



Vegetation Heterogeneity Within and Among Prairie Dog Colonies on Northern Great Plains Grasslands

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Introduction

Areas inhabited by prairie dogs are subject to continuous and intense disturbance by grazing and burrowing that directly and indirectly alters vegetation composition and structure compared to the surrounding uninhabited areas. While the general contribution of prairie dog activities to grassland heterogeneity is well recognized, specific information about how that spatial heterogeneity varies across the landscape is limited. Such information will provide valuable insight into the major drivers of vegetation dynamics in response to management and fluctuating environmental conditions.

Objective

To evaluate patterns of vegetation heterogeneity within and among prairie colonies.

Study Area

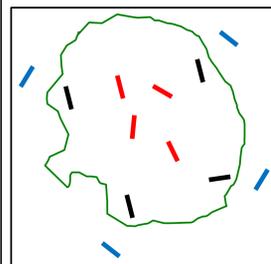
The study was conducted on the 243,000 ha Buffalo Gap National Grassland located in southwestern South Dakota. Vegetation of the Grassland is typical northern mixed grass prairie dominated by western wheatgrass (*Pascopyrum smithii*), green needlegrass (*Nassella viridula*), needle-and-thread (*Hesperostipa comata*) and shortgrass species [buffalograss (*Bouteloua dactyloides*) and blue grama (*B. gracilis*)].



Data Collection

Thirteen active prairie dog colonies and adjacent off-colony areas were sampled during the 2009 and 2010 field seasons on two Ecological Sites described by the Natural Resource Conservation Service: Clayey (6 colonies) and Loamy (7 colonies). Each colony was stratified into three sites:

- Interior – the inner most portions of the colony;
- Edge – the outer edge of the colony but still on the colony; and
- Off Colony



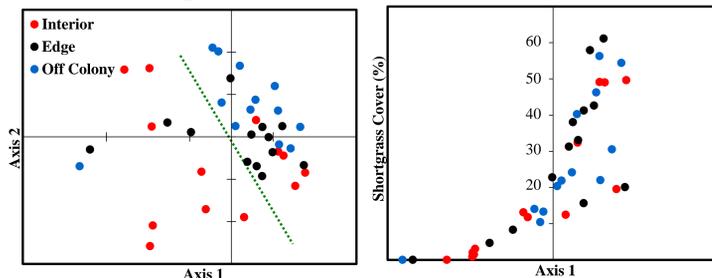
Location of transects on a sample site: Interior (red), Edge (black), Off Colony (blue).

Data Analysis

Nonmetric multidimensional scaling (NMS) was used to extract and summarize gradients and relationships within and among prairie dog colonies. NMS runs were conducted using species foliar cover on two datasets (PC-ORD, Autopilot mode, Sørensen distance; McCune, B. and Mefford, M.J., 2011. PC-ORD Multivariate analysis of ecological data. Version 6, MjM Software Design, Gleneden Beach, OR). The first dataset contained all species except those occurring in fewer than 4 colonies. The second dataset contained all of the species in the first dataset minus the shortgrass species. Using the original full dataset, native and non-native species were placed into separate matrices and Sørensen similarity indices were calculated based on presence/absence and foliar cover. One way analysis of variance was used to test for differences among Interior, Edge, and Off Colony sites (SAS, Version 9.2) with respect to mean species richness (native and non-native), standing crop, percent bare soil, percent cover of western wheatgrass, and percent cover of shortgrasses. When the test indicated a significant difference ($P < 0.05$) means were separated using the Tukey Test.

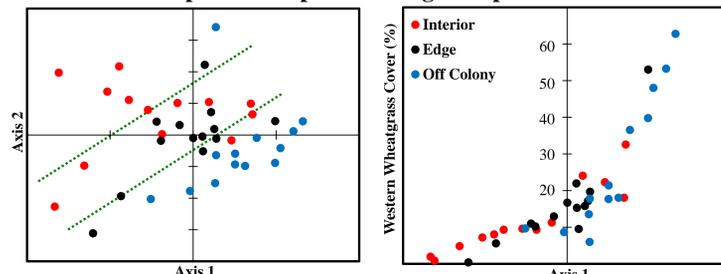
Results

NMS with all species



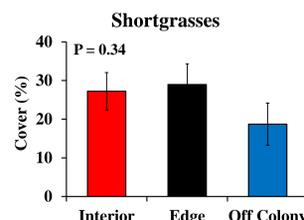
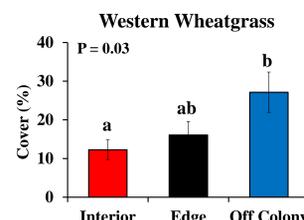
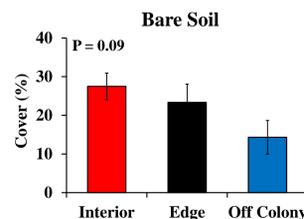
Results of the first ordination conducted with all species indicated considerable integration of Edge sites and Off Colony sites (Axis 1 = 57% of the variance, Axis 2 = 22%). The distribution of the Interior sites suggests heterogeneity in species composition and abundance relative to Edge and Off Colony sites. Foliar cover of the shortgrass species was correlated with Axis 1 scores ($r = 0.79$, $P < 0.05$), while western wheatgrass cover was the dominant species along Axis 2 ($r = 0.81$, $P < 0.05$).

NMS with all species except the shortgrass species



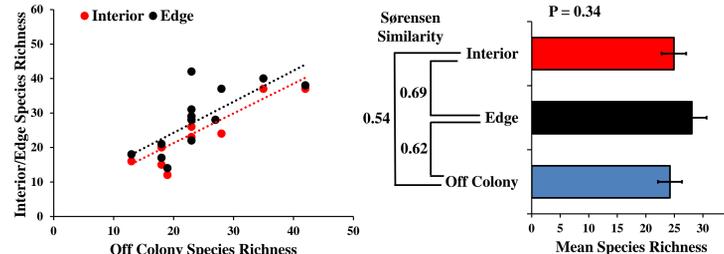
The second ordination, conducted with all species except the two shortgrass species, produced fairly distinct boundaries among Interior, Edge, and Off Colony sites (Axis 1 = 52% of the variance, Axis 2 = 29%). After removing shortgrass species, western wheatgrass cover was strongly correlated with Axis 1 ($r = 0.83$, $P < 0.05$) suggesting that the transition among Interior, Edge, and Off Colony sites is driven largely by western wheatgrass (also see figure below).

Colony-level mean percent cover of bare soil, western wheatgrass, and shortgrasses



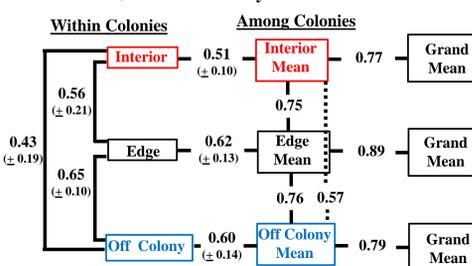
Results (cont.)

Patterns of Native Species Richness



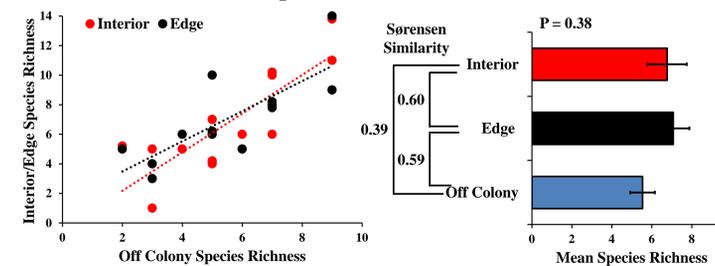
The number of native species recorded Off Colony was positively correlated ($P < 0.05$) with the number of native species recorded on Interior ($r = 0.85$) and Edge sites ($r = 0.74$). However, the mean number of species per colony was similar among sites. Based on species presence/absence, compositional similarity averaged 62% among site locations.

Sørensen Similarity Based on Foliar Cover



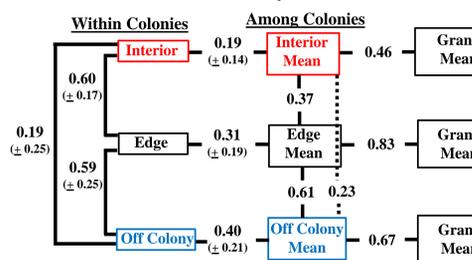
Mean similarity values (\pm SE, $n=13$) of Interior sites were distinctive in composition and abundance in comparison to Off Colony sites. However, at larger scales, Interior and Off Colony sites appeared to contribute equally to plant diversity (0.77 and 0.79, respectively). Edge sites contained species common to both Interior sites and Off Colony sites with cover values intermediate to Interior and Off Colony sites.

Patterns of Non-native Species Richness



A positive correlation between species richness Off Colony and species richness on Interior ($r = 0.83$) and Edge ($r = 0.78$) sites was also observed for non-native species. The mean number of non-native species was similar among the three sites; however, based on species presence/absence non-native species composition of Interior sites was fairly unique relative to Off Colony sites.

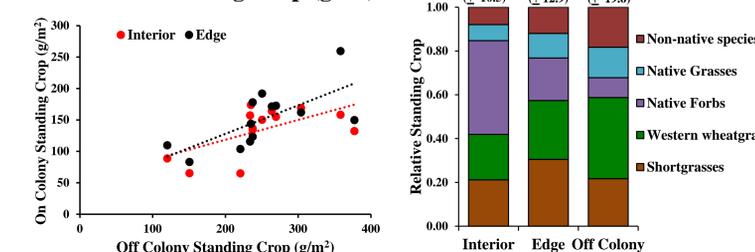
Sørensen Similarity Based on Foliar Cover



Within colonies, Interior sites contained unique assemblages of non-native species compared to Off Colony sites. Among colony, Edge sites tended to be more similar to Off Colony samples than to Interior sites.

Results (cont.)

Patterns in Standing Crop (g/m²)



Off Colony standing crop was positively correlated ($P < 0.05$) with Edge ($r = 0.69$) and Interior sites ($r = 0.59$). Although the amount of harvested biomass varied among colonies, standing crop of Interior sites averaged 45% ($SD=13.7$) less than Off Colony sites while Edge sites averaged 38% ($SD=14.3$) less ($P < 0.05$). The majority of non-native species biomass from Off Colony sites consisted of field brome (*Bromus arvensis*).

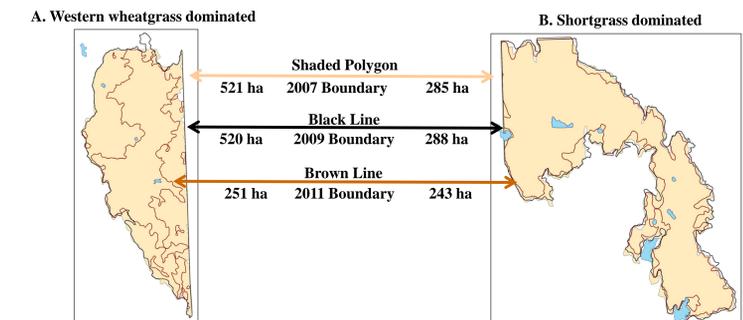
Summary

Prairie dog colonies sampled in this study were highly variable in size, shape, and management history, which was reflected in the variability in species composition and abundance. Of the 154 species recorded, only 2 were found on all 13 colonies: western wheatgrass and scarlet globemallow (*Sphaeralcea coccinea*). Shortgrass species were recorded on all but one colony.

Management and environmental conditions produced a gradient in species composition and abundance among Interior, Edge, and Off Colony sites.

Edge sites appeared to serve as transition zones between Interior and Off Colony sites. Edges contained species of both Interior and Off Colony sites with intermediate cover values. However, among colonies, Edge sites tended to more closely resemble Off Colony sites than Interior sites with respect to non-native species. Interior sites showed considerable heterogeneity in non-native species composition and abundance with assemblages that were especially distinct from Off Colony sites.

The transitional nature of Edges may be a reflection of the response of colony boundaries to fluctuating environmental conditions. During dry conditions, such as those that occurred during 2007 (shaded area in maps below, boundaries mapped with a GPS receiver), colonies reached their maximum recorded size. In comparison to 2007, colonies mapped in 2011 had contracted substantially, likely the result of 2 years of above normal precipitation (Map A below). Fluctuating boundaries may help maintain species and community level continuity across the landscape and possibly serve as the major source of plant diversity at small and large scales. Further, preliminary results suggest that boundary dynamics are strongly influenced by the relative dominance of western wheatgrass and shortgrass species. Edge boundaries can be quite large on sites dominated by western wheatgrass (Map A) and small on colonies dominated by the more grazing and drought resistant shortgrass species (Map B).



Acknowledgements

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