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SMALL MAMMALS OF A RELICT WET PRAIRIE IN OHIO

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Abstract. Killdeer Plains is a Wildlife Area in northwest Ohio managed primarily for waterfowl. At the turn of the century, the area was a wet prairie remnant of the prairie peninsula. Despite attempts at drainage and farming, parts of the area retain the characteristics of a wet prairie. Two spruce-pine (*Picea - Pinus*) clumps in the plains are used as winter roosts by long-eared owls (*Asio otus*). Pellets regurgitated by these owls were examined to determine the species and relative numbers of small mammals in the area. Nearly 90% of all individuals taken by the owls were meadow voles (*Microtus pennsylvanicus*). The rest were prairie deer mice (*Peromyscus maniculatus bairdi*), white-footed mice (*Peromyscus leucopus*), northern short-tailed shrews (*Blarina brevicauda*), masked shrews (*Sorex cinereus*), southern bog lemmings (*Synaptomys cooperi*), prairie voles (*Microtus ochrogaster*), and house mice (*Mus musculus*). This small mammal community may be quite similar to the one that occupied the area in its natural state.

Key Words. prairie peninsula, relict prairie, owl pellets, mammals, wildlife reserves, Ohio

INTRODUCTION

The prairie peninsula (Transeau 1935, Purdue and Stiles 1987) was an extension of tallgrass prairie that reached east into Michigan, western Pennsylvania, Kentucky, Indiana, and Ohio during the hypsithermal (xerothermal, altithermal) period following the retreat of the Wisconsin glacier. This relatively dry, warm period was followed by climatic change leading to the relatively mesic conditions which persist in the area today. With the increase in available moisture, forests replaced most of the prairie in the prairie peninsula (Semken 1984). Relicts of prairie remained in especially dry areas and under very moist conditions where the soil was water-logged much of the year. Most of these relicts have been destroyed by human activity, but some occurred on such rugged terrain or were so difficult to drain that they were left in their natural state. Others were farmed for a time, but eventually abandoned. Killdeer Plains Wildlife Area in southern Wyandot County, Ohio, is one of the latter.

A wet prairie at the turn of the century, the area within which the Killdeer Plains Wildlife Area is presently located was drained and farmed in the first half of the twentieth century. Farming was never very successful, apparently because of wet, difficult to work soils. In 1952, the Ohio Department of Natural Resources purchased a portion of the area and began managing it as a wildlife area. Emphasis has been on management for waterfowl, but some restoration of prairie plants and plant communities has also been conducted (Cusick and Troutman 1978). The effect of such management on nontarget community components (species and groups of species which were not a part of the management plant) is of interest in light of the current concern for the maintenance of biological diversity (Miller and Ford 1988). The presence of long-eared owls (*Asio otus* L.), which use two pine-spruce (*Picea - Pinus*) groves in the wildlife area for a communal winter roost, provided a means to determine how effective the restoration of Killdeer has been in preserving, or restoring, the small mammal community of the original wet prairie.

METHODS

Killdeer Plains Wildlife Area

The wildlife area currently consists of about 3,500 ha (of an original 12,000 ha) containing a number of constructed ponds and

marshes as well as several small woodlots all surrounded by fields. The woods contained cottonwood (*Populus deltoides* Bartr.), American elm (*Ulmus americana* L.), slippery elm (*Ulmus rubra* Muhl.), white ash (*Fraxinus americana* L.), silver maple (*Acer saccharinum* L.), sugar maple (*Acer saccharum* Marsh.), shagbark hickory (*Carya ovata* K. Koch), bur oak (*Quercus macrocarpa* Michx.), pin oak (*Quercus palustris* Muench.), red oak (*Quercus rubra* L.), white oak (*Quercus alba* L.), and other trees common in northwest Ohio woodlots. The ponds are bordered by cattails (*Typha latifolia* L.), bulrushes (*Scirpus* spp. L.), and other plants typical of northwest Ohio pond edges. Shrubs such as roses (*Rosa multiflora* Thunb. and *Rosa carolina* L.), willows (*Salix* spp. L.), red-osier dogwood (*Cornus stolonifera* Michx.), and red-panicle dogwood (*Cornus racemosa* Lam.) occur at woods and pond edges and in the fields. The fields are primarily covered with herbaceous plants. Some are planted to corn (*Zea mays* L.) as food for the waterfowl. Others are planted to bluegrass (*Poa* spp. L.) and other forage grasses, but many contain prairie species.

Some areas have extensive cover of prairie grasses such as big bluestem (*Andropogon gerardii* Vitman), little bluestem (*Andropogon scoparius* Michx.), indiagrass [*Sorghastrum nutans* (L.) Nash], slough grass or prairie cord grass (*Spartina pectinata* Link), and forbs such as prairie dock (*Silphium terebinthinaceum* Jacq.), dense blazing-star (*Liatris spicata* Willd.), gray-headed coneflower (*Ratibida pinnata* Barnh.), Sullivan's milkweed (*Asclepias sullivantii* Engel.), stiff goldenrod (*Solidago rigida* L.), and others. A distinct prairie component occurs throughout the area (Cusick and Troutman 1978).

The entire prairie area is thought to be an ancient lake bed. It is level throughout which slows runoff. The clay soils retard drainage. As a result, in many years much of the original prairie remained under water or was water-logged throughout the spring and dried only in late summer. Prairie cord grass stands were extensive in the wetter areas. Big bluestem, indiagrass, and other prairie plants grew in the areas with better drainage. Trees occurred primarily as individuals rather than in woodlots as they do today, though the area was surrounded by forests (Dobbins 1937). Shrubs grew in other wet prairies in Ohio, and Killdeer may have had clusters of shrubs as well (Sears 1926, Gordon 1969).

Two planted groves of white pine (*Pinus strobus* L.) and Norway spruce (*Picea abies* Karst.) house the roosting owls in winter. Long-eared owls roosted in both groves in all three winters of the study. They were the most important pellet producers. Short-eared owls (*Asio flammeus* Pontoppidan), saw-whet owls (*Aegolius acadicus* Gmelin) and great-horned owls (*Bubo virginianus* Gmelin) were also seen in the area, but the birds flushed from and seen in the groves were invariably long-eared owls.

Procedures

The use of owl pellets (indigestible, regurgitated remains of owl prey) allowed the collection of information with minimal impact on the community. In many studies, owls have been shown to take the same species taken by traps (Getz 1961b, Kotler 1985, Longland and Jenkins 1987). However, the relative numbers of individuals taken by the owls reflects the habitats in which the owls hunt most intensively (Getz 1961b), the ease of capture of the prey (Kotler 1985), and other variables (Longland and Jenkins 1987). Therefore, interpretation of relative population sizes must be done with caution.

Collection and analysis of pellets.

Pellets were collected in early January and early March of 1986 through 1988. A collection was also made in May, 1988. The pellets were spread in cardboard boxes to dry and then stored in cabinets until they could be examined. Each pellet was dissected. The hair was discarded, and the bones were stored in plastic vials identified to site, date of collection, and pellet number. Skull and jaw bones were identified to species primarily on the basis of tooth characteristics (Gottschang 1981, Hall 1981, Zakrzewski 1985). Not all pellets of the 1988 collections could be dissected and analyzed in the time available. Sixty pellets from each site were dissected for the January collection, and ten from each site for the March and May collections. These samples indicated that the pattern of 1986 and 1987 was continued in 1988.

Most skulls and jaws were easily identified to species, but two problems occurred. The differences between the skulls of the prairie deer mouse (*Peromyscus maniculatus bairdi* Wagner) and the white-footed mouse (*Peromyscus leucopus* Rafinesque) are subtle. The shape of the anterior palatine foramina and the least interorbital distance (Gottschang 1981) were used to differentiate the two. If only lower jaws were present, or if the two criteria suggested different species, the specimen was assigned to *Peromyscus* without designating the species.

The other problem involved only one species and one specimen in the collection. Prairie voles (*Microtus ochrogaster* Wagner) and pine voles or woodland voles (*Microtus pinetorum* LeConte) are difficult to distinguish using only skull characteristics (Kurten and Anderson 1980, Zakrzewski 1985). Comparisons with known prairie and pine vole skulls, the habitat, and the Ohio distribution of the two species (Gottschang 1981) all indicated that the specimen was a prairie vole, and it was recorded as such.

For each species, site and date of collection, the number of skulls, the number of right jaws, and the number of left jaws were counted. The largest of these numbers was used as the minimum number of individuals of that species in the pellet collection. Absolute numbers were not comparable, so a percentage of individuals captured was calculated for each species at each site for the January and March 1986 and 1987 collections and the January 1988 collection. To test for differences between sites, season, and years, the confidence limits of the percentages were obtained from a table

(Sokal and Rohlf 1987). These confidence limits were compared (site to site, season to season, and year to year). No differences approaching significance were found in any comparison. Therefore, all the data from all sites and collection times were combined for analysis.

Determination of community composition before drainage.

The characteristic habitats and recent distributions of the species of small mammals taken by the owls were used to determine whether each species was a probable member of the wet prairie community at the turn of the century. The characteristic habitats and recent distributions of small mammal species not taken by the owls were also studied to determine whether any other small mammals were probable members of that community. Brayton (1882), Baker (1968), Hooper (1968), Long (1974), Diersing (1980), Kurten and Anderson (1980), Gottschang (1981), Hall (1981), Jones *et al.* (1983), Zakrzewski (1985), Kirkland *et al.* (1987), and Jones and Birney (1988) were used to determine habitat and recent distribution for all species. Any species which is commonly found in grasslands and fields was considered to have the appropriate habitat affinity to be a potential nineteenth century community member. Evidence that the species occurred in or around northwest Ohio at or before the turn of the century was the biogeographic requirement for potential membership. Moles, strictly diurnal mammals, and those that hibernate or migrate would not normally be taken by the owls in winter and were eliminated from the comparison.

RESULTS

All species taken, except the house mouse (*Mus musculus* L.), have appropriate habitat requirements and biogeographic histories to be expected to have been present in the wet prairie at the end of the nineteenth century (Table 1). Using the same criteria for habitat affinities and recent distribution, only one small mammal species, the least shrew (*Cryptotis parva* Say), was not found in pellets, although it was determined to be a potential member of the native community at Killdeer. In addition, the proportions in which the seven new world species were found in the owl pellets was consistent with a probable organization of the community.

Table 1. Data collected from the owl pellets, 738 individuals were collected from 651 pellets.

Species ¹	Number ²	Percent ³	Origin ⁴	Habitat ⁵	Length ⁶
					----- mm -----
Meadow vole	663	89.8	Boreal	Grass	111
Prairie vole	1	0.1	Prairie	Grass	110
Southern bog lemming	3	0.4	Eastern	Grass	99
White-footed mouse	6	0.8	Eastern	Brush	90
Prairie deer mouse	25	3.4	Prairie	Fields	83
<i>Peromyscus</i> spp.	22	3.0			
House mouse	2	0.3	Europe	Buildings	82
Short-tailed shrew	14	1.9	Eastern	Varied	90
Masked shrew	2	0.3	Boreal	Varied	55

¹*Microtus pennsylvanicus*, *Microtus ochrogaster*, *Synaptomys cooperi*, *Peromyscus leucopus*, *Peromyscus maniculatus bairdi*, *Peromyscus* species not determined, *Mus musculus*, *Blarina brevicauda*, and *Sorex cinereus*, respectively.

²The total number of individuals of the species in the pellet collection.

³The percentage of the total number of individuals in the collection, which are members of the species.

⁴Geographic center of the species current distribution, from Jones and Birney (1988). These authors do not break deer mice down to subspecies. Hooper (1968) and Gottschang (1981) were used for this subspecies. Boreal = boreal forest, eastern = eastern deciduous forest.

⁵Literature sources used for habitat information are listed in the text.

⁶Head and body length is given instead of total length to eliminate the misleading effect of variable tail length. Measurements are averages of 25 to 50 Ohio adults (Gottschang 1981).

DISCUSSION

The results suggest that the modern small mammal community at Killdeer is quite similar to that expected in the wet prairie community of the late nineteenth and early twentieth century. Several aspects of this interpretation need to be explored further.

Owls as Sampling Devices

Optimal foraging theory (Colinvaux 1986) would suggest that the owls should maximize their nutritional intake per energetic cost. This may best be done if the owls take the largest and/or most easily captured prey. In addition, several studies have reported that long-eared and other owls are selective predators (Kotler 1985, Longland and Jenkins 1987). Therefore, both theoretical consideration and experimental evidence suggest that the owls do not collect random samples of their prey. The meadow vole (*Microtus pennsylvanicus* Ord) is often the most common small mammal in grassy areas in the eastern United States. It is also the largest of the animals taken by the owls (Table 1). In the situation at Killdeer then, use of the owls for sampling should overestimate the meadow vole population, and underestimate populations of other community members.

On the other hand, the owls must act as opportunists from time to time and, as such, may well take every species in the community. In most studies involving both trapping and owl pellet analysis, the owls take the same species as do the traps, though relative numbers usually differ between the two sampling techniques (Getz 1961b, Kotler 1985, Longland and Jenkins 1987). Therefore, an extensive collection of pellets should contain some members of all the small mammal species in the owls' foraging area.

The data suggest that the meadow vole was the most abundant small mammal in the area, though it is probably not as abundant with respect to the other species as suggested by that data. The data may be more accurate with respect to the relative abundance of the other species, assuming that they were taken more or less randomly as the owls searched for meadow voles. The species of rodents and shrews taken may represent all the species present that are active at night and in the winter, although the sample analyzed is not extensive enough to assure that no important component of the small mammal community has been missed.

Biogeography

With the exception of the house mouse, the Killdeer Plains small mammal community was derived from eastern deciduous forest, boreal forest, and prairie (Table 1). However, all species present in the owl pellets are, and have been for hundreds of years, established in appropriate habitats in the main body of the prairie (Hooper 1968, Kurten and Anderson 1980, Hall 1981, Zakrzewski 1985). Biogeographically, this is one type of community that should be in a remnant of the prairie peninsula. All biomes that have occupied the area contributed species to the community, but these species were well adapted for life in prairie habitats.

There are alternative theoretical possibilities for the membership of the community. One is that a larger number of species originated on the prairie. However, many of the small mammals which originated on the plains and prairies failed to move far into the prairie peninsula and were, thus, unavailable to occupy the wet prairie. Harvest mice (*Reithrodontomys* spp. Giglioli), pocket mice (*Perognathus* spp. Weid-Neuwied), and kangaroo rats (*Dipodomys* spp. Gray) are examples (Kurten and Anderson 1980, Semken 1984).

Another hypothetical community contains a larger number of northern species. Several of these passed through the area as the glacier retreated, and so had biogeographic access to the area. Most of them, however, required boreal habitats and continued north with these habitats. None of the northern species absent from Killdeer today has habitat requirements that suggest that it could have been part of the prairie peninsula or the nineteenth century wet prairie community.

Habitats and Community Organization

The habitats commonly occupied by the various species taken by the owls are also consistent with their ability to have lived in the original prairie. In addition, the relative numbers of individuals of each species is consistent with a probable community organization.

All three species of microtine rodent, the southern bog lemming (*Synaptomys cooperi* Baird) and the voles, in the pellet collection are found most commonly in grassy areas. Each can live in various types of grassland. But, where two occur together, each becomes associated with a particular aspect of the habitat. In association with the meadow vole, the bog lemming usually occupies the wetter habitat (Getz 1961a, Gottschang 1981). In contrast, when the meadow vole and prairie vole occur together, the prairie vole occupies the dryer and more sparsely vegetated grasslands (Getz 1985, Klatt and Getz 1987).

Currently at Killdeer, the meadow vole habitat is apparently abundant while that which the other two can occupy in the presence of the meadow vole is much more restricted. This may have been the case in the original prairie as well. The habitat requirements of the prairie vole suggest that it would be uncommon in a wet prairie, especially in the presence of the meadow vole. The bog lemming is seldom common and widespread in any community (Gottschang 1981). Especially in the presence of meadow voles, it would also be expected to be uncommon. The microtines in Killdeer today have a relationship similar to that expected in the natural community.

The overwhelming numerical dominance of the meadow vole may also have been a characteristic of the nineteenth century wet prairie. Microtines often dominate the grassland communities in which they occur, even to the extent shown in the owl pellets (Rose and Birney 1985). Meadow voles are commonly the dominant species in moist areas of heavy grass cover.

The house mouse was probably not a permanent member of the community at the turn of the century. The human habitation with which it is usually associated (Gottschang 1981) was not as abundant around the area as it is today. That is sufficient reason to assume the absence of the house mouse, except in years of spread from exceptionally dense commensal populations. The increase of the human population in the Killdeer area assures its presence today. However, it is probably restricted to the vicinity of buildings in most years and so may not be a central part of the modern community either.

The white-footed mouse lives in woods, at woods edges and in shrub covered areas (Baker 1968). It may have been a peripheral member of the community at the turn of the century, since the prairie was surrounded by forest but contained only scattered trees (Dobbins 1937). However, many Ohio wet prairies contained considerable shrub cover (Sears 1926, Gordon 1969) and the white-footed mouse is often found among scattered trees and shrubs. Therefore, it is also possible that this species was an integral part of the community.

The deer mouse lives in many habitats, but the prairie deer mouse (the subspecies at Killdeer) is a grassland and open field form (Baker 1968, Gottschang 1981). The various fields and grasslands in the original wet prairie almost certainly supported more deer mice than white-footed mice. The relative numbers of these mice taken by the owls suggests that this numerical relationship has also been preserved.

The northern short-tailed shrew (*Blarina brevicauda* Say) and the masked shrew (*Sorex cinereus* Kerr) have imprecise habitat requirements. They are found in woods, fields, and grasslands but are often associated with moist situations (Gottschang 1981, Jones and Birney 1988). In contrast, the least shrew apparently occurs more often in relatively dry fields (Gottschang 1981, Jones and Birney 1988). Jones and Birney (1988) also said that the least shrew is seldom taken with any species of *Sorex*. These obser-

vations suggest that habitat affinities or some form of interspecific interaction may be responsible for the absence of the least shrew from the modern community. In any case, the habitat tendencies of the three shrews is consistent with the conclusion that the wet prairie community contained the same two shrews that occur in the modern community at Killdeer.

The relative number of shrews taken by the owls may simply be another example of optimal foraging and not a reflection of relative numbers in the community. The larger, presumably containing more total nutrition, shrew was taken more often than the smaller.

Overall, these considerations suggest that the modern small mammal community at Killdeer is similar to the wet prairie community on the site at the turn of the century. Management for waterfowl has either restored or preserved a small mammal community similar to the one that occupied the site before disturbance. Thus, restoration of the area for one purpose was effective in conserving a nontarget component of the ecosystem.

The extent to which the above conclusion is relevant to other reserves and other community components, is not clear. Small reserves, or management areas such as Killdeer, are only effective for conservation of small species, and small mammals are probably among the easiest species to protect. However, the suggestion that entire, nontarget subcommunities may be conserved in the many wildlife areas and reserves in the nation is encouraging.

Finally, the importance of any community component to other, more important or more charismatic, community members must not be underestimated. Certainly, the importance of the small mammals to the owls wintering at Killdeer cannot be overestimated. In addition, the members of the small mammal community play roles in seed dispersal, spore dispersal for mycorrhizal fungi (Maser *et al.* 1978), predation on insects, predation on seeds, and grazing (Rose and Birney 1985). As a result of these activities, the intact small mammal community may be of great importance to the maintenance of the structure of the remnant prairie community itself, and, thus, to the maintenance of local and global biological diversity.

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