Effect of the Plains Pocket Gopher, *Geomys bursarius*, on the Vegetation of a Northern Minnesota Meadow

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Abstract

The fossorial plains pocket gopher, *Geomys bursarius*, creates mounds of dirt when digging its tunnels. Mounds tend to be associated with patches of vegetation distinct from surrounding areas. Data were collected and analyzed to determine the effects of gopher mounds on vegetation in a northern Minnesota meadow. Results indicate that distinct patches of vegetation are associated with gopher mounds, and there is a difference between the number of plant species growing on abandoned gopher mounds and control areas. Distinct patches could be a result of either nutrient cycling caused by the displacement of soil or invasion of plants not preferred by the herbivorous plains pocket gopher.

Introduction

The plains pocket gopher, *Geomys bursarius*, inhabits much of Minnesota. It ranges from southern Minnesota, up through the Red River Valley, and parts of northern Minnesota. The plains pocket gopher's habitat includes tall and midgrass prairies and open wooded to partly wooded areas. Currently, it is not present in the coniferous forests of northeastern Minnesota (Hazard 1982).

The plains pocket gopher is a fossorial herbivore. When digging tunnels, gophers create mounds with the displaced underground soil (Andersen, 1988). This type of behavior can lead to changes in plant productivity and biomass (Rezsutek and Cameron 2000). This soil displacement can lead to a loss of nutrients and minerals that are vital to a plant's survival; however, it can also lead to a mixing of the soil that is beneficial to plants (Reichman and Smith 1985). One such resource is nitrogen, which can be heavily

influenced by gophers, causing growth in some species or recession in other species (Inouye et al., 1987).

Here we examine the effect of plains pocket gopher mounds on the plant composition in a meadow in northern Minnesota. The first study on gopher mounds and vegetation at this site was conducted in 1989 (Melby et al., 1989). First, we tested the null hypothesis that distinct vegetation patches are independent of gopher mounds. Our alternate hypothesis is that distinct vegetation patches are not independent of gopher mounds. Secondly, we tested the null hypothesis that the number of plant species on a mound would be equal to the number of plant species in a control area. In addition, we compared the proportion of new, abandoned, and old mounds in 2008 to the data collected in 1993. Based on preliminary observations, we predicted that the presence of mounds would affect plant composition in the study area.

Methods

To examine the effects of plains pocket gopher mounds on vegetation, we conducted a study in June, 2008 in a meadow in Clearwater County, Minnesota. We first located 144 distinct patches of vegetation. If vegetation differed in density, height, or species composition, it was considered a distinct patch. Once a distinct patch was located, we noted whether each patch was associated with a mound. Secondly, we stretched a 20-meter tape measure across 40 randomly chosen transects in the same meadow. The greatest total width of all gopher mounds located on each transect was measured with a meter stick. Finally, we tallied the number of plant species found on each of 40

abandoned gopher mounds, as well as 40 randomly chosen sections of land 0.25m^2 in area not associated with mounds.

Statistical analysis

To test whether the growth of distinct patches of vegetation are independent of gopher mounds, we analyzed the data using the chi-square test. Data from 2008 was statistically compared to data collected in 1993 using the Mann-Whitney U test. Finally, to determine if there is a difference between the number of plant species found on abandoned gopher mounds and control areas, we analyzed the data using the independent, two-tailed t-test. We used a p-value of 0.05 in all statistical tests.

Results

Statistical analysis indicated that distinct patches of vegetation are not independent of gopher mounds (X^2=9, α=0.05). Of the 144 distinct patches identified, 90 were associated with gopher mounds compared to the 72 that would be expected if the gopher mounds had no effect on the vegetation. There is an association between gopher mounds and distinct patches of vegetation in the field. The second collection of data revealed that 0.259% of the total amount of land surveyed was covered in new mounds, 2.04% was covered in abandoned mounds, and 12.3% was covered in old mounds. That is, of 800 meters surveyed, 2.07 meters were covered in new mounds, 16.3 meters were covered in abandoned mounds, and 98.7 meters were covered in old mounds. When comparing current data and data from fifteen years previous (Ersbo et al., 1993), the proportion of mounds per total length of transects were not significantly different

between 2008 and 1993 (MWU<0.000, p-value=0.317). Finally, with a mean number of 4.850 plant species found on abandoned mounds and a mean of 2.75 found on control areas, abandoned mounds were found to have a 2.125 more species associated with them than the control areas nearby. The independent two-tailed t-test indicated there is a significant difference between the mean number of plant species found on abandoned gopher mounds (X=4.850, stdv=1.819) and the number of plant species found on control areas not associated with mounds (X=2.725, stdv=1.396) (t=5.861, p<0.0001; Figure 1).

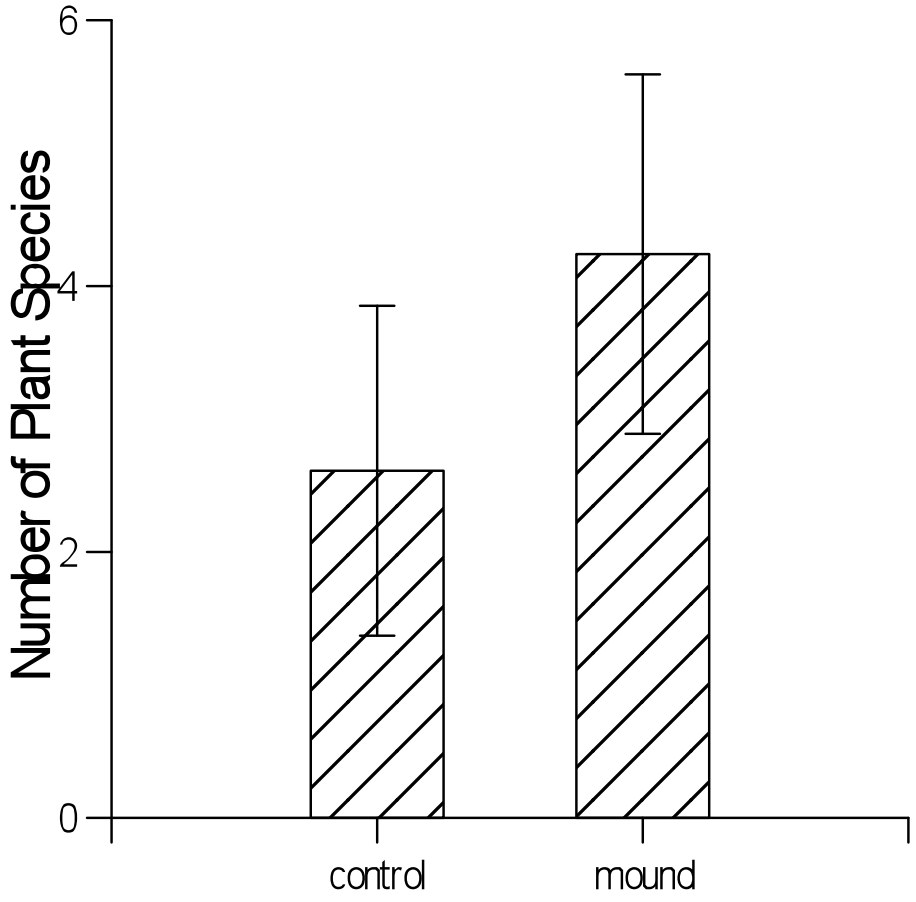

Figure 1. Plains Pocket Gopher Mound Effect on Species Diversity of Vegetation in a northern Minnesota meadow in Clearwater County. Control sites were determined as patches of land not associated with mounds measuring 0.025m^2. Bars represent mean number of plant species found on 80 areas surveyed. Error bars represent standard deviation values of a confidence level of 0.683.

Discussion

Based on the results of the chi square test, we rejected our null hypothesis that distinct patches of vegetation are independent of plains pocket gopher mounds. There is an association between distinct patches of vegetation and mounds. The displacement of nutrient-rich underground soil to the surface may allow for seeds of different species of plants to take root in areas they may otherwise have no chance at survival. Alternately, Tilman (1983) suggests that annual grasses are more likely to survive on gopher mounds if gophers preferentially feed on perennial grasses. While the meadow may be primarily composed of perennial grasses that out-compete annual grasses in a predator-free environment, gopher mounds would allow the colonization of annuals that out-compete perennials in the presence of an herbivore. However, the proper classification of plant species, and soil composition and nutrient analysis at the study site, as well as plains pocket gopher diet preference are necessary to determine which phenomenon is associated with the distinct vegetation found on gopher mounds in this field.

Our second test showed a significant difference in the number of plant species found on abandoned gopher mounds and on randomly chosen control sites, confirming our alternate hypothesis. There was a significantly higher number of plant species found on gopher mounds than on control areas. This would seem to indicate that the presence of the plains pocket gopher in an area would result in a greater diversity of vegetation in the area versus an area without the gophers. However, with records from previous studies dating back 20 years showing similar results, and statistical analysis of current year and 1993 results showing no difference in proportion of mounds, it is clear that the effect of the mounds is not permanent (Forseth et al., 2007). If there were a long-lasting effect, we

would have expected an increase in gopher mound coverage. In addition, species that initially grow on the mounds are soon out competed by the primary vegetation of the prairie as evident by the fact that distinct patches are linked to gopher mounds. Thus, as the mounds disappear, the distinct patches disappear with them.

Distinct vegetation patch disappearance can be a result of either of the two hypotheses mentioned above. If the distinct vegetation is primarily made up of plants that require upturned soil, the lack of soil and nutrient displacement to the surface could result in the primary vegetation overtaking the space as nutrients are used up by the invading species. However, if plains pocket gophers do prefer to feed on the perennials and the primary vegetation type of the meadow is perennial, then perennials should start to emerge and survive once the predator has abandoned the area. This could account for the constant relocation of plains pocket gophers in the meadow. A gopher may move into a site rich in their preferred food. As they continue to feed on the resident plant, different species of plants are able to colonize. As these species are not preferred food items, they thrive in the area. While the primary plant is not adapted to this predation, it does not regenerate, and the gophers must eventually relocate to a new area. Once the original location is void of the herbivore, the primary meadow plant species is eventually able to out-compete the invasive species. The results of this study show that plains pocket gopher mounds affect meadow vegetation in a short-term time scale in areas directly associated with the mounds; however, the effects are neither widespread, nor long lasting.

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