The Behavioral Response of Small Rodents to Increased Plant Cover

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Abstract

There are many potential impacts that may be caused by the top-down effects of the wolf recolonization in Great Lakes forest communities. One potential indirect effect is an increase in rodent populations. This population rise may have many different sources, but one of the most prominent hypotheses is that increased plant cover generated by a wolf-ungulate-plant trophic cascade provides protection for rodents from predation. This experiment isolated the protective factor of increased plant cover using a manipulative experimental design in order to isolate its effect on rodent behavior. Artificial plant cover was placed in low plant cover areas and small mammals were trapped in order to determine if a preference between the two conditions existed. We also analyzed whether sex and sexual condition of the animal affected habitat use decisions. It was found that there was no significant difference between small mammal usage of the artificial plant cover and control areas. There was also not a difference in behavior based on individual rodent characteristics. We therefore suggest that previously observed increases in rodent density in high wolf areas are due to other factors than increased plant cover generated by wolf-ungulate trophic cascade.

Introduction

“Top-down” impacts, in which predators affect lower trophic levels, can influence the conditions of forest ecosystems (Sinclair et al. 2000). This can result in changes in population levels, behaviors, and dispersal of different species. Seed dispersal greatly affects the regeneration of forests and can be strongly impacted by predation (Wunderle 1997). In temperate forests, rodents are the main seed predators and can change the dispersal of seeds and thus composition of the forest.

With rodent seed predation and the resulting seed dispersal being so closely linked, what affects seed predation from rodents also affects the seed dispersal of various plant species. Behavioral studies have shown that small rodents change their behavior based on the amount of cover provided for foraging in order to avoid predation (Kotler et al. 1991, Orrock et al. 2004). Higher cover has also been shown to increase the abundance of small rodents (Malo et al. 2013). There is a possibility that the sexual maturation and condition of the rodents may also affect individual foraging behavior in relation to plant cover protection. Males with descended testis and more testosterone are more aggressive than immature males, which may lead to bolder behavior and increased exploration into low plant areas (Giammananco et al. 2005). Females that are lactating may also exhibit higher risk behavior because they are under higher nutritional demands than non-lactating females (Hammond et al. 1994).

As part of an ongoing study on the cascading effects of wolves in a Great Lakes forest (Flagel et al. (*in prep* a)), preliminary findings have observed an increase in rodent populations in areas highly occupied by wolves. Similar results have also been documented in Yellowstone National Park (Miller et al. 2012). This increase in rodent population may be an indirect result of a trophic cascade being generated by wolf predation on deer, which increases the undergrowth in the forest, perhaps allowing rodents to find protection from avian predators. Predation from mammalian mesocarnivores, however, will not be prevented by the increased plant cover and thus will have an equal predation effect on the small rodents as in low wolf areas (Roemer et al. 2009). Using a manipulative experimental design, I tested if rodents are behaviorally responding to increased plant cover by introducing artificial plant cover in areas of low wolf use.

If rodents show a behavioral response to increased artificial plant cover, then more rodents will be captured in the areas of the plot covered by artificial plant cover than in an adjacent, uncovered area.

Methods

This experiment took place at the University of Notre Dame Environmental Research Center (UNDERC), which lies along the border of in Wisconsin and the Upper Peninsula of Michigan by Land O' Lakes, WI. Six plots of 12 by 12 meters were randomly selected for this experiment in areas of low wolf use. Each plot was divided in half with one half being the control, uncovered area and the other being the experimental, covered area. The experimental half served as a simulation of areas with thick undergrowth due to wolf-affected deer populations.

In order to due this, two 6.096 by 6.096 meter camouflage tarps were suspended at ~70cm, the average height of saplings observed in the UNDERC high wolf use areas as of 2012 (Flagel et al. (*in prep* b)). Holes were cut into the tarp to allow water and wind to pass through as well as to better simulate leaf cover with raggedly cut holes and hanging strips of tarp left attached. The tarp was also supported throughout the area by sticks to insure a consistent ~70 cm height throughout the experimental plot. Tarp was used rather than fish line in order to better simulate the conditions of thick undergrowth, creating detectable cover for the rodents. Tarp was used rather than surveyed plants in order to create a controlled, easily manipulated experiment that only had the factor of plant cover protection. The tarps were set up four days in advance of trapping in order to allow wildlife to acclimate to their presence.

Sixteen Sherman traps (Sherman, BIO-WEST, Inc, Tallahassee, FL) were set up in each plot in a four by four meter grid in order to monitor rodent use. The traps were checked daily for the five-day trapping period, and the species, sex, body weight, and body measurements of all captured individuals were taken. The trapping was separated into two sets, each containing three sites separated with trapping times separated by four-day acclimation periods.

I ran a paired t-test to analyze my data to see if there is a difference between the capture number of the control and experimental plots. All species of small rodents were categorized as a single group and treated as such for the statistical analysis due to low numbers. ANOVAs were also run to analyze differences in sex and sexual conditions.

Results

The result from the tarp versus non-tarp plots for the paired t-test was not significant with a p-value of 0.424 (Figure 1). The one-way ANOVA run between the sex of the captured individuals and the treatments was also insignificant with a p-value of 0.307 (Figure 2). The one-way ANOVA between sexual conditions for females was not significant with a p-value of 0.668 for cover, a p-value of 0.193 for sexual conditions, and a p-value of 0.433 for the interaction (Figure 3). The one-way ANOVA results for male sexual condition were also not significant for the cover conditions with a p-value of 0.215 and the interaction between cover and sexual condition with a p-value of 0.787 (Figure 4). It was significant for the difference between sexual conditions in males overall with a p-value of 0.0003, showing that there were more TD males than TA males at the time of testing.

A two-way ANOVA was run to determine if there was a difference between sets A and B, as there were notably more rodents captured during the second week of trapping. The results were insignificant for cover alone with a p-value of 0.303, but significant for the set with a p-value of 0.008 and for the interaction between the cover treatments and sets with a p-value of 0.046 (Figure 5). However, analyses for the individual weeks did not yield different results.

Discussion

The results of the artificial cover experiment were statistically not significant and do not support the hypothesis that small mammal behavior is affected by plant cover. There are many different possibilities for this result. One possibility is that increased plant cover does not affect small mammal behavior at all, although Kolter et al. 1991 found significant behavioral difference in rodents in the presence of increased plant cover. Kolter's experiment, however, was preformed in natural setting with real plants serving as cover. There may be other factors that go into the rodent's behavioral choices, which studies such as this have not teased apart.

This study does not support the hypothesis that plant cover from predation is responsible for increased rodent densities in high wolf areas. An alternative cause may be food availability rather than cover. Food availability may be a factor because in high-wolf areas, the plants are not browsed heavily and have more uneaten forbs and nuts as well as more resources to devote to these seeds. This means that there are more food resources for small mammals, which would motivate the rodents to enter high plant cover areas.

My experiment isolated the protection aspect of plant cover and may not have displayed what small mammals use high plant areas for. In order to tease apart the source of past observations of changed rodent behavior in the presence of increase plant cover, a more complex experimental design could be performed that tests rodent behavior due to both food availability and protection of plant cover with four plots of high food, low food, cover, and no cover combined among each. This would determine whether it is the protection, food availability, or interactions between the two factors that determine small mammal behavior in high plant cover areas.

The sexual traits of the capture animals were also analyzed in order to determine whether sexual condition played a role in small mammal foraging decisions concerning protective cover, but no significant results were found. Therefore, the sex of the animal may not be a factor in determining its choice when in the presence of cover. The sexual conditions of males and females were also analyzed separately for behavioral differences. Males that were sexually mature did not show more boldness into uncovered areas than sexually immature males, but this may be to the significantly higher population size of the sexually mature males than immature males. There was also no difference in the behavior of the lactating females and non-lactating females, nor was there a significant difference between the female sexual conditions populations.

There are many possibilities for improvement on this study and future studies. There is a possibility that the choice of artificial cover inaccurately simulated increased plant cover. This could be rectified by using camouflage netting or plastic plants. This way the artificial nature of cover could be maintained, and the protection variable could be isolated. Natural plant cover could also be used by planting plots of saplings in low-wolf, low-plant areas. There is another possibility of removing high plant cover from high-wolf areas to create areas of high-deer browsing and low cover. These experiments should optimally be run at the end of the summer and with more replicates in order to obtain enough captures to accurately display the small mammal behavior.

A special factor about this summer was the late winter and slow recolonization and population recovery of the small rodents. The statistical results show that there was a significant difference between the capture rate of the first week and the second week with a large increase in captures into the second week. It is possible this study was run just as the rodent population was recovering, and thus the data for the second week may be more representative for understanding small mammal behavior. However, analyses of the second week alone were also not significant.

Increased rodent densities could potentially impact Great Lakes forest community structure through increased seed predation pressure, which ultimately may affect the species composition of germinating saplings. This in turn could lead to impacts on not only the rodent species themselves but many of the other species in the forest that depend on certain tree species. Future studies should focus on predicting the ultimate impact of this complex interaction of direct and indirect top-down effects.

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Figures

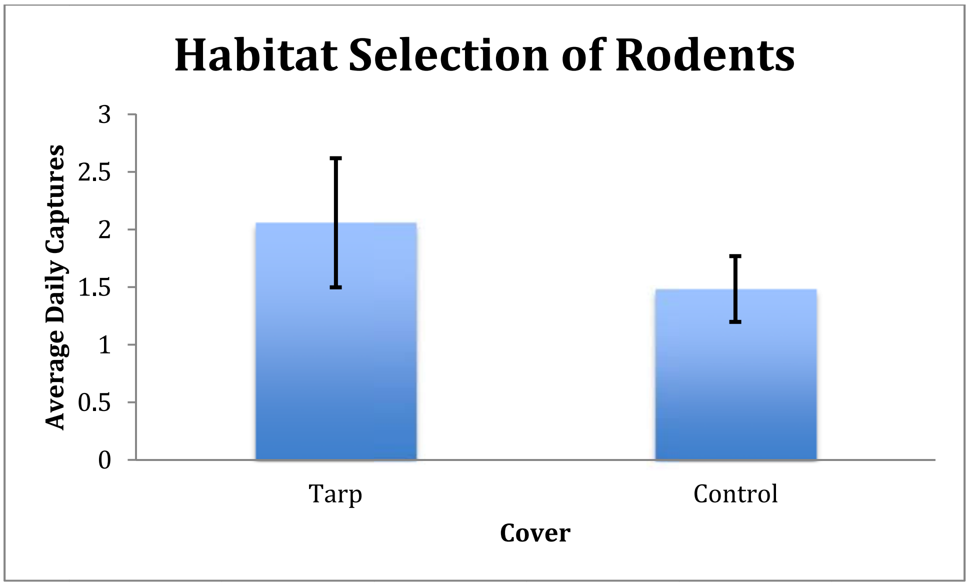

Figure 1. The average daily captures of rodents caught under the tarps and in control plots (p-value=0.424)

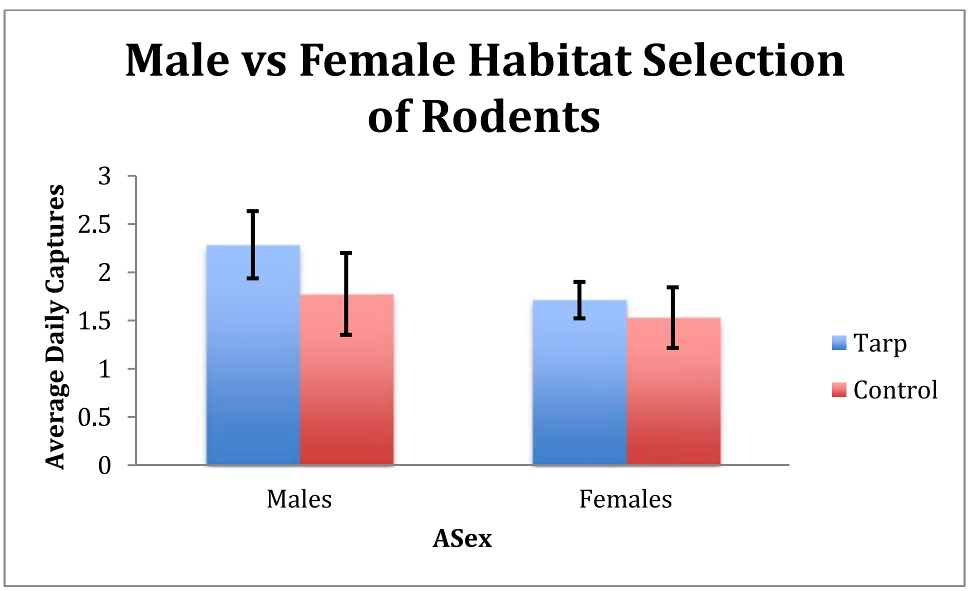

Figure 2. The average daily captures of total males and females under tarps and in control grids (p-value=0.307)

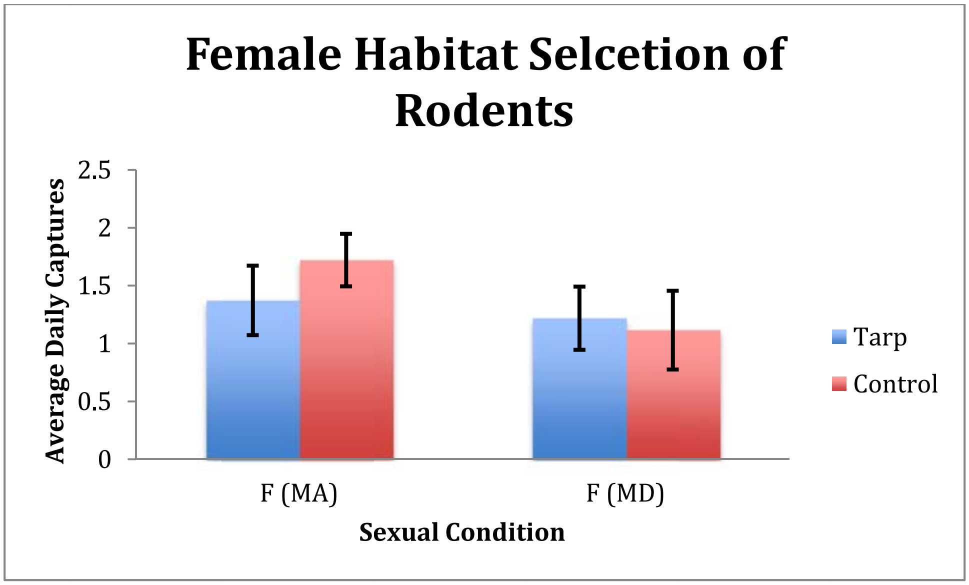

Figure 3. The average daily captures of non-lactating females under tarps and in control plots and lactating females under tarps and in control plots (p-values cover:0.668, sexual condition: 0.193, and interaction: 0.433)

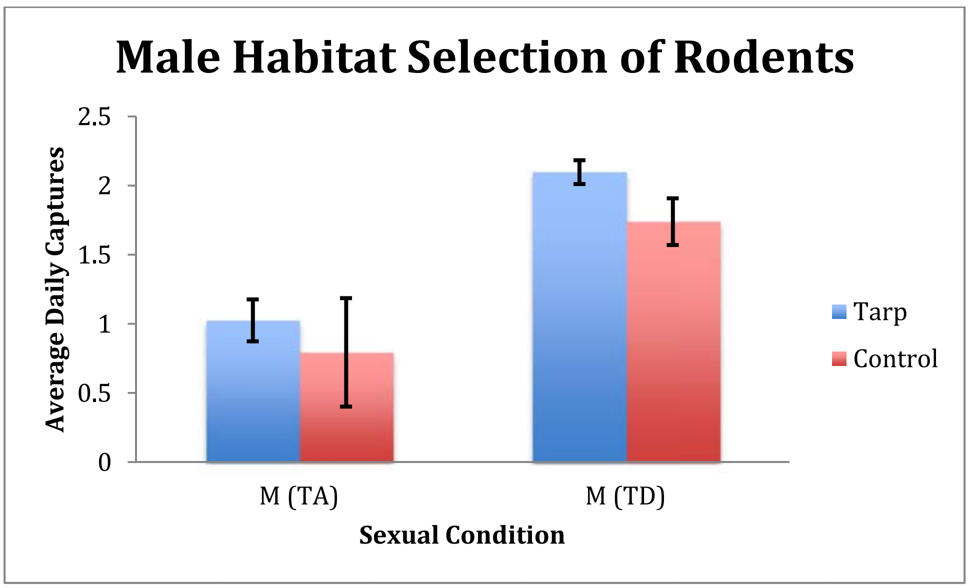

Figure 4. The average daily captures of males with ascended testies under tarps and in control plots and males with descended testies under tarps and in control plots(p-values cover: 0.215, sexual condition: 0.0003, and interaction: 0.787)

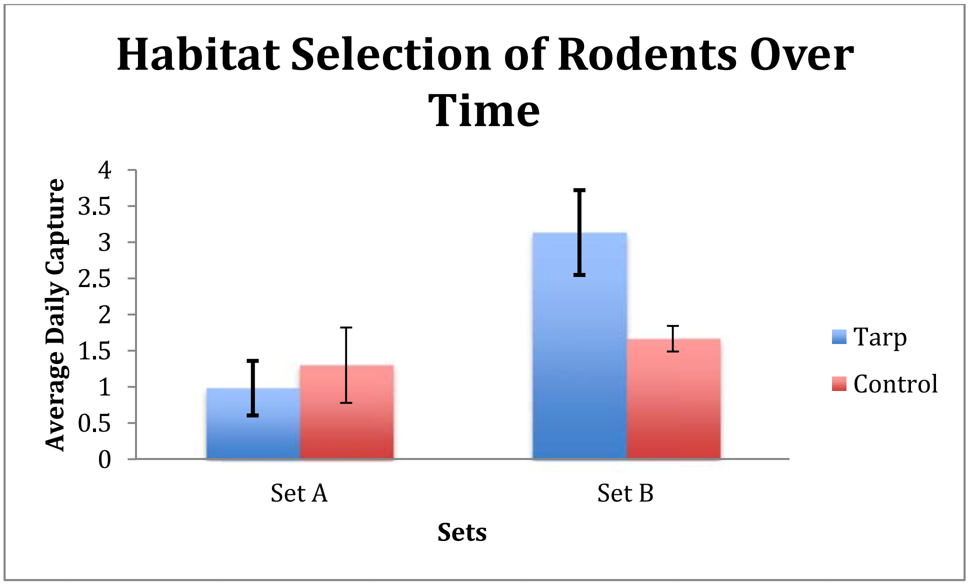

Figure 5. The habitat selection between two sets of replicate site which took place four days apart (p-values cover: 0.303, set: 0.008, and interaction: 0.046)