SMALL MAMMAL DIVERSITY AND ABUNDANCES IN THREE CENTRAL IOWA GRASSLAND HABITAT TYPES

LARRY A. HAYSLETT

and

Brent S. Danielson

Dept. Animal Ecology, ISU, Ames, IA 50011

ABSTRACT.-- Small mammals were studied in three central Iowa grassland habitat types to test the hypothesis that species diversity and abundances are lower in relatively pure stands of replanted native grasses than in vegetatively more diverse prairie or old-field habitats. Snap trapping was conducted at 10 sites of each habitat type between 19 June and 4 August 1992. Study sites were located in Jasper and eastern Polk counties, Iowa. Relevant vegetation data were recorded. Calculated small mammal diversity indices and abundances were similar for all three habitat types. The lack of significant relationships between habitat and species diversity may have been due to the small size of the study sites.

Because there were no habitat effects, and to increase sample sizes, data from all trap stations were combined. Species were grouped into guilds of grainivores, herbivores, and insectivores. Principal Component Analysis was used to characterize the vegetation data. These results, with the combined trapping data, were used to construct multiple stepwise regressions. The regression for grainivores was not significant. However, regressions for herbivores and insectivores accounted for 4% and 10% of the variation, respectively. Similar regressions, combining the data by trap lines, accounted for considerably more of the variation in these two guilds (27% for herbivores, 43% for insectivores). These results indicate that small mammal species may be responding more to vegetation structure than to plant composition.

With fewer than 0.02% of pre-settlement prairies remaining in Iowa (Smith, 1981), prairie reconstruction has received a great deal of attention in recent years. In this interest, many acres of CRP land and state hunting preserves have been planted in stands of switchgrass (*Panicum virgatum*). However, recent studies have suggested that such relatively pure stands do not provide the nutritional diversity necessary to support the small mammal populations originally occurring in Iowa's prairies.

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Schwartz and Whitson (1987), suggested that a lack of forbs, and corresponding lower structural diversity, do not provide an optimal habitat for small mammals in restored prairies. For example, the normal diet of herbivores, such as *Microtus ochrogaster*, is dominated by forbs (Cole and Batzli, 1979). When restricted to a diet of grass only, Batzli and Cole (1979) found that this rodent lost weight and died.

Small mammals are an important part of prairie ecosystems, serving both as prey for other animals, as well as agents of seed dispersal. However, fifty-five percent of Iowa's mammal species have been extripated, are rare, or have declining populations (Bowles, 1981). The results of this study could help in guiding the types of plantings necessary to re-establish fully functioning prairie ecosystems.

This study tests the hypothesis that small mammal species diversity and abundances are lower in relatively pure stands of replanted native grasses than in remnant prairie and old field habitats with higher plant diversity.

Additionally, this study provides important baseline data on species currently present at the newly established Walnut Creek National Wildlife Refuge. This information may prove useful to future researchers documenting changes in wildlife as prairie reconstruction progresses.

METHODS

Ten sample areas of each habitat type (native prairie, old field, and native monoculture plantings) were selected in and around the Walnut Creek National Wildlife Refuge, Prairie City, Iowa. These sites were in located throughout Jasper and eastern Polk counties. Field sizes varied from 0.8 to 16.2 ha.

Snap-trapping was conducted simultaneously in each of the three habitat types for 5-day periods. Trapping was conducted from 19 June through 4 August 1992.

Eleven trapping stations (consisting of one mouse trap, one museum special, and one rat trap) were placed at 10-m intervals along a 100-m transect. Traps were baited with oats and placed within 1 m of each other at each station. Traps were checked each morning, specimens removed and identified, and the traps re-baited. Transects were positioned in the center of fields, in order to minimize edge effects.

Percent cover of grasses and forbs, litter depth, vegetation height, and general characteristics were recorded at each site. Percent cover was estimated inside a 0.25-m^2 frame placed 1 m to the right of each trap station. These data were averaged for each trapline.

Species diversity for each study site was calculated using both the Simpson and Shannon-Weaver indices. Abundance of each species was indexed by direct count, as samples were too small for statistical estimation of densities. Regressions of species diversity against percent forbs and field size were calculated.

To increase sample sizes, data from all trap stations were combined. Principal Components Analysis (PCA) was used to weight the vegetation data (percent forbs, percent total cover, litter depth, and vegetation height) from each station to create new independent vegetation variables. Captures of species from each station were grouped into trophic guilds of grainivores, herbivores, and insectivores. Using the PCA results, a multiple stepwise regression was then run for each of these guilds.

Similar PCA's and regressions were calculated from the mean vegetation data and combined captures for each trapline. The Statgraphics program was used for these analyses.

RESULTS

The largest differences in vegetation characteristics between the three habitat types were in the type of grasses and the amount of forbs present (Table 1). The prairies and plantings were dominated by native tallgrasses, while brome (*Bromus* species) was most common in the old fields. The prairie and old-field areas contained approximately 25% forb cover, but forbs were almost entirely lacking from the monoculture plantings. The average total cover, litter depth, and vegetation height were similar in all three habitats. However, the large standard errors for all vegetation measurements indicates a high amount of variability within each habitat type.

During the course of this study, nine species of small mammals were captured (Table 2). *Reithrodontomys megalotis* and species of

Peromyscus dominated in all habitat types. Except for *Mus musculus*, which was only found in switchgrass plantings, all other species were found in each habitat type.

Overall abundance for most species was similar for all habitat types. The apparently higher abundance of *P. maniculatus* in monoculture plantings, and of *Sorex cinereus* in prairie habitats, were due to high populations in one or two study sites and not statistically significant (*P. maniculatus*: $P>0.2$, *S. cinereus*: $P>0.05$). The similarly high abundance of *Blarina brevicada* in prairies and old fields was due to the same cause ($P>0.3$).

While overall abundances between habitat types were similar, an average of only four species was present in each study area (Table 3). Assemblages of species, and numbers of individuals captured at different study sites within a habitat type, varied considerably.

Mean species richness, as well as the mean of both diversity indices, was higher for prairie and old field habitats than that of monocultures (Table 3). However, due to the large standard errors, these differences were not statistically significant.

Regressions of diversity against percent forbs and field size showed slight positive correlation, but also lacked statistical significance (forbs: $P=0.079$, field size: $P=0.171$).

Results of the PCA of vegetation data for individual trap stations are reported in Table 4. Principal Component (PC) 1 gave the most weight to the variables of percent of total cover and vegetation height. PC 2 reflected a strong negative relationship between the percent forbs and litter depth. These two PC's accounted for over 66% of the variance in the vegetation data. Because PC 3 and PC 4 had eigenvalues less than 1.0, they were not used.

The multiple stepwise regressions showed a small, but significant, correlation between the abundances of herbivores and insectivores and PC 1 and PC 2 (Table 5). No significant correlation was found for grainivores. This model accounts for approximately 4% of the variation in herbivores and 10% of the variation in insectivores.

PCA by each trap line gave results similar to the trap station PCA (Table 6). In PC 1, percent cover and vegetation height were still most important. However, litter depth increased in weighting, while the importance of forbs decreased. In PC 2 the percent forbs was the most important factor with other variables nearly equal in weight. The percent of variance accounted for by PC 1 and PC 2 increased to over 72%. Again, PC 3 and PC 4 had eigenvalues less than 1.0 and were not used.

Using the trapline data, the regressions showed a much higher degree of correlation between the PC's and abundances of herbivores and insectivores (Table 7). Correlation coefficients increased over the trap station analysis by about a factor of 10. Almost 27% of the variation in herbivores was accounted for and nearly 43% for insectivores.

DISCUSSION

The similar small mammal abundances between prairie and old-field habitats may, in part, be explained by the percent of forbs present. While each habitat had about the same amount of forbs, the prairie sites contained mostly native plants, whereas the old fields were dominated by weedy Eurasian species. Therefore, small mammal populations may be more influenced by the diversity of vegetation, rather than the presence of specific plants.

However, the initial results did not show a marked decrease in small mammal diversity or abundances in monoculture grass plantings, low in plant diversity. This may be due, in part, to the nature and size of the study plots. In central Iowa, land not planted in row crops tends to be small in area and prone to flooding, excessively hilly, or cut off and inaccessible. While such areas may be unsuited to agriculture, they are in no way isolated. All sites studied were bounded by woodlands, fencerows, streams, wetlands, roadsides, or ditches, in some combination. Such habitats provide both corridors for migration, as well as sources of emigration and refuge.

Simulation studies indicate the coexistence of more species as environmental variability increases (Palmer, 1992). The mass effect, described by Shmida and Wilson (1985), demonstrates the impact of surrounding habitats on patches. This model describes how species diversity in a patch is affected by dispersal from nearby dissimilar habitats, although these immigrants may not successfully compete or reproduce. Such influences from surrounding habitats helps explain the highly variable assemblages of species found in this study.

The mass effect would also help explain the high abundance of *P. leucopus* found. Mostly frequenting wooded areas, Finck et al. (1986) found *P. leucopus* to account for between 4.5 - 14.0% of all small mammals in ungrazed prairie sites in the large Konza Prairie, Kansas.

Comprising about 21% of all small mammals captured in this study, many individuals may have been immigrants from adjoining woodlands.

Batzli (1985) concluded that *Microtus* densities are often related to differences in forage quality, and therefore would be expected to be lower in areas lacking in forbs. However, all of the sites in this study were small, none being over 17 ha with many much smaller. These small sizes result in very small area:edge ratio. It may be that these herbivores in switchgrass plantings were able to meet their nutritional needs by foraging in adjacent habitats.

The influence of the surrounding habitats may overshadow the importance of the attributes of the grassland patches. Thus, small mammal communities in these small patches might not reflect internal equilibria.

Because no habitat effects were observed, sample size was increased by combining vegetation and capture data. Considerable variation occurred between habitat types, and to a lesser extent within traplines. Rather than being distinct categories, the three habitat types tended more towards a continuum. PCA allowed the synthesis of the various vegetation factors measured. Grouping similar mammal species together into trophic guilds, further increased sample sizes of the dependent variable.

While small mammal populations did not appear to respond to vegetation composition, the regressions of PCA and guild captures showed a response primarily to vegetation structure. Structural components of total vegetation cover and height, as well as litter depth to a lesser extent, were most important in the PC 1 of both trap station and trap line analyses. Percent forbs was a secondary factor, important in PC 2.

On a micro-habitat trap-station scale, these components accounted for a small, but significant, portion of the difference in the abundance of herbivores and of insectivores. On the larger trapline scale, vegetation structure was the major determinant of the abundance of these two guilds.

These relationships are consistent with the findings of other researchers. Fink et al. (1986) found *M. ochrogaster* to be most abundant in habitats with dense cover high amounts of litter in both prairie and brome fields. Hall et al. (1991) reported that *M. pennnsylvanicus* densities were related to vegetation structure, cover, and food quality, as opposed to food quantity. A well developed litter layer is also important for *B. brevicada* (Choate and Fleharty, 1975).

The differences in analysis by spatial scale indicates that the abundance of these two guilds is affected more by the overall habitat structure of a field, than by micro-site conditions. With 10-m trap station spacing, the home range of these animals could overlap more than one station. In the course of daily activity, they could be expected to visit less than ideal micro-sites. Additionally, vegetation measurements were taken 1 m from each station, and may not have reflected the exact conditions where the traps were placed. With most of the study sites being fairly uniform on a field scale, grouping the vegetation data by traplines better emphasized the differences between study plots.

Due to the small plot sizes, variable vegetation, and variety of surrounding habitats of central Iowa grasslands, generalizations about small mammal populations are difficult to make. Grainivores appear to be sufficient generalists to exploit most types of habitat. Herbivores and insectivores seem to be more dependent on vegetation structure, at least in these small, patchy habitats. The restoration of large prairie habitats, such as being undertaken at Walnut Creek, may change these parameters. On a larger scale, the importance of plant diversity, especially forbs, may increase as habitat size increases and edge effects decrease.

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Table 1. Mean vegetation characteristics of prairie, old field, and monoculture grass plantings with standard error shown in parentheses.

	Prairie	Old field	Planting
Percent Cover			
Brome	3.0 (6.6)	28.2 (24.5)	0.0
Tallgrass	30.9 (14.9)	9.8 (20.2)	55.9 (19.2)
Forbs	26.3 (14.6)	23.5 (11.7)	2.3 (2.4)
Total	62.2 (14.4)	69.1 (12.5)	58.2 (18.6)
Litter (cm)	3.5 (2.3)	3.6 (2.0)	2.8 (3.9)
Vegetation Height (m)	0.6 (0.23)	0.6 (0.17)	0.9 (0.35)

Table 2. Summary of captures by species for each habitat type.

Species	Prairie	Plantings	Old field	Total
Reithrodontomys megalotis	52	64	77	193
Peromyscus maniculatus	14	39	12	65
Peromyscus leucopus	32	42	31	105
Microtus pennsylvanicus	12	12	17	41
Microtus ochrogaster	3	6	7	16
Mus musculus	0	12	0	12
Blarina brevicada	22	7	16	45
Sorex cinereus	16	1	3	20
Zapus hudsonius	1	2	1	4
TOTAL	152	185	164	501

Table 3. Mean species richness and diversity for each habitat type with the standard error shown in parentheses.

	Species Richness	Diversity	
		Simpson	Shannon-Weaver
Prairie	4.00 (1.13)	0.656 (0.101)	1.105 (0.238)
Old field	4.44 (1.33)	0.674 (0.173)	1.185 (0.366)
Monoculture	3.50 (1.27)	0.518 (0.270)	0.905 (0.479)

Table 4. Weights of vegetation component loadings and eigenvalues from Principal Component Analysis of individual trap stations.

	PC1	PC2	PC3	PC4
Variable				
Forbs	0.362	-0.707	-3.101	0.522
Cover	0.680	-0.138	-9.318	-0.714
Height	0.552	0.262	6.924	0.384
Litter	0.320	0.642	-6.448	0.264
% Variance	37.67	28.92	19.93	13.48
Eigenvalues	1.507	1.157	0.797	0.539

Table 5. Results of stepwise regression using number of captures (dependent variable) and PCA of vegetation characteristics (independent variable) for individual trap stations.

	R-SQ	Ind. Var.	Coefficient	Sig. Level
Herbivore	0.04008	Constant	0.182	0.0000
		PC1	0.059	0.0023
		PC2	0.042	0.0533
Insectivore	0.10439	Constant	0.201	0.0000
		PC1	0.156	0.0000
		PC2	-0.079	0.0140

Table 6. Weights of vegetation components loadings from Principal Component Analysis of trap lines.

	PC1	PC2	PC3	PC4
Variable				
Forbs	0.136	-0.803	0.157	0.559
Cover	0.623	-0.382	-0.289	-0.619
Height	0.583	0.396	-0.447	0.551
Litter	0.503	0.231	0.832	-0.024
% Variance	39.46	32.74	19.13	8.67
Eigenvalues	1.578	1.310	0.765	0.347

Table 7. Results of stepwise regression using number of captures (dependent variable) and PCA of vegetation characteristics (independent variable) for trap lines.

	R-SQ	Ind. Var.	Coefficient	Sig. Level
Herbivore	0.26864	Constant	2.000	0.0000
		PC1	0.787	0.0040
Insectivore	0.42897	Constant	2.241	0.0006
		PC1	1.277	0.0103
		PC2	-1.749	0.0019