
Microhabitat Preferences of a Small Mammal Assemblage in Canadian County, Oklahoma

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Abstract: We conducted a small mammal ecological study at John Nichols Scout Ranch in Southeastern Canadian County, Oklahoma, during the summers of 2013 and 2014. Microhabitat preferences of *Peromyscus leucopus*, *P. maniculatus*, *Neotoma floridana*, and *Sigmodon hispidus* were determined using species' presence/absence and 60 habitat variables at 10 randomly selected plots. These data were subjected to principle components analysis and niche overlap. *Peromyscus leucopus* and *N. floridana* occupy similar woodland areas, featuring high degrees of litter and overhang canopy, as well as rocky outcrops. *Peromyscus maniculatus* was associated with areas of annual, barren, shrub, and tree coverage, with adjacent habitat heterogeneity—an edge. *Sigmodon hispidus* was found in open grasslands with homogeneous adjacent habitat. *Peromyscus leucopus* and *N. floridana* had the highest degree of niche overlap, while *P. maniculatus* had a smaller overlap with these species. *Sigmodon hispidus* had the lowest degree of niche overlap among all studied species, indicating high habitat specificity. ©2015 Oklahoma Academy of Science

Introduction

Rodentia comprises approximately one-third of all known mammalian species. These highly successful organisms have evolved to fill a variety of niches in most terrestrial habitats (Witmer 2004). The activities of rodent populations heavily influence both the biotic and abiotic components of their ecosystem, such as vegetation composition/dispersal, and the populations of higher-level consumers; as well as nutrient cycling and soil weathering (Beard et al. 2013, Galiano et al. 2014; Ims et al. 2013; Pavey et al. 2008). Rodents are vital to the health of terrestrial ecosystems. Like plants, rodents serve as a base that sustains the complex web of ecosystem interactions (Avenant 2011; Jones 2010). The characterization and comparison of rodent species' habitat affinities is essential to understand fundamental ecosystem interactions. Establishing rodent microhabitat preferences can yield information about these interactions, which may be useful to urban developers and wildlife managers as a tool for conservation.

Peromyscus maniculatus (deer mouse) is the most widely distributed species of the genus *Peromyscus*, and has been documented living in both grassland and forested areas (Clark et al. 2000; Hall 1981; Whitaker 1980). Lack of habitat correlation has been reported in many studies (Gore 1988; Marinelli and Millar 1989; Maser et al. 1981); indicating that *P. maniculatus* is successful in multiple habitat types. Local studies in Oklahoma have found populations of *P. maniculatus* primarily in tall grass prairies (Drabek 1977; Stancampiano and Schnell 2004). A related species, *P. leucopus* (white-footed mouse), may also be found in a variety of habitat types (Clark et al. 2000; Stancampiano and Schnell 2004), but is positively correlated with vertical vegetation complexity, overhang cover, snags and other forms of litter, and rocky outcrops (Kaufman et al. 1983; M'Closkey 1975).

Sigmodon hispidus (cotton rat) is a dominant species in tall grass prairies across the southern United States and Mexico (Bradley et al. 2008; Drabek 1977). Regional studies in Oklahoma and Texas concluded that *S. hispidus* prefers

homogeneous grassy habitats (Cameron and Spencer 2008; Stancampiano and Schnell 2004). *Neotoma floridana* (eastern woodrat) is traditionally classified as a woodland species (Clark et al. 2000; Stancampiano and Schnell 2004). Many subspecies populations are rapidly decreasing due to high habitat specificity coupled with habitat disturbance (McCleery et al. 2006).

Methods

Study area— John Nichols Scout Ranch (97-ha) is located in extreme southeastern Canadian County in Central Oklahoma (35.349987 N, -97.672389 W). The Canadian River traverses the southern border of the property. The site features a diversity of habitats—including riparian, prairie, seasonally flooded creeks, rocky bluffs, and temperate forests—with

various levels of human influence. Based on satellite imagery, we determined the study site to consist of 70% forested and 30% grassland areas. This proportion was replicated in 10 randomly selected study plots (*Appendix A*). To avoid bias, the coordinates for the trap sites were selected via random.org.

Sampling—Trapping took place each summer of 2013 and 2014. Each 650-m² trapping plot featured two parallel Sherman trap lines, spaced 10 m from the longitudinal axis of the plot, following a random azimuth (random.org). Trap stations in each line were spaced 5 m apart. Trap sets were laid at stations 1-12 and 14-25; individual traps were laid at stations 13 and 26, for a total of 50 traps per site (*Fig. 1*). Each trap was baited with rolled oats and peanut butter. The traps were checked for two consecutive

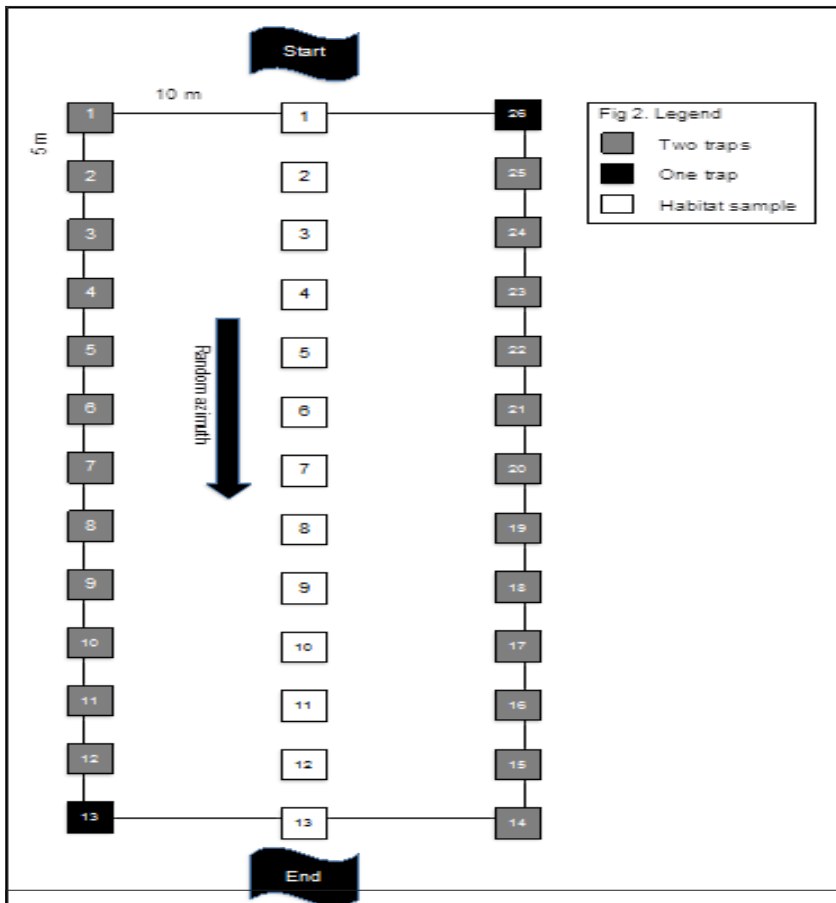


Figure 1. Orientation of the trap and habitat sampling lines in each plot.

Table 1. Description of the 60 microhabitat variables, and their associated eigenvalues (as determined by the Principle Components Analysis). Vectors with absolute values of ≥ 0.7 considered significant. Some habitat variables are described as the percentage of the total ground cover within the quadrat. Other habitat variables are the measured distance of vertical vegetation within the sample, and also horizontal distances relative to the quadrat.

Variable	Description	Eigenvectors	
		Component I	Component II
CN00-20	0-20% no cover	0.7005	0.7129
CN21-40	21-40% no cover	0.2374	-0.9672
CN41-60	41-60% no cover	-0.7953	0.6050
CN61-80	61-80% no cover	0.3868	-0.9206
CN81-100	81-100% no cover	0.8870	0.2413
CA00-20	0-20% annual cover	0.9532	0.3023
CA21-40	21-40% annual cover	0.9749	-0.1973
CA41-60	21-60% annual cover	-0.7418	0.6691
CA61-80	61-80% annual cover	-0.4723	-0.8783
CA81-100	81-100% annual cover	-0.7980	-0.5868
CL00-20	0-20% litter cover	-0.9879	-0.1541
CL21-40	21-40% litter cover	-0.8452	0.5320
CL41-60	41-60% litter cover	0.9480	0.2857
CL61-80	61-80% litter cover	0.9954	-0.0596
CL81-100	81-100% litter cover	0.9511	0.2900
CR00-20	0-20% rock cover	0.9500	0.3062
CR21-40	21-40% rock cover	0.9535	0.3014
CR41-60	41-60% rock cover	0.9401	0.3109
CR61-80	61-80% rock cover	0.9403	0.3109
CR81-100	81-100% rock cover	0.9401	0.3109
CS00-20	0-20% shrub cover	0.9510	0.2899
CS21-40	21-40% shrub cover	0.9401	0.3109
CT00-20	0-20% tree cover	0.9935	-0.0905
CT21-40	21-40% tree cover	0.9525	0.2927
CT41-60	41-60% tree cover	0.8870	0.2413
COC00-20	0-20% overhang canopy cover	-0.0015	-0.9993
COC21-40	21-40% overhang canopy cover	0.9515	0.3048
COC41-60	41-60% overhang canopy cover	0.8966	-0.4289
COC61-80	61-80% overhang canopy cover	0.9927	-0.1011
COC81-100	81-100% overhang canopy cover	0.9495	0.3066
COC00-20	0-20% overhang canopy cover	0.9401	0.3109
CM00-20	0-20% moss cover	0.9401	0.3109
CM21-40	21-40% moss cover	-0.1744	-0.9831
MHA00-02	0-2 dm mean annual height	-0.7223	0.6912

MHA02-04	2-4 dm mean annual height	0.9744	-0.2220
MHA04-06	4-6 dm mean annual height	0.9844	-0.1760
MHA06-08	6-8 dm mean annual height	0.7708	-0.6271
MHA08-10	8-10 dm mean annual height	0.9401	0.3109
MHS00-05	0-5 dm mean shrub height	0.3427	-0.9281
MHS05-10	6-10 dm mean shrub height	0.9537	0.3009
MHS11-20	11-20 dm mean shrub height	0.9401	0.3109
MHT00-15	0-15 dm mean tree height	0.8729	-0.4608
MHT16-40	16-40 dm mean tree height	0.9535	0.3014
MHT41-85	41-85 dm mean tree height	0.9359	0.3120
VegA	Annuals are major vegetation	-0.9226	0.3761
VegT	Trees are major vegetation	0.9163	-0.3884
VegS	Shrubs are major vegetation	0.9198	-0.3923
VegN	No major vegetation	0.8870	0.2413
DHA00-10	0-10 m distance to human activity	0.9474	0.3080
DHA11-20	11-20 m distance to human activity	0.9435	0.3098
DHA21-30	21-30 m distance to human activity	0.9439	0.3097
DHAgt30	>30 m distance to human activity	-0.9808	-0.1471
DDH00-10	0-10 m distance to different habitat	0.3669	-0.9295
DDH11-20	11-20 m distance to different habitat	-0.7052	0.7089
DDH21-30	21-30 m distance to different habitat	-0.1201	0.9926
DDHgt30	>30 m distance to different habitat	0.2867	0.9503
DT00-05	0-5 m distance to closest tree	0.7666	-0.6415
DT06-10	6-10 m distance to closest tree	-0.6362	0.7714
DT11-15	11-15 m distance to closest tree	-0.7509	0.6600
DT16-20	16-20 m distance to closest tree	-0.7953	0.6050
DT26-30	26-30 m distance to closest tree	-0.7953	0.6050

Table 2. Small mammal niche overlap using Horn's and Pianka's indexes of niche overlap.

Horn's Index	<i>P. l</i>	<i>N. f</i>	<i>S. h</i>	<i>P. m</i>
<i>P. leucopus</i>	1.0			
<i>N. floridana</i>	0.995	1.0		
<i>S. hispidus</i>	0.622	0.627	1.0	
<i>P. maniculatus</i>	0.852	0.828	0.703	1.0

Pianca's Index	<i>P. l</i>	<i>N. f</i>	<i>S. h</i>	<i>P. m</i>
<i>P. leucopus</i>	1.0			
<i>N. floridana</i>	0.994	1.0		
<i>S. hispidus</i>	0.618	0.629	1.0	
<i>P. maniculatus</i>	0.890	0.869	0.729	1.0

mornings, for a total of 2,000 trap nights. We identified, determined the sex of, weighed, and then released collected individuals. The majority of habitat sampling took place each summer from 2013-2014 (site 10 was sampled in the fall of 2013). Habitat samples were collected every 5 m using 1-m² quadrats, for a total of 13 samples per site. Each habitat sampling line ran directly down the middle of each plot, paralleling the trap lines. A total of 105 habitat variables, variations of biotic and abiotic components within and adjacent to the 1-m² quadrat, such as percentage of ground rock cover or distance to nearest tree, were measured in each sample (only 60 variables were considered for analysis) (Table 1).

Results

We collected a total of 88 small mammals, representing 4 different species: *P. leucopus* (60), *P. maniculatus* (1), *N. floridana* (23), *S. hispidus* (2), and unknown (2). The two unknown mammals were assumed to be *P. maniculatus*, however the handling time with these organisms was insufficient to make a positive identification.

Principle Components Analysis— We calculated the mean value of each microhabitat variable at each plot to represent habitat structure. These data were then aligned with species' presence within each given plot. This data matrix was then subjected to a principle components analysis (PCA). The PCA produced 60 variables with eigenvectors (Table 1). Only vectors with absolute values of ≥ 0.7 were used in the subsequent analysis.

Components I and II accounted for 98.45% of the data variation. Therefore, the third component was not included in further analysis. Component I accounted for 70.63% of microhabitat preference variation. This component represents an overall gradient of open, grassy habitats without larger vegetation, to denser forests with a high degree of litter cover. Component II accounted for 27.82% of the variation, and represented a gradient from heterogeneous adjacent habitat with shrub presence to homogeneous adjacent habitat without shrubs.

Niche Overlap—The data matrix was subjected to Pianka's and Horn's indexes of niche overlap (Horn 1966; Pianka 1974). *Peromyscus leucopus* and *N. floridana* had a high degree of niche overlap in both models. The niche overlap between *P. leucopus* and *P. maniculatus* was found to be lower than the overlap between *N. floridana* and *P. leucopus* in both models. Overall, *S. hispidus* had the lowest overlap with other species (Table 2).

Discussion

The projections of *P. leucopus* and *N. floridana* were closely clustered in quadrant I, indicating that these species have similar habitat requirements (Fig. 2). The other two species showed very different habitat preferences, and were located in quadrant III (*P. maniculatus*), and quadrant II (*S. hispidus*).

In this study, *P. leucopus* and *N. floridana* were found in areas with high litter and overhang canopy cover; low annual and shrub cover; some exposed rock, moss, and/or barren ground coverage; and dense tree coverage. These habitat characteristics are typical of a shaded forest. The species' presence with low annual cover, shrubs, moss, and rock may indicate that *P. leucopus* and *N. floridana* prefer aged forests— with sufficient levels of moisture and complex vertical structure. *Peromyscus leucopus* and *N. floridana* were trapped in plots featuring steep inclines and sandstone bluffs, which may also explain the species' association with barren ground and rock coverage. This habitat characterization of *N. floridana* is consistent with many studies (Clark et al. 2000; Kaufman et al. 1983; Stancampiano and Schnell 2004). *Peromyscus leucopus* has been documented in a variety of habitats, including prairies, swamps, and rocky areas; however, when studies were conducted over multiple habitat types, *P. leucopus* was more prevalent in wooded areas (Clark et al. 2000; Stancampiano and Schnell 2004). In his 2007 thesis, Sato calls *P. leucopus* a habitat generalist in woodlands, but a habitat specialist in other areas (Sato 2007). The niche overlap of 0.994 and 0.995 between *P. leucopus* and *N. floridana* indicate similar

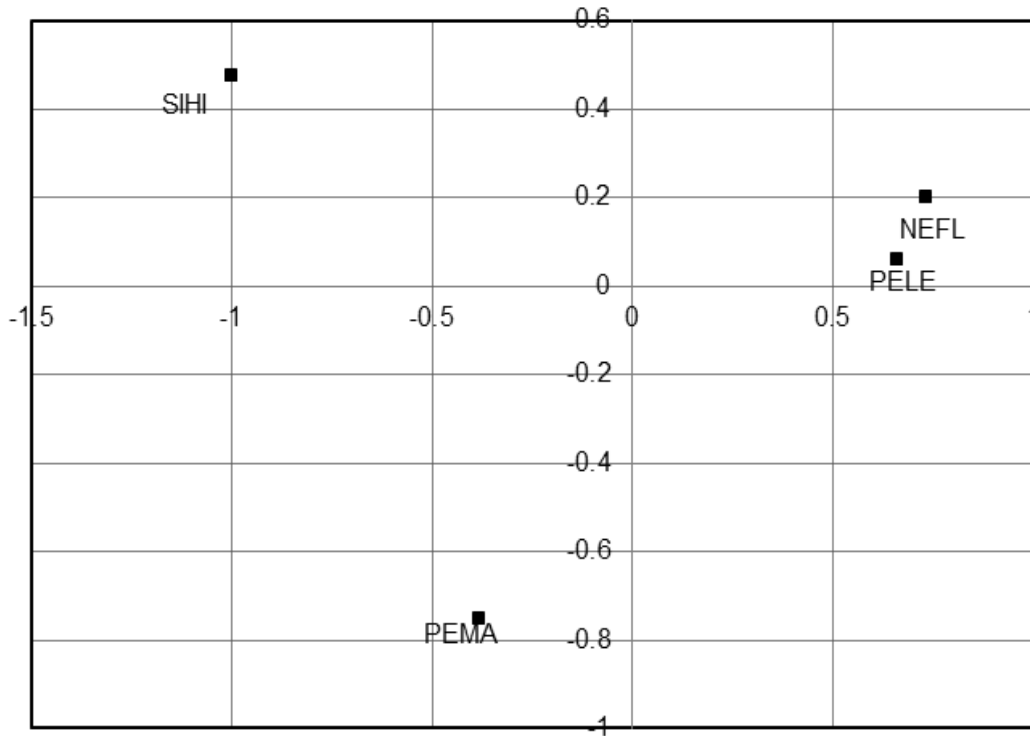


Figure 2. Projections of *P. leucopus*, *P. maniculatus*, *N. floridana*, and *S. hispidus* onto the principle components of microhabitat variable variation.

Fig. 2 Legend

NEFL= *N. floridana* *P. maniculatus*= PEMA

PELE= *P. leucopus* *S. hispidus*= SIHI

microhabitat preferences, and therefore support the PCA results. It is also interesting to note that every successful trapping plot featured both of these species; in other words, one species was never observed without the other in this study. This degree of association and niche overlap may suggest limited competitive interactions between the two species (Kaufman et al. 1983).

Peromyscus maniculatus was associated with an edge habitat, featuring some shrubs and barren ground; many annuals; and mid-distant trees with little overhang canopy. This is in contrast to other Oklahoma studies, which characterized *P. maniculatus* as a grassland species. However, a lack of habitat correlation has been described for this species in several studies, indicating that *P. maniculatus* is successful in many habitat

types (Gore 1988; Maser et al. 1981). This species was only trapped at site 8; therefore the habitat affinities attributed to this species may be particular to the trapping location. Although no other trapping plot, for this analysis, featured a gradual edge. Interestingly, the niche overlaps between *P. maniculatus* and *P. leucopus* (sympatric species) was lower than the niche overlaps between *P. leucopus* and *N. floridana* (Table 2). For our current trapping season, three new trapping locations were added to validate habitat affinities. One of the three new locations includes a similar grassland-to-forest gradient that *P. maniculatus* was previously documented in. Despite being similar in horizontal and vertical structure, the sites differ in humidity and vegetation profile. Trap site 8 is extremely arid, with its dried grasslands featuring cacti, as compared to the new location, which has lush annual coverage. The second new site is a light forest with pockets of shaded clearings dominated by small shrubs and annuals.

The other new location is described below.

Sigmodon hispidus was associated with open grasslands featuring high annual coverage, little litter coverage, and some degree of barren ground. This species was also associated with the presence of homogeneous landscape and mid-distant trees. Only two *S. hispidus* were trapped at one location; the relatively low trapping rate of this species was most likely due to the fact that all grassland plots had moderate-heavy levels of human activity (*Appendix A*). During the current trapping season, we trapped two *S. hispidus* at this location again. Our low trapping success of the species may indicate a low population at the study area. Because *S. hispidus* was only captured at site 8, our attribution of the species' habitat specialty may be due to the landscape features of the trapping site alone. Despite this, *S. hispidus* was not trapped in any non-clearing areas, and has been well documented as a grassland species (Bradley et al. 2008; Cameron and Spencer 2008; Drabek 1977; Stancampiano and Schnell 2004). In both models of niche overlap, *S. hispidus* had the lowest degree of similarity to all species of this study, indicating entirely different habitat affinities. To confirm the habitat affinities of *S. hispidus*, a new grassland site was added to the current trapping season. This new site has an adjacent harsh forest edge to the west and about 20-30 m of habitat homogeneity to the east; this site also includes a relatively unused path for vehicles.

The characterization of small mammal microhabitat preferences is important to understanding fundamental ecosystem interactions. As human influence continues to expand into natural habitats, it is important to have preservation as a goal. The goal of ecological studies, such as this one, is to understand how organisms interact with their environment; then to use this knowledge to maintain, restore, and prevent harm to ecosystems.

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