Community Assessment of Small Mammals in the Shaker Trace Wetlands: A Final Report

The present fragmentation of native habitat due to urbanization and agricultural practices has insularized much of what was once continuous habitat. This is apparent in the midwestern United States where once large expanses of prairie existed. The result is habitat that is heterogeneous in both spatial arrangement and vegetational diversity. This spatial and vegetational heterogeneity can have either positive or negative effects on the population and community dynamics of both plant and animal species that were once contained in a more continuous habitat (Karieva 1990, Levin 1992).

A vital component to the prairie community are small mammals. Small mammals are primarily thought of as prey species for many of the local predators (e.g. raptors, snakes, weasels, etc.). However, few people realize the contribution small mammals make in terms of nutrient cycling, seed dispersal, the culling of plants, and soil aeration. Fortunately, the relative ease of capturing and handling small mammals, in addition to the wealth of literature on small-mammal population dynamics, enables researchers to design experiments that can easily address the importance of small mammals in relation to the previously mentioned parameters.

Small mammals are a key element to the restorative efforts in any habitat. Recently, many private and public organizations have realized the consequences of the depletion and fragmentation of habitat and have mobilized an effort to restore tracts of land to their native habitat. This interest in restoration provides a natural partnership between ecologists and landmanagers. This partnership can then be used to develop ideas on how to implement management regimes within a restorative framework.

One such restorative effort is taking place at the Shaker Trace Wetlands which resides in the Miami Whitewater Forest; a part of the Hamilton County Park District. More than 120 acres of land that was in former agricultural use is presently being restored to a wetland habitat. This restoration is being accomplished in four phases; each phase encompassing a different region of the park. The final goal being that all phases will be contiguous.

The purpose of this research was to obtain population estimates of small mammals by live trapping existing habitats in the Shaker Trace Wetland community. Other parameters, such as growth rates, persistence, reproductive status, density, population growth, and age structure were examined and used in generating management recommendations on how the wetland ecosystem can sustain minimum viable populations of small mammals.

Field Work

Materials and Methods

Study Area

The Miami Whitewater Forest is located just west of the greater Cincinnati area. Contained within the forest, the Shaker Trace Wetlands exists having several different habitats surrounding it. A small-mammal census of five major habitat types found within the four phases of the restoration project was performed. These five habitats include: phase I, a Burr oak-Savannah (OS) located northwest of the bat shelter and a sedge-meadow (SM) habitat encountered just east of Howard Creek; phase II, the broomsedge (BS) located west of the Shaker Trace Trail and just north of Baughman road; phase III, the field of several annual wildflowers (AW) east of the largest body of water and south of the maintenance road; and finally phase IV, the broomsedge and grassland meadow (BG) located west of the Shaker Trace Trail and south of Baughman road.

Some areas in phases I, III, and IV were burned during the Spring of '95. The only habitat that was affected by burning was BG. Trapping commenced on all areas after the burn.

Small Mammals Censused

There is a diversity of small mammals inhabiting prairie fragments in southern Ohio (Gerald Svendsen, Ohio University, personal communication). Those species known to occur in relatively high densities are the deer mouse (Peromyscus maniculatus), meadow vole (Microtus pennsylvanicus), meadow jumping mouse (Zapus hudsonius), and eastern harvest mouse (Reithrodontomys humulus). Other species of small mammals also inhabit prairies in southern Ohio, however, it is unknown if they would occur in large enough densities that would preclude statistical analysis. Those other small mammals are the Virginia opossum (Didelphis virginiana), short-tailed shrew (Blarina brevicauda), masked shrew (Sorex cinerus), least shrew (Cryptotis parva), gray squirrel (Sciurus carolinensis), fox squirrel (Sciurus niger), southern bog lemming (Synaptomys cooperi), eastern chipmunk (Tamias striatus) and the least weasel (Mustela nivalis).

Small Mammal Live-trapping Grids

Grids were arranged to correctly sample small mammals that have large home ranges (e.g. Reithrodontomys) or small home ranges (e.g. Microtus) or home ranges intermediate in size (e.g. Peromyscus) (Norman Slade, University of Kansas, personal communication). Five live-trapping grids were arranged in each of the five habitats (see above). Each grid was grouped in a 8 X 8 block design containing 64 trap stations. Each trap station consisted of a Sherman live-trap (H. B. Sherman Traps, Inc., Tallahassee, FL) spaced 10 m apart. Each grid had a 10 m buffer on each side of the periphery. Therefore, each grid covered an area equivalent to a hectare.

Trapping Procedure

Bi-monthly trapping sessions took place over three successive days. Traps were set in the afternoons and checked in two successive mornings. Upon initial capture, animals were uniquely identified by or given an ear tag (National Band and Tag, Newport, KY), and sex, reproductive condition (females - vagina perforate or non-perforate, nipples visible, pubic symphysis open or closed; males - testes descended or contained in abdominal cavity), weight and trap-station location were recorded. In subsequent captures, only identification and location were noted. Traps were baited with a millet mix and remained locked open between trapping sessions to encourage animal use between trapping sessions.

Parameters Examined

The trapping procedure allowed for a comparison of several ecological parameters of animals located in the different habitats. These parameters are:

1) Growth rates - The amount of mass gained by individuals over time.
2) Persistence - Percentage of individuals trapped more than one time in a specific area
3) Reproductive status - Receptivity or propensity of an animal to mate. Females are reproductive if their vagina is perforate and/or their teats are large. Males are reproductive if their testes are descended into their scrotum.
4) Density - Minimum number of animals known to be alive within a specified area.
5) Population growth - The number of individuals present in a specified area over time.
6) Age structure - The maturation level of animals caught (determined by weight) in a specified area at a specified time.

Data Analysis

Means of densities and population growth were calculated using CAPTURE. CAPTURE is software especially designed to analyze mark and recapture data on small mammals.

The means of all parameters were analyzed for statistical significance using an analysis of variance (ANOVA) for species having large enough numbers. The independent variable were the parameter in question; the dependent variables were the specific habitats.

All statistically significant results were significant at a 95% confidence level. In the interest of brevity, F values and degrees of freedom were omitted from the text.

Results

General Results

The last trapping period was 8 November to 10 November. Since the conclusion of the last trapping period a total of 8960 trapping days (total # of traps * days trapped * trapping periods) occurred. During those trapping days, there have been a total of 1753 total captures (19.6 % capture rate) and 212 individual animals were caught. The mean number of captures per individual is 2.78, with 14 captures for one individual being the highest and several animals being captured only once.

Small Mammal Diversity

A total of seven species were trapped. The species and the percentage that species contributed to the 212 individuals captured is presented below (Table 1).

Table 1. Percentage of species contribution to total numbers caught.

Species	*Number Caught*	*% of Total Caught*
Deer Mice (*Peromyscus maniculatus*)	83	39.1
Meadow Vole (*Microtus pennsylvanicus*)	52	24.5
Short-tailed Shrew (*Blarina brevicauda*)	39	18.4
Eastern Harvest Mouse (*Reithrodontomys humulus*)	20	9.4
Meadow Jumping Mouse (*Zapus hudsonius*)	12	5.7
Southern Bog Lemming (*Synaptomys cooperi*)	5	2.4
Eastern Chipmunk (*Tamias striatus*)	1	.50
Total	212	100

Diversity on a grid-by-grid basis is presented below (Table 2). Deer mice were the only species trapped on all grids. Meadow voles and shrews were trapped on every grid except AW. Harvest mice were only trapped in AW, jumping mice were only trapped in BS, lemmings were only trapped in SM, and chipmunks were only trapped in OS. AW was the least diverse grid having only two species trapped within it.

Table 2. Diversity of mammals in different grids located in Shaker Trace Wetland area. The number in parentheses denotes the number of that species trapped within a grid. DM (deer mice), MV (meadow vole), SS (short-tailed shrew), HM (eastern harvest mouse), MM (meadow jumping mouse), SL (southern bog lemming), EC (eastern chipmunk). Grids were listed in order of greatest to least abundant for all species combined in each grid.

Grid	*Species*
OS	DM (31), MV (19), SS (14), EC (1)
SM	DM (26), MV (12), SS (10), SB (5)
BS	DM (17), MV (12), MM (12), SS (9)
AW	HM (20), DM (8)
BG	MV (9), SS (6), DM (1)

Growth Rates

Growth rates of species, among grids, were not significantly different from each other. It should be noted that individuals needed to be caught at least two times to obtain growth rates. The lack of multiple captures on certain grids may have precluded a valid statistical analysis.

Persistence

All species were grouped together in each grid for analysis. The percentage of individual animals persisting more than one trapping period, are presented below (Table 3). There was no statistical difference among the OS, SM, and BS grids, but those grids all had persistence rates statistically greater than both AW and BG grids. Finally, there was no statistical difference between AW and BG although AW had a higher persistence rate.

Grid	*Percentage Persisting*
OS	35.38
SM	35.84
BS	44.01
AW	27.80
BG	16.1

Reproductive status

The percentage of adults which were reproductive for all species in each grid was assessed. There was no statistical difference among grids in the percentage of adults that were reproductive (Table 3).

Table 3. Percentage of adults that were reproductive for all species in each grid.

Grid	*Percent Reproductive*
OS	85.1
SM	82.6
BS	90.2
AW	83.4
BG	83.2

Density

All species were grouped together in each grid for analysis. Densities are presented as the minimum number known alive (mnka) in each grid for a particular week (Table 4). The same statistical trend for persistence is observed with density. Grids OS, SM, and BS are not statistically different from ach other but all have statistically higher density values than AW and BG. AW and BG are not statistically distinct but in general, AW had higher densities than BG.

Table 4. Minimum number known alive (mnka) in each grid for a particular week. All values were rounded to the nearest whole number.

Grid	week 1	week 2	week 3	week 4	week 5	week 6	week 7	week 8	week 9	week 10
OS	5	7	9	10	10	12	11	10	7	6
SM	5	6	8	11	9	10	9	8	7	3
BS	4	5	8	8	10	11	7	6	7	3
AW	3	5	7	4	5	5	4	3	4	2
BG	3	3	4	4	4	5	3	2	4	1

Population growth

The low number of animals in a given week over the trapping period precluded any statistical analysis but trends in population growth can be viewed in table 4. All populations appeared to increase and decrease simultaneously which would indicate similar population pressures were present in all habitats.

Age structure

The percentage of adults in each grid over the whole trapping period was assessed for all species combined (Table 5). Grids OS, SM, and BS had statistically higher percentage values than both AW and BG but were not statistically different among each other. Grid AW was statistically higher than BG.

Table 5. Percentage of adults in each grid for all species combined.

Grid	*Percent Adult*
OS	65.01
SM	61.33
BS	64.35
AW	52.90
BG	35.54

Discussion

Although a longer sampling period would be preferred, the results of this study are sufficient to discuss relevant trends from the data. The following is a general discussion of the statistically relevant parameters. I conclude with management recommendations based on the gathered data.

Diversity

There are eight trappable small mammals species in the Shaker Trace Wetland area. A total of seven of these eight species was caught in this study. The only exception was the least shrew (Cryptotis parva). There is no explanation for the exclusion of the least shrew except for this species may be in direct competition with the short-tailed shrew and studies show short-tailed shrews will eat least shrews when populations overlap.

Three of the five habitats had at least four species of mammals residing in them (Table 2). Deer mice were ubiquitous in all habitats. Meadow voles and shrews were present in all but one habitat; the AW grid. The AW grid was bordered on three sides by cattails and the remaining side was a mowed strip of grass. Mowing can prevent movement of mice into or out of areas because of the perceived danger to predators (Diffendorfer, et al., 1995). Anecdotally, the AW grid has a high amount of exposed ground in between vegetation. The exposed ground could explain the absence of voles and shrews since they are ground foragers and rely on thick surface vegetation to protect them during periods of foraging (Whitaker, 1980).

The remaining four species were found in habitats specific to their natural histories. A single chipmunk was trapped twice in the OS habitat. This habitat bordered a wooded area from which the chipmunk undoubtedly came from. Lemmings were found in the SM habitat. Several lemming burrows were observed in the habitat surrounding the sedge. This type of habitat is becoming very scarce in the much of the eastern United States. The inability to consistently trap lemmings plus their relial on this specific habitat makes preservation of this area a priority. Harvest mice were only found in the AW habitat. The AW habitat contained many more seed-bearing plants than the other habitats. Since harvest mice are granivorous, it is not surprising they were relatively abundant in this habitat. Finally, the jumping mouse was found only in the BS grid. This habitat was thick and unlike the other habitats, contained many briars, thus making it suitable for jumping mice.

The lack of diversity on both the AW and BG grids is most likely due to the absence adequate vegetational cover. The AW grid was mentioned previously to be devoid of adequate ground cover for some of the small mammals. The BG grid had more ground cover but the short height of the vegetation most likely influenced the presence or absence of other small mammals. The BG grid was intentionally burned in the spring before trapping commenced and although vegetation grew back, there apparently was not enough vegetational cover to provide adequate habitat for some mammals.

Persistence

Persistence can be used to categorize how energy rich a habitat is. If a habitat is rich in energy (food) than it is more likely to house organisms longer than less energy rich habitats. It is not surprising then that persistence of individuals was greater on the OS, SM, and BS grids compared to the AW and BG grids. It is visually apparent that OS, SM, and BS grids were much richer (in terms of biomass) habitats than either AW and BG, hence the higher persistence rates.

Reproductive Status

Although some habitats housed more small-mammal species, habitat did not appear to significantly influence the reproductive status of adults. The lack of suitable habitat can shut down reproduction in some species of mice (Diffendorfer, et al., 1995) therefore stopping population growth.

Density

The density of small mammals in specific habitats can indicate how "healthy" a habitat is, as well as attest to how stable it is. The densities observed in the OS, SM, and BS habitats are considered "normal" for an area that size, thus indicating these habitats are healthy and stable. However, the lower densities detected in the AW and BG habitats indicate these habitats are more unstable and transitional. Again, the vegetational differences discussed in previous sections may contribute to this instability.

Age Structure

Age structure can also be used to gauge the health of a habitat. Recent studies demonstrate that populations with a relatively high percentage of adult individuals persist longer in absolute time (Newmark, 1995). The OS, SM, BS, and to a lesser extent, AW grids had a relatively large number of

adults. This would indicate that, although different in vegetation structure, each habitat presents suitable habitat for different assemblages of small mammals.

Management Recommendations

Habitat fragmentation or population subdivisions, either anthropogenic or natural patchiness, affects all species to varying degrees and has become a major concern in conservation biology. Populations in isolated habitat fragments are vulnerable to extinction through demographic stochasticity and environmental stochasticity. Demographic stochasticity in finite populations causes populations in a set of small remnant patches (fragmented system) to be more prone to extinction than populations in a large remnant patch (unfragmented/continuous system) with the same total area.

Worldwide, wetlands provide a habitat for a rich diversity of small mammals. Where single expanses of prairie or old fields may be limited to two or three species of small mammals, wetlands, as seen by this research, house a greater diversity of small-mammal fauna in an equivalent area of land. The eventual plan for the Shaker Trace wetland ecosystem is to be a continuous system of wetland area that is to be completed in a series of phases. By making the wetland continuous, it seriously reduces the risk of extinction to several small mammal species.

The presence or absence of small mammals in specific habitats can most likely be attributed to two characteristics; vegetational cover and connectivity. As mentioned earlier, it is crucial for mammals such as shrews and meadow voles to have vegetational cover that will not only provide protection from visual predators, but also provide food for those small mammals. Therefore primary investigator recommends habitat surrounding the wetland have at least some native species of cool-season grasses that will provide ground cover for some of the small mammals. The AW habitat had very little, if any, species of grass mixed in the herbaceous vegetation, hence the low diversity of mammals. The small number of species located within the BG habitat is mostly likely due to the burning performed on that habitat in the spring. The vegetation grew back very slowly leaving little vegetation cover for small mammals. Although the densities were low in BG, it is the opinion of the primary investigator that populations of small mammals will rebound in this habitat due to the large expanse of mature habitat surrounding it.

Connectivity refers to how well habitats are adjoined to one another. In general, the greater the connectivity, the greater the chance for populations to maintain high diversity as well as sustain minimum viable populations. The AW habitat provides an example of how the lack of connectivity can influence the diversity. The AW habitat is bordered by cattails and water on the north, west, and south while a mowed area borders the east part of the habitat. Research demonstrates that roads, mowed areas, and paved areas can limit animal movement (Diffendorfer, et al., 1995). Besides the decrease in vegetation cover, the lack of any connection to any other habitat may also contribute to why diversity is so low in this habitat. Thus, another recommendation is that all habitats in the wetland area be connected in some way. Even small corridors of appropriate vegetation can sustain an interconnection between or among habitats (Levin 1992).

Conclusion

The Shaker Trace Wetland area, when finished, will undoubtedly be a wonderful ecosystem rich in both flora and fauna. Even though the small-mammal community does not have a real aesthetic role in this ecosystem, the importance of this community to the well being and health of this ecosystem is paramount.

The purpose of this study was to obtain data and make recommendations on what land managers should consider for the maintenance of the small-mammal community in the Shaker Trace Wetland area. It is of the opinion of the primary investigator that vegetation cover and connectivity are two characteristics that will contribute the most to the viability and diversity of the small-mammal populations present in the wetland area. Areas devoid of ground cover, should be considered for a seeding program that will insure appropriate vegetational cover. Also, all habitats should be connected by continuous habitat or habitat corridors that contain appropriate vegetation. If paved trails or roads prevent connectivity of habitats, land managers should consider letting vegetation grow up to the trails, instead of leaving a mowed edge. Letting vegetation grow up to the trail may promote migration of mammals across the trail.

Literature Cited

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