton, Shirley R., and Spurr, Stephen H. 1998. Forest Ecology (4th ed.). John Wiley & Son, New York, New York, USA.

Barnes, Burton V., and Wagner, Warren H. 2004. Michigan Trees (84-85, 92-93, 126-127, 254-255). The University of Michigan Press, Ann Arbor, Michigan, USA.

Kurta, A. 1995. Mammals of the Great Lakes Region (36, 151-153). University of Michigan Press, Ann Arbor.

Schnurr, J., Canham, C., Ostfeld, R., and Inouye, R. 2004. Neighborhood Analyses of Small-Mammal Dynamics: Impacts on Seed Predation and Seedling Establishment. *Ecology,* 85(3):741-755.

University of Michigan. (accessed August 2014). *Forest Accelerated Succession Experiment.* Retrieved from http://umbs.lsa.umich.edu/research/fest/faset

Tables and Figures

Table 1: χ^2 comparison of the proportions of *T. striatus* versus *P. leucopus* between FASET and control plots (University of Michigan Biological Station, Cheboygan County, MI; 2014). There was not a significant difference in the proportion of the species present between plots.

Species	FASET	Control	$\chi^2 = 1.22$

P. leucopus	65	31	d.f.= 1
T. striatus	22	6	p= 0.2690

Table 2: χ^2 comparison of the number of *P. leucopus* caught between FASET and control plots (University of Michigan Biological Station, Cheboygan County, MI; 2014). There were significantly more *P. leucopus* in the FASET than in the control plot.

Capture	FASET	Control	χ^2 = 10.922
observed	53	24	d.f.= 1
Expected	38.5	38.5	p= 0.001

Table 3: χ^2 comparison of the number of male versus female *P. leucopus* between FASET and control plots (University of Michigan Biological Station, Cheboygan County, MI; 2014). There was no significant difference in the proportion of male versus female *P. leucopus* between the plots.

Sex	FASET	Control	χ^2 = 3.79
Male	34	10	d.f.= 1
Female	18	14	p= 0.0516

Table 4: χ^2 comparison of the proportion of immature versus adult *P. leucopus* between FASET and control plots (University of Michigan Biological Station, Cheboygan County, MI; 2014). There was not a significant difference in the proportion of juvenile versus adult *P. leucopus* between the plots.

Age	FASET	Control	χ^2 = 0.278
Juvenile	32	16	d.f.= 1
Adult	21	8	p= 0.5978

Table 5: χ^2 comparison of reproductively active versus reproductively not active *P. leucopus* between FASET and control plots (University of Michigan Biological Station, Cheboygan County, MI; 2014). There was no significant difference in the proportion of reproductively active versus non-active *P. leucopus* between the plots.

Reproductive Status	FASET	Control	χ^2 = 0.743
Active	25	9	d.f.= 1
Not Active	27	15	p= 0.3887

Table 6: Two-tailed t-test comparing the average weight (in grams) of *P. leucopus* between FASET and control plots (University of Michigan Biological Station, Cheboygan County, MI; 2014). Weights of *P. leucopus* were not significantly different between plots.

	FASET	Control	t= 0.5468
Mean	18.653	18.132	d.f.= 18

SD	4.065	5.456	p= 0.5912
S.E. of mean	0.587	1.247	
N	49	19	

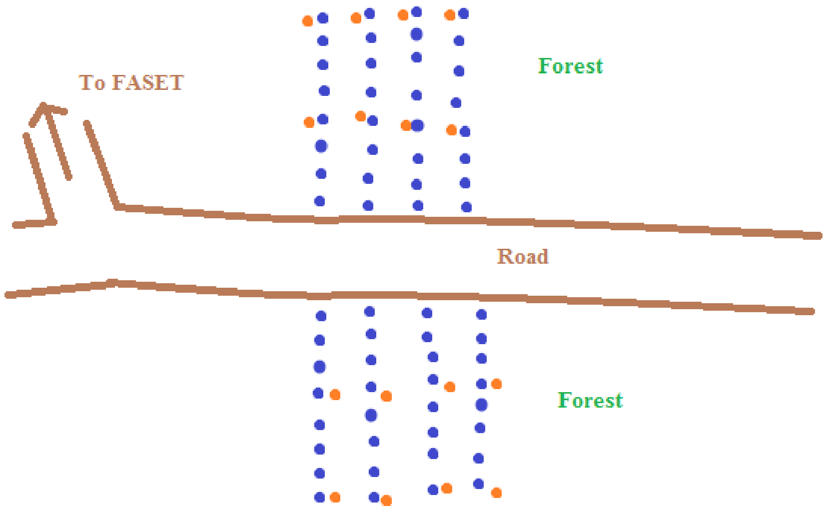

Figure 1: A map of the eight transects in the control plot (University of Michigan Biological Station, Cheboygan County, MI; 2014). Photo credit: Ariana Cerreta

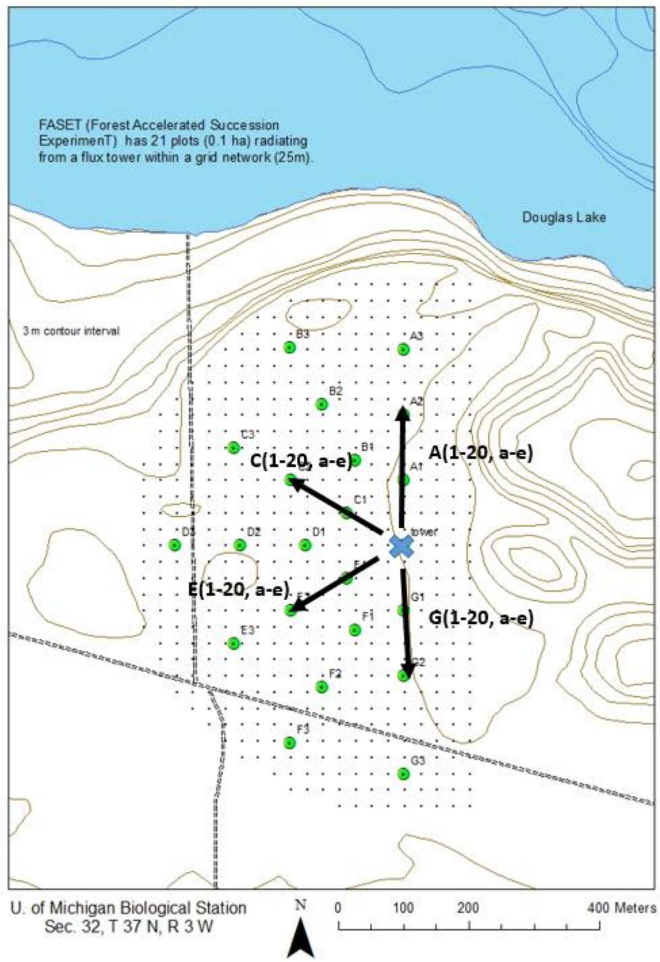

Figure 2: A map of the FASET transects, A; C; E; and G (University of Michigan Biological Station, Cheboygan County, MI; 2014). Photo Credit: http://sitemaker.umich.edu/umbs/files/faset.jpg

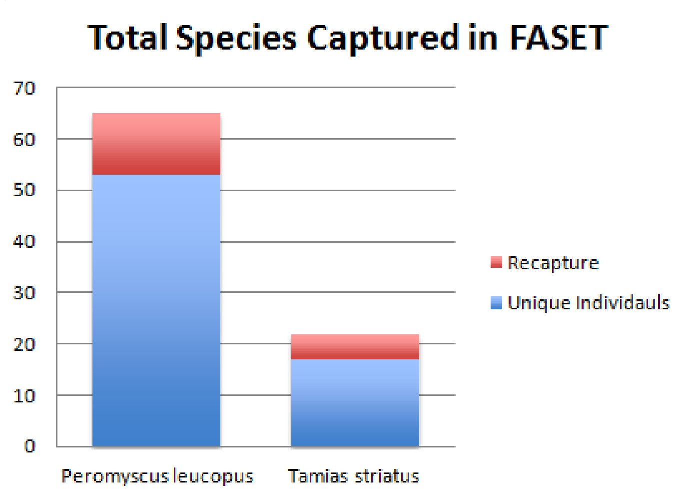

Figure 3: The number of individuals per species caught in the FASET plot (University of Michigan Biological Station, Cheboygan County, MI; 2014).

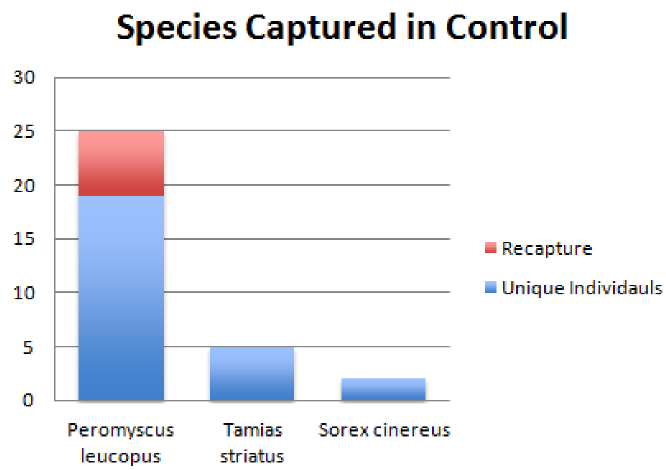

Figure 4: The number of individuals per species caught in the control plot (University of Michigan Biological Station, Cheboygan County, MI; 2014).