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Assessing the Potential Plant Community Impacts of *Not* Having Grazing in a Small Prairie Park

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Introduction

For thousands of years grazing and fire were part of the ecosystems that compose the North American Great Plains. European settlement drastically changed these ecosystems by replacing large migratory herds of bison—occasional grazers—with more continuous cattle grazing, and by suppressing fires. National parks within the Great Plains seek to maintain and restore these processes, not only to provide visitors the experience of the Great Plains as they used to be, but also to preserve the biological diversity that they promote. Prescribed burning programs have returned one of these vital processes to most prairie parks, but grazing by large herbivores is more difficult to implement, particularly in small parks. Currently, Scotts Bluff National Monument contains significant areas of native prairie but does not have any large grazers such as the bison that helped form and maintain the mixed-grass prairie ecosystem.

Just as fire suppression has affected many native ecosystems, this lack of grazing may also have significant effects on the prairie. Besides the obvious effect of grazing on the stature of vegetation, grazers affect plant community composition through their preferences for some species over others. For example, shorter grasses often increase in the presence of grazing because of reduction in competition from the taller grasses that grazers select (Bragg and Steuter 1996). In addition, large herbivores often increase grassland plant diversity by introducing heterogeneity at a variety of scales. Also, there is some evidence that uniformly heavy spring grazing may be a useful management tool for controlling invasive annual brome grasses *(Bromus japonicus* and *B. tectorum)* (Daubenmire 1940; Whisenant and Uresk 1990; Young and Allen 1997), which are a major management concern at Scotts Bluff.

On the other hand, high-intensity grazing over long periods may significantly reduce plant diversity (Fuhlendorf and Smeins 1997) and increase the diversity and abundance of undesirable, invasive species (DiTomaso 2000). Also, ungrazed areas such as Scotts Bluff may provide some heterogeneity to the regional landscape, which is largely managed for commercial ranching, and may even serve as reservoirs for plant species that are negatively affected by grazing.

To summarize, there is concern that the lack of grazing at Scotts Bluff is having negative impacts on the prairie ecosystem. Consequently, it has been suggested that a grazing program should be considered for Scotts Bluff and other small prairie parks like it. Before a decision regarding such a radical change in management can be made however, information on the potential effects of the decision is needed. This document reports on the results of a pilot project designed to begin addressing this information need.

Although grazing of any kind can affect many different components of an ecosystem, from the plant and animal communities to nutrient cycling, soil compaction, and water infil-

tration, this study focused on the richness and composition of the plant community within the dominant vegetation type at Scotts Bluff. By comparing these between the ungrazed national monument and an adjacent private cattle ranch, some preliminary conclusions about the impacts of currently *not* having grazing and potential impacts of restoring grazing into Scotts Bluff can be drawn.

Methods

Scotts Bluff National Monument lies in the Nebraska Panhandle near the town of Gering. The 3,003-acre park was established in 1919 to preserve and protect two large bluffs, the historical and cultural legacy attached to these bluffs, and the trails that passed between them. Public grazing was allowed on the property until the monument's establishment, after which a three-year grazing permit was given to a local citizen. No other use by domestic livestock has occurred since then except for a war-time permit for a portion of the monument's property during the period 1943–1945 (Harris 1962). Wild large herbivores in the monument are relatively rare. Grazing pressure on the grasslands has therefore been low for at least 58 years.

The area sampled for this project is in the South Bluff management unit of the monument. Approximately 65 ha in size, the only recorded fire in this unit was a prescribed fire in March 1998. The vegetation in this area is dominated by *Hesperostipa comata–Bouteloua gracilis–Carex filifolia* mixed-grass prairie. The private ranch used for comparison in this study belongs to the Keller family. It lies on the southwest border of the monument adjacent to the South Bluff unit. The area sampled is approximately 65 ha in size; it has not burned and is similar to the adjacent area in the monument in soils, topography and vegetation. The area is currently grazed by cattle, with stocking rate and timing of stocking varying from year to year depending on climate and market conditions, a practice typical of operations in the region.

Vegetation sampling was done on June 22–23, 2004, as part of the regular schedule of the National Park Service's Heartland Inventory and Monitoring Network and Prairie Cluster prototype monitoring program (HTLN). Seven permanent sites within the South Bluff management unit monitored by this program were used for the samples within the monument; seven additional, but temporary, sites were established in the adjacent Keller ranch in early June 2004. Because the HTLN sites that were appropriate for this study all fall in the *Hesperostipa comata–Bouteloua gracilis–Carex filifolia* mixed-grass prairie vegetation association, sampling sites at the Keller ranch were also confined to this vegetation association. Sites at the Keller ranch were located randomly within this vegetation type and established in June 2004.

Sampling followed the protocol described in DeBacker et al. (2004). To summarize, frequencies of individual species were calculated for each site from their occurrences in plots of various sizes located systematically throughout a 20x50-m sampling site. In addition, basal cover of individual species and ground cover of bare ground, litter, and rock were measured using the modified step-point method (Owensby 1973). Finally, a complete species list was compiled for the 1,000-m^2 area encompassed by the sampling site. Table 1 summarizes this design, showing the number of each size of plot sampled at each site.

Table 1. Number of points and plots of each size at each sampling site.

Point or plot size (m^2)	Number at each site
point	200
0.01	42
0.1	42
1	10
10	10
1000	1

For all data analyses, *Bromus japonicus* and *B. tectorum* were treated as one (*Bromus* spp.) as were *Pascopyrum smithii* and *Elymus trachycaulus* (*P. smithii–E. trachycaulus*) because of difficulties in distinguishing between the two species in each group in the field. T-tests were used to compare response variables between the monument and Keller ranch properties.

Results

Based on some measures, the grazed and ungrazed properties were not very different. Bare soil cover, total plant basal cover, and basal cover of four of the five species for which basal cover comparisons were possible did not differ significantly between the South Bluff unit and the Keller ranch (Table 2). Frequencies of seven of the eight species for which analyses could be done were not significantly different (Table 3). Finally, total and non-native species richness in the 1-m^2 and 10-m^2 plots were also similar (Table 4).

There were significant differences in other measures, however, particularly those involving more than just the most common species. The one species that did show significant differences in abundance was *Bouteloua gracilis*. It was more abundant in the grazed property than in the ungrazed property. *Vulpia octoflora* also showed a tendency to be more abundant at the ranch than at the monument (Table 3). Litter cover was significantly higher in the South Bluff unit than at the Keller ranch (Table 2), and native and exotic species richness were both significantly higher in the ungrazed unit than in the grazed ranch in the 1,000-m^2 plots (Table 4). Finally, similarity in plot species composition between sites within a property was significantly lower in the South Bluff unit than at the ranch ($P = 0.04$).

Table 2. Soil and plant basal cover in the grazed Keller ranch and ungrazed South Bluff unit of Scotts Bluff National Monument. Values shown are cover means and standard errors (in parentheses), expressed as percent. The final column shows the *P* value for testing for differences in the variable between the two properties.

Variable	Keller ranch	South Bluff unit	P
Bare soil	41.6 (5.5)	30.7 (3.0)	0.11
Total plant	9.3 (1.7)	6.1 (1.5)	0.12
Litter	47.1 (6.2)	62.9 (2.9)	0.04
Bouteloua gracilis	2.9 (1.1)	0.0 (0.0)	0.04
Bromus spp.	0.4 (0.1)	0.7 (0.3)	0.31
Carex filifolia	5.1 (1.1)	3.4 (1.0)	0.27
Hesperostipa comata	0.6 (0.1)	1.4 (0.5)	0.14
P. smithii–E. trachycaulus	0.2 (0.1)	0.5 (0.2)	0.26

Species	Plot size (m^2)	Keller ranch	South Bluff unit	P
Bouteloua gracilis	1	81.4 (7.7)	8.6 (4.0)	<0.0001
Bromus spp.	1	42.9 (13.4)	57.1 (16.0)	0.51
Carex filifolia	0.01	62.2 (7.5)	59.2 (6.7)	0.77
Hesperostipa comata	0.1	19.0 (6.6)	26.5 (6.2)	0.53
P. smithii–E. trachycaulus	0.1	49.0 (6.5)	50.0 (13.0)	0.95
Sphaeralcea coccinea	1	20.0 (6.2)	32.9 (6.8)	0.19
Vulpia octoflora	1	41.4 (8.6)	18.6 (7.4)	0.07

Table 3. Frequency of seven species in the grazed Keller ranch and ungrazed South Bluff unit of Scotts Bluff National Monument. The second column shows the plot size used for calculating frequency, which was determined by the plot size yielding an overall frequency of that species (in both properties) closest to 50%. Frequency values shown are means and standard errors (in parentheses), expressed as percent. The final column shows the *P* value for testing for differences in the species' frequency between the two properties.

Variable	Keller	South Bluff unit	P
Total species richness			
1-m^2 plots	4.4 (0.2)	4.0 (0.2)	0.17
10-m^2 plots	6.1 (0.3)	6.5 (0.3)	0.39
1,000-m^2 plots	15.1 (1.0)	26.1 (3.2)	0.01
Non-native species richness			
1-m^2 plots	0.4 (0.1)	0.6 (0.2)	0.43
10-m^2 plots	0.6 (0.1)	0.9 (0.2)	0.21
1,000-m^2 plots	1.4 (0.2)	3.4 (0.5)	0.008

Table 4. Total and non-native plant species richness in three plot sizes in the grazed Keller ranch and ungrazed South Bluff unit of Scotts Bluff National Monument. Values are means and standard errors (in parentheses).

Discussion

Ideally, a study to investigate the potential effects of introducing grazing into Scotts Bluff would have used replicated experimental treatments to investigate the effects of various grazing regimes on a variety of plant communities over a time covering a wide range of climatic conditions. In contrast, this pilot study used observational methods to compare the plant community composition of a single vegetation association between two properties in a single growing season in the midst of an extreme drought. (Precipitation over the year preceding this study was in the bottom tenth percentile of all previously recorded years; National Climate Data Center 2004a). Consequently, no definitive conclusions can be drawn from this work alone. Thus, this discussion focuses on interpreting the results of the pilot study for the purpose of determining what other research and evaluation are necessary to decide if *not* having grazing is detrimental to the park's ecosystem and whether to consider re-introducing large ungulates.

Results from this work. The results of this study showed almost no difference in the abundance of the most common species between the grazed and ungrazed properties. This

is not surprising for two reasons. First, sampling was limited to a vegetation association characterized by four of these species. Second, previous work in northern mixed-grass prairie has shown that climate, especially precipitation, is the primary driver of grassland vegetation composition, with grazing regime having a secondary effect within the climate context (reviewed in Biondini et al. 1998), or no effect at all depending on the grazing intensity (Biondini et al. 1998; Heitschmidt et al. 1999). Thus, given that this study took place at a time when climate effects would be expected to be extremely strong, it is notable that any differences between the two properties existed. The one species that did differ in abundance between the properties was *Bouteloua gracilis*, a short-statured, native grass. This species and the native annual grass *Vulpia octoflora*, which tended to be more frequent in the grazed property, have been shown in previous work to increase in community importance when vegetation is grazed (Smith 1940; Herbel and Anderson 1959). It is also noteworthy that the abundance (measured as frequency) of the major invasive species of concern—annual brome grasses—did not differ between properties, although the small sample size in this pilot study limits the statistical power for detecting differences.

Although it is tempting to surmise that the long history of grazing on the private property has eliminated grazing-sensitive species, the lack of control in this study for other factors makes this only one of many possible explanations. Since the major invasive species at this site, *Bromus* spp., were not considerably more abundant in the grazed property, competition from invasive species is probably not the explanation. An interaction between drought and grazing may be partly responsible, in that the combination of drought and grazing has been shown to reduce the species richness of forbs (which comprise the majority of species richness in grasslands) in similar grasslands (Hild et al. 2001). Thus, the combination of drought and grazing may have had adverse impacts on species richness in the Keller property. Greater heterogeneity among sample sites at the monument may also have played a role, as indicated by the greater difference in species composition between sites within this property than within the ranch. This greater heterogeneity may result from greater heterogeneity in underlying factors that affect plant species diversity and composition, such as soils and topography. Although these last two factors were somewhat controlled for in this study, detailed information was not collected, so some variability may have existed.

Whatever the underlying cause of the greater plant species richness in the ungrazed South Bluff unit compared with the ranch property, it is probably the most important result to come out of this study. Overall, 29 of 57 species at the monument were unique to monument samples; three of these were non-native. In contrast, only five of the 33 species encountered in the Keller ranch sample sites were unique to that property; one of these was non-native. Although those species unique to the monument are not overwhelmingly grazing-sensitive, this greater diversity of species in the monument samples suggests that the monument may be a refuge for grazing-sensitive species. Clearly much more extensive investigation is necessary to understand this result. However, it is likely that the grazing regime practiced on the Keller property has had some negative impact on species richness of the plant community.

Putting these results in a greater context. This pilot study was exactly that—a pilot study done to provide some preliminary data for a more thorough discussion of a complicat-

ed topic. Two important points need to be made when using the results of this study. First, there are many types of grazing regimes and this study compared the vegetation in only two. A grazing regime is defined not only by the number of animals per acre, but also by when the grazing occurs, whether the animals have free range of a large area or are confined to small areas, and which animals are used. All of these factors influence "grazing effects." Indeed, given the right combination of these factors, the plant species diversity within the monument could probably be increased beyond what it is now. Second, this study looked only at differences in vegetation composition between the grazed and ungrazed properties. One of the most striking and obvious effects of grazing on vegetation is of course the difference in structure. This is important not only for how it looks to people, but also for how it affects other species. Also, as noted in the introduction, grazing can significantly affect other ecosystem properties, from nutrient cycling to streambank structure.

In addition to the above caveats, one must acknowledge that decisions about such a significant change in natural resource management practice are not made based solely on natural resources. Other issues must be addressed. These include logistical issues (e.g., water availability, fencing, personnel for handling animals and/or contracts), issues involving both logistics and natural resources (e.g., grazing regime, location of grazing, interactions with the prescribed fire program), policy issues (e.g., Could domestic livestock be used or are native species the only option? Is grazing consistent with the establishing legislation for the park? How does a park choose between the need to contribute to the conservation of regional biological diversity with a need to conserve natural conditions and processes?), and visitor issues (e.g., safety, acceptance of different species, impact on the visitor experience). This pilot study was designed to address a small part of one of these issues—the potential impacts on plant community composition.

Keeping this greater context in mind, the results from this pilot study do not point to any adverse effects of *not* having grazing in this small prairie park. If viewed in a different way, however, the results also do not suggest that restoring the natural process of grazing to the monument would have large negative impacts either. If it were restored, a carefully designed and executed monitoring program would be essential to ensure that the management practice is having its desired results.

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