Effects of High Intensity Grazing and Exotic Plant Species on Grassland Biodiversity and Productivity

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Introduction

Plant species diversity has declined rapidly in grasslands, and it is poorly known how to establish and maintain diverse mixtures containing grasses, forbs, and legumes. Each of these groups can be important in at least some situations, with grasses and forbs producing forage and increasing resistance to weeds, and legumes producing forage and maintaining high fertility by fixing nitrogen. There is some evidence that exotic (introduced) plant species and changes in land use are contributing to declines in diversity. Exotic species could be causing declines in diversity in situations where they differ from native plant species in growth rates and other plant traits. However, previous studies were based on correlative data, and we have a poor understanding of whether exotic species themselves are causing direct declines in diversity or if associated land-use changes are causing the declines in diversity.

Grazing may interact with the plant species present to impact diversity. Managed grazing is the most extensive type of land-use worldwide and is often an order of magnitude higher than grazing in natural systems. Experimental studies have shown that, although moderate grazing can greatly increase diversity, if grazing is too intense, then it can reduce diversity. Exotic grassland species have often been selected and introduced for specific uses such as forage and erosion control that may allow them to have very different growth responses compared with native species. These differences might be enhanced under intense grazing. Thus, there may be trade-offs between managing for high forage production, biodiversity, and sustainability. These trade-offs need to be better understood.

Materials and Methods

We established a long-term experiment in 2007 to determine whether high intensity grazing and plant species origin (native vs. exotic) affect grassland diversity and productivity. Plots were planted as single species monocultures or four-species mixtures. Mixtures had either all native species or all exotic perennial grassland species. Native and exotic species were chosen to be comparable in other aspects besides origin such as phylogeny, functional group, growth form, and height. This will allow careful comparison of niche partitioning in time (within a growing season) and space (root distribution) among treatments. Seedlings from eight native and eight exotic grassland plant species were grown in a greenhouse during spring 2007 and then transplanted into 1-m^2 field plots
May 8–11, 2007.

The first growing season was treated as an establishment year. All seedlings that did not survive the first week were replaced. Species not planted in each plot (weeds) were removed monthly during the 2007 growing season. Plots will be weeded, as needed, throughout the duration of the experiment. The leaf area index was measured monthly from planting to peak biomass for each plot to evaluate establishment. Half the plots will be intensely grazed by cattle once during June 2008. The remaining plots are protected by exclosures and will not be grazed.

Results and Discussion

The plots successfully established during the first growing season. There were no differences in diversity or biomass among treatments at the time of planting ($P > 0.05$).

During the first growing season, the leaf area index increased in all mixture plots ($P < 0.0001$), but did not differ between paired native and exotic mixtures ($P = 0.464$), nor between paired mixtures that will be grazed or ungrazed during 2008 ($P = 0.509$), nor among compositions ($P = 0.456$) (Table 1). Thus, the establishment of these experimental communities was successful. We plan to test whether diversity will decline more over time in the exotic mixtures than in native mixtures, and whether this difference is affected by grazing in 2008–2009.

Table 1. Monthly mean leaf area index for experimental treatments for mixture plots established during the first growing season.

	May	June	July	August
Exotic	0.17	0.02	0.51	2.19
Native	0.14	0.01	0.19	2.35

Standard error = 0.09

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