Long-term Dynamics of an Early Successional Small Mammal Community

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Long-term Dynamics of an Early Successional Small Mammal Community

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ABSTRACT.—We examined changes for 15 years in the structure of a small mammal community in northeastern Kansas. Individuals of 11 species were captured by live trapping 25,927 times and all species persisted throughout the study. However, local extinctions of populations were common and Sigmodon hispidus, a recent immigrant from the southern United States, was particularly prone to rapid declines during winter and spring. The heterogeneity and successional stage of habitat were important in determining the presence, distribution and abundance of a species on the study area; this was particularly true for habitat specialists such as Peromyscus leucopus. In addition, temporal synchrony of population peaks was greater between species with similar food habits than between species with dissimilar food habits. Species interactions also influenced local distribution and abundance patterns. Sigmodon hispidus and Microtus ochrogaster captures were negatively correlated during the breeding season of the former, and a similar situation occurred between Peromyscus maniculatus and M. ochrogaster. Negative correlations between Peromyscus leucopus and P. maniculatus and between Reithrodontomys megalotis and both species of Peromyscus occurred during a peak in P. leucopus populations that resulted in their increased use of less preferred habitat. If only 2–3 yr of data had been collected, different conclusions would have been reached regarding the impact on community structure of vegetative succession, species interactions and resiliency of populations.

INTRODUCTION

The structure of a community is the number and types of species present and their relative abundances. In the majority of communities studied, community structure fluctuates (Chesson and Case, 1986), often due to local extinctions or changes in densities of constituent populations. Competition, predation, disease, parasitism, habitat heterogeneity and chance disturbances have all been advocated as principal agents in the patterning of communities (reviewed by Strong et al., 1984; Diamond and Case, 1986).

Previous attempts to understand the processes structuring a small mammal community in northeastern Kansas relied upon laboratory (Glass and Slade, 1980a) and field (Glass and Slade, 1980b; Danielson and Swihart, 1987) experiments designed to investigate interspecific interactions. Here, we summarize changes in the composition of the small mammal community from 1973 to 1988, and we examine the influence of interspecific interactions and habitat succession on species use of the area.

STUDY AREA AND METHODS

The study was conducted on a 2.25-ha live-trapping grid located at the Nelson Environmental Study Area, 12 km NE of Lawrence, Kansas. A narrow dirt road (2–3 m wide) bisected the grid in an E–W direction. The half of the grid N of the road was an abandoned
agricultural field. Vegetation in this field consisted primarily of *Setaria sp.*, *Helianthus annuus*, *Aster multiflorus*, *Asclepias sp.* and *Solidago sp.*, as well as some *Poa pratensis* and scattered patches of woody species such as *Cornus drummondii* and *Rhus glabra*. The southern half of the grid, an abandoned pasture and hayfield, was comprised mostly of the grasses *Poa pratensis* and *Bromus inermis* but also contained *Solidago sp.* and scattered woody species such as *C. drummondii*, *Maclura pomifera*, *Gleditsia triacanthos*, and *Symphoricarpos orbiculatus*. The southern half of the area also was bisected by a brushy fencerow running N and S.

**Trapping.**—One hundred trap stations were positioned at 15-m intervals in a rectangular array, with two traps (one modified Fitch trap, one Sherman trap) per station. Trapping sessions were 3 days, with traps checked both in morning and afternoon. Trapping commenced in August 1973 and continued through April 1988. For the 1st 28 mo of the study, trapping was biweekly; thereafter, monthly. Traps were baited with scratch grain (a mixture of grain sorghum, corn and wheat), and straw and cotton nesting materials were supplied during cold weather.

Species identity and trap location were recorded for each individual captured. Only prairie voles (*Microtus ochrogaster*) and cotton rats (*Sigmodon hispidus*) were marked for individual identification. Species abundance was calculated as captures per trap night, adjusted for traps that were sprung or tipped. Half a trap night was subtracted for each empty sprung trap (Nelson and Clark, 1973). We also subtracted one trap night for each tipped or moved trap. Although captures per trap night and number of individuals captured were highly correlated for prairie voles and cotton rats (*r* = 0.98, *P* < 0.001 for both species), the form of this relation may vary among species. Hence, we limited our examination of abundance patterns to intraspecific comparisons of capture frequency at different times in the study. Although capture frequencies might vary seasonally, we assumed that captures per individual did not vary among years.

Temporal synchrony of population peaks was evaluated in a pairwise manner for cotton rats, prairie voles, southern bog lemmings (*Synaptomys cooperi*), white-footed mice (*Peromyscus leucopus*), deer mice (*P. maniculatus*) and western harvest mice (*Reithrodontomys megalotis*). Capture frequencies were calculated for each species on a seasonal basis (n = 59 seasonal means; spring = March to May, summer = June to August, autumn = September to November, winter = December to February) and ranked in descending order. The 12 seasonal periods with the greatest capture frequencies for a species were used to calculate the percentage of peak seasons common to pairs of species (Sorenson’s coefficient of similarity, Greig-Smith, 1964). Cotton rats, prairie voles and bog lemmings are primarily herbivorous (Cole and Batzli, 1979; reviewed by Cameron and Spencer, 1981; Linzey, 1983), whereas deer mice, harvest mice and white-footed mice are primarily granivorous-omnivorous (reviewed by Baker, 1968; Webster and Jones, 1982; Lackey et al., 1985). Mean synchrony of pairs of species within and between trophic groups was compared using a t-test.

**Habitat.**—Vegetation was classified into three major types: grass (*Poa, Bromus, Setaria*), forb (*Helianthus, Aster, Solidago, Asclepias*) and wooded (*Cornus, Rhus, Gleditsia, Maclura, Symphoricarpos*). In 1974, 1980 and 1985, the dominant vegetation type in a 30-m² area centered on a trap was recorded at each trap station. Disproportionate use of habitat types was examined using a chi-square test to compare frequencies of trap stations in each habitat type at which a species was captured with frequencies of unsuccessful traps in each habitat. For each species, a separate test was done in each season of each year in which data on habitat types were collected. In addition, we included trapping records from 1975 and 1984 for tests using habitat data from 1974 and 1985, respectively.

To maintain vegetation in an early successional stage, trees and brush were cut in July
1981, the entire study area was mowed to a height of 30–45 cm in July 1983, and the N half of the area was plowed in May 1984.

Species interactions.—Significant habitat associations revealed by chi-square tests do not necessarily imply habitat selection by a species. Disproportionate use of a habitat type could be due to true preferences for that habitat, or competitively dominant species could force a subordinate species into less preferred habitat. To quantify the importance of habitat and interspecific interactions in determining the abundance of a species at a particular site, we used the multiple regression technique of Hallett and Pimm (1979) as applied by Dueser and Porter (1986). Frequency of capture of a species at each trap station was regressed against corresponding frequencies for each remaining species as well as dummy variables used to represent the three habitat types. Only trap stations with at least one capture were used in a regression, and a separate analysis was done for each season in each year for which data on habitat types were available. Frequency of capture of a species was first fitted by entering habitat variables into the regression model, followed by the number of captures for each of the other species. The regression was then repeated, with species variables entered before habitat variables. In this way, squared multiple semipartial correlation coefficients were obtained. These coefficients were used to assess the relative importance of habitat vs. other species in determining capture frequency at a trap station (Dueser and Porter, 1986). We calculated $R^2_{\text{H-S}}$, the proportion of variation explained by habitat variables after accounting for species effects, and $R^2_{\text{S-H}}$, the proportion of variation explained by other species caught at the trap site after accounting for habitat variables. For each species in each season, the equality of $R^2_{\text{H-S}}$ and $R^2_{\text{S-H}}$ was assessed using a two-tailed t-test with data collected in 1974, 1980 and 1985.

The frequency of significant interactions between species was assessed by tabulating the number of times that a species, serving as the independent variable, explained a significant proportion of the variation in capture frequency of the species serving as the dependent variable. Because reciprocal comparisons between two species probably were correlated (Dueser and Porter, 1986), we used only the upper half of the interaction matrix. Only comparisons among prairie voles, cotton rats, western harvest mice, deer mice and white-footed mice were tabulated.

**Results**

Population trends.—Individuals of 11 species were captured 25,927 times. At least seven and possibly as many as nine of these species were represented by resident individuals for at least some period of the study (Table 1). Twelve captures of meadow jumping mice (*Zapus hudsonius*) and four of least shrews (*Cryptotis parva*) were recorded during the 15-yr period. Of the remaining species, the house mouse (*Mus musculus*) and Eastern woodrat (*Neotoma floridana*) either were abundant only on a seasonal basis or were present in low numbers within a restricted period of time (Table 1). Short-tailed shrews (*Blarina hylompha*) were present throughout the study, although captured in low numbers. Annual peaks in captures of short-tailed shrews generally occurred in the autumn (Table 1). Bog lemmings were captured regularly, although never at a rate of >4 per 100 trap nights (Fig. 1).

Prairie voles, on average, were captured more frequently than any other species (Tables 1, 2). Voles were captured in nearly every month of the study (Fig. 1), and mean capture frequencies among seasons were nearly identical (Table 1).

Cotton rats generally were less abundant than prairie voles (Tables 1, 2) and more prone to sharp declines in spring relative to the other species (Table 1, Fig. 1). The mean value for captures per trap night during spring was only 22% of the winter value for cotton rats,
Table 1.—Mean captures (±se) per 100 trap nights, by season, for 11 species of small mammals. Seasonal averages were computed for each year from 1973 to 1988 and then averaged across years.

<table>
<thead>
<tr>
<th>Species</th>
<th>Spring</th>
<th></th>
<th>Summer</th>
<th></th>
<th>Autumn</th>
<th></th>
<th>Winter</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\bar{x}$</td>
<td>se</td>
<td>$\bar{x}$</td>
<td>se</td>
<td>$\bar{x}$</td>
<td>se</td>
<td>$\bar{x}$</td>
<td>se</td>
</tr>
<tr>
<td>Prairie vole</td>
<td>11.4</td>
<td>1.9</td>
<td>11.7</td>
<td>2.7</td>
<td>10.4</td>
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<td>12.0</td>
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</tr>
<tr>
<td>Cotton rat</td>
<td>1.2</td>
<td>0.3</td>
<td>2.4</td>
<td>0.8</td>
<td>6.6</td>
<td>2.0</td>
<td>5.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Deer mouse</td>
<td>4.3</td>
<td>1.2</td>
<td>1.6</td>
<td>0.4</td>
<td>2.1</td>
<td>0.5</td>
<td>5.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Western harvest mouse</td>
<td>3.8</td>
<td>0.6</td>
<td>1.3</td>
<td>0.3</td>
<td>1.6</td>
<td>0.3</td>
<td>5.8</td>
<td>1.1</td>
</tr>
<tr>
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<td>1.3</td>
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<td>1.3</td>
<td>0.3</td>
<td>2.3</td>
<td>0.5</td>
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<td>0.1</td>
<td>0.7</td>
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<td>0.1</td>
<td>0.04</td>
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<td>0.7</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
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<td>0.06</td>
<td>0.1</td>
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<td>0.1</td>
<td>0.3</td>
<td>0.1</td>
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<tr>
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<td>0.07</td>
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<td>0.08</td>
<td>0.03</td>
<td>0.0</td>
<td>—</td>
</tr>
<tr>
<td>Eastern woodrat</td>
<td>0.0</td>
<td>—</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.03</td>
<td>0.01</td>
<td>0.01</td>
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<td>Least shrew</td>
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<td>—</td>
<td>0.07</td>
<td>0.04</td>
<td>0.04</td>
<td>0.02</td>
<td>0.0</td>
<td>—</td>
</tr>
</tbody>
</table>

whereas spring captures were 99%, 83%, 80% and 66% of winter levels for prairie voles, white-footed mice, deer mice and harvest mice, respectively.

Deer mice typically exhibited annual peaks in captures during winter and spring (Table 1), with the largest peaks occurring in early 1977 and 1978 (Fig. 1). Abundance then declined gradually until 1984, at which time captures began to increase (Fig. 1).

Harvest mice were captured most frequently in winter and spring (Table 1). A large peak in captures of harvest mice occurred in late autumn and early winter of 1974, followed by a decline until 1979; thereafter, annual captures remained fairly constant (Table 2, Fig. 1).

White-footed mice occupied the grid in low numbers until autumn 1977, at which time they began to increase (Fig. 1). Their numbers generally remained high until summer 1983; relatively low numbers were attained during the subsequent 3 yr (Fig. 1).

The temporal occurrence of peaks in populations of the six most abundant species was associated with trophic status. Mean synchrony of pairs of species within a trophic group (31.8%) was significantly greater than for pairs of species from different trophic groups (22.1%) ($t = 1.85$, 14 df, one-tailed $P = 0.044$).

Habitat.—In 1974, 41%, 55% and 4% of trap stations occurred in predominantly grass, forb and wooded habitat, respectively. Prairie voles used grass habitat disproportionately often during summer, and cotton rats differentially used grassy areas during the growing season and wooded areas in winter (Table 3). In contrast, deer mice and harvest mice used forb habitat extensively (Table 3).

By 1980, the percentage of all trap stations in grass and forb habitats had decreased to 34.3% and 26.3%, respectively, whereas 39.4% of all traps occurred in wooded habitat. Prairie voles were captured at a disproportionately high number of traps in grass habitat during spring and autumn, as were bog lemmings during spring (Table 3). Deer mice and cotton rats exhibited disproportionate use of forb habitat during autumn and winter, respectively, and harvest mice were captured disproportionately often in forb habitat during all seasons (Table 3). White-footed mice were captured most frequently in traps in wooded habitat during winter and spring (Table 3).

Brush removal in 1981, mowing in 1983 and plowing in 1984 reduced the amount of woody vegetation compared with 1980 levels; by 1985, grass and forb habitat predominated around 48.5% and 34.3% of the trap stations, respectively, whereas 17.2% of traps occurred
in wooded habitat. Prairie voles and bog lemmings were captured disproportionately often in grass habitat during winter (Table 3). Prairie voles also frequented grassy areas in autumn and forb habitat in all seasons except spring (Table 3). Cotton rats, deer mice and harvest mice either used forb habitat disproportionately often or used habitat types in proportion to their abundance (Table 3). Captures of white-footed mice were associated with wooded habitats (Table 3).

Species interactions.—Sixty-one regressions of capture frequency against the variables of habitat and capture frequencies of other species yielded 38 significant (P < 0.05) regressions. The total proportion of variation explained when all independent (species and habitat) variables were included in a regression, $R^2_{\text{H-S}}$, ranged from 0.05–0.75. Comparisons of $R^2_{\text{H-S}}$ and $R^2_{\text{S-H}}$ for each species in each season resulted in no significant differences between these squared semipartial correlation coefficients.

Twenty-two of 120 pairwise interactions of species resulted in significantly negative (P < 0.05) partial regression coefficients, whereas only three pairwise interactions were positive.
Table 2.—Mean captures per 100 trap nights, by year, for 11 species of small mammals captured during monthly live trapping sessions. Monthly averages were calculated for each season, and seasonal values were then used in computing annual means.

<table>
<thead>
<tr>
<th>Species</th>
<th>73</th>
<th>74</th>
<th>75</th>
<th>76</th>
<th>77</th>
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<th>83</th>
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<th>86</th>
<th>87</th>
<th>Total</th>
</tr>
</thead>
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<td>12.6</td>
<td>6.8</td>
<td>2.2</td>
<td>23.7</td>
<td>17.0</td>
<td>2.9</td>
<td>14.6</td>
<td>18.5</td>
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<tr>
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<td>Cotton rat</td>
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<td>5.8</td>
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<tr>
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<tr>
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<td>0.4</td>
</tr>
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<td>0.4</td>
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<tr>
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<td>0.3</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
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<td>0.3</td>
<td>0.2</td>
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<td>0.2</td>
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<td>0.1</td>
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<td>0.2</td>
<td>0.05</td>
<td>0.0</td>
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<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>mouse</td>
<td>\textit{SE}</td>
<td>—</td>
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<td>0.06</td>
<td>—</td>
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<td>—</td>
<td>—</td>
<td>0.1</td>
<td>0.05</td>
<td>—</td>
<td>—</td>
<td>0.06</td>
<td>0.1</td>
<td>0.1</td>
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</tr>
<tr>
<td>Eastern woodrat</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.01</td>
<td>0.1</td>
<td>0.1</td>
<td>0.0</td>
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<td>0.02</td>
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<td>—</td>
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<td>—</td>
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<td>0.02</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>Least shrew</td>
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<td>0.0</td>
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<td>0.05</td>
<td>0.05</td>
<td>0.2</td>
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</table>
Table 3.—Results of chi-square tests for disproportionate use of habitat types. Cells containing W, F and/or G indicate disproportionately frequent use of wooded, forb, and grass habitat types, respectively. Cells with a line (—) had insufficient numbers of captures for testing. n.s. = not significant at the 0.05 level. Sp = spring, Su = summer, Fa = fall, Wi = winter

<table>
<thead>
<tr>
<th>Species</th>
<th>1974</th>
<th>1980</th>
<th>1985</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Sp</td>
<td>Su</td>
<td>Fa</td>
</tr>
<tr>
<td>Prairie vole</td>
<td>n.s.</td>
<td>G</td>
<td>n.s.</td>
</tr>
<tr>
<td>Cotton vole</td>
<td>G</td>
<td>G</td>
<td>n.s.</td>
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<tr>
<td>Deer mouse</td>
<td>F</td>
<td>F</td>
<td>F</td>
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<tr>
<td>Western harvest mouse</td>
<td>F</td>
<td>F</td>
<td>n.s.</td>
</tr>
<tr>
<td>White-footed mouse</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Southern bog lemming</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Binomial tests using a normal approximation and correction for continuity indicated that the probability of such a high proportion of significant negative interactions was extremely low (P < 0.001) but that three positive interactions out of 120 could be due to chance (P > 0.25).


Discussion

Community dynamics and population trends.—Capture frequencies of several species in the community fluctuated extensively during the study, and peaks in species abundance did not occur simultaneously (Tables 1, 2; Fig. 1). The fluctuations in abundance, together with local extinctions of cotton rats, house mice, Eastern woodrats, meadow jumping mice and least shrews, resulted in temporal changes in community structure. These findings suggest a nonequilibrial community (Chesson and Case, 1986). However, equilibrial properties also were evident, inasmuch as all species persisted throughout the study, and the distribution and abundance of several species were associated with changes in habitat (see Kimmerer, 1984).

Successional changes in vegetation appeared to be important in structuring long-term fluctuations in abundance. For instance, the period from 1974 to 1978 was marked first by an irruption of harvest mice and then of deer mice (Fig. 1), two species with strong preferences for habitats consisting of mixed forbs and grasses (Table 3; Birkenholz, 1967; Ford, 1977; Hansen and Warnock, 1978). Early in the study, forbs were the dominant habitat type, with 55% of all traps occurring there. By 1980, higher percentages of traps occurred in grass (34.3%) and wooded (39.4%) habitats. The reduction in forbs from 55% in 1974 to 26% in 1980 coincided with a reduction in captures of harvest mice and, to an extent, deer mice (Fig. 1). Brush removal, mowing and plowing from 1981 to 1984 resulted in increased levels of grass and forb habitat in 1985, and these increases were associated with increased captures of deer mice from 1985–1987 compared with 1979–1981 (Table 2, Fig. 1), the
period of reduced forb habitat. Unlike deer mice and several other species, numbers of harvest mice exhibited little interannual variation from 1980–1988 (Table 2, Fig. 1).

White-footed mice also responded to changes in the availability of habitat types. Early in our study, woody vegetation was confined to a hedge row and grove of a few large trees on the margin of the trapping grid. During this same period, white-footed mice were found in low numbers (Fig. 1). By 1980–1981, the amount of woody vegetation had increased to its highest level, as had the population of white-footed mice (Fig. 1). White-footed mice prefer wooded habitat (Hansen and Warnock, 1978; Kaufman et al., 1983; Snyder and Best, 1988) and used wooded habitat disproportionately often in the present study (Table 3). Thus, the increased availability of wooded habitat apparently enabled increased numbers of white-footed mice to occupy the area. Habitat alterations reduced the percentage of traps occurring in wooded habitat to 17.2% by 1985, a value intermediate between 1974 and 1980. Mean capture frequencies of white-footed mice from 1985–1987 also were intermediate to means from the early (1973–1976) and middle (1978–1981) years of the study (Table 2).

Southern bog lemmings rely on grasses for food and cover throughout much of their range, although wooded habitats also are used (reviewed by Linzey, 1983). On the two occasions in which they were present in numbers sufficient to permit testing, bog lemmings on our study area used grass habitat disproportionately often. Capture frequency also increased subsequent to brush removal (1981–1982) and mowing and plowing (1985–1987), suggesting that removal of woody vegetation and regrowth of grass had a positive impact on the population (Table 2, Fig. 1).

Prairie voles and cotton rats exhibited more generalized use of habitats than did deer mice, harvest mice and white-footed mice (Table 3); consequently, changes in abundance in response to successional changes in vegetation were not evident. Prairie voles in particular appear capable of occupying a wide range of habitats with varying degrees of cover (Sly, 1976; Getz, 1985). In late autumn and winters of peak vole density, we observed runways which were mud trenches criss-crossing areas almost devoid of ground cover. We repeatedly captured voles in traps surrounded by >50% bare soil during these peak periods.

Fluctuations in captures of cotton rats did not conform to a discernible pattern and were punctuated by frequent episodes of local extinction (Fig. 1). Cotton rats are recent immigrants to northeastern Kansas, having expanded their range northward through Oklahoma and Kansas over the past several decades (Cockrum, 1948). The cotton rat is a neotropical rodent, and winters in Kansas severely stress individuals (Frydendall, 1969; Fleharty et al., 1973; Slade et al., 1984). Adult cotton rats on our grid often lost mass during winter (Slade et al., 1984), and overwinter survival was low (4.9%, Swihart and Slade, 1985), in spite of energy-conserving strategies such as huddling, use of brush piles for nesting sites, and restricted movements (Dunaway and Kaye, 1961; Slade and Swihart, 1983; Swihart and Slade, 1985). Thus, the range expansion of cotton rats added a species to the community, whereas their relatively poor adaptations to a more stringent environment caused at least some of the temporal shifts in community structure that we observed.

Species interactions.—Our partial regression analysis indicated that interspecific interactions and habitat did not differ in their ability to influence the abundance and distribution of species. Dueser and Porter (1986) used a comparable regression analysis for an insular community of small mammals. They concluded that habitat structure was of primary importance in dictating patterns of species abundance, although they also presented evidence for considerable competitive interaction. Carnes and Slade (1988) showed that the results of such analyses depend on the variables included in the regression model. Our habitat variables were rudimentary; had we collected more detailed data, we might have reached
conclusions similar to Dueser and Porter (1986). By using dummy variables to distinguish among habitat types, we allowed for some habitat selection, but common responses to other aspects of habitat might have been confounded with interspecific interactions. Thus, our interpretations of regression coefficients cannot rely solely on statistical inference.

The best documented case of negative covariation occurring during our study was the relation between cotton rats and prairie voles in spring and summer. Cotton rats breed in Kansas from March through October (Bancroft, 1969; McCleneghan and Gaines, 1978), and the presence of reproductively active cotton rats causes prairie voles to shift their activity both spatially and temporally (Glass and Slade, 1980a). Cotton rats and prairie voles use common runway systems, and exclusion of voles is related to the frequency of contact with cotton rats (Terman, 1974; Glass and Slade, 1980b). Although cotton rats and prairie voles exhibited similar food habits, Fleharty and Olson (1969) concluded that competition was more likely for space than food. Glass and Slade (1980a) stated that coexistence of prairie voles and cotton rats was dependent upon the seasonal nature of the interaction, habitat heterogeneity, and the wider habitat tolerances of voles. All of these factors were operative in the current study. A fourth feature, the frequency with which cotton rats become locally extinct, might also influence coexistence. Extinctions typically occurred in spring on our grid, and they might have enabled voles to increase recruitment (by immigration and birth) to a level sufficient to ensure their persistence as cotton rats began to reinvade and reproduce on the area. Analysis of mean monthly capture rates of voles in spring during years of cotton rat absence and years when rats were present indicated a higher number of captures per trap night during periods of rat absence (0.16 vs. 0.10), but this difference was not statistically significant (P = 0.12).

Partial regression coefficients were negative for prairie voles and deer mice in either spring or autumn of each year for which tests were done. Autumn and spring represent the two peaks of breeding activity for voles and deer mice in northeastern Kansas (Bancroft, 1969; Gaines and Rose, 1976), and the increased number of reproductively active individuals may have intensified interactions during these seasons. Abramsky et al. (1979) observed that deer mice were excluded by prairie voles from nitrogen and water-treated sites in shortgrass prairie habitat; removal of prairie voles from the area led to an increase in the number of deer mice found there. Similarly, subspecies of deer mice that use grasslands have been shown to be excluded from these areas by voles (Grant, 1971; Redfield et al., 1977).

Negative pairwise correlations of white-footed mice, deer mice and harvest mice were confined to 1980–1981. Habitat analyses indicated considerable overlap in use of forb habitat by deer mice and harvest mice, and significant negative covariation occurred in summer and autumn 1980 and winter 1980–1981, even after effects of habitat use were considered. Although competition is likely, given the similar habitat and food requirements of these species, we cannot rule out the possibility that subtle differences in habitat preference within the forb habitat were responsible for the negative interactions we observed. Kaufman et al. (1988) examined tallgrass prairie sites with differing fire histories and noted that deer mice and harvest mice were distributed differently among the sites. They concluded that differences in the local distributions of these species were caused by differences in habitat preferences rather than by competition.

During the population peak for white-footed mice in 1980–1981, negative interaction coefficients occurred between white-footed mice and deer mice in autumn 1980 and between white-footed mice and harvest mice in every season. In general, white-footed mice used distinctly different habitat than did deer mice or harvest mice. But during summer and autumn 1980, white-footed mice used habitat types roughly in proportion to their abundance, presumably providing greater opportunity for interactions with the other two species.
Inference from short-term studies.—Studies of many vertebrate communities are conducted over relatively short time spans. Our data indicate that short-term studies may not provide a representative view of a community’s structure or dynamics. In particular, our perception of the effects of local extinction, vegetative succession and interspecific interactions in the current study would have changed considerably had we examined the community for only a 2- or 3-yr period.

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Literature Cited


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