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Assessing the Progress of Prairie Restoration on the campus of St. Olaf College; Northfield, MN

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Assessing the Progress of Prairie Restoration on the campus of St. Olaf College; Northfield, MN

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Abstract

The prairies of the United States have largely disappeared from our landscape, and with increasing knowledge of their ecological value attempts have been made at their restoration. How closely can we replicate the prairie in species diversity? A comparison was made between a remnant and restored tallgrass prairie, with data collected on type and number of species of vegetation present and biomass of grass species. Variance to mean ratios, Morisita Indices and ANOVA were used to determine differences in species numbers and spatial distribution between sites. A significant difference in the number of forb species was discovered (p=0.0048), with more species present per plot in the remnant site. Half of the forb species at each site were clumped (Morisita >4.0) and the grass biomass of the restored area is significantly higher than the remnant (p=0.0001). Results suggest that the remnant prairie is more diverse in forbs and the restored prairie is largely dominated by grass species and lacks the biodiversity and random species distribution of original prairies. This signifies differences in management practices and fire frequency, and can be used to help make future decisions to increase biodiversity on the restored site. These results are evaluated in light of evidence that the prairie species composition is not static, and can vary immensely between sites.

Introduction

Prairies were once the largest vegetative ecosystem in North America, stretching through out the Midwest from Canada to Mexico. This is no longer the case; since European settlement, grasslands in America have declined by as much as 99.9%. (Sampson et al 1994) The high amount of organic matter left from perennial grasses and flowering plants creates a fertile soil that is conducive to agriculture, and the ease of plowing and conversion to farmland made it an attractive choice to perspective farmers. Not only does this mean a decrease in prairie acreage, but it also signifies a loss of species diversity. Natural prairies often contain between 300-500 species of grasses and forbs, which is significantly more than most ecosystems, (St. Olaf 2001). In Minnesota, tallgrass prairies were common, containing a variety of species such as Indian Grass (*Sorghastrum nutans)*, Big Blue Stem (*Andropogon gerardii)*, Goldenrod (*Solidago*), Aster (*Aster*) and Yarrow (*Achillea millefolium*). Now, where diverse stands of prairie once stood, monocultures exist. In addition, frequently plowed areas are more prone to soil erosion than prairie land, contributing to a host of problems. Some research has shown that grasslands act as superior carbon sinks, storing large amounts of carbon in soil and helping to avoid increased greenhouse gases in the atmosphere. (Sampson et al 1994)

While these losses were not always apparent, ecologists have become more aware of the importance of prairie in recent years. Agencies such as the Nature Conservancy and the US Fish and Wildlife Service have been actively involved in the restoration of this lost habitat. While restoration is popular and generally good for the environment, it does come at a cost. A 13-acre prairie on the campus of St. Olaf College in Northfield, MN cost $7,500 in 1998. (Bakko 2003) In addition, they are not a self-sustaining ecosystem for some time. Numerous hours of labor must be put into prairie maintenance to get it started.

With so much effort being put into prairie restoration, one cannot help but wonder how successfully we are recreating the prairies that were lost over a hundred years ago. With many prairie remnants containing 350+ species, is it possible to create this same biodiversity? (Howe 1994) Can we replicate the random spatial assemblage that is commonly found in native prairies? As any student of ecology learns, it is very difficult to create an ecosystem. Species interactions, disturbance regimes and soil quality have all contributed to the natural prairie. Grazing by ungulates and wildfires are the main forces shaping the tallgrass prairies of the Midwest.

Several studies have attempted to evaluate the success of prairie restoration projects in the United States, but none have focused on the prairies of Minnesota. Allison (2002) evaluated the difference between native prairie remnants found in Illinois to the restored prairies surrounding Knox College in west-central Illinois. In his research, he discovered that the species distribution and the floristic quality differed between the two sites. Restored plots tended to have a patchy allotment of species, rather than a random distribution found in well-established areas. Brye, Norman and Gower (2002) completed a similar study of tallgrass prairie restoration in Southern Wisconsin. In their work, it was discovered that soil properties and vegetative characteristics tend to change immensely following agriculture, especially when compared to existing prairie remnants. Others have noted similar results. (Schwartz el al 1987, Holl et al 2003, Howe 1994)

In this study, I will be evaluating the progress and success of the tallgrass prairie restoration on the campus of St. Olaf College, found in southeastern Minnesota. Specifically I will be comparing the biodiversity and spatial distribution of the forb and grass species that grow in a restored prairie (St. Olaf) and a remnant prairie found elsewhere in Rice County, MN. It is my hypothesis that the restored prairie will contain fewer species of forbs and less grass than the prairie remnant. In addition, species of forbs will be more clumped in distribution in the restored area than the remnant. The restored prairie selected is found on the campus of St. Olaf College, and was chosen due to the fact that it is one of the older pieces of prairie on campus and has not been burned since 2000. Remnant pieces of prairie are difficult to locate, but a piece with similar soil type was found near the border of Rice and Goodhue counties in MN. It is located at a slightly higher elevation and has a rockier soil, but it is close enough to the St. Olaf prairie to enable comparison. The site has not been managed and has undergone little disturbance other than light grazing. (Angell 2003)

Methods

In order to estimate the biodiversity at each site, random transect sampling was used. A total of two 50 meter transect lines were laid in each prairie, placed away from the edges of the grassland and roughly in each half of the area. On each transect, 3 random 1 m^2 plots were sampled for species types, number of different species and number of individuals of each species. For grasses, each clump of grass was counted. In addition, at each plot another 30 in^2 plot was taken for biomass estimates. All grasses were pulled up and dried for later measurement. A visual assessment of each plot was done to estimate percent coverage by grasses and forbs. This process was repeated at the each site. In lab, all biomass samples were weighed and conversions made to account for air-drying rather than oven drying. If species could not be identified in the field, samples were analyzed for possible identification in lab.

Once collected, data was analyzed using three statistics packages—Minitab 13.1, StatView 5.01 and Morisita 2.0. ANOVA was calculated to compare the mean number of forb species between sites, and to compare the mean number of grass species between sites. Morisita Index, a measure of spatial aggregation for vegetative species, was calculated on all species of forbs found to determine whether or not they had a random or clumped distribution in each prairie. (Brower et al. 1998) To assess the differences in grass biomass, an ANOVA was also run on the biomass data obtained.

Results

A total of 6 forb species were found in the restored prairie, and 8 were obtained from the remnant area. This equates to an average of 3.33 species of forbs per plot in the restored prairie and 5.5 species in the remnant site, a significant difference (p=0.0048). (Table 2 and Figure 1) In the restored prairie, 3 of the 6 species were determined to have a clumped distribution (Morisita > 4 and X^2>20). The remnant counterpart had 4 out of 8 with a clumped distribution. (Table 1)

The restored area had a mean of 2.667 grass species per plot, and the remnant had 2, an insignificant difference (p=0.183). (Table 3 and Figure 2) Biomass averages were 132.7 g for the restored and 47.5 g for the remnant, a significant difference (p=0.001). (Table 4 and Figure 3)

Discussion

The results show that the remnant site has a higher mean forb species per plot than the restored prairie. (Figure 1) This indicates that the remnant grassland is more diverse in forbs. This is a logical result for a number of reasons. First of all, the origins of the plants on each site are distinctly different. The St. Olaf prairie was planted in 1998, using a seed mixture that contained 22 species of forbs. (Bakko 2003) While this is a diverse mix, it is a limiting factor in the possible biodiversity of the area. The actual age of the remnant prairie is unknown, but one assumes that it is significantly older than the restored. Since all of the plants found there drifted in and germinated from the environment, there is theoretically a larger selection of possible species that could have taken root. This is especially true since the land use surrounding the prairie has likely shifted through out time. At one point it was also prairie, but it has been converted to agriculture, crop and grazing land, which has likely introduced a few addition species into the mix.

With further research and investigation, we could gain a better view of the actual species diversity of the remnant prairie. It would be beneficial to take surveys throughout the year, to facilitate better identification of forb and grass species when they still have their reproductive structures intact. Regardless of the outcome of a survey, it is likely that the remnant prairie contains fewer species than before. Literature has reported that prairie loose anywhere from 0.5-1.0% of their plant species per year due to fire suppression and fragmentation. (Allison 2002) For this reason, the comparison between the two sites might have some complications.

This study provides significant evidence that restored prairie of St. Olaf contains more grass than the remnant prairie. (Figure 3). Combined with the results mentioned above, we can preliminarily assume that the restored prairie contains a greater amount of grass than forbs. There are a couple of possible explanations for this outcome. For one, each site surveyed has undergone a unique management plan that has introduced its own set of disturbances to the ecosystem. The St. Olaf prairie studied was last burned in 2000, providing stimulation to the various grasses, perhaps giving them an advantage over some forb species. The remnant prairie has not been burned in recent memory, but has undergone a bit of light grazing. (Angell 2003) This may hinder the production of grass biomass. According to Howe (1994), annual burns will favor warm-weather grasses like those found in tallgrass prairies, but the length of the interval between burns will favor forb production. Therefore, a longer period since a fire might help account for the lack of grass.

It is also worth noting that grass seed is less expensive than forb seed. (Prairie Restoration, Inc. 2003) When land managers are in the process of restoring a prairie they are normally working with a limited budget. This might contribute to the abundance of grass that is often found in restored areas. Also, the age of each site probably plays a role in the species balance found. Extended studies on the succession of restored prairies have shown that planted grasslands will go through a period called an early prairie stage. (Schwartz et al 1987) In this phase of development, prairie grasses are dominant and a lack of diversity in forb species can be found. This is similar to the restored prairie evaluated here.

Results show that neither the restored nor the remnant prairie contains an overwhelming number of species that can be classified as clumped with a Morisita Index. The species that were found to be clumped included goldenrod (*Solidago canadensis*) and a variety of aster (*Aster*), both of which have been found to reproduce via cloning. The nature of this reproductive method lends itself to clumping. Beyond this, the fact that the restored prairie contains a number of forb species that have a random distribution indicates that they are using planting techniques to avoid this. This past summer I took part in a prairie planting on the campus, and we were careful to evenly distribute both the forb and the grass seed mixtures. In addition, all of the species were mixed together into one bag, helping to eliminate clumping.

When comparing prairies, it is necessary to remember that the ecosystem is not static (Allison 2002). Individual remnants often differ from each other, and are low in floristic similarity. The numerous species result in numerous possible combinations and layouts. For this reason, the differences in proportions of grasses and forbs found between the restored and remnant prairies surveyed might not be too significant. If every prairie is different, shouldn't every restored prairie have its own distinct character? The remnant prairies have changed so much since settlement that it might be nearly impossible to recreate what we have lost. According to Allison (2002), restorations are often attractive, but they only give us a taste of pre-settlement prairies.

Despite this reality, prairie restoration is still important and shouldn't be abandoned. The benefits of increased biodiversity, decreased erosion and a possible carbon sink are only beginning to be realized. As long as we focus on creating prairies that are extremely diverse—with as many species as possible—and contain few dominant species, we are going to be helping the land. Perhaps one day, we can again see evidence of the largest and most diverse ecosystem in the United States.

Literature Cited

Allison, SK. 2002. When Is a Restoration Successful? Results from a 45-year-old Tallgrass Prairie Restoration. *Ecological Restoration* 20:10-17.

Angell, D. 2003. Personal Communication.

Bakko, E. 2003. Personal Communication.

Brower, JE, JH Zar and CN vonEnde. 1998. Field and Laboratory Methods for General Ecology. 4th ed. WCB/McGraw-Hill, Boston, MA.

Holl, KD, EE Crone and CB Schultz. 2003. Landscape Restoration: Moving from Generalities to Methodologies. BioScience 53:491-502.

Howe, HF. 1994. Managing Species Diversity in Tallgrass Prairie: Assumptions and Indications. Conservation Biology. 8:691-704.

Prairie Restoration, Inc. 2003. Company Website: http://www.prairierestro.com

Sampson, F and F Knopf. 1994. Prairie Conservation in North America. *Bioscience* 44:418-421.

Schwartz, OA and PD Whitson. 1987. A 12 year Study of Vegetation and Mammal Succession on a Reconstructed Tallgrass in Iowa. American Midland Naturalist. 117:240-249.

St. Olaf College. 2001. Natural Lands Website: http://www.stolaf.edu/other/natural-areas/

Figure 3: Mean grass biomass per plot by site. Site 1: Restored. Site 2: Remnant.