Small Mammal Abundance and Diversity at Abandoned Home Sites in a Prairie Ecosystem

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Abstract - The southwestern plains region of North Dakota is dominated by grassland prairies and riparian corridors. Interspersed throughout this area are home sites, typically abandoned and in various states of disrepair. These home sites, however, support unique assemblages of plants that differ from surrounding habitats. These home sites can be viewed as 'islands' surrounded by grasslands. I surveyed these home sites as well as the surrounding grassland areas for small mammals during the summer of 2010. Small mammals occurred in significantly greater numbers at abandoned home sites than adjacent grasslands. Rodents and soricids were detected at abandoned home sites significantly more often than in the surrounding grasslands, with common species including *Peromyscus maniculatus* (Wagner) (North American Deermouse), *Microtus ochrogaster* (Wagner) (Prairie Vole), and *Blarina brevicauda* (Say) (Northern Short-tailed Shrew). These results indicate the potentially important role of abandoned home sites as refugia for small mammals in these prairie ecosystems.

Introduction

Disturbance can be a significant contributor to the formation of habitat heterogeneity in grassland ecosystems (Azcárate and Peco 2007, Sasaki et al. 2013). Disturbance can be natural, such as fire events, or anthropogenic in origin, as in homesteading or grazing (Bock et al. 2011, Darmon et al. 2013, Doherty et al. 2015, Fuhlendorf and Engle 2001). In prairie ecosystems of western North Dakota, uniform grassland habitats contain areas modified by past human activity and residency, that is, abandoned home sites. These home sites create habitat heterogeneity on a macro-scale to the dominant prairie ecosystem and increase microhabitat diversity. Few studies have examined the role these abandoned home sites play in contributing to rodent populations and community structure in these grasslands.

Increased habitat heterogeneity increases both species richness and species diversity within habitats (Coppeto et al. 2006, Cramer and Willig 2002, Darmon et al. 2013, Fox and Fox 2000, Fuhlendorf and Engle 2001, Fuhlendorf et al. 2010). Where extensive uniformity in habitats exist, local habitat heterogeneity can be an important contributor to overall heterogeneity because it increases the number of microhabitats (Yahner 1982). Past research suggests that microhabitat features, due to local heterogeneity within grassland communities, can have significant effects on rodents and rodent community structure (Jones and Longland 1999, Kaufman and Kaufman 2015, Williams et al. 2002, Yahner 1982). In grassland ecosystems, microhabitats identified by rodents are often distinguished by differences in grass height, density and overstory cover (Doherty et al. 2015, Stancampiano and Schnell 2004, Williams et al. 2002).

Variations in the presence of small herbivores, including rodents, can also influence the species composition of grasses in a grassland community (Jones et al. 2003, Peters 2007). This dynamic interaction between grassland rodents and prairie grasses can potentially influence the local composition of rodent and plant communities of the Plains (Peters 2007).

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For example, rodents that burrow or create mounds have the greatest effects on plant species diversity and assemblages (Davidson and Lightfoot 2008, Davidson and Lightfoot 2006). In each case, rodents locally increased soil disturbance, organic content of soil, leaf litter, and presence of forbs (Davidson and Lightfoot 2008, Davidson and Lightfoot 2006).

A dynamic synergism likely exists between rodent communities and heterogenous, local plant communities in ecosystems of the Great Plains whereby unique plant assemblages foster the establishment of their characteristic rodent communities, which in turn, maintain the conditions that facilitate the persistence of plants. These patterns have been documented for both natural and anthropogenic habitats in the Great Plains (Rohde et al. 2021, Ostoja and Schupp 2009, Kaufman et al. 2000). In some cases, single or a small few plant species foster greater abundance and species richness of rodents that then interact together ecologically to increase local biodiversity across multiple taxa and guilds (Rohde et al. 2021).

Anthropogenic habitats in the Great Plains might be particularly important for increasing rodent diversity. Kaufman et al. (2000) studied small mammal communities in 11 native and anthropogenic habitats in north-central Kansas. With the exception of *Sigmodon hispidus* Say and Ord (Hispid Cotton Rat), all other small mammal species were distributed nonrandomly across the habitat types (Kaufman et al. 2000). Variation in small mammals and plants in unique habitats significantly increased species diversity within a local geographic area (Kaufman et al. 2000).

Shrews also likely are sensitive to habitat heterogeneity, especially in drier, grassland ecosystems. Shrews are sensitive to low humidity and have higher respiratory evaporative water losses than other small mammals (Churchfield 1990, Lindstedt 1980). Studies have shown that shrew species diversity and abundance increase in wetter environments (Churchfield 1990). In grassland environments, shrew abundance has also been correlated with precipitation (Matlack et al. 2002). Abandoned prairie home sites might provide important microhabitats for shrews with higher humidity and greater or more diverse food resources, shelter, or nest sites than surrounding grasslands.

Herein, I examined patterns of small mammals in two different habitats, those associated with abandoned home sites and adjacent, unaltered grasslands in western North Dakota. I viewed abandoned home sites as islands in a 'sea' of naturally occurring grassland. Furthermore, I examined the role that abandoned home sites might play as a habitat for small mammals in the Northern Great Plains. Abandoned home sites represent unique, isolated habitats that may provide novel resources to small mammals in an otherwise uniform environment.

Materials and Methods

Study area. Grassland and abandoned home site areas were located in Stark and Dunn counties in western North Dakota. Grasslands in western North Dakota are predominantly mixed grass and shortgrass prairies dominated by *Bouteloua gracilis* Kunth (Blue Grama), *Pascopyrum smithii* Gould (Western Wheatgrass), *Koeleria macrantha* Schult (Prairie Junegrass), *Selaginella densa* Rydb. (Spikemoss), *Carex duriuscula* C.A. May. (Needleleaf Sedge), *Hesperostipa comata* Trin. & Rupr. (Needle-and-Thread), *Schizachyrium scoparium* Nash (Little Bluestem) and *Bouteloua dactyloides* Columbus (Buffalograss) (Hanson and Whitman 1938). Forbs present on the study sites included *Achillea millefolium* L. (Yarrow), *Grindelia squarrosa* Dunal (Gumweed), *Echinacea augustiolia* DC (Purple Coneflower), *Leucocrinum montanum* Nutt. (Sandlily), *Penstemon angustifolius* Nutt. (Beardtongue) and *Opuntia polyacantha* Haw. (Plains Prickly Pear) (Hanson and Whitman 1938). Abandoned home sites were dominated by collections or rows of trees that included *Elaeagnus angus-*

tifolia L. (Russian Olive), *Populus deltoides* Marshall (Cottonwoods), *Picea* spp. (Spruce), and *Pinus* spp. (Pines). Shrubs and bushes were also present on abandoned home sites. These were most often *Artemisia* spp. (sages), *Juniperus horizontalis* Moench (Horizontal Juniper) and *Shepherdia argentea* Nutt. (Buffaloberry) along with ornamentals such as *Syringa vulgaris* L. (Lilac) and fruit trees. Differences in vegetation height and composition likely cause abandoned home sites to receive less total direct sunlight at the ground surface than adjacent grassland areas. Abandoned home sites also frequently contained abandoned structures and abandoned agricultural equipment.

Site selection and sampling. I sampled small mammals at 15 abandoned home sites and 15 adjacent grasslands during June, July, August, and September of 2010, in a paired sample design. Abandoned home sites were paired with adjacent grasslands that were <0.5 km of a home site. Home site/grassland pairs had the same general elevations, exposures, slopes, and aspects. Abandoned home sites were identified and selected by driving country roads and contacting landowners. I then located grassland sites no less than 500 m from home sites in un-mowed grasslands. I captured small mammals using Museum Special snap traps placed in 5x5 trapping arrays and operated during a three consecutive night sampling period. Each abandoned home site and adjacent grassland site were trapped on the same nights. I baited snap traps with rolled oats and peanut butter. I collected individuals captured each morning, and all individuals were vouchered as standard museum specimens and deposited at Dickinson State University in their Natural History Collection. Common and scientific names used herein follow Bradley et al. (2014).

Data analyses. I compared total captures of small mammals between abandoned home sites and adjacent grasslands using Wilcoxon paired-sample tests (Zar 2010). Wilcoxon paired-sample tests were also used to analyze capture data between sites among mammal orders (Rodentia) and the most commonly detected species [*Peromyscus maniculatus* (Wagner) (North American Deermouse) and *Microtus ochrogaster* (Wagner) (Prairie Vole)]. When insufficient numbers of small mammals were captured to run Wilcoxon paired-sample tests, I used chi-square analyses with 1:1 expected ratios to examine departures from expected and observed captures between paired sites (Order Eulipotyphla; Zar 2010).

Results

I documented 6 species of small mammals during the study, including 4 rodent species and 2 shrew species (Table 1). I captured 475 small mammals during 2250 trap nights (1125 trap nights/habitat) for an overall trapping success of 21.1%. At abandoned home sites, 300 small mammals (289 rodents, 11 shrews) were captured resulting in a trapping success of 26.7% (Table 1). In grasslands, I only captured 175 total small mammals (174 rodents, 1 shrew) and a trap success of 15.6% (Table 1).

Two rodent species comprised >94% of all small mammals. The North American Deermouse was the most abundant rodent captured during the study, accounting for 49.9% of all captures (50% of all captures at home sites; 49.7% of all captures in adjacent grasslands). The Prairie Vole also was abundant, accounting for 44.4% of all captures (44.3% of all captures at home sites; 44.6% of all captures in adjacent grasslands).

Small mammals were captured more often at abandoned home sites than in adjacent grasslands ($T+ =12$, $n=15$, $p = 0.005$; Table 1). Rodents also were captured more often at abandoned home sites over grasslands ($T+ = 13$, $n = 15$, $p \leq 0.05$). The North American Deermouse was the only species that was captured more frequently in abandoned home sites compared to adjacent grasslands ($T+ = 16$, $n = 15$, $p \leq 0.05$; Fig. 1). The 2 species of shrews,

Sorex cinereus Green (Masked Shrew) and *Blarina brevicauda* Say (Northern Short-tailed Shrew), when numbers of captures were combined, also were not distributed evenly between home sites and grasslands ($\chi^2 = 8.33$, df = 1, $p \leq 0.05$, Fig. 2). Differences in shrews between abandoned home sites and adjacent grasslands can be attributed to the presence of the Northern Short-Tailed Shrews exclusively being captured at abandoned home sites.

Table 1. Small mammals captured at abandoned home-sites and adjacent grasslands in western North Dakota. Asterisks indicate significant differences and † represent that numbers of both shrew species were combined in statistical analyses.

Species	Abandoned home-sites	Adjacent grasslands	Total
Microtus ochrogaster	133	78	211
*Peromyscus maniculatus**	150	87	237
Ictidomys tridecemlineatus	0	4	4
Mus musculus	6	5	11
*Blarina brevicauda**†	8	0	8
*Sorex cinereus**†	3	1	4
Total*	300	175	475

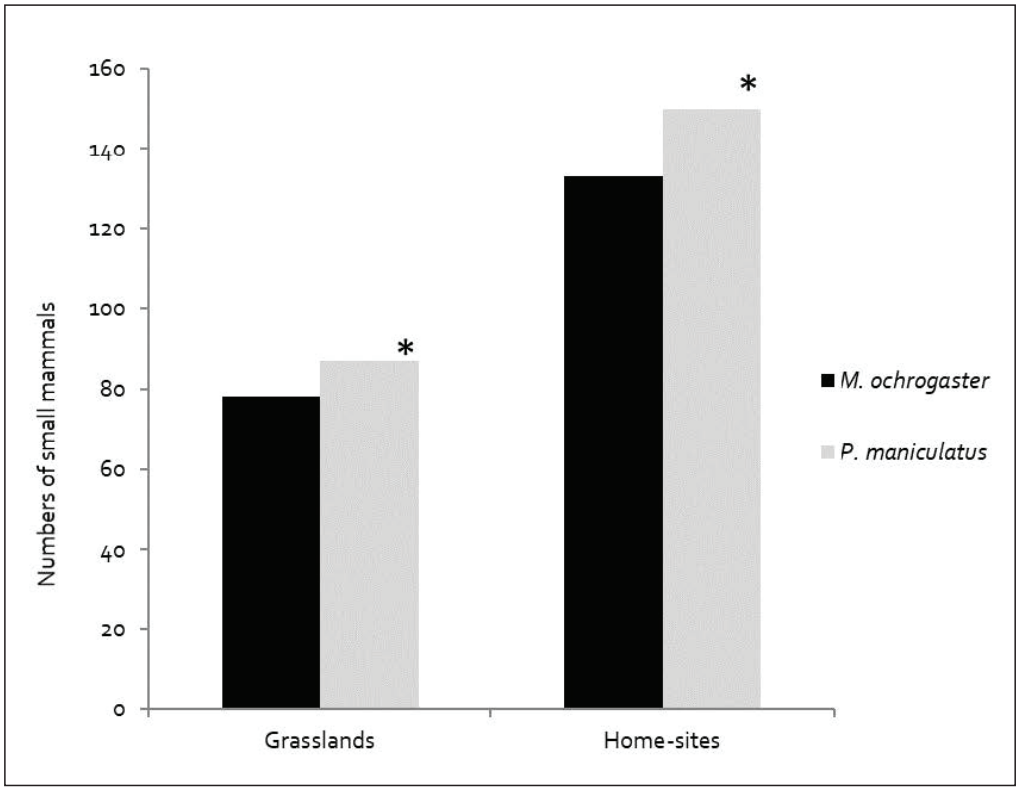

Figure 1 – Numbers of *Microtus ochrogaster* (Prairie Voles) and *Peromyscus maniculatus* (North American Deermice) trapped in grasslands and at abandoned home-sites in North Dakota (June – September 2010). Asterisks represent $p \leq 0.05$.

Discussion

Captures of small mammals were greater on abandoned home sites compared to adjacent grasslands in western North Dakota. This difference was driven by North American Deermice and Northern Short-Tailed Shrews. Abandoned home sites supported plant species not occurring in the surrounding prairie and provided increased structural heterogeneity and cover. Abandoned home sites increased local plant species richness that likely increased food resources and provided protection to small mammals.

Besides a greater variety of seed and herbaceous resources, rodents might also be responding to the greater availability of over-story cover present at abandoned home sites. Small mammals are susceptible to predation from avian predators (e.g., hawks and owls), thus increased prevalence of shrubs, bushes, leaf litter, and downed timber at abandoned home sites would be attractive to rodents for protective cover. North American Deermice use woody environments in the Great Plains (Spanel and Geluso 2018, Manning and Geluso 1989). Manning and Geluso (1989) observed North American Deermice in large numbers in unburned grasslands, but this species also inhabited *Pinus ponderosa* Douglas (Ponderosa Pine) and *Juniperus virginianus* L. (Eastern Redcedar) plantations. Wooded deciduous shelterbelts also are used by North American Deermice in the Great Plains (Spanel and Geluso 2018).

Abandoned home sites may provide unique microhabitats preferred by small mammals, and in particular, shrews. Shrews are physiologically constrained within habitats by

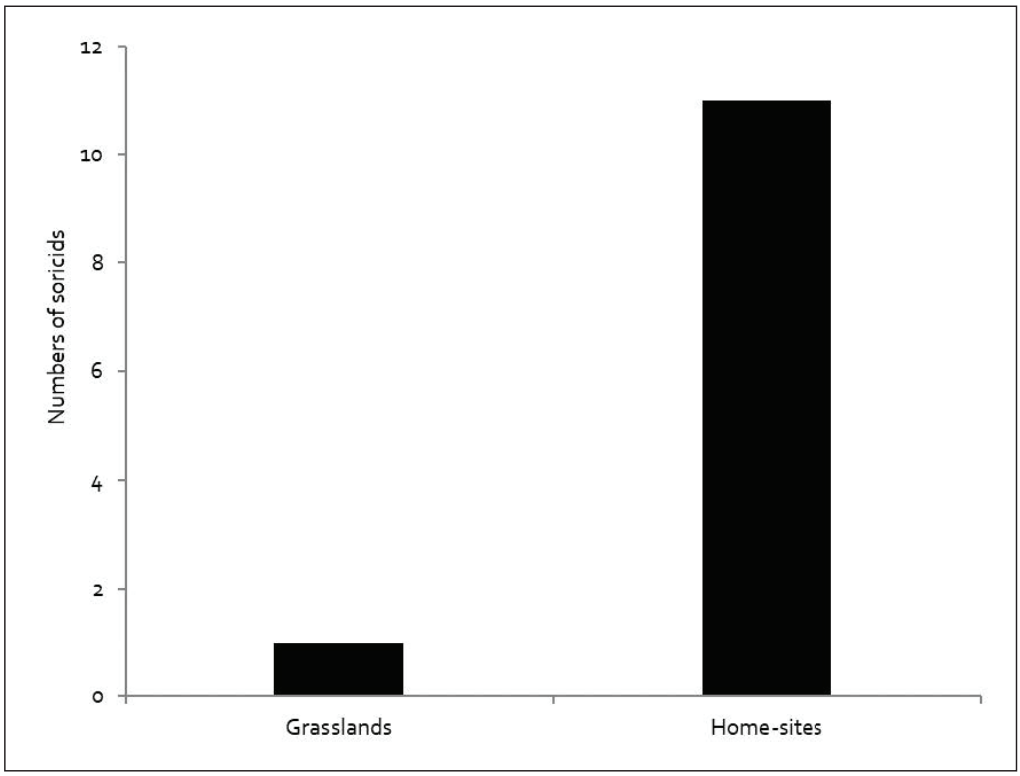

Figure 2 – Comparison of numbers of soricids trapped in grasslands and at abandoned home-sites in North Dakota (June – September 2010). Asterisk represents $p \leq 0.05$.

water, as respiratory water losses can be significant for these mammals (Churchfield 1990, Lindstedt 1980). Shrews tend to select microhabitats in ecosystems that foster high relative humidities. Woody vegetation at abandoned home sites likely produced higher humidities in microhabitats than surrounding grasslands by reducing air currents and lowering surface temperatures by increasing shade (Bhark and Small 2003, Tiedemann and Klemmedson 1977). Thus, these humid microhabitats would assist shrews in minimizing respiratory water loss and reduce overall physiological stress.

Although few studies have examined the importance of islands of woody habitat in grassland ecosystems, my findings agree with past studies on farmstead shelterbelts. Yahner (1982, 1983a, 1983b) studied small mammal populations, microhabitat use, and community structure in farmstead shelterbelts in Dakota County, Minnesota. He concluded that farmstead shelterbelts provided important microhabitats to small mammals that were sensitive to the presence of woody understory and canopy trees, in particular *Peromyscus leucopus* (Rafinesque) (White-Footed Deermice) and Northern Short-Tailed Shrews (Yahner 1982). He attributed the preference for shelterbelts for those species to benefits received related with foraging and predator avoidance (Yahner 1982).

Abandoned home sites in North Dakota appear to represent important novel human-made environments for at least some small mammals. These anthropogenic habitats are important on local scales and may have broader regional and/or landscape level impacts on small mammal populations, grassland plant structure, and overall rangeland quality. Given the prevalence of abandoned home sites (and shelterbelts) in the prairie ecosystem, the functional role of human-made environments in grassland communities warrants further investigation.

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