Aquatic Survey of Shrews in the Great Lakes Region

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Abstract

This study determined the population density and geographical distribution of *Sorex palustris* as well as other shrew species in three main regions of the UNDERC property. This study further researched the optimal habitat of water shrews in an area where there is still a steady population to discover their needs and behavior. After shrews are more understood in well-populated areas, more can be done to conserve the populations in the southern regions, where numbers are decreasing.

Trapping was performed for three weeks, capturing four species of shrews in bogs, creeks, and vernal ponds. Tests were performed to determine the correlation of the water shrew captures with vertical plant stratification, total vegetation volume, distance from permanent water and distance from temporary water. Tests showed a trend in the vertical stratification of vegetation and the different site types. Water shrews, the main focus of this study, were found only in bogs and creeks, but not in vernal ponds. The amount of captures was correlated with the amount of water present at the chosen sites. The water shrew capture sites conflicted with previously determined optimal habitats. In this study, water shrews were found near slow-moving, mucky creeks with little overhanging vegetation instead of the theorized habitat, consisting of clear, fast-moving streams with large amounts of cover and overhanging vegetation.

Introduction

Shrews are found throughout the North American continent, but there are a number that are found mainly in Canada and the upper portion of the United States. Five different shrew species have been documented in the Great Lakes region where captures were performed. These include the northern short-tailed shrew (*Blarina brevicauda)*, arctic shrew (*Sorex arcticus)*, masked shrew *(Sorex cinereus)*, pygmy shrew (*Sorex hoyi)*, and the water shrew (*Sorex palustris)*. All species except the pygmy shrew have been recorded on the UNDERC property; however, the main focus of this study will be the water shrew.

Water shrews are unique in terms of their habitat and food preferences, physical characteristics, and foraging behavior. Water shrews have dark brown backs with silver-white bellies and long, slightly furred tails (Kurta 1995, Whitaker 1996). One main distinctive characteristic of the water shrew is the adapted, modified feet; the feet are relatively larger than other shrew species and have fringed hairs on the outer portion of the foot and between the toes (Kurta 1995, Whitaker 1996). This is hypothesized to increase the surface area and trap air bubbles, allowing the water shrew to actually walk on water for short distances without sinking (Kurta 1995, Whitaker 1996). These modified paws increase the efficiency of water shrews to swim, using their paws as paddles (Kurta 1995).

Modified feet in addition to a velvety, water-resistant coat allow the shrew to live in a semi-aquatic environment (Kurta 1995, Whitaker 1996). In the Great Lakes region, the optimal habitat of a water shrew is believed to be a small, fast-flowing stream in a forest with a large amount of canopy cover and undercut banks (Kurta 1995). Water shrews have also been found near boulders or in *Sphagnum* moss patches along lakes throughout Michigan (Whitaker 1996). One study in England showed that shallow-flowing streams in riparian habitats were more likely to house a water shrew, rather than scarcely vegetated areas or areas with low inclined banks (Greenwood et al. 2002). Every water shrew captured in a survey in Virginia was trapped in a fully-canopied, first or second growth forest including: a flowing stream, large macroinvertebrate population, fully-vegetated banks, and numerous undercut areas and crevices (Pagels et al. 1998). Another study performed in Colorado resulted in water shrews being captured only in areas adjacent to bodies of water (Spencer and Pettus 1965).

Water shrews are insectivores, but will eat small fish as well. They forage on land and on bottoms of lakes, ponds, and streams (Kurta 1995). Insects preyed upon include both aquatic and terrestrial insects (mayfly, stonefly, caddisfly, and true fly nymphs) in addition to leeches and snails (Kurta 1995). Water shrews are prey for weasels, minks, pickerel, pike, bass, and large trout (Whittaker, 1996). With respect to bioindicators, water shrews eat a large number of predatory insects, maintaining their populations. In past research, water shrews have been found mostly in clearer water, rather than dirty, mucky waters; therefore, water shrews may be bioindicators of clean, healthy water (Greenwood et al. 2002).

According to the DNR, water shrews are species of concern in both Wisconsin and Michigan; however, the population of water shrews is declining throughout the rest of its southern range (Michigan DNR, 2003). This study further researched the optimal habitat of water shrews in an area where there is still a steady population to discover their needs and behavior to preserve this species' population.

Methods and Materials

Three weeks of trapping were performed in various habitats on the UNDERC property, along the border of Wisconsin and Michigan. Three different geographical locations, one for each research week, were chosen around the property. These areas contained varying habitats, including forested areas around ponds, lakes, creeks, and streams, *Sphagnum* bogs, and vernal ponds.

There were three main site types that were trapped: bogs, creeks, and vernal ponds. The bogs were mainly located in low-lying areas around lakes and consisted mostly of *Sphagnum* moss, reeds, and small shrubs. Most of the bogs also had still standing water throughout the trapping stations. The creeks ranged from small, trickling waterways to wider, slow-moving creeks surrounded by vegetation on both sides. The vernal ponds were temporary pools of water that tend to dry up or almost dry up towards the later half of the summer months.

Each week, five sites were chosen within each location to set up 50 pitfall traps and 50 snap traps in a linear transect or in a grid pattern, depending on the locale (Figure 1). There were fifty trapping stations, each consisting of one pitfall and one Victor mouse trap or Museum Special snap trap. During each research week, the traps were checked twice a day, once in the morning and once in the evening, for four consecutive days.

The pitfall traps were 32-oz. plastic cups placed flush to the ground level on runways, near logs, on deer paths, and near banks to catch the shrews as they foraged. The snap traps were baited with sardines to draw in the shrews. Because water shrews were the main focus of this study, all snap traps were removed from any of the sites after capture of this species; pitfalls were left to try to capture other shrew species or live water shrews.

A habitat assessment was also performed at each of the fifteen sites to determine the vegetation structure. A range pole was used to record the vegetation measurements in twenty randomly chosen spots at each of the sites. The range pole was divided into fifteen 10-cm increments from 0.0 to 150 cm. Check marks were used to record the increments where vegetation crossed the pole. This data was then used to calculate the Levins diversity index (*L*; Francl, 2002) for each site using the following formula:

$$L = \Sigma\ 1/ (d_i)^2,$$

where d_i is the total number of hits recorded within the given increment range divided by 20, the total number of points. This index was then used to compare the vertical stratification of plants among trapping sites.

The total vegetation volume (TVV; Francl, 2002) was also calculated using the range pole. For this estimate, a hit included vegetation within a 10-cm radius of the range pole; these "hits" were then plugged into the following formula:

$$TVV = h/10v,$$

where h is the number of vegetation hits recorded and v is the total number of intervals (15 in this project).

Also at each site, the distances from permanent water and the distances from temporary water were measured at each of the twenty random spots. These measurements were then averaged to calculate the average distance away from both temporary and permanent water for each site.

As the shrews were captured, the size measurements, weight, sex, and reproductive conditions were all recorded. In addition to this, all of the masked shrews were examined to determine if any were actually pygmy shrews. The masked and pygmy differ only in the dental formula; the masked shrew has four obvious large unicuspids, while the pygmy has only three obvious unicuspids (Kurta, 1995; Schwartz and Schwartz, 1981).

Statistical test were run using Systat to determine correlations between the number of captures of each species with the Levins index, total vegetation volume, distance from permanent water, distance from temporary water. An ANOVA was performed to determine if there was a significant difference between the Levins index and the type of site as well as the total vegetation volume (Systat, 1998).

Results

During the three weeks of trapping, ten different species of small mammals were captured; four species of shrew, with the exception of the pygmy shrew, were found. *Sorex cinereus,* the masked shrew, was the most commonly captured shrew among the fifteen sites, followed by water shrews, northern short-tailed shrew, and the artic shrew. Out of the three types of sites (bogs, creeks, and vernal ponds), the creeks had the highest overall capture of shrews (23), followed closely by the bog sites (19). Out of all individual fifteen sites, Brown Creek had the most shrew captures overall (11). A total of 51 shrews were captured among the fifteen sites (Table 4).

The water shrew was captured at two of the three types of trap sites: bogs and creeks. Northern short-tailed shrews were found only at vernal ponds and creeks, while the artic shrew was found only at creek sites. The masked shrew was the only species to be found in all three of the different habitats trapped.

The Levin's Index is the measure of vertical stratification at each site; the higher the Levin's value, the more diversified that site is. The vernal pond trio was the most diversified site, while the Northgate bog was the least diversified thru vertical plant stratification. With respect to total volume vegetation, the Northgate bog had the highest volume, while Frodo bog had the least volume. Compared all together, the vernal ponds were the most diversified vertically and had the highest total vegetation volume of the three site types.

Statistical testing showed that there was a significant ($p < 0.05$) positive correlation (Table 3) between the Levin's index and the number of northern short-tailed shrew captures. There was also a statistically significant negative correlation (Table 3) between the total vegetation volume and the number of northern short-tailed shrew captures. All other correlation test between the water, masked and arctic shrew captures and the Levin's index were not statistically significant. There was a positive trend (Table 3) in the number of masked shrews captured and the total vegetation volume.

ANOVA testing showed an almost significant difference in the Levin's index between the creeks and vernal ponds. The Levin's index for the bog and creeks were exactly the same while there was an insignificant difference between the bogs and vernal ponds. There were no significant relationship among the total vegetation volume and the three site types.

Discussion

Species diversity and species richness followed a trend among the site types. The creeks were the most species diverse as well as the most species rich; it was the only site type to contain every species of shrew captured during research. Bogs were the second most diverse in shrew species and had the second highest capture rate. Vernal ponds were the least diverse in species and had the fewest number of captures. This also followed the trend seen in the differences between the Levin's index and the site types. The creek and the vernal ponds were almost significantly different. Since the creeks had the most shrew captures and diversity and the vernal ponds had the least number of captures and diversity, the difference in the Levin's index for these two sites must have some effect on the shrew habitat preference. On average, the creeks had the lowest amount of vertical diversity, while the vernal ponds had the highest amount of vertical diversity. This would mean that shrews were found in areas with lower vertical diversity rather than in areas with higher vertical diversity.

On the other hand, the vernal ponds may have had the lowest capture rate because vernal ponds dry up throughout the summer, they would not be able to offer wetland-obligate species like water shrews the amount and duration of water required for survival. Water shrews in particular were found at sites closer to permanent water, such as the bogs and creeks, rather than sites only close to temporary water, such as the vernal ponds. There was positive correlation between the water shrew captures and the distance from temporary water. As the distance from temporary water increased, the capture rate of water shrews increased. This shows that water shrews require areas closer to permanent water sources instead of areas closer to temporary sources, since they depend greatly on the presence of water to provide a substantial amount of food and cover throughout the summer.

The individual sites that the water shrews were captured at did not follow the theorized optimal habitat of this species. The water shrews were captured at creeks containing mucky, slow-moving waters with very little overhanging vegetation rather than clear waters with fast flowing water and large amounts of overhanging vegetation. This is very significant, because shrews have been absent in captures of lower water qualities in past studies (Greenwood 2002). This study shows that water shrews can tolerate mucky, dirtier waterways and may not be as affected by habitat modification as speculated. This also questions water shrews as bioindicators, since they can survive in mucky, dirty waters.

These finding can be used to examine a larger variety of locations in the southerly range, where the water shrew populations are decreasing. These finding have opened up a wide range of possible habitats in which the water shrews can be found, so this may help to end decreasing population numbers farther south.

The northern short-tailed shrew was found in only two of the site types: creeks and vernal ponds. Statistical testing showed that the northern short-tailed shrew captures were positively correlated with the vertical stratification and negatively correlated with the total vegetation volume. Therefore, the number of northern short-tailed shrews captured increased with increasing vertical stratification, but decreased with increasing vegetation volumes. This shrew species prefers moist areas with large amounts of leaf litter (Kurta 1995). The *Sphagnum* bogs did not have a large amount of litter; the creeks varied with leaf litter. The vernal ponds contained large amounts of leaf litter and would be acceptable habitats for the northern short-tailed shrews.

Masked shrews, on the other hand, were captured at every site type, showing that the masked shrew are generalists and typically ubiquitous in this region. The masked shrew was able to survive in varying vegetation volumes and vertical stratification as well as various distances from both temporary and permanent water sources.

The arctic shrew, only found at creeks in this survey, prefers moist areas close to lakes and swamps. However, its numbers tend to decrease with higher water levels (Kurta 1995). Not much is known on the arctic shrews, but in this study, both captures were at wide, slow-moving creeks dominated by sedge and alder.

Since water shrews are species of concern, actions must be taken now to maintain their preferred habitat types. Finding the water shrews in these different habitats may provide aide in the preservation of the populations in the southern range. Captures in mucky, slow-moving streams may mean that the species are adapting to the changes occurring in their environments, which will greatly aide in the preservation of the species.

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Table 1: Site Information

Information for every site and the map number for each site correlating with the map in Fig. 1.

Site Name	Trapping Dates	Map #	Habitat Description
Bergner south	May 31-June 4	1	*Sphagnum* moss dominant w/ small shrubs
Buck Creek	May 31-June 4	2	Small, slow-moving stream with sedge dominant
Firestone A/B	May 31-June 4	3	*Sphagnum* moss dominant w/ small shrubs
Hummingbird	May 31-June 4	4	*Sphagnum* moss dominant w/ small shrubs
Wood Duck Pond	May 31-June 4	5	Seasonal Pond
Brown Creek	June 21-25	6	Slow-moving creek w/ dominant sedge and alder
Frodo Bog	June 21-25	7	*Sphagnum* moss dominant w/ small shrubs
Kickapoo Creek	June 21-25	8	Slow-moving creek w/ dominant sedge and alder
Plum Creek	June 21-25	9	Slow-moving creek w/ dominant sedge and alder
Vernal Pond Trio	June 21-25	10	Seasonal Pond
Foggy Creek	July 12-16	11	Shallow, trickling stream w/ dominant sedge
Northgate Bog	July 12-16	12	*Sphagnum* moss dominant w/ small shrubs
Reddington Bog	July 12-16	13	*Sphagnum* moss dominant w/ small shrubs
Vernal Ponds 5, P, Roach	July 12-16	14	Seasonal Pond
Ward Lake	July 12-16	15	Shallow, trickling stream w/ dominant sedge

Table 2: Site Data

List of the measured data for each of the sites.

Site	Levin's	TVV	Dist.f/ Perm H2O	Dist f/ Temp H2O
Bergner	524.941	0.6000	30.00	0.000
Brown	159.600	1.0133	1.80	0.300
Buck	175.195	0.9600	1.09	0.000
Firestone	149.100	0.9467	8.10	1.200
Foggy	130.084	1.1933	0.90	0.000
Frodo	730.667	0.4933	65.50	7.000
Hummingbird	121.800	0.7733	30.60	0.700
Kickapoo	175.469	1.0000	5.30	0.000
Northgate	71.400	4.5333	2.40	0.800
Plum	135.302	1.1867	12.30	0.200
Reddington	251.078	0.9000	1.00	13.200
V.P.5, P, &Roach	86.100	0.5467	58.20	0.000
Vernal trio	1299.944	4.2000	218.40	1.200
Ward	135.098	1.0867	0.60	0.000
Wood duck	617.104	0.5533	327.50	0.700

Table 3. Correlation Testing Results

Correlation testing comparing the number of each shrew species captured vs. vegetative and habitat measures. The *r* value is presented, with , p-value in parentheses. The results in bold are statistically significant. The species names are abbreviated using the first two letter of the genus and species.

Species	TVV	Levin's	Dist. F/ Temp. Water	Dist. F/ Perm. Water
BLBR	**-0.518 (0.048)**	**0.560 (0.030)**	-0.141 (0.617)	0.292 (0.291)
SOCI	0.382 (0.160)	-0.001 (0.998)	0.272 (0.328)	-0.166 (0.554)
SOAR	0.321 (0.244)	-0.205 (0.463)	-0.176 (0.530)	-0.214 (0.445)
SOPA	0.279 (0.314)	-0.194 (0.488)	**0.601 (0.018)**	-0.271 (0.328)

Table 4: Site Capture Data and Trap Success

Data of the species captured and trap success of all fifteen sites.

Site	Species Captured	Number Captured	Trap Success	Total Captures	Overall Trap Success
Bergner		0	0	0	0
Firestone		0	0	0	0
Frodo Bog	SOCI	6	0.015	6	0.015
Hummingbird		0	0	0	0
Northgate Bog	SOCI	5	0.0125	5	0.0125
Reddington	SOCI	3	0.012	6	0.024
	SOPA	3	0.012		
Ward	SOCI	1	0.004	2	0.008
	SOPA	1	0.004		
Brown	SOCI	8	0.02	11	0.0275
	SOAR	3	0.0075		
Buck	SOCI	2	0.005	3	0.0075
	BLBR	1	0.0025		
Foggy	BLBR	2	0.005	2	0.005
Kickapoo	SOPA	2	0.006666667	3	0.01
	SOAR	1	0.003333333		
Plum	SOCI	2	0.006666667	4	0.013333
	SOPA	1	0.003333333		
	SOAR	1	0.003333333		
VP 5, P, & Roach	SOCI	4	0.01	4	0.01
Vernal Trio	SOCI	2	0.005	5	0.0125
	BLBR	3	0.0075		
Wood Duck Pond		0	0	0	0

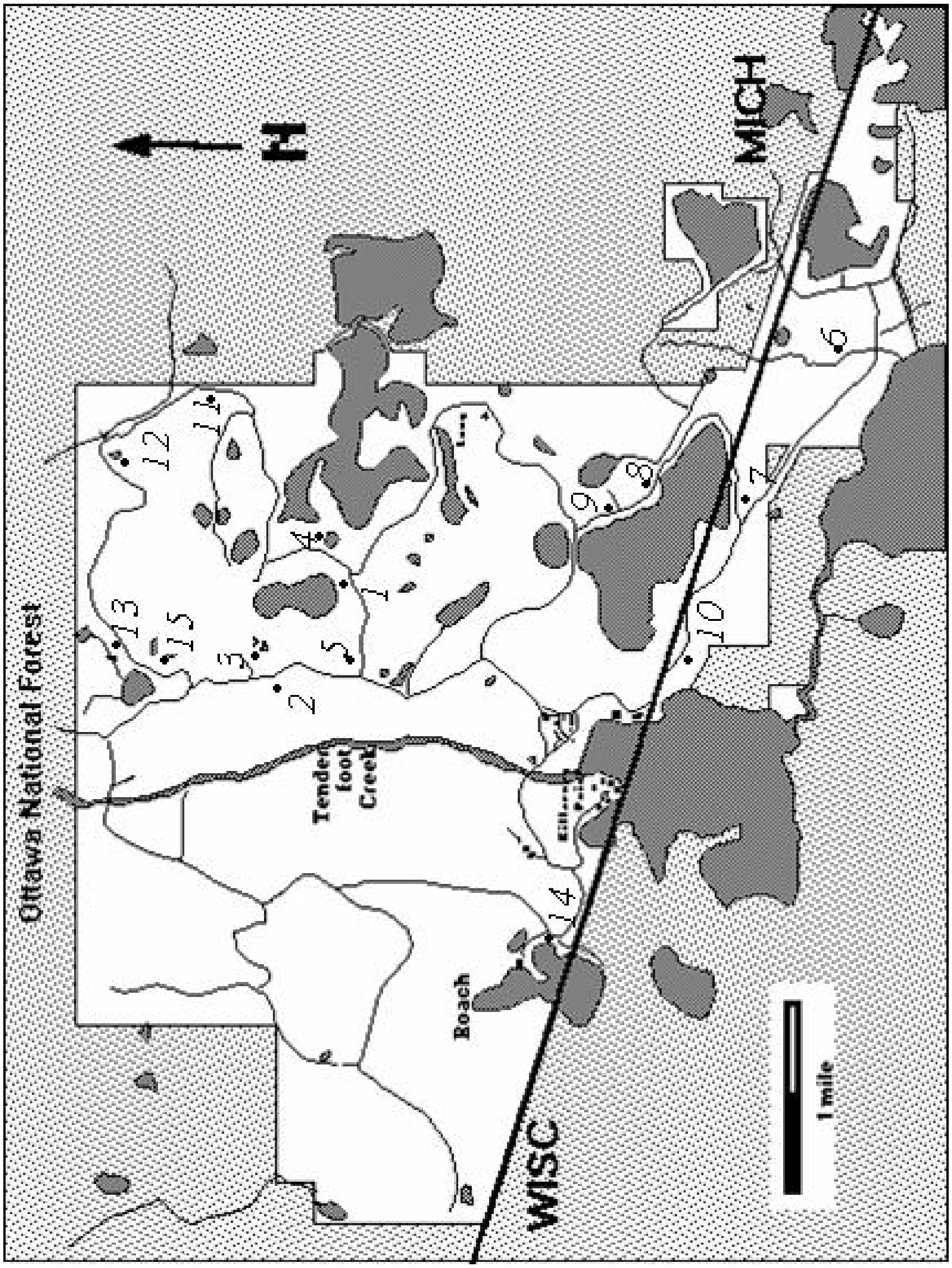

Fig. 1: Map of the Property
Locations of all fifteen sites are located on this UNDERC property map. Map numbers are matched to sites in Table 1.