Impacts of *Geomys Bursarius* on vegetation patterns found in an old field in Clearwater County, MN

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ABSTRACT
The effects of the plains pocket gopher (*Geomys bursarius*) mound building on plant species diversity were investigated in an old field in June 2008. Past studies have shown conflicting results that mound building negatively impacts plant species diversity or that mound building positively impacts plant species diversity. To conduct our study we compared vegetation on new mounds, abandoned mounds, old mounds, and control areas with no mounds. Our results support our hypothesis that *G.bursarius* activity in an old field increases plant species richness. It also agrees with historical studies that gopher mound building can generate a prairie ecosystem in disturbed areas and increase plant heterogeneity present.

Introduction

Mammals are known for their tendency to impact their habitats in different ways. One mammal that modifies its habitat is the plains pocket gopher (*Geomys bursarius*). The plains pocket gopher is fossorial and feeds underground on roots and tubers (Hazzard, 1982). The plains pocket gopher creates small mounds of soil on the surface and extensive underground burrows to live and feed in. The plains pocket gopher reigns from the *Geomyidae* family and like other members of this family has specialized front claws that help it dig (Mielke, 1977).

There are currently two contradicting opinions that exist on the impacts that gopher mound building has on plant species diversity. Inounye et al. (1987) found that when the pocket gopher burrows underground it is moving the soil around and that the movement of the soil has the effect of changing the composition of the soil on the mounds and within the burrows. This change generates areas of soil with different nitrogen levels (a limiting agent in soil) and has been found to increase the diversity of plant species in the field as a whole when compared with similar fields where no pocket gophers are present. In contrast with Inounye et al., was a study in mountainous Utah by Coggins et al. (2005) that found no significance between plant species

diversity on a plot with pocket gophers and a plot without pocket gophers. In agreement with Coggins et al. was a study by Rogers et al. (2001) that found initial ephemeral impacts on vegetation of mound building, but after three growing seasons found no statistical significance of the effects of mound building on plant species richness (2001). Beyond these studies, Mielke's study on pocket gophers noted a correlation between pocket gopher activity and regeneration of a prairie ecosystem (1977).

In our study we looked at impacts of *Geomys bursarius* (plains pocket gopher) on an old field's structure and vegetation diversity. Specifically we looked at mound age on distinct patches of vegetation, mound quantity, size, and age on multiple 20 meter transects, and plant diversity on abandoned mounds versus a control area nearby. Our null hypothesis was that the presence of the pocket gopher would have no impact on plant diversity. We predicted, however, that the presence of the pocket gopher would result in greater plant diversity.

Methods

We collected data at an old field located just west of the north entrance of Itasca State Park in Clearwater County, MN. First, we looked at mound age by walking in a random direction and stopping at 144 different plots that contained noticeable variation in vegetation determined by difference in height, density, or different plant species. For each plot we classified them into four different groups: new mound, old mound, abandoned mound, and no mound. New mounds were identified by freshly uplifted dirt typically without any vegetation present. Old mounds were distinguished from others by gravel being present along with primary vegetation coverage. Abandoned mounds were identified as recently dug with sparse vegetation coverage. The no mound category was areas that had distinctive vegetation without any of the characteristics of the other categories.

Second, we looked at mound coverage within a randomly selected transect. To do this we chose a random starting point and then threw a flag to determine a direction. Next we ran a 20 meter transect in this direction and determined how many gopher mounds were on the transect and categorized mound age by the previously described method. We also measured each mound with a meter stick. We continued this process for 39 more transects for a total of 40 different transects within the field.

Third, we looked at plant diversity on abandoned mounds versus a nearby control patch of vegetation. To do this we located 10 abandoned gopher mounds and 10 randomly chosen "control" areas within 2 to 3 meters adjacent to the abandoned mounds (that did not contain gopher mounds). The control plot was approximately 0.5 meters. At each mound and control plot we counted the number of plant species found.

We used a chi-square goodness of fit test to determine if there was a significant difference between patches with distinct vegetation that were mounds versus those that were non-mounds. In our calculation of chi-squared we grouped the patches into two groups: no mound or mound (which included abandoned, old, and new mounds). We also used an un-paired t-test to determine if the quantity of plant species on an abandoned mound versus a control patch is different due to random chance or if they are different due to gopher activity

Results

We found that the distinct vegetation patches were classified as follows: 6 abandoned mounds, 41 old mounds, 43 new mounds, and 54 no mounds (**Fig. 1**). Patches were significantly associated with mounds (Chi Square=9, df=1, $p<0.05$, Critical Value=3.841).

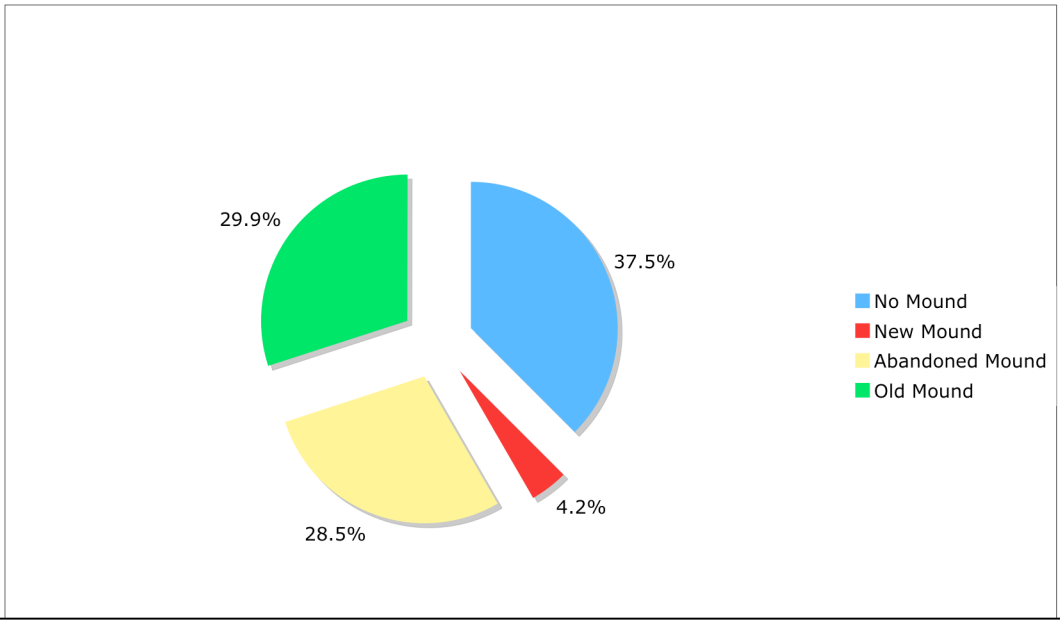

Fig 1 Distribution of distinct patches of vegetation grouped by mound type observed in an old field in Clearwater County, MN, in June 2008

The proportion of mound by type within the field and found that for every 1 meter of field that the following proportions of mound composition existed: 0.002m of new mounds, 0.02m of abandoned mounds, 0.12m of old mounds, and 0.85 with no mound coverage (**Fig. 2, Fig. 3**).

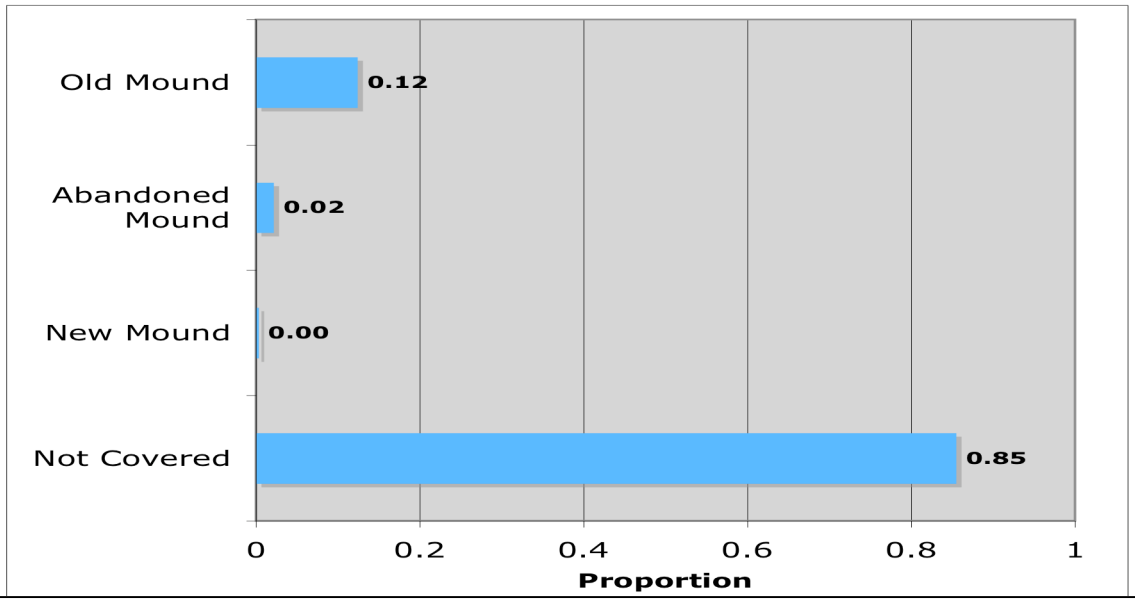

Fig. 2 Proportion of field measured that was or was not covered by plain pocket gopher mounds observed in an old field in Clearwater County, MN in June 2008.

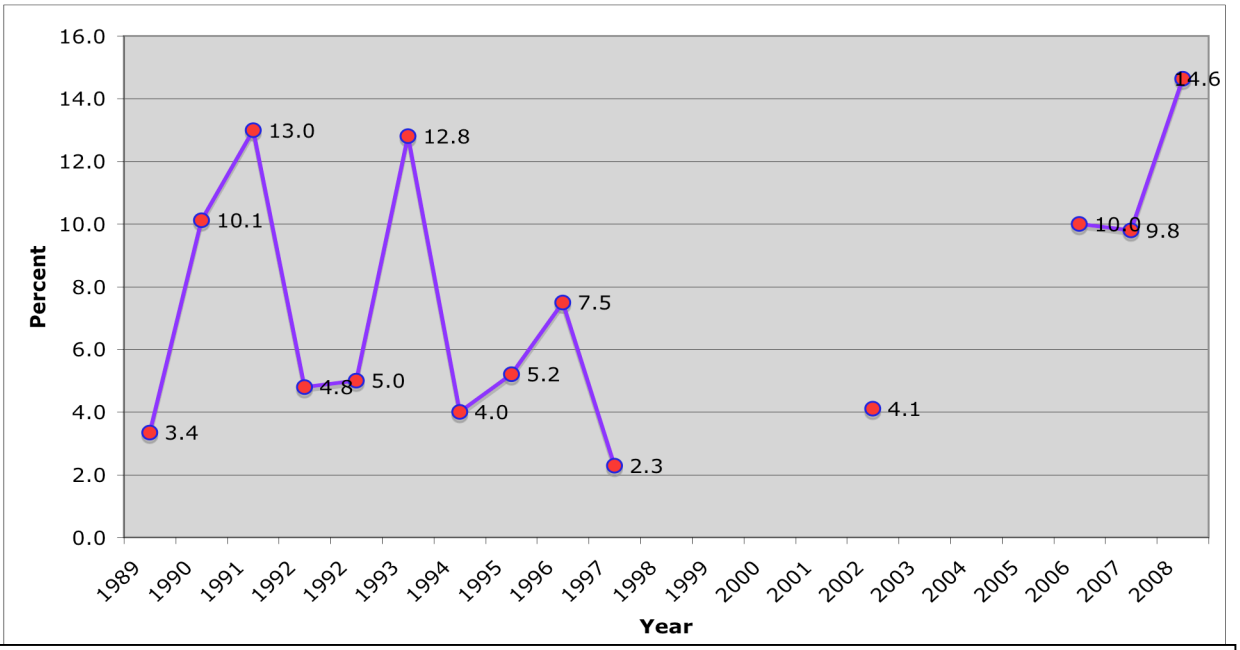

Fig. 3 Percent of transects measured that was covered by plain pocket gopher mounds observed in an old field in Clearwater County, MN from 1989 thru 2008 (Forsyth et al., 2008)

The abandoned mounds had a mean of 4.850 (+/- 0.288 S.E.) plant species present. In contrast we found that the control patches had a mean of 2.725 (+/- 0.221 S.E.) plant species present (**Fig. 4**). Significantly more plant species were seen on mounds as opposed to control patches ($t=5.861$, $df=78$, $P < 0.0001$).

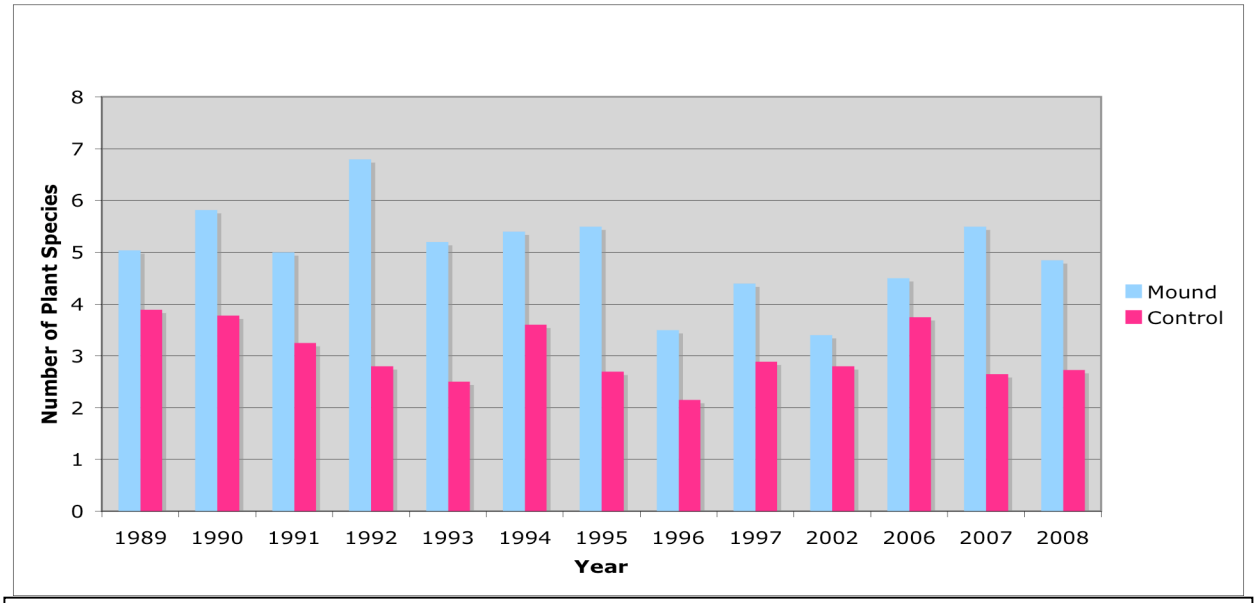

Fig. 4 Mean number of different plant species found on abandoned plain pocket gopher mounds and nearby control patches observed in 1989 thru 2008 in Clearwater County, MN (Forsyth et al., 2008)

Discussion

We observed that new mounds contained no vegetation and that inactive mounds contained differing quantities of plant species depending on mound age. New mounds are characterized by freshly dug soil and a likely absence or near absence of vegetation (Whittaker, pers. com.). Vegetation will not grow on an active mound because constant bombardment of soil by digging inhibits growth. We found that the vast majority of plant inhabitation is on abandoned (28.5% distinct patches) and old mounds (29.9% of distinct patches). We observed that old mounds contained vegetation similar to spots with no mounds while abandoned mounds had a greater quantity of new growth and plant diversity. Foster et al. found that as mounds age the plant species present on them tends to go back to grasses (1980). While this is true to some extent our chi-square value indicated a significant difference between heterogeneity of vegetation on patches with mounds and patches without mounds. The heterogeneity found on abandoned mounds was more distinct than that found on old mounds. This is likely because some of the new plant species found on abandoned mounds were taken over by original grass species while other species remained on the mounds. As such there is sufficient evidence to reject our null hypothesis.

The area of our field covered by mounds in 2008 of 14.6% indicates a rise in pocket gopher mound building when compared with previous years at the same sight (**Fig. 3**). It is hard to pinpoint the exact cause for this increase in mounds, but the shift from a sheltered wetter environment to a drier more wind-affected one (due to a blow down of trees), may have impacted the presence and abundance of certain species. Historically our site was a common habitat for voles. However, during a four-week arbitrary trapping period we found very few voles. This decline in vole population could have directly or indirectly impacted abundance and

presence of other species like *G. bursarius*. If the population of the pocket gopher increased in our field, it would explain the increase in pocket gopher mounds per meter. To test this further research needs to be done.

As our hypothesis predicted, our un-paired t-test showed that there is a significant difference in the quantity of plant species located directly on top of gopher mounds when compared with the control patches. Plains pocket gophers do have an impact on the vegetation diversity atop their mounds. The plains pocket gopher's impact on our study field varies from year to year, but our results and historical results show that the mean number of plant species found on abandoned mound has been greater than that on nearby control patches (**Fig. 4**). The increase in plant species found may be a result of abandoned gopher mounds acting as a catalyst for early successional plant species (Spencer et al., 1985). The freshly dug soil ameliorates conditions for new plant species that were historically unable to grow with the existing grass species covering the field. Another explanation for the increase in plant species may be an increase in soil nutrients and richness on the mounds. Our results are in disagreement with the results found by Coggins et al. and Rogers et al.. This may be because Coggins et al. study differed from our study as Coggins' research was done in Utah near mountain cliffs, was grazed by cattle (*Bos Taurus*), sheep, elk (*Cervus canadensis*) and mule deer (*Odocoileus hemionus*), and was inhabited by the northern pocket gopher (*Thomomys talpoides*). Along with this as Rogers et al. study was located on a tall-grass prairie reserve (2001). In contrast, our field was categorized as an old field, which may explain the differing results found in each study.

The plains pocket gopher has an impact on short-term species richness and acts as an instigator for early successional vegetation growth and diversity. The presence of the plains pocket gophers and consequent mound building may cause contempt amongst property owners,

however, their activity is laudable when looking to regenerate specie richness in an old field.

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