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6-16-2018

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Spanel, Tyson J. and Geluso, Keith, "Small mammals in cornfields and associated peripheral habitats in central Nebraska" (2018).
Transactions of the Nebraska Academy of Sciences and Affiliated Societies. 517.
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Small mammals in cornfields and associated peripheral habitats in central Nebraska

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Abstract

In the Great Plains, many native grasslands have been converted to agricultural fields during the last two centuries. Peripheral habitats along edges of crop fields generally consist of linear habitats along roads, with many of these habitats used by native fauna. Our study examined capture rates and species composition of small mammals in cornfields, herbaceous roadside ditches, and wooded shelterbelts in central Nebraska. We captured nine species of small mammals. The Prairie Vole (*Microtus ochrogaster*) and Western Harvest Mouse (*Reithrodontomys megalotis*) were captured almost exclusively in roadside ditches, the White-footed Deermouse (*Peromyscus leucopus*) was captured most often in wooded shelterbelts, and the North American Deermouse (*Peromyscus maniculatus*) was common to abundant in all three habitats. Capture rates of small mammals were greatest in roadside ditches and least in cornfields. Herbaceous roadside ditches contained the greatest species richness with seven species, whereas shelterbelts and cornfields each had five species. Species composition of rodents differed in shelterbelts comprised solely of eastern red-cedars (*Juniperus virginiana*) compared to those with a mixture deciduous and coniferous trees. Our study demonstrated that roadside ditches associated with agricultural fields serve as habitats for many prairie species whereas wooded shelterbelts along agricultural fields support both woodland and prairie species in central Nebraska. Cornfields mainly were inhabited by North American Deermice but did not support many other species of small mammals. Although agricultural practices have reduced the quantity of grasslands for prairie species across the region, habitats associated with periphery of fields appear to serve as alternative habitats for small mammals throughout the Great Plains.

Keywords: agricultural fields, cornfields, croplands, eastern red-cedar, Great Plains, Nebraska, roadside ditches, shelterbelts, small mammals

doi: 10.13014/K21J97ZR

Introduction

Throughout the Great Plains, agricultural practices have converted much of the native prairies to croplands. Declines of tallgrass prairies alone in the Great Plains exceed losses of any other major ecosystems in North America (Samson and Knopf 1994). In Nebraska, for example, about 98% of tallgrass prairies and 77% of mixed grass prairies were converted to agricultural lands during the last two centuries (Samson and Knopf 1994). Conversion of prairies to agricultural areas also resulted in the creation of many small, linear habitats such as roadside ditches (i.e., narrow strips of land between roads and agricultural fields) and wooded shelterbelts (i.e., parallel rows of trees planted in flat areas to slow winds, reduce erosion, and prevent snow from creating severe drifts; Fleharty and Navo 1983). Small mammals use these environments even where the total area of native prairies has

declined radically in the Great Plains, such as in Iowa (Bowles 1981) and eastern Nebraska (Kirsch 1997).

Because of widespread alterations to native prairies across the Great Plains, it is important to understand how agricultural development has affected native species and whether human-created habitats are valuable to wildlife (Kaufman and Kaufman 1989). A number of studies have reported on the abundance and diversity of small mammals in prairies, croplands, and peripheral habitats associated with agriculture in the Great Plains (Fleharty and Navo 1983, Navo and Fleharty 1983, Kaufman and Kaufman 1989, Kirsch 1997, Kaufman *et al.* 2000). Some studies demonstrate a reduction in species richness, diversity, or abundance in croplands compared to that in prairies, illustrating the impacts that agricultural practices have had on small mammals throughout the region (Navo and Fleharty 1983, Kaufman and Kaufman 1989, Kirsch 1997). However, there is generally greater diversity and

abundance of small mammals in peripheral habitats along agricultural fields than in nearby native prairies and agricultural fields (Fleharty and Navo 1983, Kaufman and Kaufman 1989, Kirsch 1997).

Due to differing results from studies of small mammals in agricultural areas as well as regional differences in small mammal communities throughout the Great Plains (Jones *et al.* 1983), we examined how small mammals in central Nebraska use three common habitats associated with agricultural practices. Our study examined the capture rates and composition of small mammals in cornfields, herbaceous roadside ditches, and wooded shelterbelts. We also examined how differences in the composition of vegetation in shelterbelts affected small mammals by comparing captures in shelterbelts with only eastern red-cedar (*Juniperus virginiana*) to those with a mixture of deciduous and coniferous trees.

Materials and Methods

In September–October 2007 and again in March 2008, we trapped small mammals in three habitats (cornfields, roadside ditches, and shelterbelts) associated with agricultural lands in Custer County, Nebraska. The landscape consisted of a matrix of cropland and upland mixed-grass prairie along the edge of the Sandhill Region of the state. Within this diverse landscape, we selected six sites that each contained the three habitats of interest all in close proximity to each other. Sites included 1) 3.0 km N, 6.3 km W Merna, 41°30.626'N, 99°50.177'W, 2) 7.9 km N, 9.5 km W Merna, 41°33.222'N, 99°52.491'W, 3) 8.1 km N, 12.1 km W Merna, 41°33.407'N, 99°54.247'W, 4) 6.7 km N, 13.7 km W Merna, 41°32.673'N, 99°55.396'W, 5) 0.2 km N, 0.3 km E Berwyn, 41°21.163'N, 99°29.742'W, and 6) 0.5 km E Berwyn, 41°21.059'N, 99°29.636'W. Coordinates of trapping sites were determined with handheld global positioning units using North American Datum 1983.

Dominant plants varied among the three habitats. For shelterbelts, three sites contained a mixture of deciduous and coniferous trees including white mulberry (*Morus alba*), hackberry (*Celtis occidentalis*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), and *J. virginiana* whereas the other three shelterbelts consisted solely of *J. virginiana*. Both types of shelterbelts had complete canopy cover. Herbaceous roadside ditches generally contained dense cover and plant species varied among sites. The most common grass was smooth brome (*Bromus inermis*), and the most common forbs were sunflower (*Helianthus* spp.) and Arkansas rose (*Rosa arkansana*), with some stinging nettles (*Urtica dioica*)

and poison ivy (*Toxicodendron radicans*). Harvested cornfields with stubble had the least cover of all three habitats, but patches of nightshade (*Solanum* spp.) were present in some fields. Common and scientific names of plants follow Kaul *et al.* (2006).

We set a total of 1440 live-traps (i.e., a total of 1440 trap nights; H.B. Sherman Traps, Tallahassee, FL) baited with mixed bird seeds. At each of the six sites in 2007, we set trap lines of 40 traps in each of the three habitats (i.e., cornfield, ditch, and shelterbelt) for a total of 720 trap nights. In March 2008, we repeated the procedure at the same six sites for a total of another 720 trap nights. Traps only were left at each site for a single night each year. For each night of trapping ($n = 6$), equal trap nights were deployed in all three habitats. In general, traps were placed 8–10 m apart. We set traps in the late afternoon and checked them the following morning. We recorded species, sex, reproductive condition (non-reproductive, pregnant, lactating, or scrotal), and age (based on pelage coloration) for each individual captured. Common and scientific names of mammals follow Bradley *et al.* (2014). We used G-tests of goodness-of-fit to determine whether captures of each species of small mammal as well as total captures were distributed randomly among habitats (Kirsch 1997; Kaufman *et al.* 2000). Species with less than ten total captures were not analyzed due to low sample sizes.

Results

We captured 273 individuals representing eight species of rodents and one species of shrew in habitats associated with crop fields and their periphery in central Nebraska (Table 1). The four most abundant species were Prairie Vole (*Microtus ochrogaster*), North American Deermouse (*Peromyscus maniculatus*), White-footed Deermouse (*Peromyscus leucopus*), and Western Harvest Mouse (*Reithrodontomys megalotis*; Table 1). For these species, we detected differences in the number of individuals captured in the three habitats ($P < 0.01$), with *M. ochrogaster* and *R. megalotis* most frequently captured in roadside ditches, *P. maniculatus* most frequently captured in cornfields and ditches, and *P. leucopus* most frequently captured in shelterbelts (Table 1).

Roadside ditches had the greatest capture rates (36.2%) of small mammals, whereas cornfields had the lowest capture rates (8.5%, Table 1). In two narrow roadside ditches in spring of 2008, we had almost a 90% capture rate with our 40 traps, which represents a great concentration of small mammals in a limited area. Herbaceous roadside

Table 1. Species and total number of small mammals captured in three habitats in central Nebraska, Custer County, in 2007-2008. Capture rates are reported as the total number of individuals of all species captured per 100 trap nights. An asterisk indicates a significant difference between habitats for that species or the total captures of all species ($P < 0.01$) with a G-test of goodness-of-fit. Species with less than ten total captures were not analyzed due to low sample sizes. Numbers in parentheses for each habitat represent the number of individuals captured during autumn/spring trapping sessions, respectively. There were equal trapping efforts in both seasons.

Common name	Scientific name	Corn	Ditch	Shelterbelt	Total
Prairie Vole	<i>Microtus ochrogaster</i>	1 (1/0)	96 (23/73)	1 (0/1)	98*
North American Deermouse	<i>Peromyscus maniculatus</i>	36 (13/23)	36 (7/29)	14 (6/8)	86*
White-footed Deermouse	<i>Peromyscus leucopus</i>	0 (0/0)	5 (3/2)	37 (21/16)	42*
Western Harvest Mouse	<i>Reithrodontomys megalotis</i>	0 (0/0)	26 (7/19)	0 (0/0)	26*
House Mouse	<i>Mus musculus</i>	2 (2/0)	2 (2/0)	4 (4/0)	8
Northern Short-tailed Shrew	<i>Blarina brevicauda</i>	1 (1/0)	6 (6/0)	0 (0/0)	7
Ord's Kangaroo Rat	<i>Dipodomys ordii</i>	0 (0/0)	3 (0/3)	0 (0/0)	3
Hispid Pocket Mouse	<i>Chaetodipus hispidus</i>	0 (0/0)	0 (0/0)	2 (2/0)	2
Northern Grasshopper Mouse	<i>Onychomys leucogaster</i>	1 (1/0)	0 (0/0)	0 (0/0)	1
TOTAL CAPTURES		41 (18/23)	174 (48/126)	58 (33/25)	273*
CAPTURE RATES		8.5	36.2	12.1	
SPECIES RICHNESS		5	7	5	9

ditches also contained the greatest species richness with seven species, whereas shelterbelts and cornfields each contained five species (Table 1). In cornfields, we documented four native and one introduced species, with the North American Deermouse captured most frequently (Table 1). In this habitat, almost all *P. maniculatus* ran into a nearby crack in the soil < 10 m from the site of capture, whereas others entered small rodent holes. *Peromyscus leucopus*, a woodland species, was the most abundant small mammal captured in both types of shelterbelts, although a few grassland species, especially *P. maniculatus*, also were documented in these wooded habitats (Table 2). Shelterbelts comprised only of *J. virginiana* had fewer species but the same number of captures compared to shelterbelts with deciduous and coniferous trees (Table 2).

Discussion

Conversion of native prairies to agricultural fields has resulted in prairie species being displaced into new types of habitats throughout the Great Plains. In central Nebraska, we observed that many native species of small mammals occurred in habitats associated with agricultural areas, but different assemblages of species occurred in roadside ditches, wooded shelterbelts, and crop fields. Cornfields were dominated by a single species (*P.*

maniculatus), roadside ditches contained the most grassland species as well as greatest capture rates of small mammals, and wooded shelterbelts were inhabited by both woodland and grassland species. All three habitats associated with agricultural practices (cornfields, roadside ditches, and shelterbelts) seem to represent alternative habitats for prairie species whereas wooded shelterbelts also represent novel habitats enabling woodland species to expand their distribution (and abundance) across former grasslands. We did not trap the native grasslands in the area, thus species richness and abundance is unknown and cannot be compared to results in our study. The abundance of small mammals in roadside ditches likely represents an important concentrated food resource for predatory mammals and birds, but proximity to roadways likely increases mortality by collisions with vehicles.

Cornfields

Crop fields represent vast areas of potential habitat for small mammals across the Great Plains. Of five species documented in cornfields, the North American Deermouse was the most common. Similarly, cornfields in eastern Nebraska also were dominated by this species with five other uncommon species (Kirsch 1997). In western Kansas, Fleharty and Navo (1983) observed

Table 2. Species and total number of small mammals captured in two types of shelterbelts, eastern red-cedar (*Juniperus virginiana*) and a mixture of deciduous trees and eastern red-cedar (a coniferous species), in central Nebraska, Custer County, in September–October 2007 and March 2008. Numbers in parentheses for each type of shelterbelt represent the number of individuals captured during autumn/spring trapping sessions, respectively. There were equal trapping efforts in both seasons.

Species	Eastern red-cedar	Deciduous/Coniferous
<i>Peromyscus leucopus</i>	21 (5/16)	16 (16/0)
<i>Peromyscus maniculatus</i>	8 (3/5)	6 (3/3)
<i>Mus musculus</i>	0 (0/0)	4 (4/0)
<i>Chaetodipus hispidus</i>	0 (0/0)	2 (2/0)
<i>Microtus ochrogaster</i>	0 (0/0)	1 (0/1)
TOTAL CAPTURES	29 (8/21)	29 (25/4)

eight native and one introduced species inhabiting irrigated cornfields, with three species being relatively common, the Northern Grasshopper Mouse (*Onychomys leucogaster*), North American Deermouse, and introduced House Mouse (*Mus musculus*). In eastern parts of the United States, *P. maniculatus* also is common in cornfields (e.g., Linduska 1942, Whitaker 1967). North American Deermice do not necessarily require much cover, as they were documented in cornfield with only stubble, and are a widespread and common species in upland habitats in Nebraska (Jones 1964).

Other types of crop fields, such as winter wheat, alfalfa, and sorghum, also support small mammals in the Great Plains (Navo and Fleharty 1983, Kaufman and Kaufman 1989, Kaufman and Kaufman 1990a, Kaufman and Kaufman 1990b, Kaufman *et al.* 2000). In these types of crop fields, *P. maniculatus* also is abundant (Navo and Fleharty 1983, Kaufman and Kaufman 1989, Kaufman and Kaufman 1990b, Kaufman *et al.* 2000). Use of crop fields by native small mammals varies by location, season, vegetative cover remaining on fields, and substrate. In western Kansas and Iowa, researchers report that although large areas of the landscape were cultivated to crops, no species of small mammal has been extirpated from those regions (Bowles 1981, Fleharty and Navo 1983).

Roadside ditches

Roadside ditches, fence lines, and other non-wooded habitats along the periphery of crop fields represent limited habitats where abundance of small mammals can be great (Fleharty and Navo 1983, Kirsch 1997, Kaufman and Kaufman 1989, this study). In eastern Nebraska, Kirsch (1997) captured nine different species and had the greatest

abundance of small mammals in roadside ditches compared to nearby cornfields and prairies. Fleharty and Navo (1983) and Kaufman and Kaufman (1989) both observed 10 species and the greatest abundance of small mammals in edge habitats in western and central Kansas compared to native uncultivated lands and croplands. Roadside ditches in central Kansas were moderate for species richness and abundance, but fallow fields had the greatest species richness and abundance (Kaufman *et al.* 2000). Although the cumulative area of roadside ditches is substantially less than the area covered by cultivated crop fields, these studies demonstrate the importance of such limited areas for native small mammals in the Great Plains.

Assemblages of small mammals in roadside ditches vary by location in the Great Plains. Similar to our results in central Nebraska, *P. maniculatus*, *R. megalotis*, and *M. ochrogaster* frequently were captured in grassy roadside ditches in eastern Nebraska (Kirsch 1997). However, Kirsch (1997) also commonly observed the White-footed Deermouse, Meadow Vole (*M. pennsylvanicus*), and Northern Short-tailed Shrew (*Blarina brevicauda*) in this habitat. Both *M. pennsylvanicus* and *B. brevicauda* are more abundant in eastern parts of the state (Jones 1964, Jones *et al.* 1983). In central Nebraska, *M. pennsylvanicus* occurs most often in marshes or other mesic habitats (Jones 1964, Manning and Geluso 1989). We did not capture this species in relatively dry ditches in central Nebraska. In contrast, some roadsides in our study consisted of open, sandy habitats where we captured Ord's Kangaroo Rats (*Dipodomys ordii*), which is similar to observations of *D. ordii*, Plains Pocket Mice (*Perognathus flavescens*), and other more upland, arid species inhabiting corners of center pivots in dry, sandsage habitats of western Kansas (Fleharty and Navo 1983). Other studies also

demonstrate that species composition in roadside habitats reflect local small mammal assemblages in the Great Plains (Kaufman and Kaufman 1989).

Shelterbelts

Shelterbelts are common along crop fields in central Nebraska, where linear rows of trees were planted by farming and ranching families during the last century to protect livestock and farmsteads. The White-footed Deer-mouse was the most commonly captured species in shelterbelts in central Nebraska. This species also is the most abundant species in wooded habitats in eastern Nebraska and throughout the Great Plains (Jones 1964, Jones *et al.* 1983). In central and western parts of the state, *P. leucopus* generally is restricted to deciduous riparian habitats, but the species also occurs in woodlots, shelterbelts, and overgrown fencerows of plum (Jones 1964, Manning and Geluso 1989). Our observations of grassland species occurring in wooded habitats dominated by eastern red-cedars also has been documented in the Sandhill Region of Nebraska (Manning and Geluso 1989). Manning and Geluso (1989) observed *P. maniculatus*, *D. ordii*, *P. flavescens*, and Hispid Pocket Mouse (*Chaetodipus hispidus*) in human-made stands of eastern red-cedar in Thomas County at the Nebraska National Forest. Occurrence of house mice in shelterbelts appears novel for the state. Our capture of *M. ochrogaster* in a small grassy area within a wooded shelterbelt is an appropriate habitat for the species (Jones 1964, Jones *et al.* 1983).

Shelterbelts represent relatively new habitats for mammals across the Great Plains and probably represent one of only a few habitats where *P. leucopus* occurs in abundance besides wooded river systems and other patches of eastern red-cedars in central Nebraska (Jones 1964). A number of woodland mammals, including *P. leucopus*, have shifted ranges westward across Nebraska in recent decades associated with the expansion of wooded habitats (Benedict *et al.* 2000). Other westward moving woodland species in Nebraska include the Virginia Opossum (*Didelphis virginiana*), Evening Bat (*Nycticeius humeralis*), Woodchuck (*Marmota monax*), and Eastern Fox Squirrel (*Sciurus niger*; e.g., Benedict *et al.* 2000, Roehrs and Genoways 2004, Serbousek and Geluso 2009, Johnson and Geluso 2017). In Nebraska, Benedict *et al.* (2000) documented that many of the 20 species of mammals shifting distributions westward in the last 40 years were woodland/forest species. Yahner (1983b) stated that without wooded shelterbelts, woodland species of mice, such as *P. leucopus*, would be drastically less abundant in the Midwest.

Conclusions

As humans continue to convert grasslands for agricultural purposes, it is important to understand which native vertebrates will continue to occupy these areas and which might be expected to decline (Bowles 1981). Studies also demonstrate that agricultural fields and associated peripheral habitats provide sources of cover and food for a variety of native and non-native mammals as well as birds throughout the Great Plains (Fleharty and Navo 1983, Yahner 1983a, Yahner 1983b, Kaufman and Kaufman 1989, Kirsch 1997, Schroeder *et al.* 1992). However, many of these habitats lie along roadways, which can restrict movements of small mammals and be a source of mortality (Oxley *et al.* 1974, Kozel and Fleharty 1979, Adams and Geis 1983, Swihart and Slade 1984, Kuykendall and Keller 2011). Most small mammals serve as prey for larger predatory species, and thus, small mammals in roadside ditches represent an important food source for both mammalian and avian predators. An abundance of small mammals in these limited areas likely concentrates birds of prey along roads (Meunier *et al.* 2000), especially those with powerlines or fence posts used as perches above roadside ditches. Such a concentration of prey might reduce energetic costs of finding prey, but also might be detrimental because raptors frequently are killed by vehicles when hunting along roadways (e.g., Loos and Kerlinger 1993, Fajardo 2001).

Acknowledgments — We thank Dan Spanel for his help with field work. We thank a number of reviewers for comments and suggestions to improve our manuscript.

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