2-2016

Use of Ecological Sites in Managing Wildlife and Livestock: An Example with Prairie Dogs

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Use of Ecological Sites in Managing Wildlife and Livestock: An Example with Prairie Dogs

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On the Ground

- The perception of prairie dogs among Native Americans living on the Standing Rock Sioux Reservation is mixed. Some Native Americans focus on the loss of forage productivity, whereas others are interested in the cultural and ecological aspects of prairie dogs.
- The use of ecological sites may provide a mechanism for developing a management framework that would consider both livestock and prairie dogs.
- The three ecological sites we surveyed had large differences in off-colony standing crop, but in 2 of the 3 years we surveyed, there were no differences between standing crop on-colony.
- This suggests that management of prairie dogs on rangelands should focus on limiting prairie dogs on more productive ecological sites with less productive sites receiving less emphasis.

Keywords: Ecological sites, wildlife-livestock interaction, species diversity, Standing Rock Sioux Reservation.

Rangelands 38(1):23–28
doi: 10.1016/j.rala.2015.11.001

The mixed-grass prairie of the Northern Great Plains (NGP) occupies most of North and South Dakota, large areas of Montana, Wyoming, and Nebraska[1] and extends north into Canada. The mixed grass prairie is also home to a native rodent, the black-tailed prairie dog (*Cynomys ludovicianus* Ord). On the Standing Rock Sioux Reservation, which straddles North and South Dakota, the perception of prairie dogs by Native Americans is complex. Some Native American livestock producers are concerned about potential livestock production losses associated with prairie dog colonies on their rangelands. However, other Native Americans value prairie dogs for their role in cultural traditions, as a source of food, for medicinal value (James Garrett and Linda Black Elk, personal communications), and as a native component of prairie ecosystems. Livestock production is one of the primary land uses on many Native American reservations in the western United States, so reconciling the concerns of livestock producers with more traditional tribal members requires development of strategies that support the simultaneous maintenance of prairie dog colonies and livestock production.

A key in developing management strategies that benefit both prairie dogs and wildlife is to understand how the impacts of prairie dogs on the vegetative community and forage production may differ among ecological sites. Ecological sites are "a distinctive kind of land, based on recurring soil, landform, geological, and climate characteristics that differ from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation and in its ability to respond similarly to management actions and natural disturbances."[2] Each ecological site is unique in its ability to support different types of plant communities, and so different ecological sites have different production potentials. The responses of those plant communities to environmental factors, disturbance, and/or management provide the basis for developing state and transition diagrams for each ecological site. Rangelands in the NGP are a complex mosaic of ecological sites. The overall plant community within a pasture is made up of plant communities associated with the ecological sites, with each responding differently to prairie dog and livestock herbivory.

Many studies have compared vegetation on prairie dog towns to vegetation on nearby, off-town sites, but an evaluation of the role of soils and ecological sites is often lacking [see Gabrielson[3] for discussion]. A previous evaluation of how prairie dogs influenced soil properties on these same three ecological sites in South Dakota[4] indicated that prairie dogs contributed to considerable variation in soil properties but that soil properties within each ecological site responded

similarly to prairie dog disturbance. It is essential that any comparison of on-town and off-town vegetation be done on the same ecological sites; otherwise it is difficult to determine whether the differences can be attributed to prairie dogs or are a result of different edaphic conditions or other environmental factors. It is also important that intentional comparisons of plant communities and production on-town and off-town be conducted *between* ecological sites.

In this study, we asked the question: can we use ecological sites as a metric for use in managing prairie dogs? The objective of our study was to determine how the impact of prairie dogs on plant communities differed between ecological sites. Our null hypothesis was that the impact of prairie dogs would be similar across all ecological sites.

Data Collection and Analysis

Our study site (45.74 N; 100.66 W) was located approximately 12.2 km southeast of McLaughlin, South Dakota, on a 1400-ha privately owned ranch that was a mix of private land and tribal lease land. Anecdotal information suggests that in the 1950s, prairie dog colonies on the ranch were restricted to two small 7-ha colonies in the toe-slope position. The prairie dog colonies began to expand in the 1980s and have since moved onto higher landscape positions (Ricky McLaughlin, personal communication). At the time of the study, prairie dog colonies occupied approximately 800 ha.[4] Management of the ranch was fairly consistent from the 1940s until the early 2000s, with approximately 300 cows and 100 horses grazing throughout the season. By 2010, the majority of grazing was done by horses. In 2012, additional changes were made in the grazing regime to accommodate an USDA- Agriculture and Food Research Initiative grant. Also, prior to the 2012 grazing season, 25 grazing exclosures were distributed across the landscape.

We selected three ecological sites that represent a majority of the rangelands on the ranch: (1) a Thin Claypan, (2) a Loamy, and (3) a Shallow Loamy site. These sites also correspond to toe-slope, backslope, and summit landscape positions, respectively. Both prairie dog colonies and noncolonized areas are represented on all three ecological sites on the ranch (Fig. 1). For more information regarding soil properties and site descriptions, see Barth et al.[4]

Within each ecological site, four prairie dog mounds were randomly chosen in colonized areas, and four random points in uncolonized areas were selected. Around each mound or random point, two 0.125 m^2 quadrats were located 1 m from the center of the prairie dog hole, or from the designated point in noncolonized areas. The addition of exclosures in 2012 required the sampling sites to be moved slightly, but care was taken to stay on the same ecological sites with the same long-term grazing history. Quadrats were clipped by species to

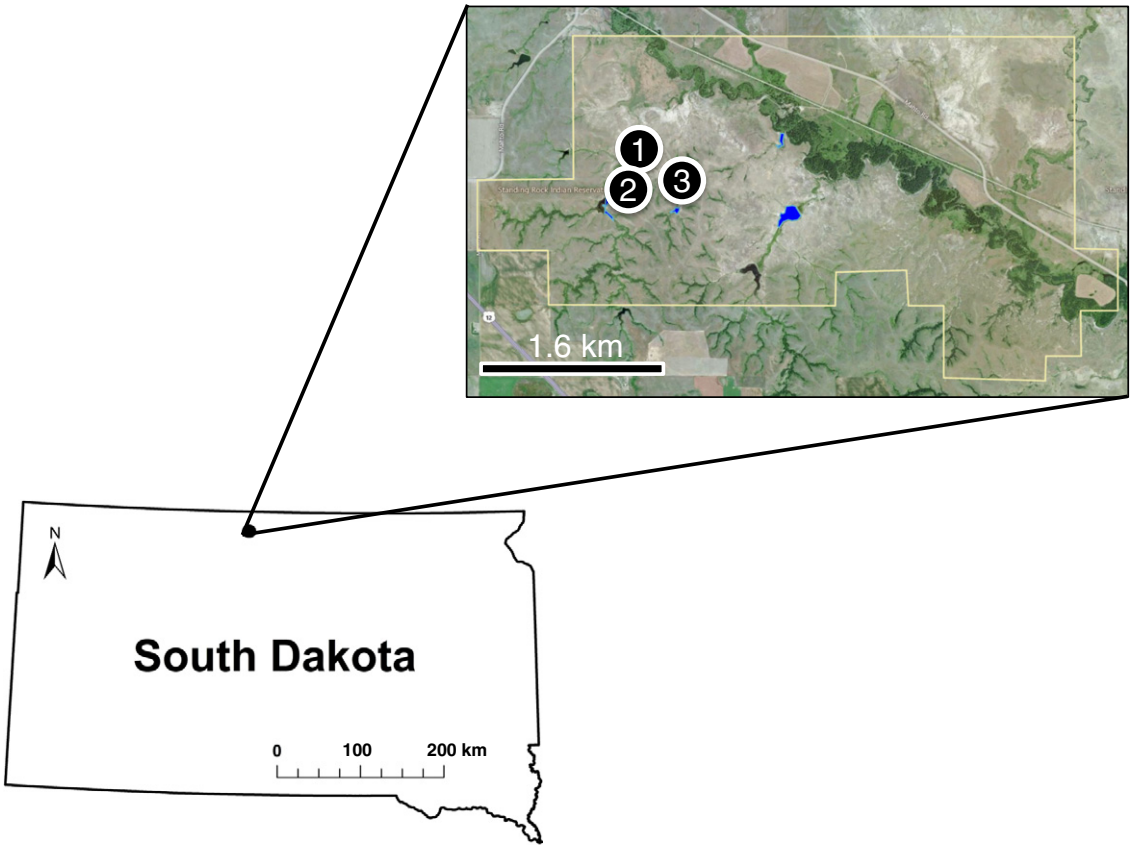

Figure 1. Research ranch location in South Dakota and study site location on the research ranch. The sites are identified as (1) Thin Clay Ecological Site, (2) Shallow Loamy Ecological Site, and (3) Loamy Ecological Site.

ground level in July of 2010, 2011, and 2012. Following clipping, all vegetation was dried for 3 days at 60°C in a forced air oven and then weighed.

The biomass estimates obtained from clipping in this study represent *standing crop* rather than *production*. In all years, prairie dogs had year-round access to on-colony quadrats, and horses had access to those plots in 2010 and 2011. In 2010 and 2011, off-colony quadrats were available to be grazed by large herbivores (mainly horses). Only in 2012 were off-colony quadrats protected from large herbivore grazing by virtue of being located in grazing exclosures. The authors saw little evidence of large herbivore grazing on off-colony quadrats in all 3 years; grazing was, however, obvious on all on-colony quadrats. The biomass data are representative of the standing crop remaining mid-season following defoliation by prairie dogs and/or horses, depending on location.

The number of species in each of the two 0.125 m^2 quadrats for a mound or point were averaged to obtain an estimate of species richness for that sampling location. Species diversity was calculated with the Shannon Weaver index, using individual species biomass to estimate evenness.

The data were analyzed using PROC GLIMMIX in SAS.[5] Year, ecological site, and treatment were considered fixed effects, and quadrat was considered to be random. Means were separated by using Tukey's HSD test at a P value of ≤ 0.10.

Rainfall at the McLaughlin, South Dakota, weather station, which was closest to the site, was 549, 493, 663, and 373 mm for 2009, 2010, 2011, and 2012, respectively. This was 125%, 112%, 151%, and 84% of the long-term average of 439 mm for the respective years. April–June 2011 and August 2011 were particularly wet months, whereas February, March, and June 2010 were drier than normal. In 2012, rainfall was below the long-term average, but many of the driest months occurred during or after the late-July harvest (Fig. 2).

Results

Variables responded differently to the presence or absence of prairie dog colonies (on-colony and off-colony, respectively), on different ecological sites and in different years (a year by site by treatment interaction). Biomass data were analyzed by treatment and by year so the focus could be on standing crop differences between sites. This approach was chosen because a great deal of information has been generated about how prairie dogs can reduce forage availability; however, less is known about how this occurs across ecological sites. Species richness and species diversity were analyzed by year and by site to evaluate differences in species richness and diversity on and off colonies.

In the off-colony areas, July standing crop on the Loamy and Shallow Loamy ecological sites was greater than on the Thin Claypan ecological site in 2010 and 2011 (Fig. 3). In 2012, standing crop on the Loamy ecological site was greater than either the Shallow Loamy or the Thin Claypan sites (see Fig. 3). For on-colony areas, there were no differences in standing crop remaining between any of the ecological sites in 2010 and 2012 (see Fig. 3). In 2011, however, there was less standing crop on the Thin Claypan site than on the other two ecological sites (see Fig. 3).

The patterns in species richness varied between years for all three ecological sites. In 2010, on-colony sites had lower species richness compared with off-colony for the Thin Claypan and Shallow Loamy ecological sites, but the opposite occurred for the Loamy ecological site (Fig. 4). In 2011, species richness only differed for the Loamy ecological site, where it was greater off-colony compared with on-colony. In 2012, species richness was greater on-colony for the Loamy site but less on-colony for the Thin Claypan site (see Fig. 4).

For all 3 years of the study, the Shannon-Weaver index was greater off-colony than on-colony for the Thin Claypan, and there was no difference between on- and off-colony for the Loamy ecological site. The Shannon-Weaver index was greater off-colony for the Shallow Loamy ecological site in 2010, with no difference for the other 2 years (Fig. 5).

Discussion

The ecological sites in this study vary dramatically in their production cap potential acity. The Loamy ecological site has

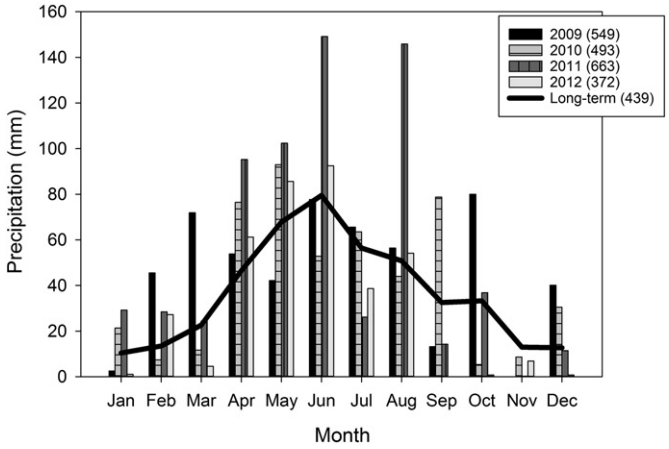

Figure 2. Precipitation recorded at McLaughlin, South Dakota, weather station. Numbers in parenthesis after each year in the legend indicates annual precipitation for that year in millimeters. The long-term precipitation was recorded from 1948 to 2012.

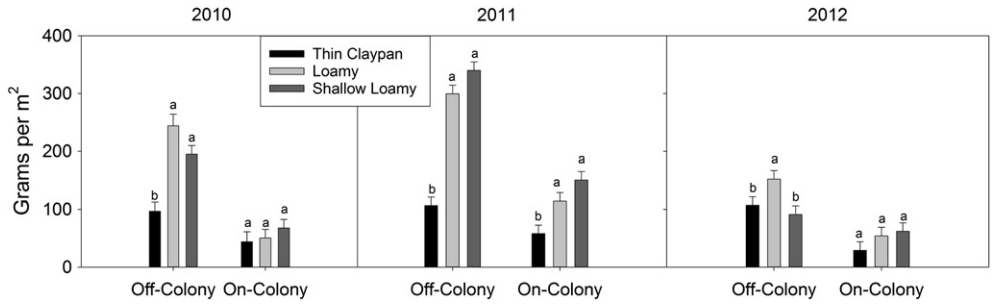

Figure 3. July standing crop, either in areas without prairie dogs (off-colony) or with prairie dogs (on-colony), for each ecological site in 2010, 2011, and 2012. Different lower case letters over the bars signify significant differences (P .10) between ecological sites within a year and within prairie dog occupation (on-colony or off-colony).

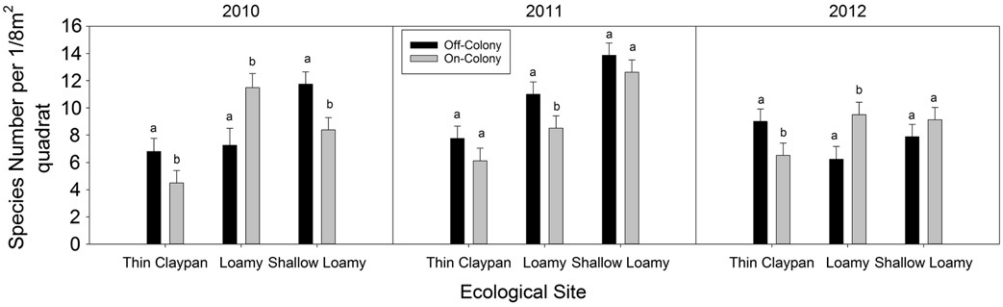

Figure 4. Differences in species richness (species number) between areas with prairie dogs (on-colony) and without prairie dogs (off-colony) for each ecological site and year. Different lower case letters over the bars indicate differences between on-colony and off-colony species richness within each ecological site.

the greatest production potential,[6] followed by the Shallow Loamy site,[7] and the Thin Claypan with the least potential production capacity.[8] There was limited apparent grazing impact from the horses on the site in 2010 and 2011 and exclosures were in place in 2012. In 2010, a somewhat wet year, the pattern of off-colony standing crop remaining in July reflects the relationships to production potential well. In a wet year (2011) and a dry year (2012), the relationships in off-colony standing crop between ecological sites varied. However, the Loamy ecological site maintained higher standing crop compared with the Thin Claypan in all years (see Fig. 3).

With the variation in off-colony standing crop, it is interesting that there are so few differences between ecological sites for the July on-colony standing crop. In 2 of the 3 years, there were no differences between ecological sites for July standing crop. Only in 2011, a wet year, was July standing crop for on-colony Thin Claypan ecological sites less than the other two sites (see Fig. 3). This suggests that prairie dogs clip forage down to a certain level regardless of ecological site productivity, likely as an effort to improve their ability to see predators.[3,9–13] The amount of forage lost to prairie dogs grazing in a less productive site, such as the Thin Claypan ecological site, is less than the amount of forage lost on a more productive site, such as the Loamy site.

Species richness also varied by ecological site. Some of these effects may be linked to duration of prairie dog

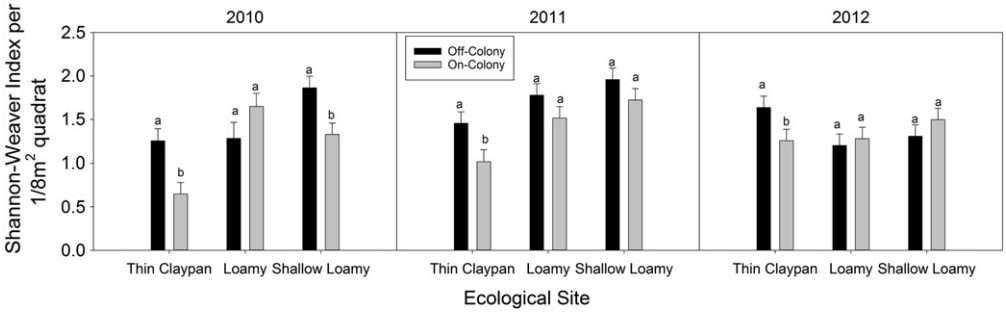

Figure 5. Differences in species diversity as measured by the Shannon-Weaver index for areas with prairie dogs (on-colony) and without prairie dogs (off-colony) for each ecological site and year. Different lower case letters over the bars indicate differences between on-colony and off-colony species diversity within ecological site.

occupation. Our data indicated vegetation species richness was lower off-colony than on-colony for the Thin Claypan site in 2 of the 3 years, whereas the opposite was true for the Loamy ecological site. The prairie dog colonies on our study site originated on the Thin Claypan site but moved upslope as the colony expanded (Ricky McLaughlin, personal communication). Therefore prairie dogs were present on the Thin Claypan site for longer than the Loamy site. Fahnestock and Detling[11] found that species richness and diversity on mixed-grass prairie of South Dakota decreased as the duration of colonization increased beyond a decade. Studies have reported both higher[11,14,15] and lower[16,17] species richness and diversity on colony compared with off colony. Varying results for species richness and diversity may be related to season, vegetation community,[18] soils, climatic factors, and sampling dates.[12] It is likely, however, that the presence of prairie dogs increases species richness and diversity when viewed at the landscape scale.

It is clear that prairie dogs are a valuable, natural component of mixed-grass prairie ecosystems, providing habitat to a variety of plant and animal species. Prairie dogs are also viewed as destructive pests when their populations are large. Their colonial nature, foraging behavior and burrowing activities alter grassland vegetation where they occur.[19] Less forage is available to large ungulates, such as bison and cattle, on prairie dog towns compared with similar off-town areas,[3,12,20–23] and prairie dogs can reduce livestock carrying capacity[3,12,24] and weight gains.[13,25]

Derner et al.[13] found that as prairie dog encroachment increased, livestock gain decreased, but at a slower rate than the rate of encroachment. This suggests there are levels of encroachment that are less damaging economically to the producer. In addition, forage quality is reported to be higher in prairie dog towns.[26] Studies in Mexican grasslands suggest that cattle preferentially graze the edges of a prairie dog colony and use the center for resting.[27] These studies suggest there may be a level of prairie dog occupation in which the relationship between cattle and prairie dogs could be symbiotic rather than entirely competitive.

In our study, we found that the impact of prairie dog occupation on available standing crop differed by ecological site. All on-colony sites were reduced to approximately the same standing crop regardless of inherent production capacity. The amount of forage lost as a result of prairie dog activity was much greater on the more productive sites (Loamy and Shallow Loamy) compared with the less productive site (Thin Claypan). This suggests that the impact of prairie dogs on livestock production could be minimized if the colonies were largely confined to ecological sites that are inherently less productive.

Implications

Prairie dogs have long been considered a nuisance species by livestock producers, primarily because of their impacts on forage productivity. However, the desire of livestock producers to eradicate prairie dogs conflicts with the concerns of more traditional Native Americans to maintain a species they consider to be a key part of the ecosystem and an important part of their culture. The results of this study suggest that one option for addressing this conflict could be to confine prairie dogs to ecological sites that are inherently less productive. This provides a mechanism for maintaining prairie dog populations while minimizing livestock production losses. Strategies to accomplish this may include fencing to ensure that prairie dogs colonies do not exceed a given percentage of the pasture and targeting eradication efforts on highly productive sites instead of the whole pasture.

Acknowledgments

The authors would like to thank M. K. Tokach, T. Fleck, A. Fisher, S. Jangula, C. Barth, D. Kastner, and M. Bingert for their help with data collection.

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