

Gopher disturbance and plant diversity in prairie communities

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Abstract

*The diversity of plant species associated with pocket gopher mound disturbance was examined at Frenchman's Bluff, a prairie on a hill in northwestern Minnesota. Species richness and evenness between disturbed and undisturbed portions of a study area were investigated. An application of the Shannon diversity index to the collected data reveals greater diversity in areas with evidence of pocket gopher (*Geomys bursarius*) activity.*

Introduction

The role of disturbance in shaping the succession of forest communities is the focus of much attention (Frissell 1973, Hickler *et al.* 2004). Studies have demonstrated that major disturbances such as wind and fire are required to maintain representation of certain species within a forest community. Prairies are also subject to fire disturbance, but disturbance related to the activity of both terrestrial and fossorial animals is also important. For example, grazing by large mammals exerts significant control on prairie plant community composition (Gibson 1989). Small-scale animal disturbance, such as the burrowing done by rodents, can also have an impact on grassland communities. Hobbs and Hobbs (1987) developed a model to predict vegetation response to gopher activity, concluding that gopher disturbance strongly affected plant community composition.

The plains pocket gopher (*Geomys bursarius*) is an herbivore with a range throughout the central plains of the United States. The network of burrows that plains pocket gophers dig, and the mounds they build as they remove soil from their tunnels, constitute a small-scale but significant disturbance of the habitat. Gophers dig tunnels 10-20cm beneath the soil surface and form mounds of excavated soil (Hobbs and Hobbs 1987). These mounds are 30-50 cm in diameter and bury existing vegetation to a depth of 10cm. By bringing subsurface soils to the

surface, gophers locally arrest succession (Jones *et al.* 2008).

Our study of the impact of gopher activity on plant diversity was undertaken at Frenchman's Bluff. Frenchman's Bluff is a 52 acre site in Norman County, (47°11'49" N 96°10'35" W) Minnesota. The Nature Conservancy leases the land to the Minnesota Department of Resources Scientific and Natural Areas Program. Tall grasses, short grasses, wildflowers, a rare fern and invasive species may be found at Frenchman's Bluff. Invasive species may shade out other plants, and affect soil composition, thereby having a negative effect on biodiversity (Leicht-Young *et al.* 2009), although we did not investigate these effects because our team was not equipped to undertake positive identifications to the species level on a large scale (but see Gibson 1989, Martinson 1989, and Tilman 1983 for more species-specific work). Our objective was to survey Frenchman's Bluff in order to ascertain the variety of plant growth and the evenness of dispersion in the presence and absence of gopher mounds within our study area. We expect that gopher activity, by churning up soil and creating more varied microhabitats, will enhance plant growth and diversity at fine scales.

Methods

We delineated a 100m × 100m plot on a low-gradient patch of prairie and randomly selected 30 1m × 1m plots with evidence of pocket gopher activity (from 50 identified gopher mounds) and 30 similar plots with no such evidence. We visually estimated percent cover for each plant species present in each plot, and summed the total species present. To quantify diversity in each plot, we applied the Shannon Index (Peet 1974). Although the Shannon Index typically takes data on individual organisms as inputs, as an index it is still informative for comparing two disturbance conditions.

Results

Plots with evidence of pocket gopher activity had an average of 7.9 species of plants. Plots with no evidence of gopher activity had significantly fewer species, (mean = 6.4, $p < 0.001$, $n = 30$, Fig. 1). Similarly, H' (Shannon Index) was significantly higher in plots with gopher activity ($p < .005$, $n = 30$, Fig. 2).

Discussion

Our results suggest that gopher mounds have a significant effect on species richness. Gopher mound plots have an average number of plants that is more than 1.5 plants greater than control plots (Fig. 1). This indicates that soil disturbances by gophers have a positive effect on species richness. This effect was highly statistically significant with a relatively modest sample size, supporting the hypothesis that gopher disturbance enhances species richness. Because there was no experimental manipulation in this study, we cannot conclusively reject the idea that gophers simply select more diverse plots to forage and tunnel. However, most animals can be expected to prefer the most efficient forage, which would be maximized in a plot homogeneous for a favored highly nutritious food (MacArthur and Pianka 1966).

Plant diversity was also positively affected by the presence of a gopher mound. The Shannon Index gave us results that signify a greater diversity in gopher plots against undisturbed plots (Fig. 2). While the Shannon Index ordinarily achieves a maximum at 1, it took on a value greater than 1 in gopher-disturbed plots. This is because we measured percent coverage rather than counting individual plants, and this often added up to more than 100% due to layering of grasses. The difference in H' was significant with $p < 0.005$, supporting our hypothesis that diversity is greater in plots with evidence of pocket gopher activity. Pocket gophers may increase species richness and the value of the Shannon Index by several mechanisms, including turning up nutrients, moister soil, and organic matter, all of which have the potential to increase

plant growth (Mielke, 1977).

These results may have been slightly skewed by human error in the study's data collection. In the 100m × 100m area, only 50 mounds were flagged, and sampled mounds were randomly selected among these. Bias might have been better avoided had we flagged every mound in the study area. Further, some of the flagged mounds may not have actually been gopher mounds, misidentified by field workers unfamiliar with the appearance of gopher mounds. An interesting aspect of gopher mound activity that could be addressed in future research might be the age-dependence of diversity, that is, the time scale over which a disturbed plot achieves maximum diversity and its decline on a long-abandoned mound.

References

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Appendix: Figures

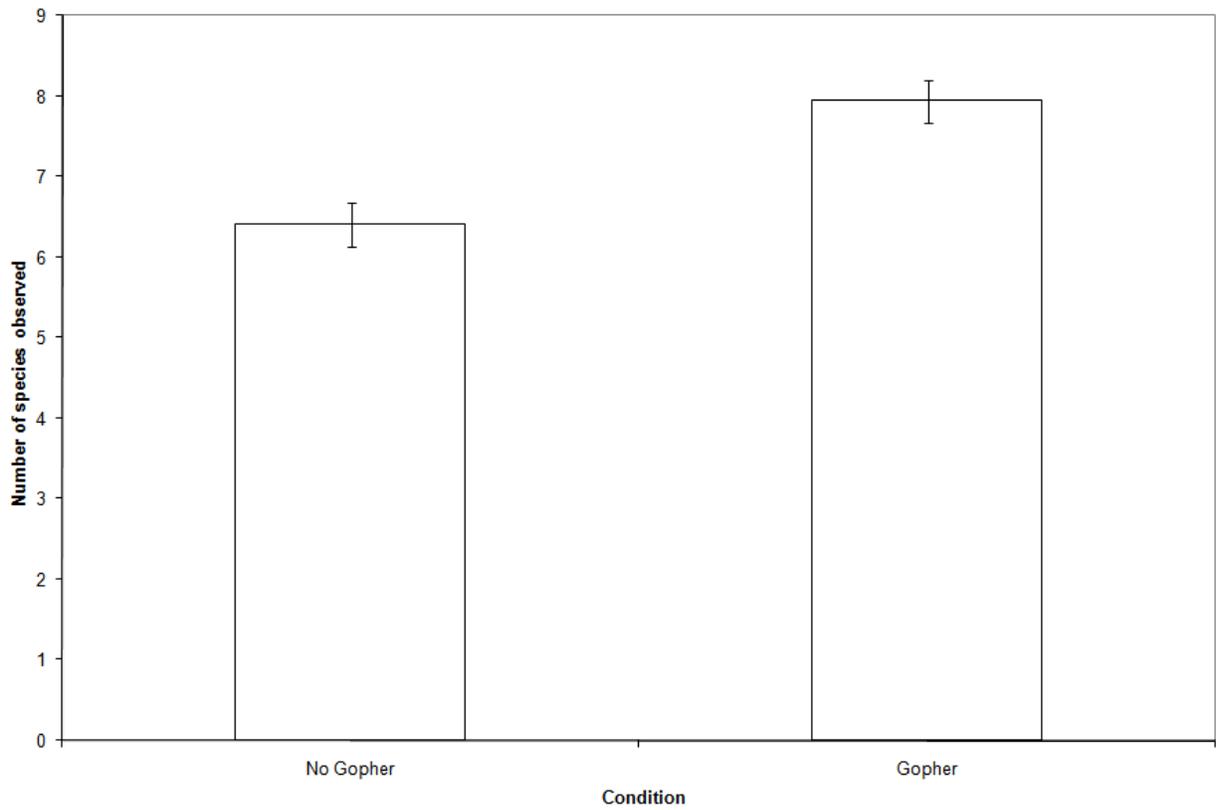


Figure 1: Average Species Richness (\pm S.E.) in sites with and without gopher disturbance.

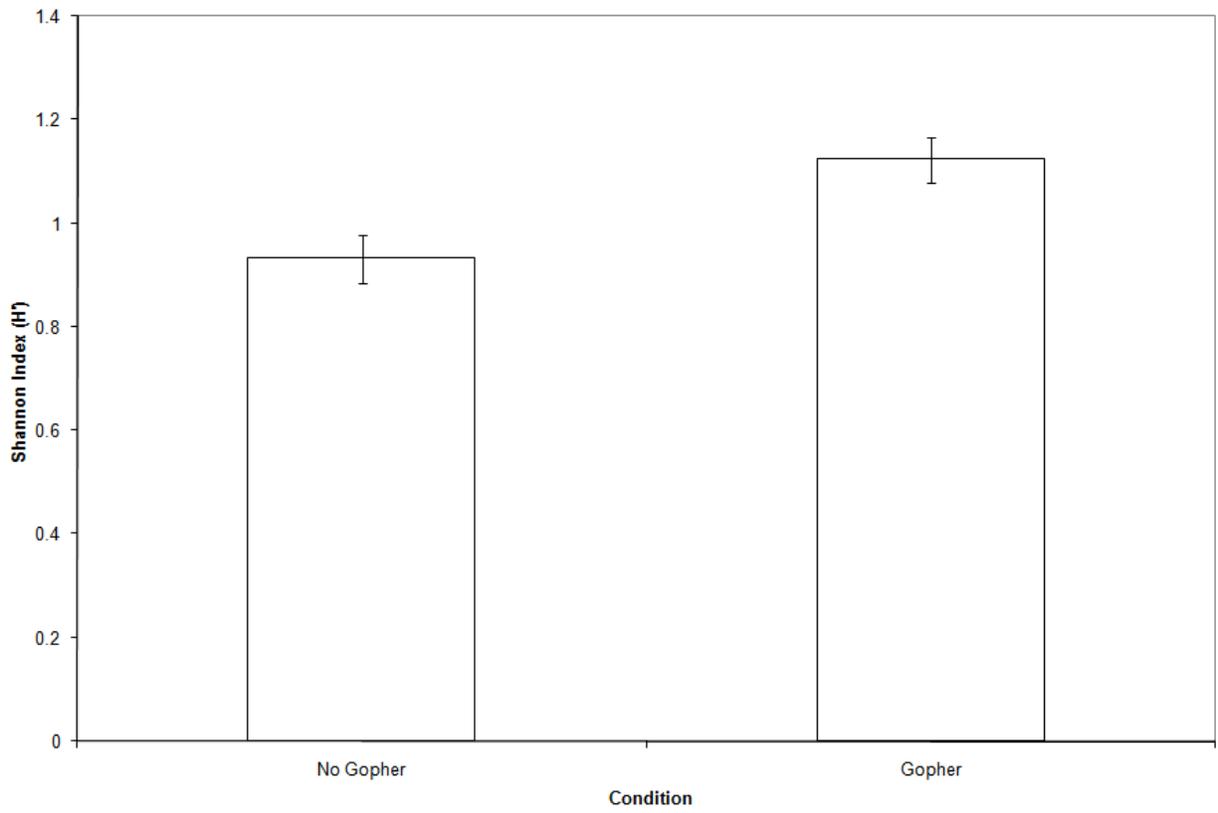


Figure 2: Average value of Shannon Index H' (\pm S.E.) in plots with and without evidence of pocket gopher activity.