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Effects of Short-Term Cattle Exclusion on Plant Community Composition: Prairie Dog and Ecological Site Influences

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On the Ground

- Maintaining cattle and prairie dogs on rangelands is important ecologically, economically, and culturally. However, competition between these species, both actual and perceived, has led to conflict.
- We explored the effects of short-term (2-year) cattle exclusion on plant communities both on and off prairie dog towns and among three common ecological sites.
- Plant communities were different between on-town and off-town plots and among ecological sites but were similar between cattle-excluded and nonexcluded plots.
- Plant community composition did not differ between rangeland targeted for moderate forage utilization and that in which cattle had been excluded for 2 years.

Keywords: prairie dogs, cattle, grazing, plant communities, ecological sites.

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Plant community composition is one of the most important indicators of healthy and properly functioning rangelands. Species composition plays an important role in shaping forage quantity and quality, wildlife habitat type, nutrient and water cycling, drought tolerance, and more. Diverse native communities promote resilient ecosystems through these mechanisms. Northern mixed-grass prairie plant communities evolved under frequent and varied disturbance. Historically, the primary disturbances in this ecosystem were fire and grazing by bison (*Bison bison*) and prairie dogs (*Cynomys ludovicianus*). These disturbances led to a diverse mix of tall, mid, and short stature grasses and forbs, which provided habitat to a variety of wildlife. Since European settlement, free-ranging bison have been almost entirely replaced by domestic cattle[1] and prairie dog range has been reduced by as much as 98%.[2] Where prairie dogs remain, plants on prairie dog towns often are subjected to grazing by both cattle and prairie dogs. Maintaining both prairie dogs and cattle on the landscape is important ecologically, culturally, and economically. As part of a larger study assessing the effects of a prairie dog–cattle relationship on both ecosystems and people, we examined the effects of prairie dog and cattle grazing on the plant composition of three common ecological sites in the semiarid mixed-grass prairie of the Northern Great Plains.

Plant Community Drivers

Precipitation is the major driver of plant community composition in northern mixed grass prairie,[3] with cattle grazing playing a less important, but still significant, role. Plant community composition, and changes in composition, are also highly influenced by ecological site[4] and grazing intensity.[3] Neither moderate (50% use) nor heavy (90% use) grazing appear to cause plant community change in the short term,[3] but long-term heavy grazing can cause shifts to more grazing-tolerant, shortgrass communities[5] and long-term absence of grazing can cause increases in invasive cool-season grasses such as smooth brome (*Bromus inermis*),[6] which can lead to near-monocultures in this ecosystem, decreasing biodiversity.

Prairie dog activity has a substantial effect on plant community species composition and function. Vegetation on prairie dog towns is characterized by grazing-tolerant grasses, annual forbs, high percentages of bare ground, and high plant species diversity.[7] These shifts can take place in as little as 2 years after prairie dog habitation[7] and often are viewed unfavorably by livestock producers because of the approximately 60% dietary overlap between cattle and prairie dogs.[8] Cattle grazing can increase prairie dog density and extent by creating short stature vegetation.[9] Additionally,

Figure 1. Landscape photo of the McLaughlin, South Dakota, study site. Photo taken by Amanda Lipinski.

cattle point attractants (water, mineral, etc.) encourage prairie dog colonization when present[10] and create increased affects in areas where cattle and prairie dogs coexist.

Other factors that influence plant community composition include landscape position, and soil physical and chemical properties, often categorized as ecological sites. The US Department of Agriculture, Natural Resource Conservation Service defines an ecological site as "as a distinctive kind of land with specific soil and physical characteristics that differ from other kinds of land in its ability to produce a distinctive kind and amount of vegetation and its ability to respond similarly to management actions and natural disturbances."[11] In our study area, the three most common ecological sites are claypan, loamy, and thin loamy. Claypan sites are usually found at the base of hills and characterized by higher levels of bare ground and lower phytomass production. Loamy sites are found on gentle slopes and are highly productive. Thin loamy sites are found on shoulder slopes and are usually less productive than loamy sites, largely due to greater runoff. These ecological sites are a useful classification system for rangelands, allowing producers and managers to make focused decisions. As stated in the definition, they also have the potential to respond differently to disturbances, including prairie dog and cattle grazing.

Study Design and Methods

We conducted the present study on the Standing Rock Indian Reservation approximately 15 miles southeast of McLaughlin in north central South Dakota (Fig. 1). Fifty permanent 40 × 40 m plots were systematically located on rangelands either grazed by cattle only, prairie dogs only, or both in 2012. Of the 50 plots, 32 were located on a prairie dog town (*on-town*), and 18 off towns (*off-town*). Plots were distributed among three common ecological sites with 18 plots located on claypan, 18 on loamy, and 14 on thin loamy ecological sites. Cattle grazing occurred from 1 June through 15 October, at which point approximately 50% forage disappearance was achieved. Before our study, the study site was season-long continuously grazed by cattle and horses at unknown stocking rates.

Vegetative data were collected pretreatment and 2 years after treatment. Average growing season precipitation (May through September) is 29.9 cm. Growing season precipitation on the site was slightly below average in 2012 (27 cm), but was well above average in 2013 and 2014 (50.1 and 40.9 cm, respectively). Absolute percent canopy cover for each plant species was estimated using a 0.25 m^2 frame. Results from six readings were averaged for each plot. We used function metaMDS[i] to ordinate our community data and the function envfit to fit a test for differences among groups.[12] We chose the Bray-Curtis dissimilarity for our ordination. Species scores for common species were plotted using the orditorp function[ii] with priority given to species toward the outside of the ordination.

Figure 2. Cattle exclosure on prairie dog town. Photo taken by Aaron Field.

Results and Discussion

Plant community composition was different between *on-town* and *off-town* sites[iii] and among ecological sites.[iv] This fits with prior research by Johnson-Nistler and colleagues[13] who found that prairie dog activity influenced plant communities, with greater bare ground percentage and dwarf shrub biomass *on-town* greater tall shrub biomass *off-town*. Differences among ecological sites were also expected due to different soil chemical and physical properties at these sites.[11] Short term (2-year) cattle exclusion did not result in plant community changes,[v] regardless of prairie dog activity or

[i] Nonmetric multidimensional scaling with stable solution from random starts, axis scaling, and species scores: *vegan* package 2.2.1, R version 3.2.0, three dimensions, stress = 0.123.

[ii] V*egan* package 1.16-32.

[iii] $P \leq 0.01$.

[iv] $P \leq 0.01$.

[v] $P > 0.7$.

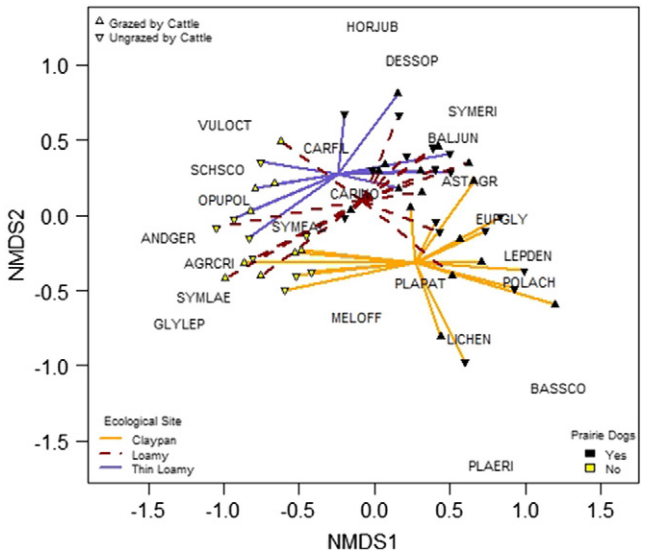

Figure 3. Nonmetric multidimensional scaling ordination of plant community data using Bray-Curtis dissimilarity. Points represent plots; colored vectors connect plots on the same ecological site; shape indicates cattle presence; fill indicates prairie dog presence. Six-letter codes are derived from the first three letters each of the Latin genus and species names of common plants and show their ordination locations.

ecological site (Fig. 2). This was similar to findings by Fahnestock and Detling,[14] who found that 3 years of bison exclusion did not change plant community species composition on or off prairie dog towns. Although cattle and bison do not have identical grazing habits,[15] with cattle spending more time grazing and being less selective, they have many similarities and are both attracted to prairie dog towns under certain conditions.[16]

Species near the right side of the ordination figure (Fig. 3) were found mostly *on-town*. Species toward the left were found mostly *off-town*. *On-town* species (Table 1) were usually annual forbs or short, grazing tolerant grasses. Species that were only common *off-town* were generally perennial species, including grasses, forbs, and shrubs. These results are similar to those found by King[17] and Fahnestock et al.,[18] where annual forbs dominated the on-town community, whereas perennial grasses were more common off-town. This is likely due to the intensive grazing and clipping activity of prairie dogs,[17] which inhibits reproduction of taller, slower growing species. This difference in plant community is an important factor in the persecution of prairie dogs. Annual forbs and grasses produce less usable forage for cattle than perennial grasses and forbs. This fact is not lost on livestock producers, who often choose to eradicate prairie dogs to increase cattle forage. It is important to consider the ecological goods and services provided by prairie dogs and the cost of eradication before making such a decision.

Previous work has also debated the uniqueness of prairie dogs as ecosystem engineers. Vermeire and colleagues[19] cited numerous ways in which heavy cattle grazing can create similar conditions to those on prairie dog towns. A rebuttal was offered by several others (see Miler et al.[2] for a review). Our data seems to support the idea that prairie dogs produce a unique plant community as compared to cattle, however, our moderate stocking rates do not approach the effect of the heavy stocking used by others who have tested this idea.[20]

Our findings show short-term cattle exclusion does not lead to plant community species composition changes in this ecosystem, regardless of ecological site or prairie dog activity. This supports the findings of Biondini and colleagues[3] that showed moderate grazing is sustainable in this ecosystem and those of Fahnestock and Detling[14] that showed that short-term exclusion of large ungulates does not change plant communities. Longer-term grazing exclusion can change plant communities in this ecosystem,[5] and more research is needed to determine the long-term effects of grazing

Table 1. Selected Species Commonly Found at Our Study Site That Were Commonly Found On or Off Prairie Dog Town.

On Town			
BASSCO	*Bassia scoparia*	Kochia	Annual forb
POLACH	*Polygonum achoreum*	Leathery Knotweed	Annual forb
LEPDEN	*Lepidium densiflorum*	Common Pepperweed	Annual forb
PLAERI	*Plantago eriopoda*	Redwool Plantain	Annual forb
EUPGLY	*Euphorbia glyptosperma*	Sandmat	Annual forb
Off Town			
ANDGER	*Andropogon gerardii*	Big Bluestem	Perennial grass
GLYLEP	*Glycyrrhiza lepidota*	American Licorice	Perennial forb
SYMLAE	*Symphyotrichum leave*	Smooth Blue Aster	Perennial forb
AGRCRI	*Agropyrum cristatum*	Crested Wheatgrass	Perennial grass
SCHSCO	*Schizachyrium scoparium*	Little Bluestem	Perennial grass

exclusion under different prairie dog activity and on different ecological sites.

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