The Influence of Plains Pocket Gophers, *Geomys bursarius*, On Vegetation Abundance and Diversity

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Abstract

In this study we examined and quantified the effects plains pocket gophers had on vegetation. We predicted that we would see an increase in vegetation diversity on gopher mounds compared to our controls with no gopher activity. New, abandoned, and old gopher mounds covered 9.8% of our study area. We predicted the correct outcome as there was an average diversity of 3.183 plants on our control plots and more than double that with 6.700 plants on abandoned gopher mounds. This diversity is mainly due to the natural succession of plants with the pocket gophers being a natural disturbance and allowing early succession plants to grow.

Introduction

The plains pocket gopher (*Geomys bursarius)* is an herbivore that resides in the central plains states. In Minnesota, plains pocket gophers inhabit the majority of the state except for the northeastern portion which consists of unsuitable coniferous forests. Their preferred habitats are mainly grasslands, prairies, pastures, and partly wooded areas. The pocket gophers diet is strictly vegetarian and consists of mainly leafy vegetation, grasses, forbs, and roots (Hazard, 1982).

Plains pocket gophers build and maintain intricate burrowing trails beneath the surface and live the majority of their lives underground. Their burrow system is a form of food storage, protection from predators, and reproduction (Hazard, 1982). The constant burrowing of the gophers leads to the development of patchy landscape and changes the fertility, bulk density, structure, and porosity of the soil. Since the soil patches have a higher surface area to the sunlight, the temperature of the soil increases, which increases the diversity of plant growth on the patch. The growth of diverse plants can be beneficial in some situations and detrimental in others (Eldridge, 2004). The mounds created by the gophers decrease the amount of nitrogen that is present on the soil surface, which increases the soil moisture retention therefore increases productivity (Inouye et al., 1987).

The short-term and long-term effects of the plains pocket gopher mounds on the vegetation were examined. Our experiment observed a plot of abandoned prairie land inhabited by pocket gophers and analyzed their impacts on the variety of plants species that are present on the gopher mounds. We predicted that the mounds of the plains pocket gopher would increase the vegetation diversity present in the abandoned prairie.

Materials and Methods

In order to determine the short-term and long-term affects the plains pocket gopher mounds have on the vegetation in a grassland, we selected an open field of a few acres consisting of tall grass and mixed vegetation no more than one meter in height. This field was located behind a residence with deciduous trees and shrubs surrounding it on three sides.

The experiment consisted of three separate procedures that were followed in order so as to obtain the most accurate data with the least bias. No equipment was required for the first procedure, which consisted of each person finding 12 distinct patches. To do this, we spread out and walked in different directions until we each found 12 patches that differed from their surrounding area in height, density, or plant species. From there, we recorded whether or not these patches were associated with gopher mounds and, if so, how old the mound was. The different categories included: new mound, abandoned mound and old mound. We classified new mounds as mounds that were current or active with fresh dirt and no plants on the mound. Abandoned mounds were mounds between a few weeks to a few years old that were still recognizable but had no signs of recent digging with a few plant species beginning to grow on top of them. We declared old mounds as mounds over two years old that were nearly unrecognizable except for the gravel present in the soil and being almost completely covered with vegetation.

The second part of the procedure required a 20-meter tape measure, meter stick and a small red flag. We stretched the tape measure 20 meters in a randomly chosen direction. To determine the direction and the location we tossed a red flag over our shoulder and ran the tape measure in a straight line from where the flag landed. We then walked our transect looking for

gopher mounds that intersected with our tape measure. After locating them, we used the same characteristics from the first procedure to determine whether the gopher mound was new, abandoned or old and used a meter stick to measure the total width of the mound. After recording the data for all the mounds in the 20-meter stretch, we repeated this method nine more times. To ensure the transects remained random, we each took turns tossing the flag and choosing the direction of the next transect.

The last part of the procedure involved locating 10 abandoned gopher mounds and comparing the number of plant species on the mound to plant species in the controlled area two to three meters away from the mound. The "control" areas could not contain another gopher mound. Once we found and counted the number of plant species on the abandoned mound, we then took the meter stick and tossed it in a random direction within two or three meters of the mound and counted the plant species in that area. We took turns tossing the meter stick to ensure that the controlled areas remained random and estimated a 0.5-meter quadrant for each of the control areas. Each part of the data collection was replicated a total of six times by our class of 21 students.

Results

The data shows that various types of gopher mounds covered 9.8% of the study field (*Figure 1*). The old mounds covered the most area which was

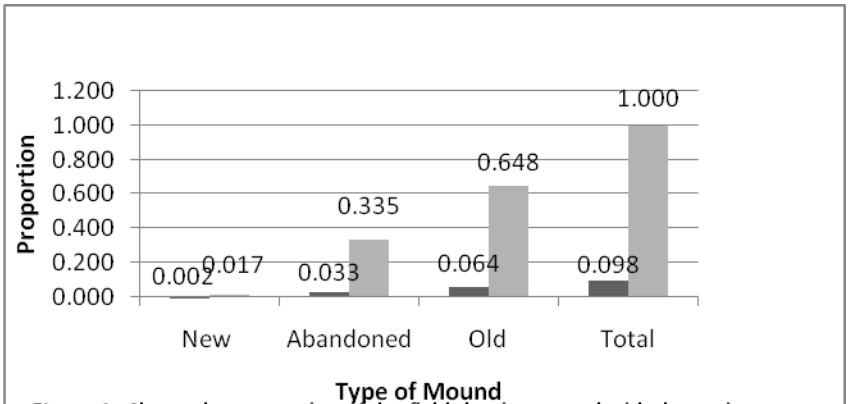

Figure 1. Shows the proportion of the field that is covered with the various types of mounds along with their relative proportions. Light bars are relative proportions and dark bars are proportion of the field.

6.4% of the field. Abandoned mounds covered approximately half the area of the old mounds at 3.3% of the field, and new mounds only consisted of 0.2% of the field. Old mounds had the largest relative proportion of all the mound types at 0.648. New and abandoned mounds have relative proportions of 0.017 and 0.335 respectively (*Figure 1)*.

221 distinct patches were reported. Of those, a relative proportion of 0.231 did not have mounds. From the remaining patches, the relative proportions for new, abandoned, and old mounds are 0.05, 0.348, and 0.371 respectively (*Figure 2*). Looking at all the types of mounds together and comparing them to the distinct patches with no mounds, one can conclude that there is a significant difference between the number of distinct patches with and without a mound (p-value <0.0001).

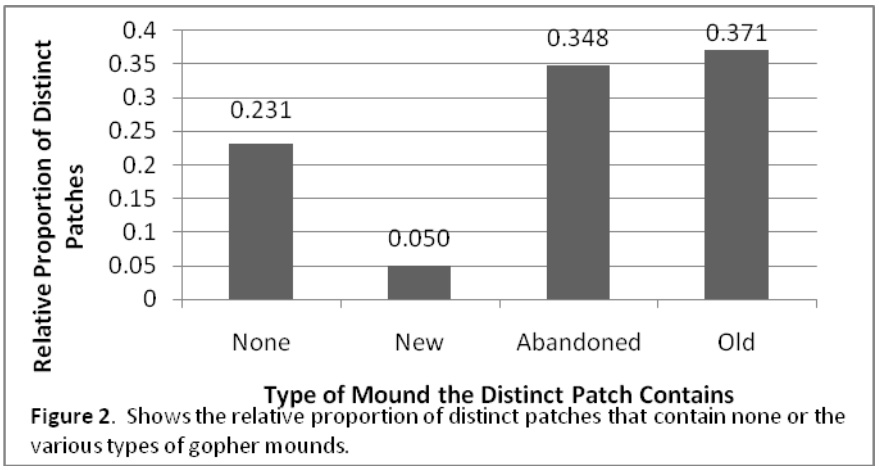

Figure 2. Shows the relative proportion of distinct patches that contain none or the various types of gopher mounds.

The relative proportions of distinct patches with and without gopher mounds are 0.769 with gopher mounds and 0.231 without gopher mounds (*Figure 3*). This shows that distinct patches that had a gopher mound present were over three times as abundant as distinct patches that did not have a gopher mound.

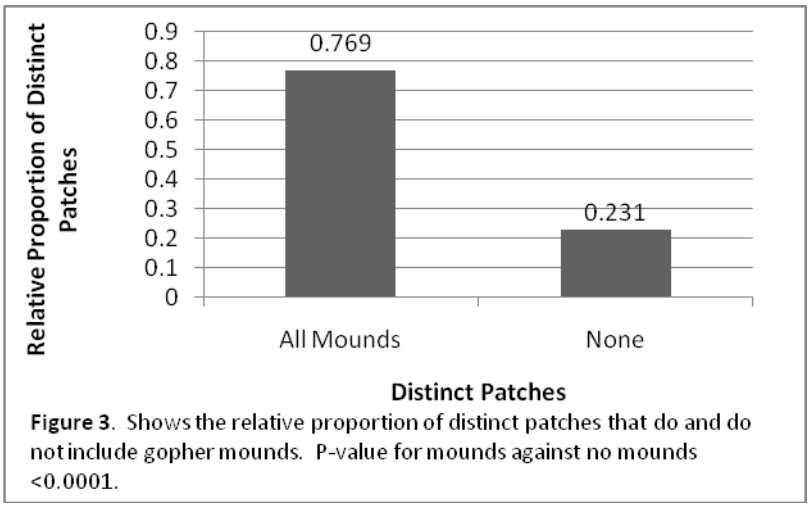

Figure 3. Shows the relative proportion of distinct patches that do and do not include gopher mounds. P-value for mounds against no mounds <0.0001.

Abandoned mounds were shown to have a

significantly larger average number of plant species when compared to a control area near the mound (p-value <0.0001) (*Figure 4*). Control areas did not contain any type of mound. The abandoned mounds had an average of 6.7 plant species per mound while the control areas had an average of 3.18 different species of plants per area. Abandoned gopher mounds at our study site created habitats that were able to facilitate twice as many plant species and a more diverse species of plants as the control areas of the field.

Discussion

We were successfully able to gather evidence against our null hypothesis, which states that there is no significant difference in vegetation between gopher mounds and undisturbed soil. Inversely, we were able gather data to support our research hypothesis that there is a significant difference in the two area types. As already stated, we had a P-value of <.0001 indicating that we have a very low chance of disproving our null hypothesis when it is actually true. Also, the chi square test shows that our data is statistically significant. The critical value for our experiment was 3.841. We easily achieved that number with a chi square value of 64.077. These values once again show that there is a difference in vegetation diversity due to gopher activity.

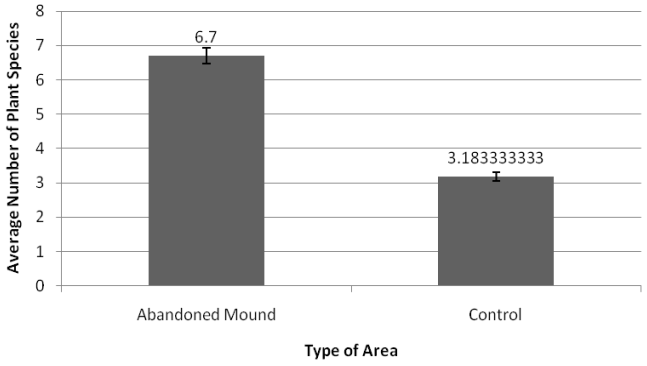

Figure 4. Shows the average number of plant species at the abandoned gopher mounds and the control areas. P-value <0.0001. Error bars represent ±SE.

The results for our testing show the effects of pocket gophers on vegetation. We strictly tested vegetation diversity and field coverage, and as you can see in *Figure 4*, the pocket gophers

had a huge effect on the diversity of the plants. As stated before, there may be many reasons why there is a higher diversity of plants on gopher mounds than on the control areas. One main reason is that gophers disrupt the vegetation and soil on and around a new mound. The fresh and newly available soil allows for early succession species (most dicots) to outcompete late succession plants (most monocots) and grow on the mounds (Martinsen et. al., 2004). Also, pocket gophers affect the nutrients in the soil. By digging and moving the soil, the pocket gophers can increase or decrease nutrient composition of the surface soil and greatly influence the ability of plants to grow on mounds (Inouye et. al., 1987). The very short-term effect of gophers is that first there is a reduction of plant diversity on the disturbed mound area and eventually a great increase in plant diversity.

Gophers are a natural disturbance on the land and vegetation. This disturbance and other disturbances can greatly increase the diversity of plants of an ecosystem if the disturbance in just right (enough to have an effect but not too much so as to completely ruin all growing conditions) (Frissell, 1973). Frissell claims that with a semi-frequent disturbance, early succession trees, like pines, can grow faster and take advantage of the nutrients and sunlight better than late succession trees, like sugar maple and birch. Late succession plants eventually outcompete and start to take over until the next fire, which is very beneficial to pines. This fluctuation in late and early succession plants creates greater overall plant diversity. This is definitely true in the grassland we sampled. However, fire historically was a natural disturbance of prairie areas that created higher plant diversity (Lavorel et al., 2006). With current fire repression techniques, pocket gophers may have a greater influence on the land than before. Mounds make up a fairly large portion of the study area which shows the gophers have a fairly long-term effect on the overall plant diversity.

Each single gopher mound is an example of the short term effect. The mound is bare and has no vegetation right after disturbance. The mound then becomes abandoned and starts to produce a diverse population of early succession vegetation. It then becomes abandoned and starts to get overrun by late succession plants, still maintaining a more diverse habitat. After several years the mound reverts back to its old soil and vegetation. The whole field is an example of the longer term effects. Gophers are one of the main disturbances and therefore have a fairly large impact on the whole field ecosystem. Mounds make up a significant portion (10% in our study area) of some fields so this greatly effects the vegetation of the entire field.

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