# Small Mammal Community Responses to Fire and Grazing in the Northern Mixed-Grass Prairie

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**Summary**

*We evaluated the effects of two different land management strategies on small mammal community use. The land management strategies evaluated were patch-burn grazing, which is designed to create structural and compositional heterogeneity of plant communities, and conventional season-long grazing. Here we present results from 2017 through 2019 growing season.*

**Introduction**

Heterogeneity is essential to a biodiverse ecosystem (Ostfeld et al. 1997, Fox & Fox 2000). The combination of inherent heterogeneity, caused by abiotic factors such as soil, climate, topography, and nutrient availability, and disturbance-driven heterogeneity cause habitat heterogeneity (Fuhlendorf et al. 2017). Heterogeneous habitat is crucial for supporting a variety of wildlife species at extreme ends of the habitat structure gradient (Fox & Fox 2000, Fuhlendorf et al. 2009). Historically in the Great Plains, the interaction between grazing and fire has been the main source of disturbance-driven heterogeneity, otherwise known as pyric-herbivory (Fuhlendorf et al. 2009).

Pyric-herbivory creates a shifting mosaics of plant communities due to the temporal and spatial interactions of fire and grazing (Fuhlendorf et al. 2009). This occurs when large herbivores, like bison or cattle, preferentially graze areas that have recently burned, due to new growth being more palatable and nutritious (Fuhlendorf & Engle 2001; Fuhlendorf et al. 2009; Knapp et al. 1999; Vermeire et al. 2004). Large herbivores focus their grazing efforts on recently burned patches, which allows patches that had previously been burned and grazed to recover (Fuhlendorf & Engle 2001, 2004; Gates et al. 2017). These patches begin accumulating plant litter from a lack of grazing, which leads to increased fuel loads and probability that this patch will burn again, repeating the cycle of this fire-grazing interaction (Fuhlendorf & Engle 2001, 2004). This produces varying plant community composition and structure through space and time, suitable for sustaining diverse wildlife communities (Fox 1990; Fuhlendorf et al. 2010; Ricketts & Sandercock 2016). Due to present land management, the interaction between grazing and fire has been removed from the landscape, creating more homogenous ecosystems and habitat types. To counter act this, there has been an effort to develop land management strategies to reintegrate pyric-herbivory on the landscape. One such strategy is the patch-burn grazing system (Fuhlendorf & Engle 2001, 2004).

The patch-burn grazing system was developed to re-establish the historical fire-grazing relationship back on the landscape. This grazing system creates a shifting mosaic of plant communities by establishing discrete patches of burned and non-burned patches within a pasture, where livestock focus their grazing efforts on the more nutritious burned patches, while the non-burned patches experience a decrease in grazing efforts (Fuhlendorf & Engle 2001). This cycle occurs every growing season, where previously non-burned patches are subsequently burned and previously burned patches will now experience a decrease in grazing pressure due to the availability of new nutritious forage in the burned patches (Fuhlendorf & Engle 2001). This interaction between burned and non-burned patches creates a heterogeneous landscape that varies in structure and composition, providing a wide variety of habitat for wildlife, such as small mammals (Fuhlendorf & Engle 2004; Fuhlendorf et al. 2010; Ricketts & Sandercock 2016).

Small mammals fill an important niche within grassland ecosystems. They are a major food source for many raptor species, where prairie voles can make up to 41% of an owl's diet (Huebschman et al. 2000) and mesocarnivores, such as coyotes (Brillhart and Kaufman 1995). They can also influence plant community composition through granivory and herbivory (Maron et

al. 2012; Reed et al. 2004). *Peromyscus maniculatus* (deer mice), the most abundant small mammal in North America, have been found to be major source of seed predation, primarily consuming large seeded native plants and avoiding small seeded exotics such as *Bromus inermis* (smooth brome) (Everett et al. 1978; Witmer & Moulton 2012). This has been found to limit re-establishment of desirable plant species in some cases (Everett & Monsen 1990). In previous studies, patch-burn grazing treatments were found to create spatial and temporal patterns of differing habitat types suitable for diverse small mammal communities (Fuhlendorf et al. 2010; Ricketts & Sandercock 2016). Because small mammals are an integral part of the grassland ecosystem, it's important we study the effects of different grazing management systems on their community structures.

The objective of this study is to determine what effect a patch-burn grazing system has on small mammal communities using two treatments. One treatment being a patch-burn grazing treatment and other being a conventional season-long grazing treatment, as a control treatment. We hypothesis that the patch-burn grazing treatment will create a shifting mosaic of plant communities that will support a diverse small mammal community, while the season-long grazing treatment will promote even grazing pressure, creating a uniform habitat and little biodiversity.

**Methods**

*Study Area*

This study is conducted at the North Dakota State University Central Grassland Research Extension Center (CGREC) in south-central North Dakota. The CGREC is in the Missouri Coteau ecoregion in the northern mixed-grass prairie of the Great Plains. This area is characterized by irregular, rolling plains and depressional wetlands. The climate is characterized as temperate and receives an average of 40.3 cm. (51.9 in.) and has an average temperature of 5.0 C (41.0 F) (1991-2019, North Dakota Agricultural Weather Network). The vegetation of this area is typical of a northern mixed-grass prairie invaded by Kentucky bluegrass (Limb et al. 2018).

*Treatment Structure*

Two treatments are applied to this study area, in which we compare three intervals of time since fire and non-burned areas of the patch-burn grazing treatment (PBG), and a season-long grazing treatment (SLG). Each 160-acre pasture used in these treatments is split into eight, 20-acre plots. There are eight PBG pastures divided between two 640-acre units and 4 SLG pastures within one 640-acre unit. All pastures are stocked with cow/calf pairs to achieve approximately 30 percent degree of disappearance.

*(a) Patch-burn grazing treatment* is a management technique that is used to mimic a historic disturbance regime of pyric-herbivory (Fuhlendorf & Engle 2001). Prescribed fire is applied to 12 plots in the spring of each year, with one to two plots being burned per pasture. Data from this treatment is analyzed by zero, one, and two years since fire, and by non-burned plots.

*(b) Season-long Grazing treatment* is intended to replicate a conventional cow/calf grazing management system and will serve as a controlled comparison for other treatments.

*Data Sampling*

Sampling of small mammals occurs from late May to Late June. Each sampling period is consistent of 25 days. Treatments are sampled concurrently to prevent biases associated with weather or time of day. We establish 40x40 meter grids of 25 Sherman live-traps (7.6 x 8.9 x 22.9 cm), spaced 10 meters apart per each plot. In one day, 12 separate plots, one plot per pasture, are sampled (8 PBG and 4 SLG). 300 traps are set per night, and 4,200 total traps are set per sampling period. Traps are baited with a combination of peanut butter and rolled oats. Sampled individuals are recorded and marked with ear tags – Style 1005-3 from the National Band and Tag Company.

**Results**

Number of species captured in the patch-burn grazing treatment was 3 in PB1 unit (Table 2) and 4 in PB2 unit (Table 3), while the season-long grazing treatment had 2 species (Table 1). New captures in the patch-burn grazing treatment was 38 in PB1 unit (Table 3) and 32 in PB2 unit (Table 2), compared to the season-long treatment that had 18 (Table 1). Deer mice was the most abundant in all treatments and units (Tables 1, 2, & 3). Thirteen-lined ground squirrels were present in both patch-burn grazing treatment units and Richardson's ground squirrels were present in the patch-burn grazing treatment unit 1, but not in the

season-long treatment (Tables 1, 2, & 3). We captured 7 prairie voles in the season-long treatment (Table 1) compared to 1 in each of the patch-burn treatment units (Tables 2 & 3).

**Table 1.** Number of individuals captured per species in the season-long grazing treatment (SLG)in the Missouri Coteau of south-central North Dakota in 2017-2019**.**

| SLG | |
|---|---|
| Species | Count |
| *Peromyscus maniculatus* (deer mice) | 11 |
| *Microtus ochrogaster* (prairie vole) | 7 |
| new captures | 18 |
| recaptures | 2 |
| total captures | 20 |

**Table 2.** Number of individuals captured per species in the patch-burn treatment unit 1 (PB1) in the Missouri Coteau of south-central Dakota in 2017-2019.

| PB1 | |
|---|---|
| Species | Count |
| *Peromyscus maniculatus* (deer mice) | 32 |
| *Ictidomys tridecemlineatus* (thirteen-lined ground squirrel) | 6 |
| *Microtus ochrogaster* (prairie vole) | 1 |
| *Urocitellus richardsonii* (Richardson's ground squirrel) | 5 |
| new captures | 38 |
| recaptures | 4 |
| total captures | 42 |

**Table 3.** Number of individuals captured per species in the patch-burn treatment unit 2 (PB2) in the Missouri Coteau of south-central North Dakota in 2017-2019**.**

| PB2 | |
|---|---|
| Species | Count |
| *Peromyscus maniculatus* (deer mice) | 24 |
| *Ictidomys tridecemlineatus* (thirteen-lined ground squirrel) | 2 |
| *Microtus ochrogaster* (prairie vole) | 1 |
| *Urocitellus richardsonii* (Richardson's ground squirrel) | 5 |
| new captures | 32 |
| recaptures | 6 |
| total captures | 38 |

**Literature Cited**


Brillhart, D. E., and D. W. Kaufman. 1995. Spatial and seasonal-variation in prey use by coyotes in north-central Kansas. Southwestern Naturalist 40:160-166.

Limb, R.F., T.J. Hovick, J.E. Norland, and J.M. Volk. 2018. Grassland plant community spatial patterns driven by herbivory intensity. Agriculture Ecosystems & Environment 257:113-119.

Everett, R., R. O. Meeuwig, and R. Stevens. 1978. Deer mouse preference for seed of commonly planted species, indigenous weed seed, and sacrifice foods. Journal of Range Managent 31(1):70-73.

Everett, R., and S. Monsen. 1990. Rodent problems in range rehabilitation. Proc. Vertebrate Pest Conf. 14:186-191.

Fox, B. J. 1990. Changes in the Structure of Mammal Communities over Successional Time Scales. Oikos 59:321-329.

Fox, B. J., and M. D. Fox. 2000. Factors determining mammal species richness on habitat islands and isolates: habitat diversity, disturbance, species interactions and guild assembly rules. Global Ecology and Biogeography 9:19–37.

Fuhlendorf, S. D., and D. M. Engle. 2001. Restoring heterogeneity on rangelands: Ecosystem management based on evolutionary grazing patterns. Bioscience 51:625-632.

Fuhlendorf, S. D., and D. M. Engle. 2004. Application of the fire-grazing interaction to restore a shifting mosaic on tallgrass prairie. Journal of Applied Ecology 41:604-614.

Fuhlendorf, S. D., D. M. Engle, J. Kerby, and R. Hamilton. 2009. Pyric herbivory: rewilding landscapes through the recoupling of fire and grazing. Conservation Biology 23:588-598.

Fuhlendorf, S. D., D. E. Townsend, R. D. Elmore, and D. M. Engle. 2010. Pyric-herbivory to promote rangeland heterogeneity: evidence from small mammal communities. Rangeland Ecology & Management 63:670-678.

Fuhlendorf, S. D., R. W. S. Fynn, D. A. McGranahan, and D. Twidwell. 2017. Heterogeneity as the basis for rangeland management. In: D. D. Briske (ed.). Rangeland Systems: Processes, Management and Challenges. p. 169-196.

Gates, E. A., L. T. Vermeire, C. B. Marlow, and R. C. Waterman. 2017. Fire and Season of Postfire Defoliation Effects on Biomass, Composition, and Cover in Mixed-Grass Prairie. Rangeland Ecology & Management 70:430-436.

Huebschman, J. J., P. W. Freeman, H. H. Genoways, and J. A. Gubanyi. 2000. Observations on small mammals recovered from owl pellets from Nebraska. Prairie Naturalist 32:209–217.

Knapp, A.K., Blair, J.M., Briggs, J.M., Collins, S.L., Hartnett, D.C., Johnson, L.C., Towne, E.G., 1999. The keystone role of bison in North American tallgrass prairie. BioScience 49, 39–50.

Maron, J. L., D. E. Pearson, T. Potter, and Y. K. Ortega. 2012. Seed size and provenance mediate the joint effects of disturbance and seed predation on community assembly. Journal of Ecology 100:1492-1500.

Ostfeld, R. S., S. T. Pickett, M. Shachak, and G. E. Likens. 1997. Defining scientific issues. In: S. T. Pickett, R. S. Ostfeld, M. Shachak, and G. E. Likens [EDS.]. The ecological basis for conservation: heterogeneity, ecosystems, and biodiversity. New York, NY, USA: Chapman and Hall. p. 3–10.

Reed, A. W., G. A. Kaufman, and D. W. Kaufman. 2004. Influence of fire, topography, and consumer abundance on seed predation in tallgrass prairie. Canadian Journal of Zoology 82:1459–1467.

Ricketts, A. M., and B. K. Sandercock. 2016. Patch-burn grazing increases habitat heterogeneity and biodiversity of small mammals in managed rangelands. Ecosphere 7.

Vermeire, L.T., Mitchell, R.B., Fuhlendorf, S.D., Gillen, R.L., 2004. Patch burning effects on grazing distribution. Rangeland Ecology & Management 57, 248–252.

Witmer, G. W., R. S. Moulton, 2012. Deer mice (Peromyscus spp.) biology: damage and management: a review. Proc. Vertebrate Pest Conf. 25, 213–219.