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Small mammals are integral to the maintenance of the tallgrass prairie

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Abstract

The invasion of exotic woody species into savanna and prairie habitats is an obstacle to the restoration of these areas. Small mammals, often viewed as pests, may actually decrease the invasion of woody species into savanna and prairie habitats. We studied the role of small mammals on maintaining the savanna and prairie at the Conard Environmental Research Area (CERA) by setting up buffet-style feeding stations of bur oak acorns on prairie, savanna, and woodland sites. We found that habitat was significant for acorns consumed by small mammals; more acorns were consumed in the prairie and savanna than in the woodlands. This indicates that small mammals do play an important role in the maintenance of prairie and savanna habitats by decreasing tree succession.

Introduction

Because Iowa's savannas and tallgrass prairies have been almost completely destroyed, the study of prairie and savanna restoration has become important to scientists and students. One factor often considered in these studies is the invading of surrounding woodlands on the restored savannas and tallgrass prairies. In the past, tallgrass prairies were maintained by natural fires and grazing. When tallgrass prairies are not burned or grazed, woody species can invade and dominate the landscape (Robertson 1992). Keeping trees out of tallgrass prairies such as those found in Iowa is a serious problem because tallgrass prairies receive enough moisture to support tree growth (Howe 1999). Like prairies, savannas are also threatened by tree succession. Although savannas contain several species of trees, trees do not completely dominate the landscape. The trees in the savanna are sparse, allowing grasses to be integrated into the landscape. Therefore, the invasion of additional woody species in the savanna limits the habitat available to the grasses.

Oak trees are often the dominant species in the savannas and woodlands of the tallgrass prairie. Acorns produced from oaks are one way trees invade prairie, but they also provide food for many animals. For this reason, we examined the effect of small mammal consumption and burial of bur oak acorns (*Quercus macrocarpa*) on maintaining prairie and savanna in comparison to woodlands. We hypothesize that small mammals help maintain the savanna and tallgrass prairie by consuming the seeds of the surrounding oak species.

Methods

On November 6,8, and 13, 2000, we conducted an experiment to determine the number of acorns eaten by small mammals in prairie, savanna, and woodland sites at Conard Environmental Research Area (CERA) in central Iowa. The site, located in the northeast section of CERA, was a prairie woodland ecotone that was altered in 1992 to create a savanna transition zone (Fig. 1-end of article). We collected bur oak acorns along the Orange Trail in the west portion of CERA (Fig. 1). Small mammals cannot determine the difference between good and infested acorns (Weckerly 1989). Therefore, we chose acorns that appeared to be intact, but not necessarily uninfested. After collecting the acorns, we set up 15 buffet-style feeding stations at 10 meter intervals beginning 10 meters into the site and cleared the acorns and husks within a one meter radius of each pan. We placed 15 to 20 *Quercus macrocarpa* acorns in each pan at each site. One day after filling the trays, we returned to record the number of acorns missing from each pan and the number of acorn husks found within a one meter radius of each pan. We used the average number of husks remaining in the trays to determine the average number of acorns consumed.

To characterize the habitat surrounding each feeding station, we recorded the number of oak trees and the diameter of the biggest oak tree within a 5 meter radius of each pan. We recorded the amount of light received at each pan site with a light meter in order to access canopy cover in the area and determine whether each pan was located in prairie, savanna, or woodland.

We analyzed the number of remaining husks, or the remains of eaten acorns, left within a one meter radius of each site in order to determine the number of acorns that were definitely eaten by small mammals. We used analysis of variance to determine the effect of habitat on light and tree density and to determine the effects of habitat and time on the remaining bur oak acorns and husks. After using the analysis of variance, we used Tukey post-hoc tests to make pairwise comparisons between habitat types and time periods.

Results

Using values on light penetration data, we grouped trays 1-5 as prairie, trays 6-10 as savanna, and trays 11-15 as woodland. The amount of light gradually decreased from the prairie to the woodland (Fig. 2). The light in the prairie was 2.75 times greater than that in the savanna (Turkey's Post-hoc test; t=5.55, p=0.00) and 12.14 times greater than in the woodland (t=8.00, p=0.00). This corresponds with our data on the numbers of trees, which gradually increased as we moved deeper into the woodland. Tree abundance had a significant effect on habitat (F=7.82, p=0.01). There was a significant difference in tree abundance between the prairie and the savanna (t=2.96, p=0.03) and the prairie and woodland (t=3.75, p=0.01), because there were no trees in the prairie sites. There were 1.23 times more trees in the woodland than in the savanna, however this was not significant. The more trees in the area, the less light reached the trays (Fig. 3). We also found that there was not a significant difference between tree diameter in the savanna and woodlands (Fig. 4).

As we moved from the prairie to the woodland, the average number of acorns remaining increased (Fig. 5). There were 1.57 times more acorns remaining in the savanna than in the prairie and 1.71 times more acorns remaining in the woodland than in the savanna. The number of acorns remaining was affected by both habitat (F=23.13, p=0.00) and time (F=11.64, p=0.00). The number of acorns remaining in the prairie was lower than those left in the woodland (t=6.69, p=0.00), and the number of acorns left in the savanna was again lower than that in the woodland (t=4.42, 0.00). Our data changed between the first trial and both the second (t=4.15, p=0.00) and third trials (t=4.21, p=0.00). More acorns remained in the second two trials than in the first trial.

The average number of acorns remaining in the trays is inversely related to the average number of acorns consumed on the same gradient (Fig. 5).

Figure 1 (not available; please contact Vicki J. Wade at wadev@grinnell.edu or (641-269-3044) for a FAX of this figure)

The number of husks remaining in trays was dependent on both habitat (F=30.05, p=0.00) and time (F=10.43, p=0.00). The number of husks remaining greater in the prairie than the number left in both the savanna (t=5.41, p=0.00) and the woodland (t=7.52, p=0.00). The number of husks remaining at the first trial was greater than that from both the second (t=3.20, p=0.00) and third trials (t=4.39, p=0.00)

Figure 2: Comparison of light radiation values for each tray in prairie, savanna, and woodland sites (+/- S.E.).

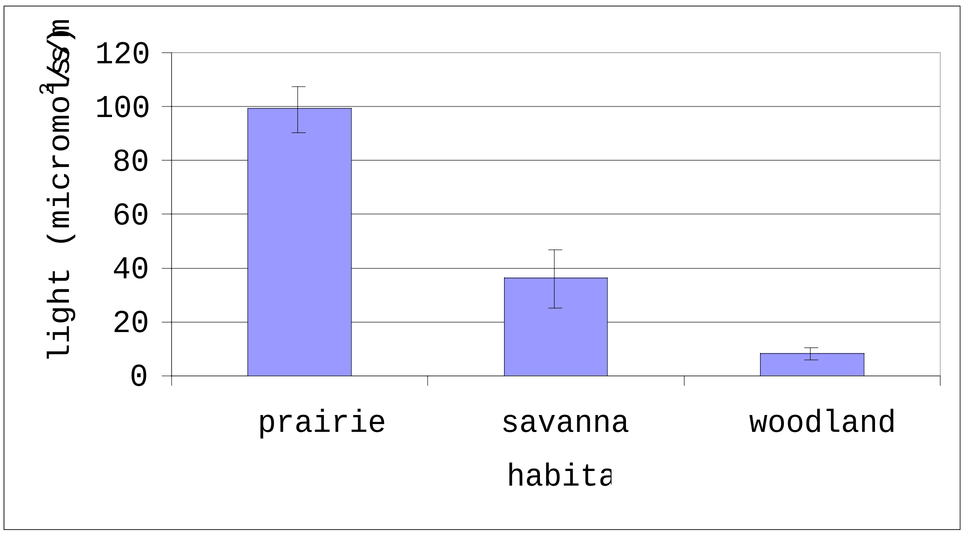


Figure 3: Comparison of the number of trees within a 5 meter radius of each tray in prairie, savanna, and woodland sites (+/- S.E.).

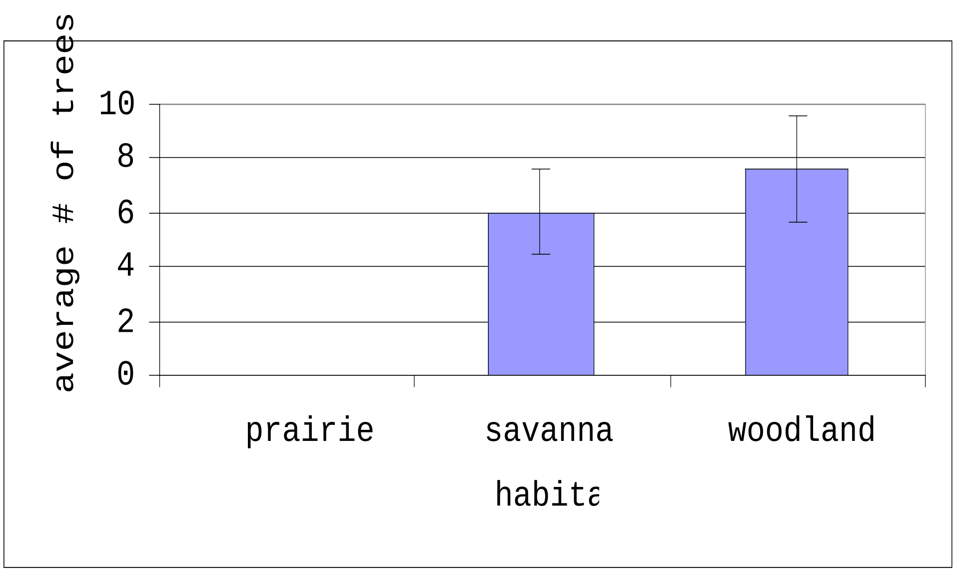


Figure 4: Comparison of diameter of largest tree within five meters of tray in savanna and woodland habitats (+/- S.E.).

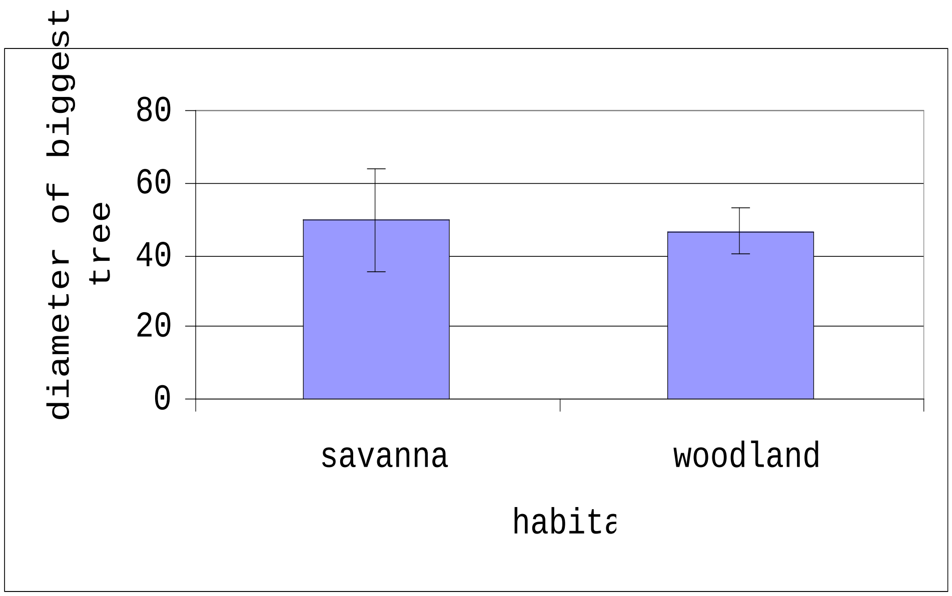


Figure 5: Comparison of the average number of acorns remaining in trays at prairie, savanna, and woodland sites (+/- S.E.).

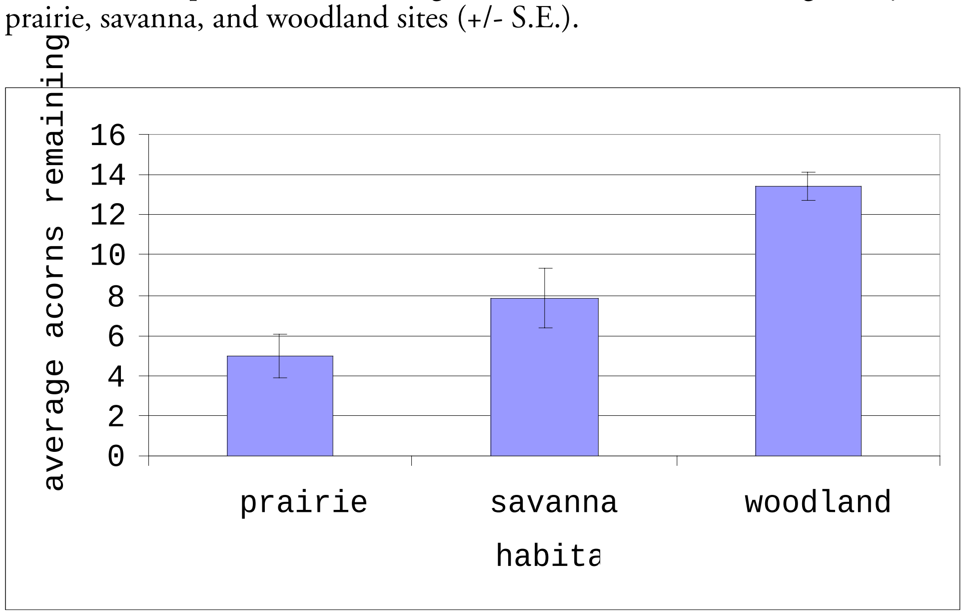
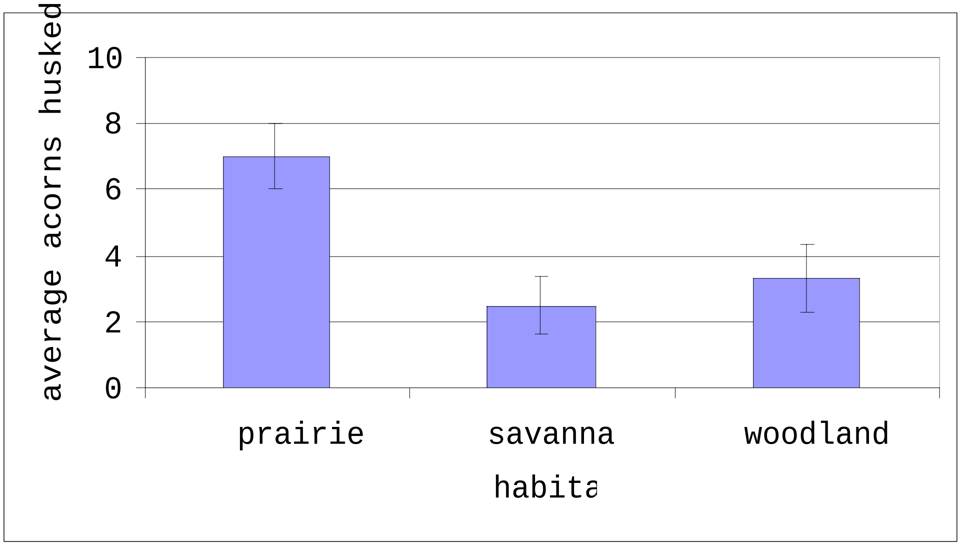


Figure 6: Comparison of average number of acorns husked on prairie, savanna, and woodland sites, shown by husks remaining in the trays (+/- S.E.).



Discussion

We saw a decline in the number of acorns consumed from the prairie to the savanna to the woodlands. These data indicate that small mammals do actually eat more acorns in a prairie habitat than in a savanna or woodland habitat, preventing the growth of woody species in the prairie. This corresponds with our hypothesis that small mammals are integral in maintaining the prairie.

We found that most of the acorns that were eaten were in fact eaten by small mammals, such as squirrels, because a high number of acorn husks were left in each tray. Unlike deer, small mammals would not consume the husk along with the seed. The few acorns missing without husks left were most likely taken by a large animal to be eaten elsewhere, or buried by a small mammal. Haas et al. (1997, cited in Weltzin) state that seeds buried greater than five centimeters deep do not survive to germination (Weltzin et al. 1997). If small mammals bury their acorns deeper than five centimeters in the ground, it may actually aid in the preservation of the prairie because although the tree seeds are not eaten, they are still prevented from germinating.

While the potential effects of the greater consumption of acorns in prairie and savanna than woodlands are clear, the reason for this difference is not. Perhaps more acorns were consumed in the prairie because of the lack of trees and therefore low volume of acorns overall. We observed that this volume of acorns increased greatly as we moved from prairie to woodlands. Stapanian and Smith (1986) suggest that squirrels will not spend as much time foraging for buried nuts in open habitats because of increased risk of being preyed upon. This could explain why the small mammals took advantage of the buffet-style trays more in the prairie as opposed to the savanna or woodlands. The small mammals spend more time looking for buried or dispersed acorns, or burying those that they find, in areas with better cover; therefore, they did not take full advantage of the buffet-style trays.

Our finding that small mammals are important in prairie preservation is contradictory to the beliefs of many farmers. According to the U.S Department of Interior, prairie dog colonies have been reduced by 98% since 1900. This occurred because prairie dogs were, and still are, regarded as pests that compete with livestock for food and land, and create health hazards for humans (Weltzin et al. 1997). However, Weltzin et al. Contest that prairie dogs are helpful to farmers, because they decrease the number of trees invading cattle grazing land (Miller 1991). According to our results, small mammals are by no means pests; instead, they help to maintain the integrity of the prairie. The eradication of small mammals has played a significant role in the succession of trees in the past, and will continue to if we do not realize their benefits and begin to protect them (Davidson et al. 1999).

Small mammals have been often viewed as pests but play an important role in the preservation of the prairie. Our data indicate that they are integral in keeping woody species from invading the grasslands. It would be interesting to know which specific animals are consuming the acorns, because it would give us insight into which animal species are most helpful in prairie management and reconstruction. Another question that arose from our experiment is what is being done with the acorns that are not consumed. This could be answered by carefully observing the sites with a video camera. This would tell us if the burial of seeds is significant, and how it affects prairie preservation. Another direction for our research would be to use seeds of woody species, forbs, and grasses, to see the effect of small mammals on plant species diversity in the prairie. Taking another angle, an interesting experiment would be to study the progress of the prairie without the control of mammals. After removing small mammals from a prairie site adjacent to woodland, an increase in the number of trees in the prairie would show the importance of mammals in maintaining the grasslands.

It is important to know the role of small mammals in the prairie for numerous reasons. Our knowledge of herbivory in the savanna and prairie can help us to restore and maintain it. It will also help us to discourage farmers and other landowners from viewing small mammals as pests and to see the benefits of these creatures on the land.

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