1995

Small Mammals of Quarry Park Stearns County, MN

David Winecoff
College of Saint Benedict/Saint John's University

Small Mammals of Quarry Park, Stearns Co., Minnesota

A THESIS
The Honors Program
College of St. Benedict/St. John's University

In Partial Fulfillment
of the Requirements for the Distinction "All College Honors"
and the Degree Bachelor of Arts
In the Department of Biology

by
David Winecoff
May 1995

PROJECT TITLE: A Small Mammal survey of Quarry Park, Stearns Co., Minnesota: A Field Guide.

Approved by:

Assistant Professor of Biology

Assistant Professor of Biology

Professor of Biology

Chair, Department of Biology

Director, Honors Thesis Program

Director, Honors Program

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Acknowledgments

I would like to thank the people that helped in putting this project together. Marcus Webster has been instrumental in keeping me on track, and in helping me over the various hurdles. Gordon Brown, Norm Ford, Steve Saupe, and Chuck Wocken have also contributed valuable information.

I would also like to thank my roommates for allowing me to keep dead critters in our freezer over the summer. And finally, St. John's University and the Honors Department for the opportunity and the challenge to do this research.

Preface

In the relations of man with the animals, with the flowers, with the objects of creation, there is a great ethic, scarcely perceived as yet, which will at length break forth into light.
-Victor Hugo

I began my research on a warm June afternoon; an arrogant wide-eyed honors student. I loaded up my bike with the sun at my back and headed out to the quarries. Being the budding environmentalist, I was anxious to explore the park, excited by the novelty of sleeping, working, and being in the wilderness. I wanted to take advantage of the park, not only for my research but also for a place to explore and relax.

I woke the next morning to a sky of green clouds, buckets of rain, and more lightning than I had ever seen. I raced to get out of the park and get back on the road where there was some sense of security. This benevolent wilderness I had been so eager to explore 12 hours earlier had become an unforgiving creature. The lock on the gate of the park gave me three shocks of lightning before allowing my return to civilization.

It was a humbling morning to say the least. This congenial Nature, which I'd been exploring as if it were an amusement park, had given me a thorough spanking. We got along well after that first day, once we had decided who was in charge.

I hope that this survey will enable its readers to connect with the park and perhaps learn some of the same lessons that I was able to. The main one being, we are very small in terms of our Mother Earth(or Quarry Park as the case may be), and yet we are inexorably a part of her. If our tinkering with nuclear energy, water or air pollution become too much of an intrusion, it is not so much Planet Earth that will be in danger. . .it is us. Nature will not hesitate to give humanity a thorough spanking until we realize who is in charge.

Introduction

The 100-Acre Quarries Park in Waite Park, MN. is actually a 200 acre section of land containing old granite quarries, woods, and open areas. In 1992, the land was sold by the Cold Spring Granite Co. to Stearns County for use as a public park. Granite for buildings, roads, and bridges was mined there during the first half of this century, from the 1920's up until the late 1950's. More recently it has been a site for clandestine rock climbing, mountain biking, cliff diving, and parties. The quarrying done in the past has resulted in the dominant features of the area: its water-filled quarries and rock tailing piles. The rest of the park is relatively flat, comprised of a variety of habitats. Aspen (*Populus sp.*), oak (*Quercus sp.*), and red pine (*Pinus sp.*)are the dominant woody plants (Ackerman 1994). There are two large old hay fields, cut seasonally until the 1950's, which have grown wild for several decades. There are also wetlands and natural rock outcroppings throughout the park (Fig.1). This area of Minnesota has historically consisted of oak/aspen brushlands. Stearns County is a transitional area

between the grasslands of southwest Minnesota and the coniferous forests of the northeast (C. Wocken pers. comm.). The areas of the park that have remained relatively undisturbed resemble the original vegetation of this part of the state. Other areas, such as the grasslands and aspen that was planted are obviously newer, more homogenous habitats.

The future plans for the park include a cultural interpretive center to tell the story of granite quarrying in Stearns County from the late 1800's to the present. This center will also serve as a educational base and trail head to the park. Trails around the perimeter of the park will be established for mountain biking and cross-country skiing, and areas for rock climbing, swimming, and family camping will be developed. The center region of the park will be maintained as an area of ecological restoration. It will include the central grassland and surrounding oak/aspen woodlands (Fig.1). It is expected that the park will attract a significant number of people once it is opened. Because of the park's proximity to St. Cloud, it is estimated that there are already more users of Quarry Park than most other Stearns County parks (C. Wocken, pers. comm.).

This area, with its wide variety of habitats and future plans for public involvement, has created an urgent need for ecological study. Uncovering

some of the diversity and fragility of this environment will help to educate the park officials and public on how to enjoy and protect this area for generations to come.

In this study, I wanted to examine the association between the different small mammal species and the habitats in which they lived. I hoped to determine if there were any unusual or fragile habitats, or areas that contained a high diversity of small mammals.

In order to get some idea of what species are dealt with in this study some background should prove useful. I have included a summary of the natural history of the different species present in the area, as well as a key, located in Appendix A & B to aid in the education and identification about the small mammals found in the park.

Materials & Methods

I conducted this survey between 19 June and 16 August 1994. I sampled small mammals at 22 separate locations in the park, which I selected to represent the variety of habitats in the area (See Appendix C&D). Sherman Live traps were used to conduct nocturnal trapping. In the morning, captured animals were marked either with permanent ink, or by cutting some hair off of their back. This way I could recognize recaptured individuals. I placed the traps at 10 m intervals. Trapping grids ranged in size from 5x5 to 6x7, using 25 to 42 traps. I baited the traps with a mixture of oatmeal and peanut butter.

I also sampled small mammal occurrence using scat boards, 6"x6" pieces of plywood placed on the ground. Small mammals tend to defecate on open areas, and these boards serve as a easy method to collect the genus-specific scat they leave behind. I placed these boards at 14 different sites in different habitat types, and checked them weekly. I placed 16 boards at 5 m intervals in a grid at each location (Fig.3).

Pit traps were used in three different habitat types: grassland, wetland, and a small oak stand surrounded by aspen. These consisted of a buried

coffee can with its top level with the ground. In the grassland and oak stand, the three traps were separated by approximately 7 m, with guide fencing used to increase trapability. In the wetland habitat, the guide fencing was removed and the three traps were separated by approximately 15 m. I used bacon to bait these traps, and checked them in the morning and evening for captures.

An analysis was used to determine whether or not species were randomly distributed among the different habitat types. I compared animal capture rates using trapnights, a measure of trapping effort that allowed for comparison of species abundances (Fig.2b). One trap used for one night is equal to one trap night. On average, I used 30 traps each night and therefore had approximately 30 trapnights per night of trapping.

Study area

Trapping was done in five major habitat types. 1) A relatively mature aspen (*Populus tremuloidies*) stand, with a moderate to heavy undergrowth of woody plants; 2) An oak savannah (*Quercus virginianus*) stand with a lighter undergrowth, which consisted of fewer woody plants and more grasses; 3) The central grassland area was last hayed in the 1950's, and consisted mainly of *Castelleja sp., Poa sp.,* and *Solidago sp.,* which are

perennial, early successional species. This area is also being rapidly invaded by aspen (*Populous tremuloidies*), and especially sumac (*Rhus glabra*; Matuska 1995), and contains little or no woody vegetation. 4) Natural rock outcroppings, which were surrounded by woodlands, but had grasses (e.g. *Poa sp.*) growing in isolated patches of soil atop the rock floor. 5) Rock tailing piles, which ranged from 2-20m in height were surrounded by oak stands, and had growing in them a few aspen. I also survey a number of minor habitat types which included an area of planted red pines (*Pinus sp.*), which had almost no undergrowth, and a few areas of wetlands, which were dominated by cattails (*Typha latifolia*).

Results

The different small mammal species captured in Sherman live traps occurred almost exclusively in either grassland or woodland habitat types (Fig. 2a,b). There was very little if any crossover of one species into the habitat of another. 12 meadow voles (*Microtus pennsylvanicus*) were captured during 150 trapnights in the grassland areas, along with a single masked shrew (*Sorex cinereus*). 83 white-footed mice (*Peromyscus sp.*) were captured in 292 trapnights in the aspen and oak woodlands, which were most likely white-footed species (*Peromyscus leucopus*). 49 *Peromyscus sp.* were also captured in the rock tailing piles in 80 trapnights. The eastern chipmunk (*Tamias striatus*) was also found to be prevalent in the woodland areas. However, chipmunks were generally too large to enter into the traps and as a result were not captured in large numbers. A wider variety of species were captured on and around the natural rock outcroppings, but in very small numbers. 13 *Peromyscus leucopis* were captured in this habitat type in 128 trapnights, along with one meadow vole and one red-backed vole. Chi-squared tests (Fig.3) showed that the small mammal species in Quarry

Park were associated strongly with their habitats listed above ($P<0.001$).

The scat data also supported these findings (Fig.4). Meadow voles left scat all the way to the edge of the central grassland, which was bordered by dense aspen in the area that was tested. I did not detect any white-footed mice in this habitat. There was a total absence of scat found on boards placed in areas that were devoid of vegetation, such as trails and natural rock outcroppings.

Only one animal was captured in 15 trapnights of pit-trapping, a short-tailed shrew (*Sorex cinereus*) that was found in an aspen/wetland habitat.

Discussion

Small mammals, mostly Rodentia, are about the most widespread and numerous members of the Class Mammalia. Their effects on humankind have been quite formidable, destroying crops and spreading disease (Stoddart 1979). But, They also aid in the reseeding of areas and like all organisms, function as an intricate component of their respective ecosystems(Stoddart 1979). On a smaller scale, they make up a large portion of Quarry Park's animal population.

The results of this survey suggest that the small mammals of this area are very habitat specific. Each species seemed to spend the majority of time in its respective ecological community. They were never detected to cross over into another habitat type (i.e. a meadow vole in the woods). In a similar survey by M'closkey & Fieldwick (1975) in Michigan, no co-occurrence was found of *Microtus sp.* and *Peromyscus sp.* in grassland habitats. Small mammals certainly must venture into adjoining areas from time to time, but for the most part they appear to stay put in their own area, their own niche. The question naturally comes to mind: What keeps them from living in adjoining habitats, exploiting a wide variety of resources?

Small mammals are very adept at exploiting the environments in which they live. Their populations have the ability to rapidly increase in size and area given unlimited resources and favorable conditions(Begon et.al. 1990). This kind of ideal unlimited environment is referred to as an organisms "fundamental niche" (Begon et.al. 1990). However, organisms never truly experience unrestricted growth. There are almost always competitors, a limited amount of resources, predators, or some other factor that limit a populations growth and dispersal. This community in which the organism actually lives is termed its "realized niche" (Begon et.al. 1990).

A wide variety of factors determine an organism's niche. In 'choosing' a habitat in which to live, animals presumably are more responsive to certain habitat features than others. The most important cues for small mammal populations seem to be the presence of food or foraging areas and adequate shelter or nest sites, because they are the most necessary requirements for survival (Stoddart 1979).

When we look at Quarry park, we can start to see the relationship between these factors and the small mammal populations that are present. Although the actual data from this survey is rather slim, there are definite patterns that are visible in the segregation of species into one habitat type or

another.

In the central grassland, meadow voles (*Microtus pennsylvanicus)* were the dominant species. Except for one grassy area of the natural rock outcroppings, this was the only region of the park in which *Microtus pennsylvanicus* were found. Meadow voles are herbivores and depend on the seeds and vegetative material of the grasslands (Grant & Birney 1979). Grasses also serve as protective cover for meadow voles. They are widely known to form runways through their habitat, sheltered by the litter layer and canopy of grasses. *Microtus sp.* populations have been found to correlate with habitats that have a high vegetative cover, such as is found in old hay fields (Hazard 1982). The older a grassland is the more dense its litter layer will be, which will contribute to higher vole populations. Their populations are also known to fluctuate widely in a cyclic pattern (Begon et.al. 1990). Grasslands seem to be a necessary part of a meadow vole's niche. The lack of grass in the woodland areas might help to explain the absence of this species. They also do not compete well with mice in woodland habitats (Foster 1991).

White-footed mice (*Peromyscus leucopus*) are omnivores and are able

to exploit a wide variety of habitats (Grant & Birney 1979). However, they are most often found in deciduous woodlands (Hazard 1982). They find shelter in fallen trees, abandoned rodent burrows, and in and under a variety of other natural shelters. They play a secondary role to voles and other rodents in grassland habitats and other perennial grasslands (King 1968), perhaps due to the fact that voles are also larger than mice, and capable of killing them (Stoddart 1979). Along with food sources and available cover, competition may also play a large role in the niche differentiation of these two species. These factors may help to explain why the two species are separated.

The red-backed vole (*Clethrionomys gapperi*) is known to occur in woodland and grassland habitats (Hazard 1982). One individual was captured in a natural rock outcropping/aspen woodland in this survey. *Clethrionomys sp.* Coexist with meadow voles, except during breeding time, when the red-backed vole is excluded from grasslands by *Microtus sp.* (Stoddart 1979). It is interesting that the area in which the single red-backed vole was captured, was the "Special area" (Appendix D) in which the prickly pear cactus (*Opuntia fragilis*) also exists. This area has two unique species; further study might turn up some interesting ecological surprises.

There was also a single masked shrew (*Sorex cinereus*) captured in the central grassland, and a short-tailed shrew (*Blarina brevicauda*) in grass adjacent to a wetland area. It is hard to make any assumptions about the shrew populations of the park, given that only two individuals were captured. Shrews are difficult to trap and a thorough study will require more intensive efforts. Shrews are most abundant in areas characterized by cool, moist, temperate forests, and are generally less diverse in drier forests and prairie ecosystems (Churchfield 1990).

I did little trapping in the wetland areas of the park, which comprise considerable acreage. These areas may prove to be a haven for larger populations of shrews. This would make sense, because shrews have relatively high water requirements given their high metabolic rates and constant activity (Churchfield 1990). Getz (1961) studied the interaction between short-tailed shrews (*Blarina brevicauda*) and masked shrews (*Sorex cinereus*) in southern Michigan. She concluded that the type of cover as well as interspecific interactions were not important factors in the selection of a habitat (Getz 1961). *Blarina brevicauda* existed only in moist habitats and only where there were high densities of large invertebrates they eat, which they consume. *Sorex cinereus* were found a wider variety of habitats, and

did not require high invertebrate populations. There is debate as to the priority of moisture versus prey availability when it comes to habitat selection of the shrew (Spencer & Pettus 1966).

One species that I expected to find in the grasslands which was not detected in the survey was the meadow jumping mouse (*Zapus hudsonius*). I have found this species in other areas of Stearns County. It ranges across Canada and half way down into the central and eastern portions of the United States. *Zapus sp.* tend to out compete voles in native prairies, but voles are dominant in areas with a lot of early successional species (Hazard 1982). The areas in Quarry Park resemble the latter.

The eastern chipmunk (*Tamias striatus*), as a rule, was too large for the live traps. However, they were captured on occasion. They are also quite visible, and with their territorial barks it is relatively easy to tell when they are in the area. They have a relatively generalized diet, and can occupy a variety of different habitats, but are most often found in woodland habitats. I observed them in wooded areas on the natural rock outcroppings and rock tailing piles, but never in a grassland habitat. Chipmunks might be restricted to the woodlands because of their food requirements.

All species involved in this study seemed to stay away from wide open

areas, with little or no vegetation. For example, the individuals caught on the natural rock outcroppings were always caught near the edge of the rocky area, close to some type of cover. Scatboards that were placed on trails collected no specimens. This is possibly due to the surface resemblance between the scatboards and the relatively smooth, open substrate. However, it also makes sense that small mammals would stay away from areas that made them vulnerable to avian predators. The high density of white-footed mice in the rock slag piles also points to the importance of shelter when it comes to habitat selection.

Another important aspect of small mammal ecology is their use of "edge habitats." There are many different habitats in the park as well as transitional areas that give small mammals a variety of resources. *Peromyscus spp.* for example, tend to prefer edge habitats so they can utilize two habitat types (i.e. one type for nesting and one type for foraging; Boone & Keller 1993). The high density of white-footed mice on and around the rock tailing piles suggests that they shelter in the rock tailings, and forage in the surrounding forests. I cannot say to what extent the small mammals in the park utilize many of the edge habitats based on this survey, but nonetheless it is an important aspect of landscape design for preserves.. The

more habitat diversity is maintained in the park, the more edge habitats will be available for small mammals to utilize.

Conclusion

Quarry Park will be undergoing major development within the next few years to make it safe and accessible for public use. I feel it is my responsibility to try to give some sort of idea on how this development might effect the small mammal populations.

Small mammal species were strongly tied to the specific habitat types. Because of interspecific competition, predation, and other selection pressures small mammals are associated with a particular habitat type. This being the case, maintaining habitat integrity is very important in the course of developing park areas. The major intrusion into small mammal populations is going be the destruction of their habitats.

I would like to give special attention to the two main grasslands. Some thought has been given to burning of the grasslands in order to aid in succession. Burning of a grassland area decreases the amount of vegetative cover for sometime, which favors colonization by *Peromyscus spp.* *Microtus spp.* are most often correlated with high vegetative cover. A recent study (Schwartz & Whitson 1987) showed that high populations of white-footed mice are found in grasslands that have been recently burned, mowed,

or otherwise disturbed. I would recommend that if the prairie is to be burned, that it should be done so in sections so as not to drive out the vole population entirely.

The rock tailing piles are also an area of notable importance. Dismantling the rock piles would eliminate a haven for an entire community of white-footed mice. Eliminating the rock piles would certainly increase the safety of the area, but would also dislodge quite a few *Peromyscus sp.*

The area seems to be slowly recovering from the intense ecological disturbances that occurred in the first half of this century. The prairie is showing some signs of succession. The tailing piles have aspens and lichens growing on them. Future development will, most likely, not have nearly as harsh an impact on the environment as the quarrying did forty years ago. In any case, a good balance needs to be found between human accessibility and maintaining the natural environment.

On another note, a few threatened or rare mammals may occur in Quarry Park. Although the listed species were not observed in this study, many of them have been observed in and around Stearns County. Here is a list of species that are listed with an federal status of: SPECIAL CONCERN. They are the northern myotis *(Myotis septentrionalis)*, eastern pipistrelle

(Pipistrellus subflavus), prairie vole *(Microtus ochrogaster)*, eastern spotted skunk *(Spilogale putorius)*, and the mule deer *(Odocoileus hemionus)*.

There is much work yet to be done if we want to get a handle on the ecology of Quarry Park. As development in this area continues and it becomes available for public use the environment is certain to change. It would be interesting to see what effects an increased human population will have on the park. The wetlands and "special area" have not yet been thoroughly studied, and all areas of the park would certainly benefit from further explorations. As far as small mammals go, our knowledge is far from complete. There could certainly be species present in abundance that did not appear in this survey. The range of shelter present in the rock tailing piles also provides for the possibility of a bat population.

Summary

Live trapping was conducted in 5 different major habitat sites. Scat boards were used in 14 different sites including "edge habitats." Pit traps were used in three different locations. The wooded areas along with the rock tailing piles were dominated by white-footed mice (*Peromyscus sp.*), along with eastern chipmunks (*Tamias striatus*). Grassy areas, in turn, were dominated by meadow voles (*Microtus pennsylvanicus*). Two shrews were found during the survey. One masked shrew (*Sorex cinereus*) was found in the central grassland, and a short-tailed shrew (*Blarina brevicauda*) in grass on the edge of a wetland in the northeast corner of the park. A red-backed vole (*Clethrionomys gapperi*) was found on the edge of a natural rock outcropping on the southern boarder of the park, in the "special Area." Other mammal species that were observed in the park were: Raccoon (*Procyon lotor*); Striped skunks (*Mephitis mephitis*); White-tailed Deer (*Odocoileus virginianus*), and Fox (*Vulpes sp.*).

Small mammal species were found to be habitat specific. That is, they were very rarely observed to crossover into adjacent habitat types of other small mammals. This illustrates the importance of maintaining a diversity of

habitats within the park, for they are necessary to maintain the different small mammal populations

If dramatic changes of the environment are planned in the course of development, It is my hope that this study will illuminate how those changes might effect the small mammal diversity in the park. And in return, how a change in the small mammal populations might show a particular change in some aspect of the environment.

Figure #1: Map of Quarry Park

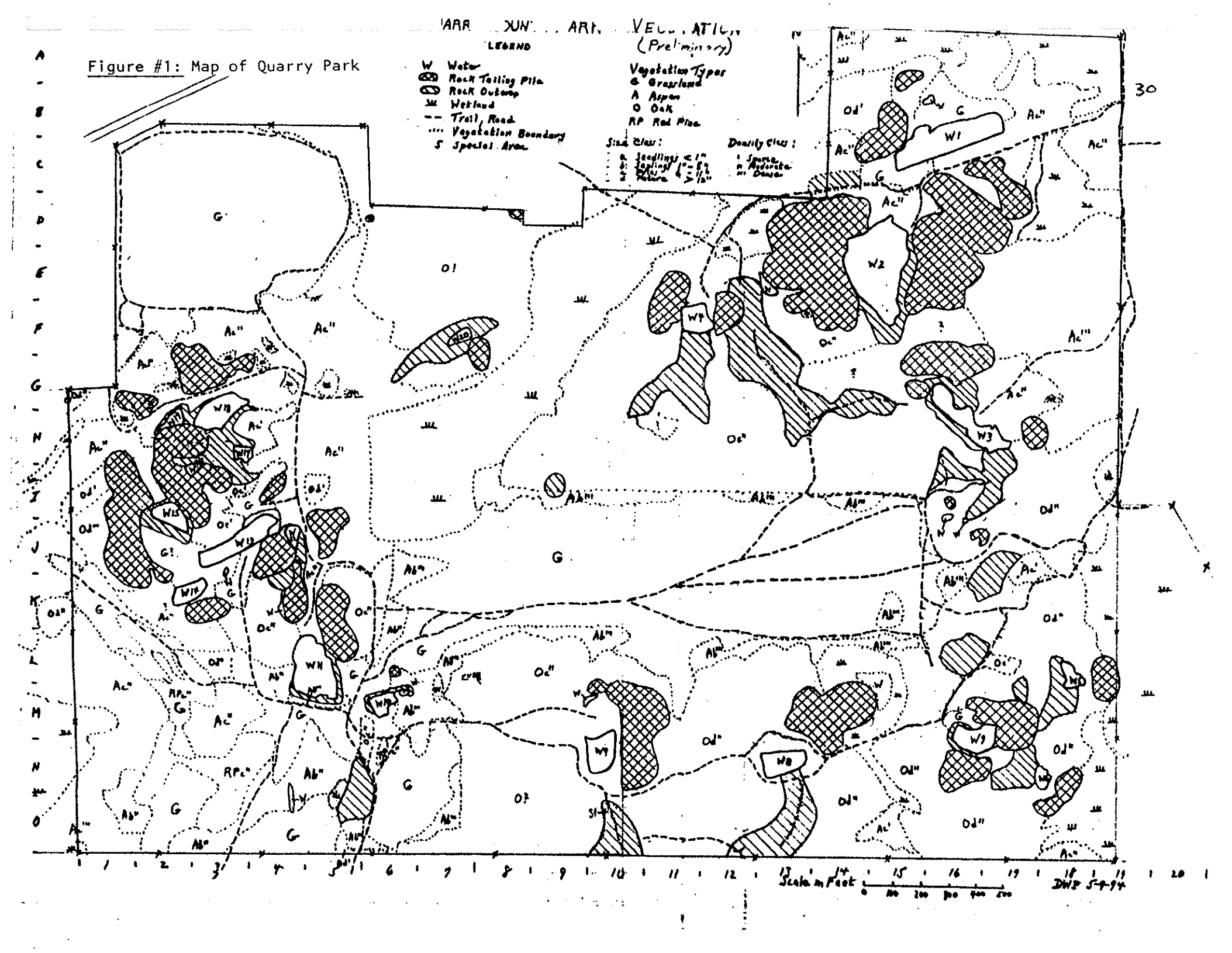


FIGURE #2a: The Number of Captures in Each Habitat Type

	grass	rock tailing	aspen	oak	natural rock	wetland
Microtus	12	0	0	0	1	0
Peromyscus	0	49	36	47	13	0
Tamias	0	0	2	0	0	0
Sorex	1	0	0	0	0	0
Blarina	0	0	0	0	0	1
Clethrionomys	0	0	0	0	1	0
Total captures	13	49	38	47	15	1

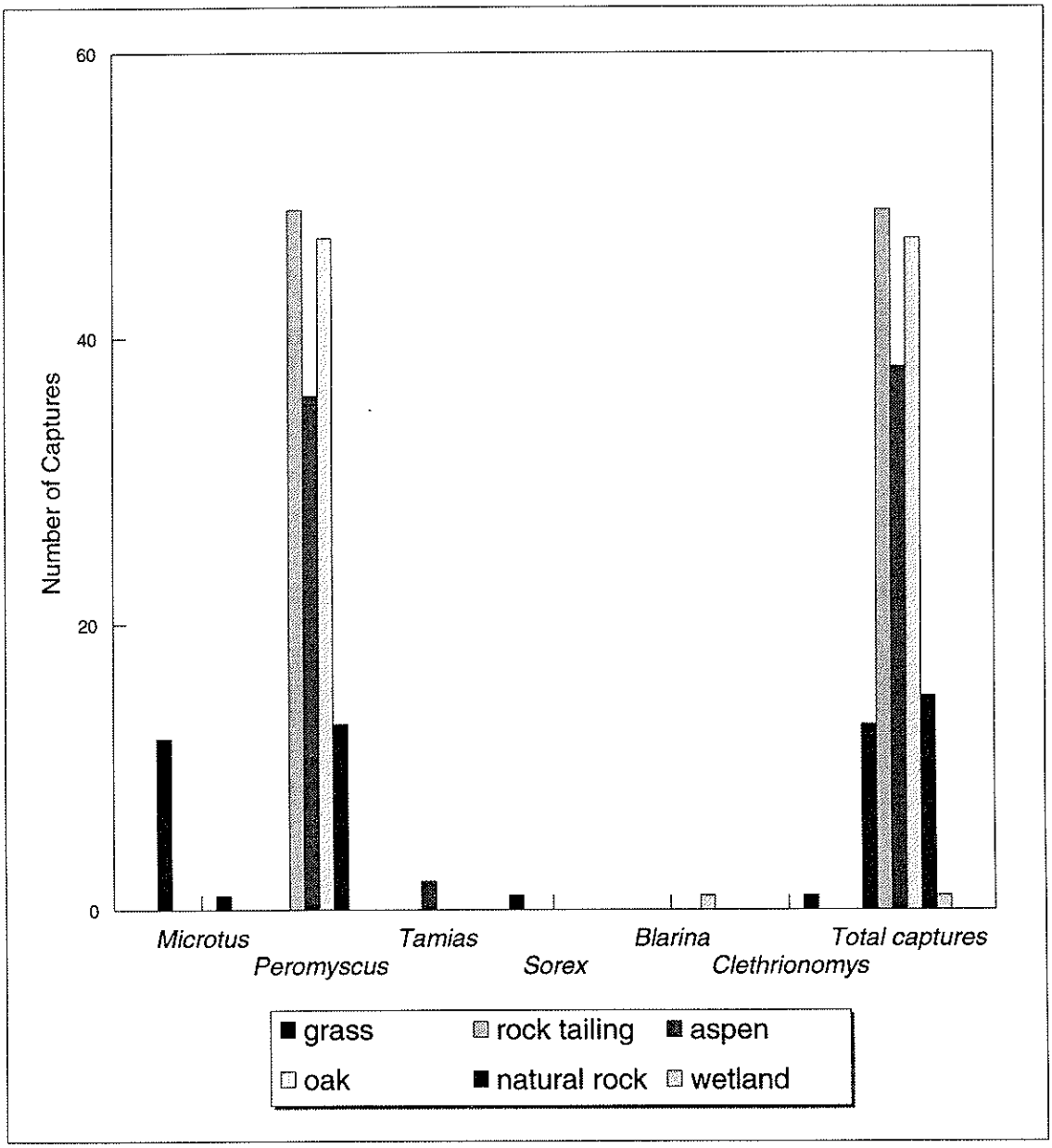


FIGURE #2b: Captures per number of Trapnights

	grass	rock tailing	aspen	oak	natural rock	wetland
Microtus	0.08	0	0	0	0.007813	0
Peromyscus	0	0.6125	0.243243	0.326389	0.101563	0
Tamias	0	0	0.013514	0	0	0
Sorex	0.006667	0	0	0	0	0
Blarina	0	0	0	0	0	0.066667
Clethrionomys	0	0	0	0	0.007813	0
Totals	0.086667	0.6125	0.256757	0.326389	0.117188	0.066667

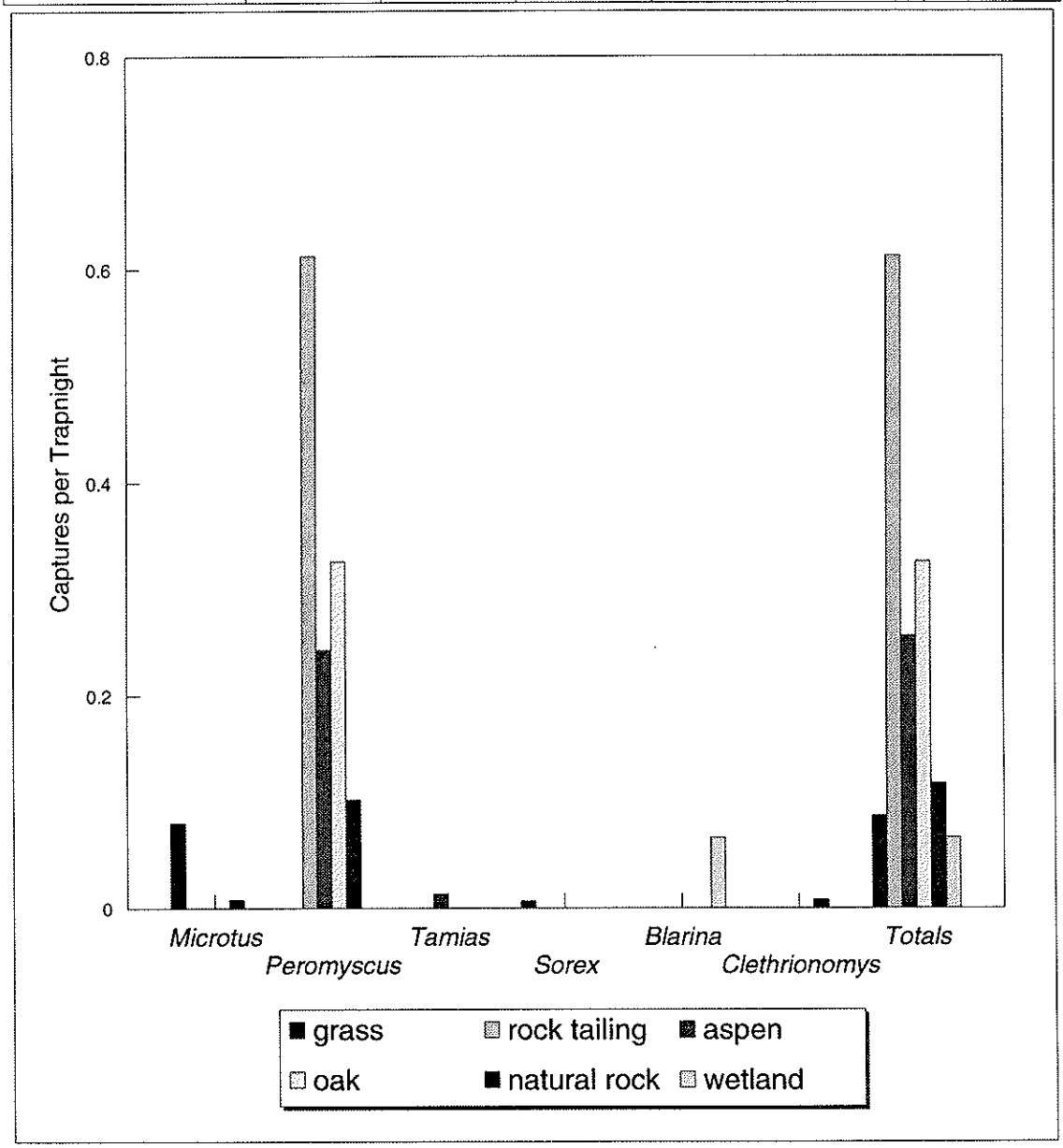


Figure #3: Scat Board Data

Scat Board	Habitat Type	Results
1	Northwest prairie 3' grasses	*Microtus spp.*
2	Main prairie(within T2) 3' grasses	*Microtus spp.*
3	Edge of Red Pine, Aspen, and 2' grasses	Nothing, perhaps due to rain.
4	Oak, dense understory of woody plants	Nothing, perhaps due to rain.
5	Rock outcropping and 1' grasses. "Special Area"	Nothing on coutcroppings. Small scats in grass, perhaps Shrew. *Sorex spp. / Blarina spp.*
6	Perimeter of rock slag. Small Aspen and Oak	Nothing
7	Aspen, with dense under-story of woody plants. Within T3	*Peromyscus spp.*
8	Oak, with moderate under-story of woody plants and grasses. Within T4	*Peromyscus spp.*
9	Edge habitat. Aspen and grasses(continued into Aspen). South of central Prairie	*Microtus spp,* only in open priaire, Nothing found in Aspen
10	Edge habitat. Aspen and grasses(dense Aspen, minimal grasses. North edge of central prairie.	*Microtus spp.,* only in open prairie,. Nothing in Aspen.

Figure#3: Scat Board Data(Continued)

Scat Board	Habitat Type	Results
11	Open prairie. Varied grasses	*Microtus spp.*, plus another unknown
12	Aspen stand in main praire. Understory of 4' grasses	Nothing
13	Along a walking trail which traverses a swamp. 4' grasses plus a few small Oak and Aspen.	*Peromyscus spp.*
14	Crossroads of trails. 0.5' grasses. Heavily traveled by humans.	Nothing in the open. Minimal *Peromyscus spp.* directly off the beaten path. In the brush.

Figure #4:

This data shows that individual species are not randomly correlated to the habitat types in which they live($P<0.001$).

Chi-squared test : Correlation of Species and Habitat

		Oak	Aspen	Grassland	Rock pile	Natural rock
Microtus pennsylvanicus	Observed	0	0	12	0	1
	Expected	3.37	2.61	0.89	5.3	0.83
	Chi-square	3.37	2.61	137.94	5.3	0.04
Peromyscus leucopus	Observed	47	36	0	49	10
	Expected	44.07	34.18	11.69	45.07	10.79
	Chi-square	0.19	0.1	11.69	0.2	0.06
Sorex cinereus	Observed	0	0	1	0	0
	Expected	0.26	0.2	0.07	0.41	0.06
	Chi-square	0.26	0.2	12.61	0.41	0.06
Tamias striatus	Observed	2	2	0	0	0
	Expected	1.04	0.8	0.28	1.63	0.25
	Chi-square	0.89	1.78	0.28	1.63	0.25
Clethrionomys gapperi	Observed	0	0	0	0	1
	Expected	0.26	0.2	0.07	0.41	0.06
	Chi-square	0.26	0.2	0.07	0.41	13.81

Appendix A: Individual Species Descriptions

Meadow Vole *(Microtus pennsylvanicus)*

This species ranges from Alaska down through the Rockies, and as far east as Georgia. *Microtus sp.* are among Minnesota's most prolific rodents and occur throughout the state. *Microtus sp.* are found most often in prairies which have a dense grass cover (Eadie 1953; M'closkey & Fieldwick 1975), but do not usually do well in native tail grass prairies. *Microtus sp.* are generally good colonizers of suitable habitats, moving into adjacent woodlands if their populations in a prairie becomes too dense, especially if the woodland contains a grass understory, and no other competitors (Grant 1971,1975; Hazard 1982).

Microtus sp. have an average of five to six offspring per litter, and may have up to eleven. Gestation lasts 21 days or less. Females can breed when they are 25 days old, in some cases before they are even weaned. Thus, generation time for this species is under seven weeks. This is one of the reasons that they can have such a rapid population increase under favorable conditions (Stoddart 1979, Hamilton 1937).

Meadow voles are mainly herbivores, eating a variety of green plants. They will also eat insects, but not to the extent of some of the other small mammals in the area (Grant & Birney 1979). The types of plants they eat tend to dominate in previously tilled fields, which have gone unmanaged, such as those in Quarry Park.

Meadow voles interact differently to the different species of their community. They are usually dominant in their native habitat; grassland with dense cover. The less grass cover there is in an area the more likely it is that one will find populations of the prairie deer mouse (*Peromyscus maniculatis bairdii*; Lobue & Darnell 1959). Meadow voles been shown to have a harder time occupying woodlands that are already inhabited by white-footed mice (*Peromyscus leucopus*) or red-backed voles (*Clethrionomys gapperi*; M'Closkey & Fieldwick 1975; Morris 1969). They will avoid short-tailed shrews (*Blarina brevicauda*), since meadow voles make up a part of the shrew's diet (Stoddart 1979).

Meadow voles are active both day and night. Interestingly, they are less active during brightly moonlit nights. This is partly due to increased light levels which make them more vulnerable to nocturnal predators, but also because of an internal biological clock that is related to lunar phases

(Doucet & Bider 1969). They also seem to use the sun as a compass, suggesting the use of an internal biological clock (Fluharty et al. 1976).

White-footed mouse, Wood Mouse (*Peromyscus leucopus*)

The white-footed mice range from eastern Mexico, up to Alberta and Saskatchewan, and east to the Atlantic. They do not exist in the extreme southeastern United States. They are also absent from extreme northeastern Minnesota (Hazard 1982). This species lives primarily in deciduous woodlands. It is more tolerant of open conditions and early stages of ecological succession than are other species of woodland *Peromyscus* (Bowker & Pearson 1975; Hirth 1959; Iverson et al. 1967)

They have 3-6 offspring, with a gestation period of around 23 days. The female can first breed at 8-10 weeks, and has 4 or more litters in a season (Hazard 1982). The females of this species are territorial, which may help to prevent overpopulation. However, big population swings do still occur. They are naturally exploratory and will readily spread out in a response to crowding, dispersing across areas of unsuitable habitat, including water barriers of up to 125 m long (Sheppe 1965, 1966).

White-footed mice are nocturnal omnivores, feeding on seeds and

insects (Grant & Birney 1979). These animals have proved a nuisance in forest reseeding projects, but also help to control insect populations (Stoddart 1979).

Short-tailed Shrew *(Blarina brevicauda)*

The Romans believed that shrews were evil, poisonous creatures, and their reputation has not improved much in the succeeding ages. In the seventeenth century, the natural historian Topsell described the shrew as "a ravening beast, feigning itself gentle and tame, but being touched it biteth deep, and poisoneth deadly. It beareth a cruel mind." (Churchfield 1990).

The short-tailed shrew (*Blarina brevicauda*) occurs mainly in northeastern and north central United States, and into southern Canada. This species also occurs throughout Minnesota (Hazard 1982). They favor moist habitats (Getz 1961), but are probably less limited to them than is the other shrew to be found in this survey, the masked shrew *(Sorex cinereus)*. However, they generally avoid open water. They are often one of the more common mammals of an area, but like other small mammals their population can fluctuate markedly.

Gestation lasts from 17-21 days. Two to four litters of five to eight

offspring are average for a season. The age at which females reach sexual maturity is uncertain. Buckner (1966) suggests that they do not become mature until their tenth month, while Dapson (1968), states that males and females are able to breed at under two months.

Shrews are classified as insectivores and when abundant, they can be major predators of insects, earthworms, snails, and small vertebrates. They also show preferences for different types of prey when they are available (Churchfield 1990).

Shrews have glands in their flanks that produce a scent which can be recognized by humans. It may be used to repel predators, but is more prominent in males and is probably mainly used to attract the opposite sex (Churchfield 1990). This secretion is not dangerous and is nowhere near the potency of another member of the park; the Striped Skunk (Hazard 1982).

Masked Shrew *(Sorex cinereus)*

The masked shrew occurs across the northern United states, Canada, and a variety of habitats throughout Minnesota. *Sorex sp.* does not seem to be restricted to one habitat type as many of the other small mammals appear to be. *Sorex sp.* have been found in grasslands and open habitat, and

deciduous and coniferous forests throughout the state. *Sorex sp.* have been shown to inhabit moist areas, as well as areas with adequate ground cover (Iverson et al. 1967; Spencer & Pettus 1966; Tester & Marshall 1961).

Masked shrews, because of their small size, lose heat at a very rapid rate. Therefore, *Sorex sp.* must eat a lot of high-energy foods in order to maintain their basic metabolic rate. Shrews must eat every few hours, and will quickly starve if they go without food for a prolonged period of time. *Sorex sp.* will typically eat more than their own weight in food every day. Insects, mice and other shrews, and some plant material make up their diet (Hamilton 1930; Whitaker & Schmeltz 1973). *Sorex sp.* are active day and night, throughout the winter months, always looking for food under the snowcover.

Little is known about the reproductive habitats of this common small mammal. Gestation is about 18 days. Females have approximately five litters per year of four to ten offspring. The young leave the nest when they are 10 to 12 days old. Shrews are preyed upon by foxes, owls, hawks, frogs and other shrews (Hazard 1982).

Eastern Chipmunk *(Tamias striatus)*

The eastern chipmunk occurs in the eastern half of the United Sates and southern Canada. They are a ground squirrel that favors woodland and brushland habitats, making their home underground. They are seldom found in grassland or wetland areas (Forbes 1966; Iverson et al. 1967). They inhabit these types of habitats throughout Minnesota, except for the extreme southeastern corner of the state (Ernst & Ernst 1972). They also occur around human inhabitants, wherever houses or land development provide shelter.

This is one of the parks most impetuous inhabitants (It is for this reason that we know so much about them). They are territorial animals, who will defend their habitats, especially during mating season. Chases can often be seen during a season of high population density (Forsyth & Smith 1973). However, their cackling or bark is used to announce their home range to other chipmunks in the area, so that costly fights may be avoided (Hazard 1982). On a summer evening, it is one of the most prolific sounds in the forest.

The eastern chipmunk is the only member of the family sciuridae that is able to breed twice a year. The young are born in a relatively complex

underground burrow, which consists of a nest chamber, food storage chambers, and multiple entrances (simple refuge burrows are also built within the animal's home range).

They are generalist feeders eating primarily seeds, buds, and fruits. Their diet also includes mushrooms, insects and other invertebrates, frogs, snakes, birds, and voles. They have internal cheek pouches which allows them to collect large quantities of food, and bringing it back to their burrow for storage (Hazard 1982).

Eastern chipmunks are true hibernators. They will disappear in October, usually until March. However, they are not deep hibernators, and will emerge during the warm spells of winter. During this time of hibernation, they will also awake on occasion to feed on their stores of food.

Red-backed Vole *(Clethrionomys gapperi)*

The red-backed vole lives mainly in a Taiga habitat; coniferous forests, with a relatively cooler climate and high to moderate precipitation. They are generally the most common rodents in these areas. It occurs across Canada and south, along the Appalachian and Rocky Mountains. In the central United States, Minnesota is along the southern edge of this species range. In

Minnesota, they are most common to the north, in the moist coniferous forests (Getz 1962; Hazard 1982; Hirth 1959; Iverson et al. 1967; Kirkland and Griffin 1974).

Gestation lasts 17 to 19 days. There can be several litters in a season of, on average, 4 or 5 offspring. The young become sexually mature between 4 and 5 months. When population densities become too high, they have been known to disperse into adjacent grasslands and disturbed areas (Hazard 1982).

Populations of red-backed voles and meadow voles seem to be pretty compatible where woodland and grassland habitats meet, except during the breeding season. *Clethrionomys gapperi* compete for food and shelter with *Peromyscus sp.*, which occur throughout much of its range (Clough 1964; Iverson & Turner 1972).

Red-backed voles are active day and night. *Clethrionomys gapperi* makes its burrows around natural shelters, such as fallen trees and roots. Like the meadow vole, *Clethrionomys gapperi* is mainly a herbivore, feeding on leaves, the bark of young trees, a variety of fruits and nuts, and a few insects. On the other hand, *Clethrionomys gapperi* are food for a variety of predators, from haws and owls, to Masked and Short-tailed Shrews

(Hamilton 1941; Hazard 1982; Jackson 1961).

Appendix B: Key to Identifying the small mammals of Quarry Park (Hazard 1982).

length(millimeters), mass(grams); 1st number = average, 2nd two = range.

Meadow Vole *(Microtus pennsylvanicus)*

Measurements: Total length--average 155mm(137-171); tail 39mm(32-43); hind foot 19mm(17-20); ear from notch 12mm(10-15); weight 40.0g(31.3-52.2).

Description: It has a dark-brown back with slightly lighter sides. Its gray-brown belly hairs are tipped with silver. It has a much shorter ear and tail than do *Peromyscus spp.* It's distinguishable from *Clethrionomys gapperi* by its lack of red shading down the back and by its ears which are less noticeable. It is the largest vole in Minnesota.

White-footed mouse, Wood Mouse *(Peromyscus leucopus)*

Measurements: Total length 166mm(153-178); tail 75mm(65-84); hind foot 20mm(19-22); ear from notch 16mm(15-17); weight 27.3g(19.0-35.4).

Description: The White-footed Mouse has yellow/brown fur on its back and sides, and white on its belly and feet(Thus, its name). Its tail is much longer than that of the *Microtus spp.,* and is distinctly bicolored--brown on the top and white on the bottom. It also has much larger ears than voles or shrews, forming a prominent feature of the head.

Red-backed Vole *(Clethrionomys gapperi)*

Measurements: Total length 134(114-150); tail 37(30-45); hind foot 18(17-19.2); ear from notch 14(11.5-17); weight 24.3(14.8-34.3).

Description: The Red-backed Vole has a grey belly, brown sides, and a crimson red back that distinguishes it from the Meadow Vole. It also has short ears and tail, and a stocky build that distinguish it from any of the *Peromyscus spp.*

Short-tailed Shrew *(Blarina brevicauda)*

Measurements: Total length 129mm(124-134); tail 25mm(22-27); hind foot 16mm(16-17); ear from notch 7mm(6-8); weight 27.3g(22.9-35.5).

Description: This is the shrew that is most often mistaken for a vole or mouse. Like the Meadow Vole, it is large and has a short tail. However, The pointed snout, tiny eyes, and absence of visible ears clearly distinguishes it as a shrew. It also has teeth which are brown at the tips, like all American shrews, characterizing it as a member of the Order Insectivora. It has slate-colored fur which may vary from dark, to glossy, to pure white in albino individuals. It's short tail distinguishes it from other shrews found in Minnesota.

Masked Shrew *(Sorex cinereus)*

Measurements: Total length 94mm(83-104); tail 39mm(36-41); hind foot 12mm(11-12); ear from notch 6mm(4-8); weight 4.1g(3.0-6.5).

Description: The species is one of Minnesota's smallest mammals. It has the small eyes and ears, brown tipped teeth, and pointed snout characteristic of shrews. Its soft fur is dark brown above and dark gray below. It's small size will distinguish it from mice and voles and most other shrews. Its is indistinguishable, without an inspection of the dental pattern, from the Pygmy Shrew *(Microsorex sp.)*. This similar species of shrew

usually is found farther north in coniferous forests, but has been known to occur as far south as Scott and Sherburn counties.

Eastern Chipmunk *(Tamias striatus)*

Measurements: Total length 260mm(250-272); tail 101mm(93-106); hind foot 36mm(33-38); ear from notch 18mm(16-18); weight 114.7g(100.3-130.2).

Description: There are two species of chipmunk that inhabit Minnesota. The Least Chipmunk and the Eastern Chipmunk. The Eastern Chipmunk is the only one of the two to be recorded as far south as Stearns county. They are easily distinguishable from mice, voles and shrews by their multi-colored fur. Both species have five dark brown stripes on their back and sides, separated by four light ones. The Eastern Chipmunk is generally the larger of the two species. It has a rump that is reddish brown, and its stripes do not run all the way to the end of its tail, as they do in the Least Chipmunk. They are also distinguishable by their dental patterns.

Appendix C: Key to Map of Observed Sites

T# = Sherman Trap site

S# = Scatboard site

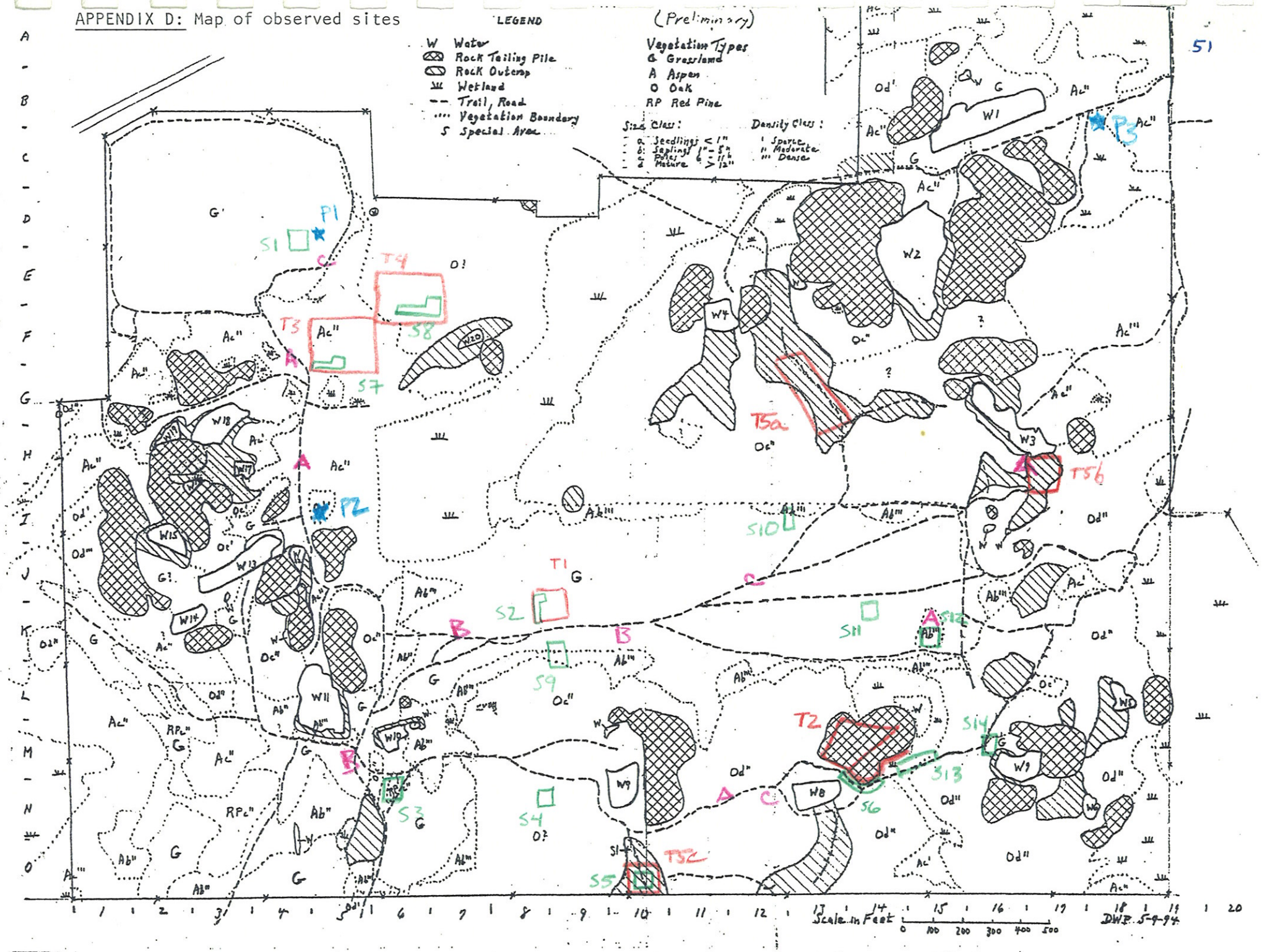
P# = Pit Trap site

A = White-tailed deer(*Odocoileus virginianus*) sighting.

B = Striped skunk(*Mephitis mephitis*) sighting.

C = Dead animals, apparently by gunshot.
(Vesper sparrow, Fox, Woodchuck)

APPENDIX D: Map of observed sites



Bibliography

Ackerman, D. 1994. A Biological Survey of Woody Plants In the Proposed Hundred Acres Quarry Park. Honors Thesis, St. John's Univ. Collegeville MN.

Begon, M., J.L. Harper, and C.R. Townsend. (Eds.). 1990. Ecology: Individuals, Populations and Communities. Blackwell Scientific Publications. Boston.

Boone, J.D., and Keller, B.L. 1993. Temporal and spatial patterns of small mammal density and species composition on a radioactive wast disposal area: The role of edge habitat. J. Mamm. 32:74-80.

Bowker, L.S., and P.G. Pearson. 1975. Habitat orientation and interspecific interaction of *Microtus pennsylvanicus* and *Peromysucs leucopus*. Am. Midl. Nat. 94:491-496.

Buckner, C.H. 1966. Populations and ecologicaal relationships of shrews in tamarack bogs of sourtheastern Manitoba. J. Mamm. 47:181-194.

Churchfield, S. 1990. The Natural History of Shrews. Cornell University Press. New York.

Clough, G.C. 1964. Local distribution of two voles: evidence for interspecific interaction. Can. Field. Nat. 78:80-89.

Dapson, R.W. 1968. Reproduction and age structure in a populationof short-tailed shrews, *Blarina brevicauda*. J. Mamm. 49:205-214.

Doucet, G.J., and J.R. Bider. 1969. Activity of *Microtus pennsylvanicus* related to moon phase and moonlight revealed by the sand transect technique. Can. J. Zool. 47:1183-1186.

Eadie, W.R. 1953. Response of *Microtus pensylvanicus* to vegetative cover. J. Mamm. 34(1):263-264.

Ernst, C.H., and E.M. Ernst. 1972. The eastern chipmunk, *Tamais striatus*, in southwestern Minnesota, U.S.A. Can. Field-Nat. 86:377.

Fluharty, S.L., D.H. Taylor, and G.W. Barrett. 1976. Sun-compass orientation in the Meadow vole, *Microtus pennsylvanicus*. J. Mamm. 57:1-9.

Forbes, R.B. 1966. Studies of the biology of Minnesotan chipmunks. Am. Midl. Nat. 76:290-308.

Forsyth, D.J., and D.A. Smith. 1973. Temporal variability in home ranges of eastern chipmunks *(Tamias striatus)* in a southeastern Ontario woodlat. Am. Midl. Nat. 90:107-117.

Foster, J. 1991. The effects of successional habitat mosiac on a small mammal community. Ecology. 72(4):1358-1365.

Getz, L.L. 1961. Factors influencing the local distribution of shrews. A,. Midl. Nat. 65:67-88.

--1962. Notes on the water balance of the redback vole. Ecology 43:565-566.

Grant, P.R. 1971. The habitat preference of *Microtus pennsylvanicus*. and its relevance to the distribution of this species on islands. J. Mamm. 52:351-361.

--1975. Population performance of *Microtus pennsylvanicus* confined to woodland habitat, and a model of habitat occupance. Can. J. Zool. 53:1447-1465.

Grant, W.E., and E.C. Birney. 1979. Small mammal community structure in North America grasslands. 60(1):23-36.

Hamilton, W.J. 1930. The food of the Soricidae. J. Mamm. 11:26-39.

--1937. Growth and lifespan of the Fieldmouse. Amer. Nat. 71(736):500-507.

--1941. The food of small forest mammals in eastern United States. J. Mamm. 22:250-263).

Hazard, E.B. 1982. The Mammals of Minnesota. Univ. of MN. Press. Mpls.

Hirth, H.F. 1959. Small mammals in an old field succession. Ecology 40:417-425.

Huntlyu, N, and Inouye, R.S. 1987. Small mammal populations of an old-field chronosequence: successional patterns and associations with vegetation. J. Mamm. 68:739-745.

Iverson, S.L., R.W. Seabloom, and J.M. Hnatiuk. 1967. Small mammal distribution across the prairie-forest transition of Minnesota and North Dakota. Am. Midl. Nat. 78:188-197.

Iverson, S.L., and B.N. Turner. 1972. Winter coexistence of *Clethrionomys gapperi* and *Microtus pennsylvanicus* in a grassland habitat. Am. Midl. Nat. 88:440-445.

Jackson, H.H., 1961. Mammals of Wisconsin. Univ. Wisconsin Press, Madison.

King, J.A. 1968. Biology of Peromyscus. The American Society of Mammology. New York.

Kirkland, G.L., Jr, and R.J. Griffin. 1974. Microdistribution of small mammals at the coniferous-deciduous forest ecotone in northern New York. J. Mamm. 55:417-427.

Lobue, J., and R.M. Darnell. 1959. Effect of habitat disturbance in a small mammal population. J. Mamm. 40(3):425-437.

M'Closkey, R.T., and B. Fieldwick. 1975. Ecological separation of sympatric rodents. J. Mamm. 56:119-129.

Morris, R.D. 1969. Competitive exclusion between *Microtus* and *Clethrionomys* in the aspen parkland of Saskatchewan. J. Mamm. 50:291-301.

Schwartz, O.A., and Whitson, P.D. 1987. A 12-year study of vegetation and mammal succession on a reconstructed tall grass prairie in Iowa. Amer. Midl.

Nat. 117:240-249.

Sheppe, W.A. 1965. Dispersal by swimming in *Peromyscus leucopus*. J. Mamm. 46:336-337.

--1966. Exploration by the deer mouse, *Peromyscus leucopus*. Am. Midl. Nat. 76:257-276.

Sietman, B.E. 1994. Effects of haying and old-field succussion on small mammals in tallgrass prairies. Amer. Midl. Nat. 131(1):1-8.

Spencer, A.W., and D. Pettus. 1966. Habitat preferences of five sympatric species of long-tailed sgrews. Ecology 47:677-683.

Stoddart, D.M.(Ed.). 1979. Ecology of Small Mammals. Halsted Press. New York.

Tester, J.R., and W.H. Marshall. 1961. A study of certain plant and animal relations on a native prairie in north-western Minnesota. Univ. Minn. Mus. Nat. Hist., Occ. Pap. 8.

Whitaker, J.O., Jr., and L.L. Schmeltz. 1973. Food and external parasites of *Sorex palustris* and food of *Sorex cinereus* from St. Louis County, Minnesota. J. Mamm. 54:283-285.