Documenting relationships between small mammals, ground-nesting passerine birds, and grazing systems on private rangelands in the Nebraska sandhills.

Kent A. Fricke

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Advisor: Larkin A. Powell

School of Natural Resources

University of Nebraska-Lincoln

Introduction

Biologists lack a great deal of information about wildlife in the Nebraska Sandhills, especially on private rangelands. For example, there is little knowledge about the small mammals of the area and their role in the ecosystem in which they live. Because only three percent of Nebraska is public land (Schneider et. al 2005), private land management is, by default, critical to the biodiversity of grasslands in Nebraska. Thus research on private property in the state can be very useful to planning.

The Nebraska Sandhills are geographically unique and biologically diverse. The region is the largest grass-stabilized sand dune area in the Western Hemisphere, stretching 265 miles and covering approximately 19,300 square miles (Bleed and Flowerday 1989). The rolling sand dunes were formed by blowing sand and are currently stabilized by grass. These dunes typically have dry uplands and wet inter-dunal lowlands. Biodiversity is also high in the Sandhills. Terrestrial vertebrates include 55 species of mammals (Freeman 1989b), 27 species of amphibians and reptiles (Freeman 1989a), and 137 species of birds (Labedz 1989). There is also a diverse plant community of approximately 720 species (Kaul 1989).

A small mammal community can have several effects on the ecological community of an area. For example, 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). Their place in the food web makes small mammals an important component of the Sandhills ecosystem.

There were two objectives for this study. The first was to inventory the small mammal community in eastern Cherry County, located near the center of the Sandhills region of the state.

The second objective was to document any relationships between small mammals, ground-nesting passerines and their nests, and vegetation composition of sampled pastures.

Methods

Field Methods

I conducted this small mammal study on six private ranches in the Nebraska Sandhills, in eastern Cherry County (Figure 1). I sampled small mammals on three grazing systems in conjunction with a grassland songbird study (S. Finkbeiner, UNL, unpublished data). There were two replicate pastures assigned within each grazing treatment (long-, medium-, and short-duration grazing, Table 1). Long-duration pastures were grazed continuously throughout the grazing season. Medium-duration pastures were managed to rotate grazing pressure through five or more paddocks in each pasture. Short-duration pastures contained an average of 40 paddocks, of which grazing pressure was rotated throughout the grazing season. Three pastures, one from each grazing system, were randomly chosen for each round of small mammal trapping from the pool of pastures where we had obtained permission to conduct bird surveys and small mammal trapping.

I trapped small mammals over 4 trap days and nights twice during the summer of 2004. The first round of trapping took place from June 10-13, and the second round of trapping occurred from July 26-30. Forty Sherman live traps were placed at fifteen-meter intervals along randomly chosen line transects in each pasture, creating a trap line approximately six hundred meters 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 while also sampling a greater area (Pearson and Ruggiero 2003). Traps were baited with mixed bird seed and peanut butter packets, and were checked twice daily (morning and evening) to document capture of both diurnal and nocturnal small mammals. I placed traps on the ground near the closest available cover; if no cover was available within two meters of the trap location, I rotated each trap orientation clockwise ninety-degrees.

For each capture, I recorded species, sex, hind foot length, tail length, overall body length, and weight. Lengths were measured with a ruler and calipers, and weights were measured with a spring scale. When possible, I took digital pictures of captured animals to ensure positive identification. Captured animals were released at the site of capture. During the second round of trapping, I identified captured animals with a black permanent marker, marking numbers on the ventral side of the animal. I only encountered recaptures on one of the three pastures during this round, and some marks were not distinguishable between recaptured animals on this pasture. Thus, I used a Schnabel population estimate (Schnabel 1938) to estimate the population size of each species for this single pasture.

Vegetation measurements were taken during the week of small mammal trapping. I determined percent cover available using a Daubenmire frame (Daubenmire 1959) and horizontal vegetation density (visual obstruction reading) with a Robel pole (Robel et al. 1970).

To determine the nest success of ground-nesting passerines, I systematically searched for bird nests throughout the field season with a twenty-meter rope drag along the same randomly chosen transects used for the bird surveys, small mammal trapping, and vegetative data collection. With this method, I was able to locate nests from zero to sixty meters from the transect. Nests were also located and marked when found while conducting surveys or traveling to and from transects. I marked each nest with a single flag five meters to the north and south, and recorded GPS coordinates. The nesting bird species was identified at the time of nest location. If eggs were present in the nest, one to two eggs were candled to determine stage of incubation (Lokemoen and Koford 1996). I monitored nests every 3-4 days until the nest either failed because of predation or abandonment, or at least one young fledged, which was documented as a successful nest.

Statistical Analyses

Small mammal capture indices were calculated as a catch/unit effort index for each pasture by dividing the total number of captures per pasture by the total number of trap nights for each pasture. These indices represented the relative abundance of small mammals using each pasture (Lancia et al. 1996) and have been shown to be an acceptable way to communicate small mammal abundances and richness (Hopkins and Kennedy 2004). The catch/unit effort index was used because (1) it reflects the same pattern of total captures as the patterns derived from population estimates using recaptured animals, and (2) I recaptured animals on only one pasture, so I was unable to estimate population size (Hopkins and Kennedy 2004).

Vegetation data was summarized on each pasture by calculating the average percent cover of annuals, bunch grass, rhizomatous grass, sedges, forbs, shrubs, yucca, cactus, bare soil, standing and lying litter, and bovine fecal material (cowpies) (Daubenmire 1959). I also used data from each sample to calculate the average visual obstruction reading for each pasture (Robel et al. 1970, Weins 1974).

I 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):

$$S = 2*K/(a+b)$$

(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. I used a correlation analysis in Microsoft Excel to compare the small mammal and avian similarity indices for each pair of pastures.

Daily nest survival (DNS), the probability of a nest surviving one day, for each pasture was estimated using program MARK's nest survival module (White and Burnham 1999). I compared DNS with the small mammal capture indices using Microsoft Excel, and I used a linear regression to determine trends in the data.

Results

I 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 I captured 36 and 34 individuals, respectively (Table 2). Mean capture indices were highest (0.24) on each of the long duration pastures (Table 3), and short and medium duration pastures did not have different capture indices (0.10 and 0.08, respectively; Figure 2).

The mean daily nest survival was highest (DNS = 0.935) in the short duration pastures, although the highest nest survival of 0.94 was found in both a long and short duration pasture (Table 3). I found no linear relationship between small mammal capture indices and daily nest survival on my study pastures ($P = 0.91$, Figure 3).

Small mammal capture indices decreased with increased percent cover of lying litter in each pasture ($P = 0.03$; Figure 4), and capture indices increased with increased percent cover of bare soil ($P = 0.183$; Figure 5). Visual obstruction readings for each pasture were not correlated with small mammal capture indices ($P = 0.348$), although capture indices tended to decrease as visual obstruction increased. I found no other correlations between vegetation characteristics and small mammal abundance (Table 4).

Communities of small mammals varied among ranches. In fact, no single species was captured at all of my 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. The thirteen-lined ground squirrel was 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. The pairs of pastures with the highest small mammal similarity indices (0.857) were MUN/OK3, HA2/MLN, OK3/EGE, and OK3/MLN. Similarity indices for bird communities ranged from 0.409 to 0.773. The pair of pastures with the highest bird similarity index (0.773) was MUN/OK3, which also showed high similarity for small mammals. MUN and OK3 were located within one kilometer of each other. HA2/OK3 and HEL/EGE showed the lowest similarity indices for small mammals and birds, respectively. These pastures were geographically distant from each other (>40 kilometers). The similarity indices for small mammals and birds tended to have a positive relationship ($P = 0.234$, Figure 6).

Discussion

Small mammals are abundant throughout the Nebraska Sandhills, and have been documented as a predator of passerine bird nests in the Great Plains (Peitz and Granfors 2000). I found no relationship between small mammal abundances and daily nest survival of passerine birds on ranches in Cherry County, which indicates small mammals are not the most influential nest predator in the Sandhills.

But, there are additional factors that affect the survival rates of passerine bird nests in the Nebraska Sandhills. Mesopredators such as coyotes have been documented as ground-nest predators, along with snakes, badgers, various raptors, brown-headed cowbirds, and whitetail deer (Peitz and Granfors 2000). Coyotes (*Canis latrans*) and whitetail and mule deer (*Odocoileus virgianianus* and *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). Also, Paine et. al (1996) documented cattle trampling bird nests in highly stocked, Wisconsin dairy pastures. Although my study indicates that trampling is not a problem in the Sandhills, one would predict a higher risk from trampling in short duration pastures because of higher cattle densities.

Burger et. al (1994) found that predation rates were highest in smaller prairie fragments. From this, one would predict the daily nest survival of the ground-nesting birds found in the Sandhills would be high, because the Sandhills region is essentially contiguous grassland. Instead, I found low to medium DNS values for ground-nesting birds on the ranches in my study in 2004 (Table 3). Thus, it is not 'edge effects' that create the low DNS. This may suggest that effective habitat management has the potential to have an impact on bird populations, if we can determine what is causing low DNS values on these ranches. Because there is no correlation between small mammal abundance and DNS of birds, this suggests that something else on the landscape is more important to nest mortality than small mammals.

My analysis suggests that long duration pastures may have higher populations of small mammals than medium or short duration pastures in eastern Cherry County, Nebraska. My study was replicated across space, but may not translate to the entire Sandhills region. Long duration pastures in my 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.

Pastures that had similar small mammal communities also tended to have similar bird communities. I hypothesize that these similarities are driven by the habitat structure of each pasture, as vegetation structure influenced capture indices of small mammals. Thus, grazing management can affect wildlife communities. 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. So, the community composition of small mammals appears to be a function of habitat structure and geographic locations.

As shown in this study, wildlife 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 of wildlife responses to various grazing regimes will yield additional information that will prove useful to landowners who seek high wildlife diversity on their property.

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Table 1. General description of grazing systems used on the 6 ranches sampled in this study during summer 2004. Ranches were located in Cherry County, Nebraska, and statistics shown are averages for each grazing system.

Grazing system	Acres	Herd size	Grazing duration	AUM/acre	Paddocks in rotation
Long	1400	150	~3 months	0.45	1
Medium	450	175	25 days	0.32	5+
Short	200	550	3 days	0.30	40

Table 2. Small mammal species captured on 6 ranches in Cherry County, Nebraska during summer 2004.

Species	Common name	Number of captures
Peromyscus maniculatus	Deer Mouse	36
Dipodomys ordii	Ord's Kangaroo Rat	34
Onychomys leucogaster	Northern Grasshopper Mouse	29
Perognathus flavescens	Plains Pocket Mouse	19
Spermophilus tridecemlineatus	Thirteen-lined Ground Squirrel	13
Spermophilus spilosoma	Spotted Ground Squirrel	1

Table 3. Small mammal capture indices (individuals captured per trap night) and daily avian nest survival (DNS, probability of nest surviving one day) for 6 pastures in Cherry County, Nebraska during summer 2004. University policy prohibits the identification of landowners; thus, pastures are labeled cryptically. Grazing systems observed were continuous (long duration), 4-pasture (medium duration), and management intensive (short duration).

Grazing system	Pasture	Capture index	DNS
Long	MUN	0.26	0.94
Long	HEL	0.22	0.85
Medium	OK3	0.12	0.90
Medium	HA2	0.04	0.89
Short	EGE	0.12	0.93
Short	MLN	0.09	0.94
Long	Mean	0.24	0.895
Medium	Mean	0.08	0.895
Short	Mean	0.10	0.935

Table 4. Vegetation data (mean % cover and visual obstruction reading [VOR]) used in analyses from 6 ranches in Cherry County, Nebraska during summer 2004. University policy prohibits the identification of landowners; thus, pastures are labeled cryptically. Grazing systems observed were continuous (long duration), 4-pasture (medium duration), and management intensive (short duration).

Duration	Pasture	Annuals	Bunch Grass	Rhizomatous Grass	Sedges	Forbs	Shrubs	Yucca	Cactus	Bare Soil	Standing Litter	Lying Litter	Cowpie	VOR
Long	MUN	2.0	6.8	5.0	5.6	4.5	2.1	2	0.0	72	3.8	7	0.6	0.1775
Long	HEL	0.0	5.5	2.4	1.9	7.2	6.3	0	0.0	82	3.0	13	0.4	0.6156
Medium	OK3	0.6	3.3	5.3	3.2	2.9	3.6	0	0.1	71	2.8	19	0.6	0.2161
Medium	HA2	0.5	27.0	14.0	3.3	5.0	3.2	0	0.0	44	0.9	47	1.0	1.0600
Short	EGE	1.8	15.0	7.5	3.7	4.3	0.6	0	0.0	26	9.1	44	1.6	0.2057
Short	MLN	0.0	10.0	8.8	2.8	5.8	2.1	0	0.3	58	4.8	29	1.8	0.3698
Long	Mean	1.00	6.15	3.70	3.75	5.85	4.20	1	0.00	77.0	3.40	10.0	0.5	0.3966
Medium	Mean	0.55	15.15	9.65	3.25	3.95	3.40	0	0.05	57.5	1.85	33.0	0.8	0.6381
Short	Mean	0.90	12.50	8.15	3.25	5.05	1.35	0	0.15	42.0	6.95	36.5	1.7	0.2878

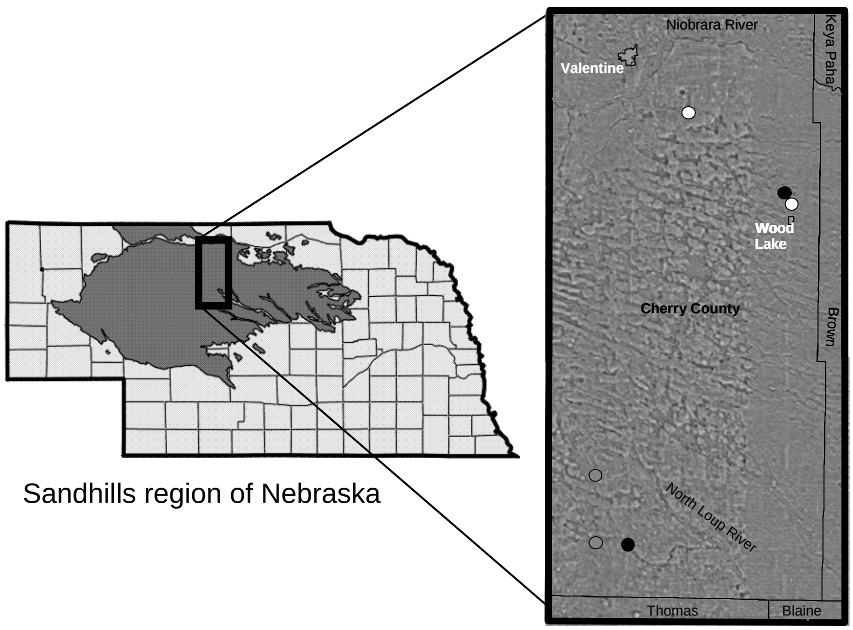

Figure 1. Locations of the 6 study sites in Cherry County, Nebraska during summer 2004. Long duration ranches are white, medium duration ranches are black, and short duration pastures are gray.

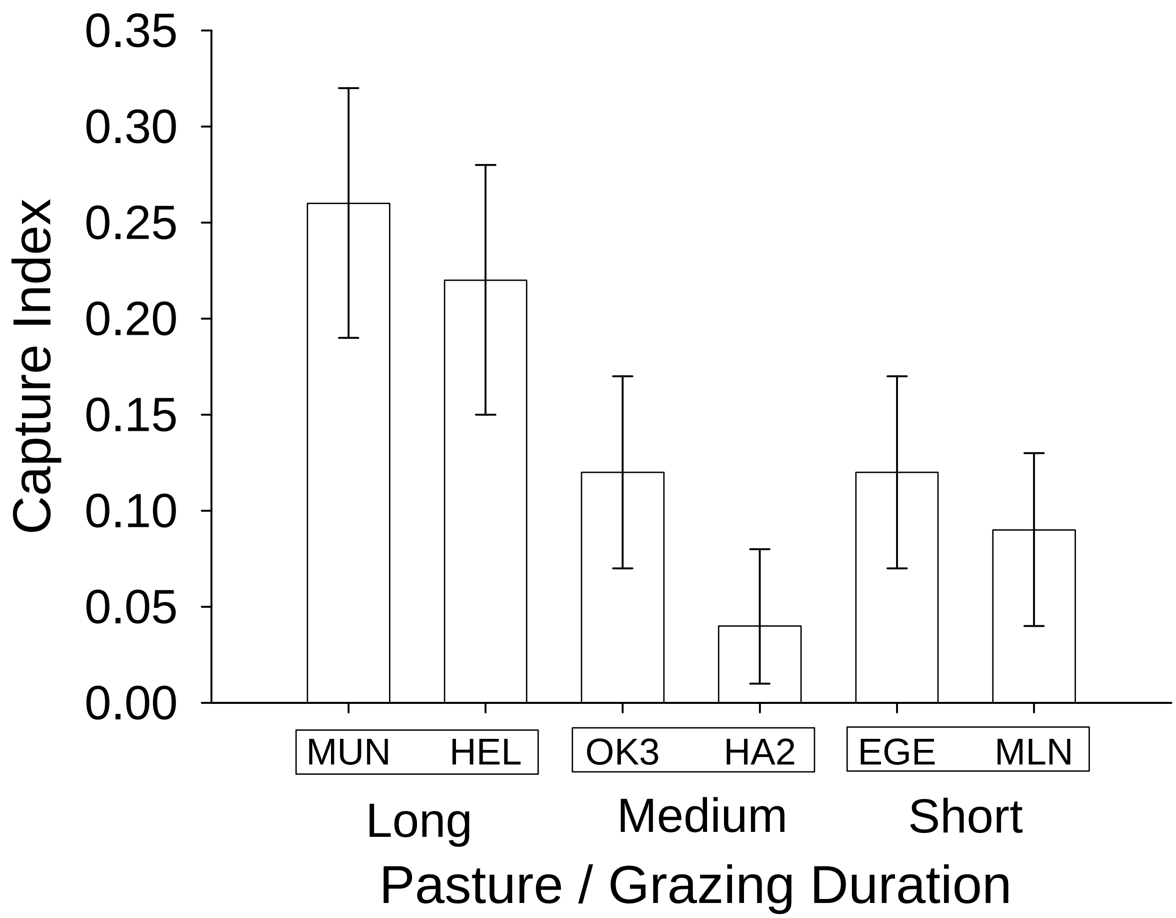

Figure 2. Small mammal capture indices with 95% confidence intervals for 6 privately owned ranches during summer 2004 in Cherry County.

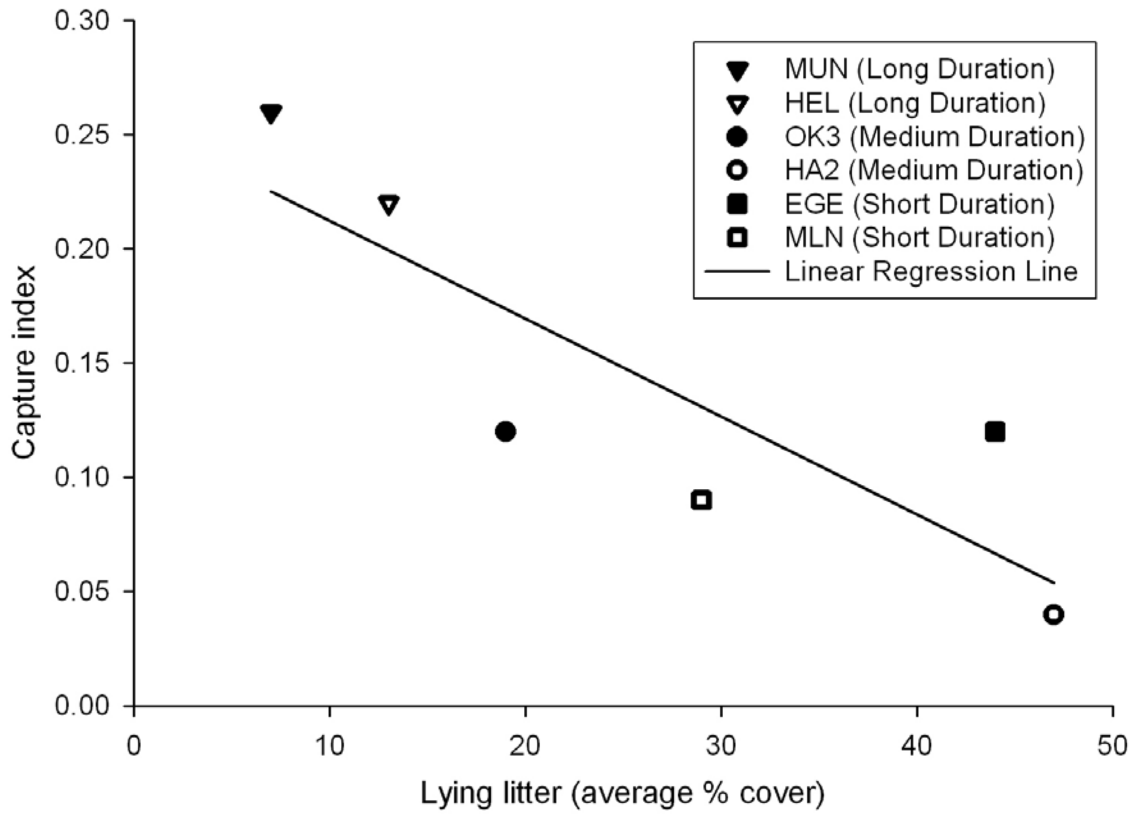

Figure 4. Relationship between percent lying litter and small mammal capture index for 6 private ranches during summer 2004 in Cherry County, Nebraska ($P = 0.03$). Symbols in figure indicate grazing treatment (■: short-term grazing, ●: medium-duration grazing, ▼: long-duration grazing).

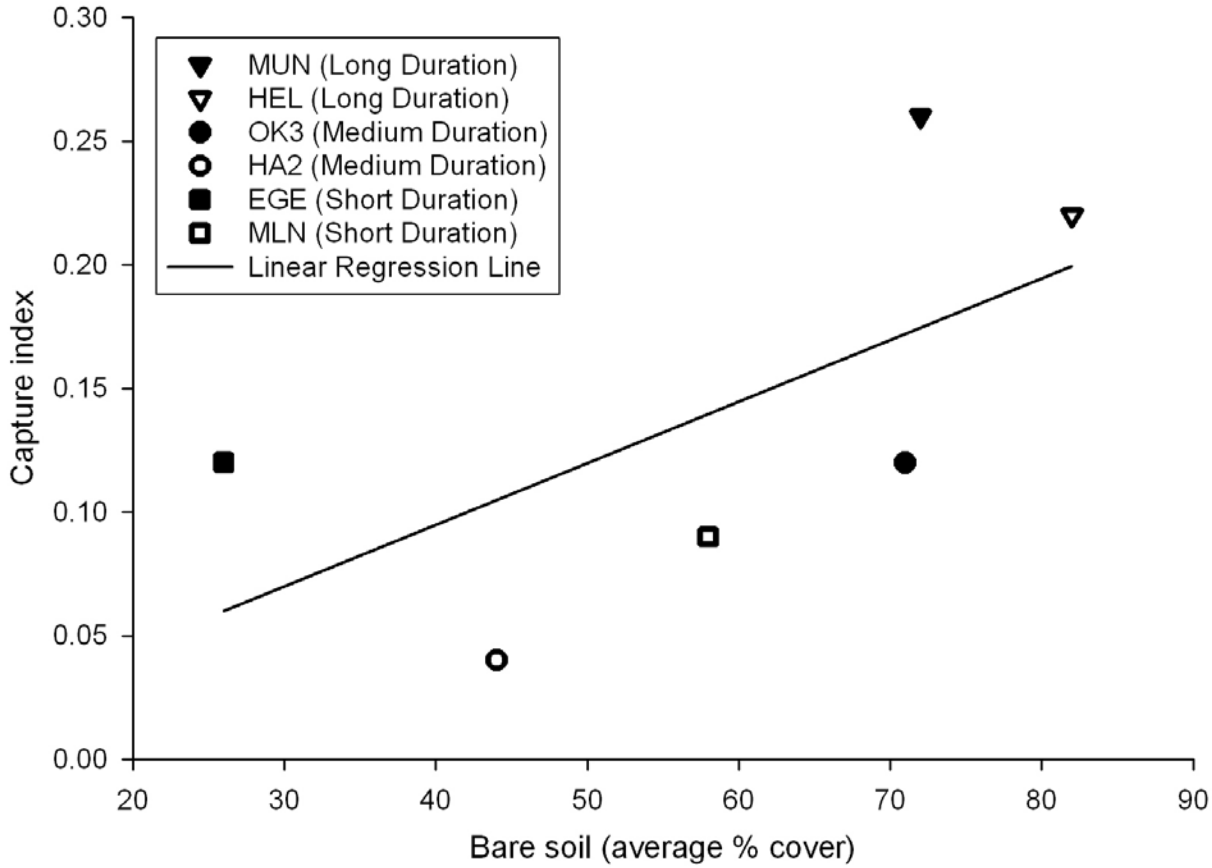

Figure 5. Relationship between percent bare soil and small mammal capture index for 6 private ranches during summer 2004 in Cherry County, Nebraska (P = 0.183). Symbols in figure indicate grazing treatment (■: short-term grazing, ●: medium-duration grazing, ▼: long-duration grazing).

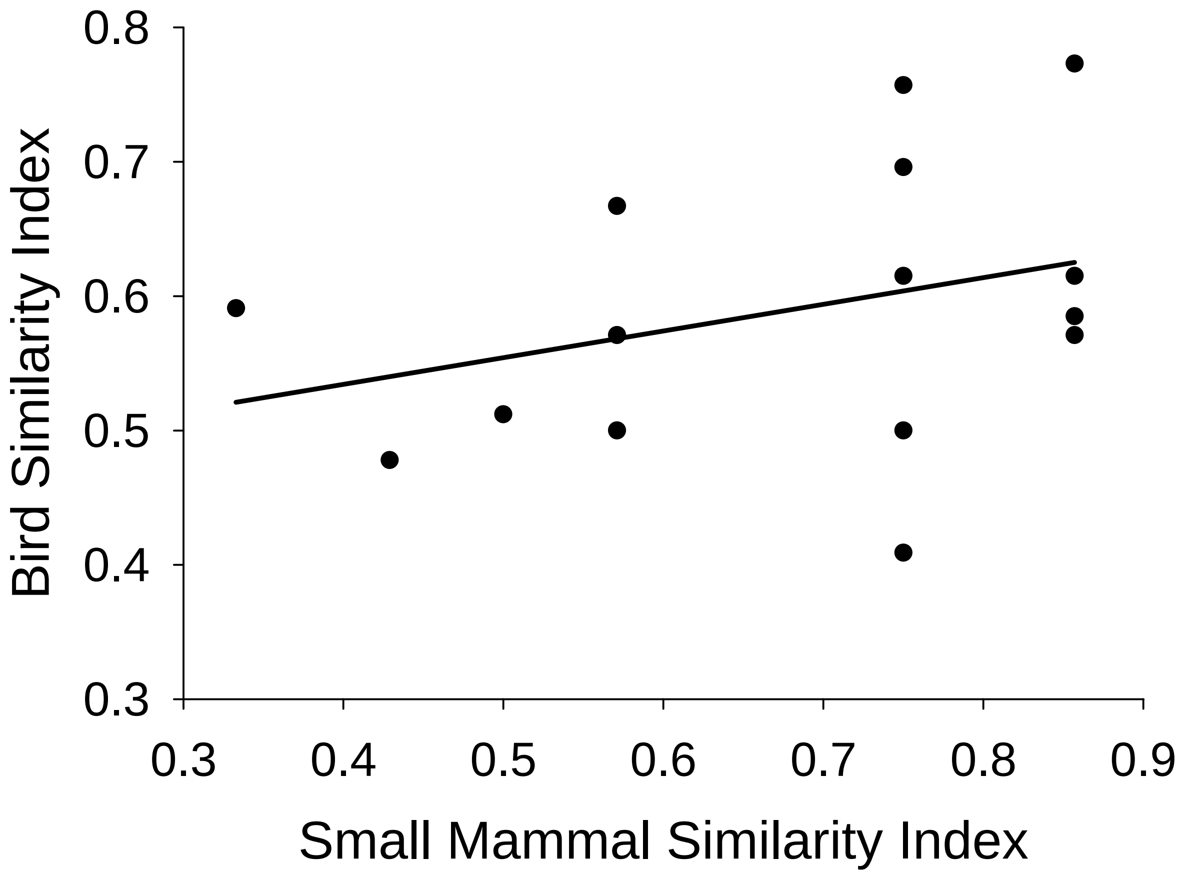

Figure 6. Relationship between similarity index of small mammal community and similarity index of bird community for pairs of 6 pastures during summer 2004 in Cherry County, Nebraska (P = 0.234).

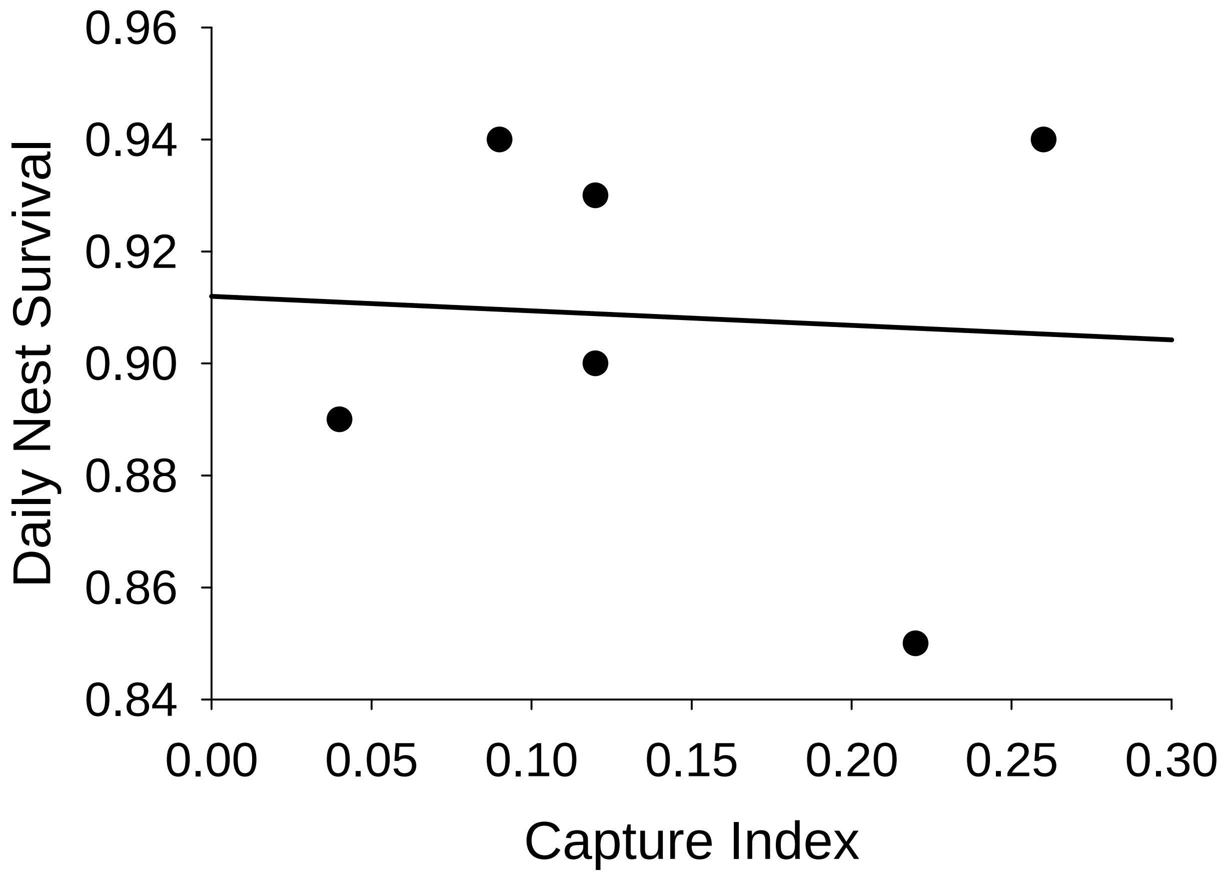

Figure 3. Relationship between small mammal capture index and avian daily nest survival in 6 pastures during summer 2004 in Cherry County, Nebraska with linear regression line ($P = 0.91$).