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Small Mammal Abundances in a Grassland and Forest Area at the Lake Fayetteville Environmental Center, Arkansas

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Running Title: Small Mammal Trapping at Fayetteville, Arkansas

Abstract

We examined changes in abundance of small mammals in forest and prairie-grassland habitat at Lake Fayetteville, Arkansas over a period of 32 years. We estimated the population size of small mammals using a mark-recapture method by capturing small mammals employing rat-sized Sherman live traps laid out in a grid with 8 rows of traps, 15 traps per row, 9.14 m (30 feet) between traps and rows covering an area of 1.01 ha (2.5 acres) in size. Six species of mammals were trapped in the prairie-grassland and three species were captured in the forest habitat. In the forest, the white-footed deermouse (*Peromuscus leucopus*) was greatest in 1998 and in 2006. In the prairie-grassland, the population of hispid cotton rats (*Sigmodon hispidus*) were greatest in 2004, 2008, 2010 and 2014 and have increased over the years with the change in grass composition. The prairie-grassland in 1962 was mainly a broomsedge bluestem (*Andropogon virginicus*) field but as time progressed more and more prairie grasses invaded helped by controlled burns and removal of the invading eastern red cedars *(Juniperus virginiana*). The population of *Sigmodon hispidus* was weakly correlated with the minimum winter temperatures from the previous year.

Introduction

Long term field studies of small mammals are essential for establishing general patterns of population abundance (Rehmeier *et al*. 2005). Small mammals play vital roles in ecosystems, serving as dispersers of fungal spores (Maser and Maser 1988; Pyare and Longland 2001) and seeds (Vander Wall 1993; Vander Wall *et al*. 2001); consumers of plants, seeds, and fruits (Carey *et al*. 1999); and as prey for mammalian and avian predators (Zielinski *et al*. 1983; Forsman *et al*. 1984; Carey *et al*. 1992). Their essential interactions with flora and fauna across multiple trophic levels (Forsman *et al*. 1984; Carey *et al*. 1992) implicates that land management should be based in part on an understanding of the ecology of small mammals.

Population density of small mammals can respond to habitat changes at different scales (Morris 1987). Variation in sizes of population of *Sigmodon hispidus* also appears to be regulated by minimum winter temperature of the previous year (Sealander and Walker 1955; Goertz 1964). The main objectives of this study were to 1) identify small mammal species in forest and prairie-grassland habitat, and 2) examine the population dynamics of small mammals over time.

Methods

The data for small mammal abundance were collected in oak-hickory forest and prairie-grassland at the Lake Fayetteville Environmental Center, Fayetteville, Arkansas. Although no detailed analysis of the vegetation was conducted throughout the years that trapping was conducted at the prairie-grassland area. D. James observed that throughout the years, the prairie-grassland's vegetation was transitioning from an old field mainly consisted of broomsedge bluestem (*Andropogon virginicus*) grass to a vegetation that consisted of diverse prairie grasses. The new grasses observed included little bluestem (*Schizachyyrium scoparium*), big bluestem (*Schizachyyrium gerardii*), switchgrass (*Panicum virgatum*) and indiangrass (*Sogastrum nutans*). This data was collected as part of Mammalogy class trapping experiences from 1983 to 2014.

The population of small mammals in the forest and prairie-grassland was estimated using mark-capture-recapture method (Nichols 1992). We used grid-trapping using rat-sized Sherman live traps laid out in a grid around 1.01 ha (2.5 acres). The grid consisted of eight rows with 15 traps per row. The distance between each trap and each row was 9.14 m (30 feet). The forest grid and prairie grassland grid were nearby each other separated approximately by more than 100 m. The traps were baited with oats and peanut butter paste and cotton (for nesting material). Students in the Mammalogy class

checked the traps each morning for three days under the supervision of the instructor. We identified all small mammal species caught in the traps and recorded weight, sex and reproductive condition. Each trapped animal was marked with a unique identifying number using ear-tags and then released. The trap setting was interrupted by a heavy rain in 2014 causing the students to seek cover so that only 0.61 ha (1.5 acres) of the grid was set. In 2008, a hurricane forced wind passed through northwestern Arkansas that blew down many limbs and trees in the study area, making it impossible to establish the forest trapping grid thereafter. Thus, there were only six years of trapping in the forests compared to nine years in the prairie-grassland habitat. Table 1 lists the scientific and common names of the mammals trapped in both the forest and the prairie-grassland. Table 2 and Table 3 show the details of species captured for each year in prairie-grassland and forest respectively.

We estimated the total small mammal population (N) using the following formula

$$N = mn/x$$

where n is the total number of individuals captured on a given night, m is the number of individuals captured and tagged in previous trappings and x is marked individuals (recaptured) trapped on the subsequent night (Giles 1969).

In addition, we recorded the minimum winter temperature for the previous year. Using the software R 3.3.2 software (R Core Team 2016), a regression analysis was conducted for the minimum winter temperature of the previous year and *Sigmodon hispidus* populations in fall of the current year.

We analyzed the change in population size of small mammal population in both forest and prairie-grassland habitat using regression analysis in R. We also analyzed the change in abundance of each species to assess the trends in their population over the duration of the study. The abundance data for year 2014 was excluded from the all analysis because the grid was setup only for .61 hectare and the abundance was corrected to account for difference in trapping area.

Results

Six species of small mammals were trapped in the prairie-grassland habitat and three species were captured in the forest (Table 1). Table 2 and Table 3 show the number of individuals of each species captured for each year in prairie-grassland and forest respectively. The estimated small mammal population for each year in prairie-grassland and forest habitat is listed in Tables 4 and 5 respectively.

A regression analysis on *Sigmodon hispidus* abundance (column in Table 2) showed a significant relationship between abundance and time ($p = 0.0164$, $R^2 = 0.7479$). The regression formula was

$$y = 0.335x - 1999.03$$

where y is the number of *Sigmodon* captured, 0.335 is the slope of the regression line, x is the year and -1999.03 is the intercept of the regression line. This was the only significant relationship found between abundance of each species and time in Table 2.

Even though there was no significant relationship between abundance of *Reithrodontomys fulvescens* and year, the population was greatest in 2002 followed by 2004 (Table 2). There were six species trapped in the prairie-grassland (Table 2). Only in 1983, the grassland subspecies of *Peromyscus maniculatus bairdi* was captured in prairie-grassland.

Regression analysis on the total population in the prairie-grassland habitat (N) in Table 4, showed that N

Table 1. Scientific and common names of mammals captured.

Scientific Name	Common Name
Sigmodon hispidus	Hispid cotton rat
Reithrodontomys fulvescens	Fulvous harvest mouse
Cryptotis parva	Least shrew
Peromyscus leucopus	White-footed deermouse
Mus musculus	House mouse
Peromyscus maniculatus	North American deermouse
Tamias striatus	Eastern chipmunk
Glaucomys volans	Southern flying squirrel

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Table 2. Species captured in prairie-grassland trappings.

Year	*Sigmodon hispidus*	*Reithrodontomys fulvescens*	*Cryptotis parva*	*Peromyscus leucopus*	*Mus musculus*	*Peromyscus maniculatus*
2014	33	0	0	0	0	0
2010	36	5	0	0	0	0
2008	17	3	0	0	0	0
2006	2	1	1	1	0	0
2004	15	8	0	0	3	0
2002	4	16	1	0	0	0
2000	9	3	0	0	0	0
1998	2	1	0	0	0	0
1983	5	5	0	0	0	5

and year was significantly correlated. The formula for regression was

$$y = 0.253x - 1996.03$$

The coefficient of determination for N in Table 4 was 0.7556 (=R^2). The value for F-statistic was 16.46 (1 and 4 *df*, p=0.01539).

There was a weak correlation (p = 0.609, R squared = 0.0393) between minimum winter temperature of the previous year and population of *Sigmodon hispidus* of the current year.

There were only 3 species of small mammals trapped in forest in 6 years of trapping as compared to 6 species in the prairie-grassland trapped in 9 years of trapping in the prairie-grassland. The wind storm in the forest produced so much downed timber that it was impossible thereafter to establish the trapping grid. The average population of small mammals captured in forest was estimated by averaging N for each night (Table 5).

Discussion

Sigmodon hispidus showed a cyclical population dynamic where abundance was greatest in certain years and declined in intervening years at our study site from year 1998-2008 (Table 2). However, the population has been increasing steadily since 2008, this might be attributed to the change in vegetation composition of the prairie-grassland habitat. We trapped nothing but *Sigmodon hispidus* in 2014 (Table 2) this has happened before in northwestern Arkansas (Gipson 1968). The cyclical nature of hispid cotton rats is found extensively in literature (Smith 1964; Fleharty *et al*. 1972; Martin and Huffman 1980; Doonan and Slade 1995; Calisher *et al*. 2005).

Table 3. Species captured in forest trappings.

Year	*Peromyscus leucopus*	*Glaucomys volans*	*Tamias striatus*
2008	2	0	1
2006	5	0	0
2004	1	0	1
2002	2	1	0
2000	1	0	0
1998	4	1	0

Table 4. Prairie-grassland small mammal population estimate (N).

Year	N	N/ha
2014+	105.6	104.3772
2010	49	48.4326
2008	34	33.6063
2006	*	*
2004	39	38.5484
2002	31	30.6410
2000	15	14.8263
1998	4	3.9536
1983	18.8	18.5823

*Indicates no calculations due to no recaptures
+The population estimate of year 2014 is corrected, given smaller acreage of trapping due to rain.

Table 5. Forest small mammal population estimate (N)

Year	AVG N	N/ha
2008	2.5	2.4691
2006	6	5.9259
2004	*	*
2002	3.5	3.4567
2000	0	0
1998	4	3.9506

* One unknown organism set off numerous traps without being captured which made it impossible to interpret the trapping results.

Although no detailed analysis of the vegetation was conducted throughout the years that trapping was conducted at the prairie-grassland area. D. James observed that throughout the years, the prairie-grassland's vegetation was transitioning from mainly broomsedge bluestem (*Andropogon virginicus*) grass to vegetation that consisted of diverse prairie grasses. The new grasses observed included little bluestem (*Schizachyyrium scoparium*), big bluestem (*Schizachyyrium gerardii*), switchgrass (*Panicum virgatum*) and indiangrass (*Sogastrum nutans*). This change was aided by controlled burns and removal of invading eastern red cedars (*Juniperus virginiana*). Change in grass composition might have caused an increase in abundance of *Sigmodon hispidus* in the grassland as depicted by the data (Table 4).

We did not observe any strong correlation between population of *Sigmodon hispidus* and the lowest recorded temperature of previous year in Arkansas. In higher latitudes at the northern limits of geographic range of *S. hispidus*, temperature is the major driving factor in controlling the population (Sealander and Walker 1955; Goertz 1964). However, as Arkansas is far below the northern limit for *S. hispidus* range, the lowest recorded temperature does not play a major role here.

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