2009

Ecology of Small Mammals, Vegetation, and Avian Nest Survival on Private Rangelands in Nebraska

Kent A. Fricke  
*University of Nebraska-Lincoln*, kfricke@huskers.unl.edu

Silka L.F. Kempema  
*University of Nebraska-Lincoln*

Larkin A. Powell  
*University of Nebraska-Lincoln*, lpowell3@unl.edu

Follow this and additional works at: [http://digitalcommons.unl.edu/greatplainsresearch](http://digitalcommons.unl.edu/greatplainsresearch)

Part of the [Other International and Area Studies Commons](http://digitalcommons.unl.edu/greatplainsresearch)

[http://digitalcommons.unl.edu/greatplainsresearch/993](http://digitalcommons.unl.edu/greatplainsresearch/993)

This Article is brought to you for free and open access by the Great Plains Studies, Center for at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Great Plains Research: A Journal of Natural and Social Sciences by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.
ECOLOGY OF SMALL MAMMALS, VEGETATION, AND AVIAN NEST SURVIVAL ON PRIVATE RANGELANDS IN NEBRASKA

Kent A. Fricke,1 Silka L.F. Kempema,2 and Larkin A. Powell

School of Natural Resources
419 Hardin Hall
University of Nebraska–Lincoln
Lincoln, NE 68583-0974

ABSTRACT—Small mammals can be an important bioindicator of ecosystem health. They serve as both predator and prey in many ecosystems. By means of live trapping and nest monitoring, we studied the ecological relationships between small mammals, avian nest survival, and vegetation composition and structure on six private ranches in the Sandhills of Nebraska during 2004. Our study documented six species (132 captures) of small mammals, and we monitored 139 bird nests. Pastures with high small-mammal populations did not suffer higher nest mortality, indicating that small-mammal abundance does not predict avian productivity. We found several vegetation characteristics that influenced small-mammal abundance on our sites. Small-mammal capture indices declined with increased percentage of lying-litter cover in pastures. Long-duration grazing systems had higher small-mammal indices than medium- or short-duration grazing systems, and proximal pastures had higher similarity indices for both birds and small mammals. Our study shows that landowners can affect the small-mammal community through grazing management.

Key Words: daily nest survival, grassland, grazing, Nebraska Sandhills, small mammals

INTRODUCTION

The Nebraska Sandhills is a geographically unique region with a diverse biota. It is the largest grass-stabilized sand dune area in the Western Hemisphere, stretching over 425 km of longitude and covering 50,000 km² (Bleed and Flowerday 1989). The rolling sand dunes were formed by blowing sand and typically have dry uplands with wet interdunal lowlands. Vertebrate diversity is high in the Sandhills: there are 55 species of mammals (Freeman 1989b), 27 species of amphibians and reptiles (Freeman 1989a), and 137 species of birds (Labeled 1989).

Biologists have limited information about wildlife in the Nebraska Sandhills, especially on private rangelands. Beed (1936), Jones (1964), and Gunderson (1973) inventoried small-mammal communities throughout the entire Sandhills. Schrad (1976) documented effects of limited grazing on small mammals on the Valentine National Wildlife Refuge. No information exists to illustrate small-mammal community dynamics on the more intensely grazed private rangelands that dominate the region. Biologists lack information about the ecological relationships among small mammals and their habitat in the Sandhills. Because only 3% of Nebraska is public land (Schneider et al. 2005), private land management is, by default, critical to the biodiversity of grasslands in Nebraska.

A small-mammal community can have several effects on the ecology of an area (Leis et al. 2008). Small mammals can serve as a prey species for first-level carnivores (Greenwood 1982), while also acting as nest predators of ground-nesting passerine birds (Maxson and Oring 1978; Pietz and Granfors 2000). Small mammals serve as primary and secondary consumers, making them an important component of the Sandhills ecosystem.

Our objectives were to (1) compare similarity of small-mammal communities on private ranches in the Sandhills of Nebraska, (2) determine if small mammals affected avian nesting survival on our study sites, and (3) document relationships between small mammals and the vegetation structure of sampled pastures.
METHODS

Field Methods

We conducted this small-mammal study on six private ranches in the Nebraska Sandhills, in eastern Cherry County (Fig. 1). We sampled small mammals on three grazing systems in conjunction with a grassland bird study (Table 1; Kempema 2007). We selected two replicate pastures from each grazing treatment (grazing of long, medium, and short duration). Long-duration pastures had one paddock and were grazed continuously throughout the grazing season. Medium-duration pastures were rotationally grazed for approximately 25 days in each of five or more paddocks. Short-duration pastures were grazed for two to three days in each of approximately 40 paddocks during the growing season. We randomly selected six pastures from the pool of Kempema’s (2007) study sites (two pastures from each grazing system), and trapped small mammals on the same transects used for bird surveys and nest searches.

We trapped small mammals over four trap days and nights twice during the summer of 2004. The first round of trapping took place June 10-13, and the second round of trapping occurred July 27-30. Forty Sherman live traps were placed at 15 m intervals along a randomly chosen line transect in each pasture, creating a trap line approximately 600 m long. Transects were used instead of grids or webs because transects have been shown to yield greater numbers of captures, individuals captured, and species captured. Transects also sample a greater area (Pearson and Ruggiero 2003). Traps were baited with mixed birdseed and peanut butter packets, and were checked twice daily (morning and evening) to document capture of both diurnal and nocturnal small mammals. We placed traps on the ground near the closest available cover; if no cover was available within 2 m of the trap location, we consecutively rotated each trap orientation clockwise 90°.

Figure 1. Location and grazing system of the six study sites in eastern Cherry County, Nebraska, during summer 2004. Circles indicate long-duration; triangles, medium-duration; and squares, short-duration grazing systems. Shaded area on Nebraska map designates the Sandhills.
For each capture, we recorded species, sex (if known), hind foot length, tail length, overall body length, and total body mass. Lengths were measured with calipers, and we determined weight with a spring scale. When possible, we took digital pictures of captured animals to aid in positive identification. Animals were released at the site of capture. Released animals were not marked.

We measured vegetation composition and structure during both weeks of small-mammal trapping. We used a 20 × 50 cm Daubenmire frame (Daubenmire 1959) to estimate the percentage of plant cover. Cover classes, estimated to the nearest 5%, included bunchgrass and rhizomatous grass, sedges, forbs, shrubs, cactus, yucca, litter either lying (residual vegetation standing ≤45° to the ground) or standing (residual vegetation standing >45° to the ground), bare soil, and cattle dung (cowpie). We used a Robel pole (Robel et al. 1970) to measure horizontal vegetation density (visual obstruction reading [VOR]) to the nearest 0.25 dm.

We systematically searched for bird nests throughout the field season using a 20 m rope drag along the same transects we used for bird surveys, small-mammal trapping, and vegetation measurements. We marked each nest with a flag 5 m to the north and south, and recorded GPS coordinates at the nest site. The nesting bird species was identified at the time we located the nest. If eggs were present in the nest, we candled one or two eggs to determine the stage of incubation (Lokemoen and Koford 1996). We monitored nests every three to four days according to Martin and Geupel (1993), until the nest either failed (predation, abandonment, or other disturbance) or at least one young fledged, which was documented as a successful nest.

**Statistical Analyses**

Small-mammal capture indices were calculated by dividing the total number of captures per pasture by the total number of trap nights for each pasture. These catch-per-unit-of-effort indices represent the relative abundance of small mammals using each pasture and have been shown to be an acceptable way to communicate small-mammal abundance and richness (Lancia et al. 1996; Hopkins and Kennedy 2004).

We determined small-mammal and avian similarity indices between all pairs of pastures for small mammals trapped and species of birds viewed using the Sorenson’s similarity index ($S$):

$$S = \frac{2 \cdot K}{a + b}$$

(Krebs 2001), where $K$ is the number of species in both pastures, $a$ is the number of species in pasture 1, and $b$ is the number of species in pasture 2. We used Pearson’s correlation analysis to compare the small-mammal and avian similarity indices for each pair of pastures.

We used Shaffer’s (2004) logistic exposure method to assess variation in daily nest survival (DNS), the probability of a nest surviving one day. We used a linear regression to compare DNS with small-mammal capture indices.

Vegetation data were summarized on each pasture by calculating the average percentage of cover for each cover class and average VOR for each pasture (Robel et al. 1970; Wiens 1974). We related pasture-specific vegetation characteristics to small-mammal capture indices by creating a correlation matrix of the values and performing a principal components analysis (PCA) on the correlation matrix. PCA scores, or factor loadings, from the first principal component were used to create a vegetation index for each pasture sampled. We used this approach because (1) it allowed us to standardize percentage cover and VOR values, and (2) the number of vegetation characteristic variables exceeded the number of pastures sampled. We used a linear regression to compare capture indices to the vegetation factor having the strongest factor loading.
RESULTS

We captured six species of small mammals and recorded 132 total captures during 952 trap nights. The most abundant species captured were deer mice (*Peromyscus maniculatus*) and Ord’s kangaroo rats (*Dipodomys ordii*), of which we captured 36 and 34 individuals, respectively (Table 2). Mean capture indices were highest (0.24 captures/trap night) on long-duration pastures, and short- and medium-duration pastures had similar capture indices (0.10 and 0.08, respectively).

Communities of small mammals varied among sampled pastures. No single species was captured at all of our study sites. Two species, northern grasshopper mouse and Ord’s kangaroo rat, were captured on five of the six ranches, and two species, deer mouse and plains pocket mouse, were captured on four of the six ranches. Thirteen-lined ground squirrels were captured on three of the six ranches. The rarest species was the spotted ground squirrel, which was captured on only one ranch.

Similarity indices for pairs of pastures for small mammals ranged from 0.333 to 0.857, and similarity indices for bird communities ranged from 0.409 to 0.773. The pair of pastures with the highest bird similarity index (0.773) also showed high similarity for small mammals. Less proximal pastures tended to have lower similarity indices for both small mammals and songbirds; the relationship was especially strong for songbirds (P < 0.01; small mammals: P = 0.28).

We found a total of 139 nests of 12 avian species (Kempema 2007). We found no linear relationship between small-mammal capture indices and DNS on our study sites (P = 0.91).

We found that the most variation in the small-mammal trapping index (36.2% of the overall variation) was explained by the first principal component (Table 3; Fig. 2), which was influenced by lying litter, rhizomatous grass, cowpie, bunchgrass, bare soil, and shrubs. Pastures with a lower percentage cover of lying litter, rhizomatous grass, cowpie, and bunchgrass and a higher percentage of bare soil and shrubs had lower small-mammal capture indices (Table 3; Fig. 2). Lying litter (linear relationship: P < 0.05; Fig. 3) and bare soil had the strongest factor loadings in the first principal component.

**DISCUSSION**

Small mammals are abundant throughout the Nebraska Sandhills. They have been documented as a predator of passerine bird nests in the Great Plains (Pietz and Granfors 2000) and in the Sandhills (L. Powell, University of Nebraska–Lincoln, unpublished data). However, we found no relationship between small-mammal abundance and DNS of passerine birds on ranches in Cherry County. Although predation accounted for 46% of failures for nests with known outcome in a study of the effects of grazing systems on the Sandhills grassland bird community (Kempema 2007), small mammals may not be the most influential nest predator in the Sandhills. Mesopredators such as coyotes (*Canis latrans*) have been documented as ground-nest predators, along with snakes, badgers (*Taxidea taxus*), various raptors, brown-headed cowbirds (*Molothrus ater*), and white-tailed deer (*Odocoileus virginianus*) (Pietz and Granfors 2000). Coyotes and white-tailed and mule deer (*O. hemionus*) are abundant throughout the Nebraska Sandhills (Jones 1964; Freeman 1989b), as well as various snakes, including the bull snake (*Pituophis malanoleucus*) (Freeman 1989a) and various raptors (*Buteo* spp.) (Labedz 1989). Paine et al. (1996) documented cattle trampling bird nests

### Table 2

<table>
<thead>
<tr>
<th>Species</th>
<th>Common name</th>
<th>Number of captures</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Peromyscus maniculatus</em></td>
<td>Deer mouse</td>
<td>36</td>
</tr>
<tr>
<td><em>Dipodomys ordii</em></td>
<td>Ord’s kangaroo rat</td>
<td>34</td>
</tr>
<tr>
<td><em>Onychomys leucogaster</em></td>
<td>Northern grasshopper mouse</td>
<td>29</td>
</tr>
<tr>
<td><em>Perognathus flavescens</em></td>
<td>Plains pocket mouse</td>
<td>19</td>
</tr>
<tr>
<td><em>Spermophilus tridecemlineatus</em></td>
<td>Thirteen-lined ground squirrel</td>
<td>13</td>
</tr>
<tr>
<td><em>Spermophilus spilosoma</em></td>
<td>Spotted ground squirrel</td>
<td>1</td>
</tr>
</tbody>
</table>
TABLE 3
FACTOR LOADINGS (FROM PRINCIPAL COMPONENTS ANALYSIS) FOR VEGETATION MEASUREMENTS ON SIX PRIVATE RANCHES IN CHERRY COUNTY, NEBRASKA, DURING SUMMER 2004

<table>
<thead>
<tr>
<th>Vegetation measurements</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annuals</td>
<td>0.108</td>
<td>-0.444</td>
<td>0.207</td>
<td>0.196</td>
<td>-0.042</td>
</tr>
<tr>
<td>Bunchgrass</td>
<td>0.359</td>
<td>0.178</td>
<td>0.333</td>
<td>0.003</td>
<td>-0.141</td>
</tr>
<tr>
<td>Rhizomatous grass</td>
<td>0.372</td>
<td>0.164</td>
<td>0.218</td>
<td>-0.344</td>
<td>-0.010</td>
</tr>
<tr>
<td>Sedges</td>
<td>0.052</td>
<td>-0.420</td>
<td>0.281</td>
<td>-0.250</td>
<td>-0.153</td>
</tr>
<tr>
<td>Forbs</td>
<td>-0.119</td>
<td>0.278</td>
<td>-0.071</td>
<td>0.255</td>
<td>-0.795</td>
</tr>
<tr>
<td>Shrubs</td>
<td>-0.343</td>
<td>0.311</td>
<td>0.096</td>
<td>0.159</td>
<td>0.073</td>
</tr>
<tr>
<td>Yucca</td>
<td>-0.147</td>
<td>-0.357</td>
<td>0.272</td>
<td>-0.236</td>
<td>-0.421</td>
</tr>
<tr>
<td>Cactus</td>
<td>0.043</td>
<td>0.091</td>
<td>-0.494</td>
<td>-0.593</td>
<td>-0.104</td>
</tr>
<tr>
<td>Bare soil</td>
<td>-0.446</td>
<td>0.049</td>
<td>0.001</td>
<td>-0.217</td>
<td>-0.043</td>
</tr>
<tr>
<td>Standing litter</td>
<td>0.192</td>
<td>-0.262</td>
<td>-0.364</td>
<td>0.452</td>
<td>-0.139</td>
</tr>
<tr>
<td>Lying litter</td>
<td>0.428</td>
<td>0.158</td>
<td>0.041</td>
<td>0.130</td>
<td>0.134</td>
</tr>
<tr>
<td>Cowpie</td>
<td>0.369</td>
<td>-0.006</td>
<td>-0.355</td>
<td>-0.118</td>
<td>-0.265</td>
</tr>
<tr>
<td>Visual obstruction reading</td>
<td>0.090</td>
<td>0.402</td>
<td>0.357</td>
<td>-0.013</td>
<td>-0.138</td>
</tr>
</tbody>
</table>

Percentage explained: 36.167 31.287 17.357 8.7087 6.47912

*Vegetation was measured as a percentage of cover, except for visual obstruction reading, which was obtained using a Robel pole. Bolded numbers indicate the vegetation measurements that explain the most variation in the first principal component.

Figure 2. Relationship between small-mammal capture indices (number captured per trap night) and vegetation index (Principal Component Analysis 1) from six pastures in Cherry County, Nebraska, during summer 2004 ($R^2 = 0.57$). Pastures with higher values of PCA 1 had a higher percentage of cover consisting of lying litter, bunchgrass, rhizomatous grass, and cowpies, and a lower percentage of cover consisting of bare soil and shrubs (Table 3).
in highly stocked Wisconsin dairy pastures. However, Kempema (2007) found that trampling was not a problem in the Sandhills, as it caused less than 2.5% of all nest failures.

Our analysis suggests that long-duration pastures have higher populations of small mammals than medium- or short-duration pastures in eastern Cherry County, Nebraska, and that small-mammal communities may be responding to the differences in vegetation composition between different grazing regimes. Our study was replicated across space but may not translate to the entire Sandhills, where vegetation characteristics can be extremely variable. Long-duration pastures in our sample also had higher percentages of bare soil and lower percentages of lying litter, indicating that small-mammal abundances may be driven by vegetative structure and pasture management. Kempema (2007) found the same trends in bare soil and lying litter among a larger selection of pastures in the same grazing systems over a two-year period. We conducted our small-mammal study on a subset of Kempema’s (2007) study sites, which lessened our ability to detect significant effects. We believe that sampling over a larger number of pastures would result in significant results.

Pastures with similar small-mammal communities also tended to have similar bird communities. We believe that these similarities are driven by the habitat structure of each pasture, as vegetation structure influenced capture indices of small mammals. Pairs of pastures that were geographically close had higher similarity indices than pairs of pastures distant from each other for both small-mammal and bird communities. Thus, the community composition of small mammals appears to be a function of both habitat structure and geographic location.

As shown in this study, small-mammal populations vary in abundance in response to vegetative structure. Because a landowner can regulate the vegetative structure on his or her land through various grazing regimes, landowners can therefore manipulate the vegetative structure to impact the characteristics of the wildlife communities found on their property. Continued research into wildlife responses to various grazing regimes will yield additional information that will prove useful to landowners who seek high wildlife diversity on their property.

ACKNOWLEDGMENTS

We thank K. Unstad and A. Reade for assistance with small-mammal trap lines. We are grateful to C. Lemen and P. Freeman for assistance with small-mammal identification and to M. Collyer for statistical assistance and
review of an earlier draft. KAF received support from the Undergraduate Creative Activities and Research Experiences (UCARE) program at the University of Nebraska–Lincoln. Other project support was provided by the Center for Great Plains Studies Research Grants-in-Aid for Graduate Students, the Sandhills Task Force, the Nebraska Game and Parks Commission, the Sampson Foundation, and USDA’s Sustainable Agriculture and Rural Education fund. Thanks to the University of Nebraska–Lincoln Honors Program and the School of Natural Resources for support. This research was supported by Hatch Act funds through the University of Nebraska–Lincoln, and USDA’s Sustainable Agriculture. Thanks to the Nebraska Game and Parks Commission, the Sampson Foundation, and USDA’s Sustainable Agriculture and Natural Resources, University of Nebraska–Lincoln.

REFERENCES


