Water Shrews in Minnesota

Project Summary

prepared for

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INTRODUCTION

The purpose of this study was to gain a better understanding of the biology and distribution of the water shrew (Sorex palustris) and the methods by which water shrew populations can be estimated. In Minnesota, water shrews have been reported in 17 counties (Hazard, 1982), primarily in the northern third of the state. There are sporadic occurrences throughout the remainder of the state suggesting that water shrews may to be more common than current records indicate if appropriate sites and trapping strategies are selected.

The dependence of Sorex palustris on aquatic or semi-aquatic habitats is well-documented (Spencer and Pettus, 1965; Wrigley et al., 1979). However, water shrews have also been reported in more upland sites (Whitaker and Schmeltz, 1973). Although this animal forages at or very near the water-edge (Spencer and Pettus, 1965), its dependence upon aquatic prey has not been conclusively documented. For example, several studies suggest that terrestrial insects (Hamilton, 1930) or slugs and earthworms (Whitaker and Schmeltz, 1979) comprise a majority of the diet.

The specific objectives of this study were to determine: (1) if the recorded distribution and abundance of Sorex palustris in Minnesota is complete; (2) the effectiveness of different trapping strategies for sampling water shrew populations; (3) the vegetative and physical characteristics of habitats occupied by S. palustris; and (4) the location of foraging for this species.

METHODS AND MATERIALS

Study Areas: Two areas were selected for this study. The primary study area was the LABS (Linneman Avian and Botanical Sanctuary) tract located at T 142N, R 29W, sec. 4, NE 1/4. (Fig.1) This 142.5 acre tract of land in Stearns County is owned by the College of St. Benedict and is maintained as a natural area. Three study sites in the LABS tract were selected for trapping: Site 1 bordered the South Fork of the Little Watab River; Site 2 was just south of the confluence of the South and North Forks of the Little Watab; and Site 3 was just north of the confluence of the South and North Forks. Diagrams of these areas are provided in Figures 2-4.

The other study area was Itasca State Park (ISP) and environs in Clearwater County. This area was selected for its more northerly location within the range of the water shrew in Minnesota (Hazard, 1982). Seven sites at Itasca were trapped: Site 1 - Boutwell Creek (T 143N, R 36W, Sec. 15, NE 1/4): Site 2 - Chambers Creek (T 143N, R 36W, Sec. 15, SE 1/4); Site 3 - Elk Lake (T 143N, R 36W, Sec. 23, SW 1/4); Site 4 - Mississippi River (T 144N, R 36W, Sec. 34, SE 1/4); Site 5 - Sucker Creek (T 144N, R 36W, Sec. 33, NW 1/4); Site 6 - LaSalle Creek (T 143N, R 35W, Sec. G, NE 1/4); and Site 7 - Chill Creek (T 144N, R 36W, Sec. 14 NW 1/4). Sites surveyed twice are plotted on the topographic map in Fig 2 and all sites are diagrammed in in Figures 5-12.

Trapping Strategy. Saturation trapping, continuous-selective trapping, and water surface trapping (floating traps) were the trapping strategies employed in this study. Saturation trapping involved placement of 150 snap traps three abreast in 50 successive settings. The three traps in each setting were placed at 0-1, 1-2 and 2-3 meters from water. Continuous-selective trapping consisted of 30 snap traps placed very selectively in sites such as undercut stream banks, rodent runways at the water's edge and partially submerged logs that have been reported to be prime water shrew habitat (Wrigley et al., 1979; Conaway, 1952). Floating traps were prepared by attaching standard snap traps to styrofoam blocks. These traps were anchored by weighted lines and were distributed three abreast at 0-1, 1-2 and 2-3 meter distances from shore. Thirty floating traps were placed in position during saturation and continuous-selective trapping of each area.

Three different baits were used in each trapping regime. A "standard" mixture was prepared from peanut butter, rolled oats and bacon grease. An "anise" bait was prepared by adding anise oil to the standard mixture for additional scent. An "arthropod" bait was prepared from a mixture of insects, arthropods and earthworms homogenized in a blender. The baits were rotated during trap placement to insure an equal representation of baits at each trap position.

Traps were set only in semi-aquatic to aquatic habitats. Non-aquatic controls were not performed because of time limitations and the consistent association of water shrews with aquatic habitats (Wrigley et al., 1979; Conaway, 1952; Spencer & Pettus, 1966). All traps were generally within 3 meters of water and typically closer.

Study sites were surveyed for two or three successive nights, conditions permitting. The most promising sites were trapped twice with a minimum of two weeks between surveys.

Total trap nights were calculated as the number of traps set per night times the days trapped. Available trap nights were calculated as the total trap nights minus the number of snapped and/or missing traps times 0.5. Indices of trapping success were calculated as the number of animals captured per available trap night.

Vegetation Analyses. Plants were collected and preserved as herbarium specimens by standard techniques. All nomenclature follows Gleason and Cronquist (1963). Herbarium specimens were deposited in the College of St. Benedict/St. John's University Herbarium (CSB)

Semi-quantitative analyses of plant communities were made on randomly distributed 0.5 m^2 quadrats. Abundance was estimated by an abundance scale adapted from Shimwell (1972). Cover was estimated by the Braun-Blanquet cover scale (see Kuchler, 1967). Relative frequency was calculated as the percent of quadrats in which a species occurred.

RESULTS

In this study, 10 sites in two different regions of Minnesota were trapped for small mammals. One study site was located within the boreal forest (Itasca State Park) and the other (LABS tract) was within the deciduous forest. Trapping was carried out on 31 nights during the summer of 1984 (Table 1). At each site an effort was made to use each of the three different trapping strategies (continuous-selective, floating, saturation). In some instances, concurrent trappings of two sites or logistic problems prevented deployment of all methods. A total of 8148 trap nights represent the trap effort for this study (see Table 1).

One hundred ninety small mammals representing at least 10 species (*Peromyscus maniculatus* and *P. leucopus* were not distinguished) were captured (Table 2). Of these, 116 were trapped at Itasca State Park and 74 in the LABS tract. Trapping success at the two sites was similar (Table 3). Indices of success for all mammals captured by each method are virtually identical indicating that the two areas were equally productive habitats for small mammals.

In the LABS tract, five species were captured (Table 2). The predominant species encountered in traps were Zapus hudsonicus and Microtus pennsylvanicus which represented 56.8% and 29.7% of the total captures in this area, respectively. Five water shrews were trapped, which represented only 6.8% of the total animals captured. Blarina brevicauda and Peromyscus spp. were the least common animals observed (4.1% and 2.7% of the total, respectively).

At Itasca State Park, 10 species of small mammals were captured (Table 2). Zapus hudsonicus was again the predominant animal (36.2% of the total animals taken in this area) and was followed in abundance by Peromyscus spp. (19.8%), M. pennsylvanicus (18.1%) and B. brevicauda (12.9%). Synaptomys cooperi, Condylaura cristata and Sorex arcticus were represented by a single capture, Eutamias minimus by two captures. The latter four species were not observed in the LABS tract. Two water shrews (1.7%) and 8 masked shrews (Sorex cinereus; 6.9%) were trapped in this area.

A comparison of the indices of success for the three trapping strategies for all species is provided in Table 3. The floating traps proved ineffective for all species including S. palustris. In fact, only 2 of the 190 animals (both Z. hudsonicus) were trapped by this method. Prolonged use of floating traps in site 1 of the LABS tract and Sites 1 & 2 at Itasca did little to improve the efficacy of this technique. When it became apparent floating traps were not productive, the deployment of this method was terminated in favor of saturation and continuous-selective trapping.

Continuous-selective trapping appears to be the most effective trapping strategy for all mammals (Table 3). Approximately a twofold increase in trapping success (.021 vs. .043) was realized with the more careful placement of continuous-selective traps. These data suggest that the most productive trapping strategy for all species involves careful placement of traps in select rodent haunts.

Sunken pit traps were set on a trial basis at one Itasca site during the second week of June, 1983. Ten traps, which consisted of a #10 can buried to the rim, were placed along a small stream near the University of Minnesota Biological Field Station in Itasca State Park. Placement was laborious, involved severe habitat disruption and several traps filled with mud and water following a heavy rainfall. Further, seven of the 10 traps were displaced to some degree by the rains. For these reasons, this method was abandoned. Spencer and Pettus (1965) used sunken pit traps to capture water shrews in a Colorado marsh and recorded low indices of success (from .0001 to .0005). Although water shrews may have escaped from their traps, this rate was much lower than that achieved by continuous-selective or saturation trapping in either area of this study and supports the decision to terminate utilization of this method.

Analysis of trapping success for just water shrews (Table 4), indicates that the continuous-selective trapping was also the most effective strategy for this species. Continuous-selective trapping was almost three times more effective than saturation trapping in the LABS tract. In contrast, at Itasca State Park no water shrews were taken by the continuous-selective strategy. This difference in trapping effectiveness occurred because water shrews were found in only one site at Itasca State Park (Sucker Creek - #5) that was only saturation trapped.

Comparison of the total index of trapping success for water shrews in each study area (Table 4) suggests a higher density of S. palustris in the LABS tract. On the basis of trap night effort, our success rate for this species was three times greater in the LABS tract (.0016) than at ISP (.0005).

Water shrews did not appear to have a preference for any of the baits used in this study (Table 5). An approximately equal number of shrews was trapped with each bait (standard, anise, or arthropod). A larger data base is required before more definitive conclusions concerning bait preference can be made.

To determine if a relationship exists between rain and S. palustris foraging, water shrew captures were compared to local weather data (Table 6). All the water shrews captured in this study occupied traps during overcast and/or rainy weather. The evenings of back-to-back shrew captures at the LABS tract (8-16, 8-17) and Itasca (8-3, 8-4) are of particular interest since both of these trapping periods were characterized by moderate-to-heavy rainfall. Although only 0.16 in. was measured at the University of Minnesota Biological Field Station on August 3rd, it is likely that other parts of the Itasca region received considerably more rain. A heavier rainfall at Sucker Creek (#5) would account for the large number of snapped (151) or missing (42) traps for that date.

Proximity to the water-edge appears to be an important requisite for capturing S. palustris. Of the seven specimens logged for this study, five were captured within 15 cm. of water (Table 7). The remaining two water shrews were trapped in tall grass adjacent to mud flats within 2 meters of the water.

To summarize the captures of S. palustris, seven animals were trapped during this study (Table 2). Of these, five were captured in the LABS tract. Three of these water shrews were trapped in Site 3 and one each in sites 1 and 2. These data suggest that the three sites in LABS tract were relatively similar and that water shrews were uniformly distributed in this area. Both water shrews at Itasca State Park were trapped at Sucker Creek (Site 5) and none in any other site despite a significant trapping effort. These data suggest water shrews are not abundantly distributed in all "likely-looking" habitats. Rather, water shrews are restricted to specific locales.

Plant community analyses supported the above conclusions that the LABS tract study sites were relatively uniform. Approximately 27 species of vascular plants were collected in or near the study area (Table 8). Of these, most were uncommon. Semi-quantitative estimates of cover, abundance and frequency indicated that Phalaris arundinacea (Reed canary grass) was by far the dominant species (Tables 9, 10, 11). This species was found in 100% of the quadrats surveyed, was extremely abundant in each site and covered more than 70% of each site. In addition, a few forbs were observed (Impatiens biflora, Ribes spp. and Urtica dioica) and scattered willows (Salix spp.) and alders (Alnus rugosa) were found, mostly bordering the stream (Figures 3, 4, and 5). Thus, this area is characterized by a stream flowing through a grass-dominated marsh with a few forbs and small shrubs (willows and alders).

Maps of the Itasca State Park sites trapped are provided in Figures 5-12. Estimates of plant cover, abundance and frequency were made for Boutwell Creek (Site 1), Elk Lake (#3), Mississippi River (#4) and Chambers Creek (#2) but are not included. Because Sucker Creek was one of the last sites trapped, there was not time for a community analysis. A list of species collected at Sucker Creek is provided in Table 12. Several grasses, sedges and rushes were collected but not identified because they lacked reproductive structures. Phalaris arundinacea was not one of the grasses in this site.

ISP sites, like the LABS tract site, share similar features including a moving stream and grass-dominated banks with scattered shrubs. There does not appear to be a major difference in habitat or vegetation type between Sucker Creek (#5), the only ISP site where water shrews were trapped, and the other sites.

There is little similarity in the species of plants occurring in the areas (LABS #1,2,3; ISP #5) in which water shrews were trapped. As previously discussed, the LABS sites were dominated by P. arundinacea but few other forbs, grasses or woody plants. Sucker Creek lacked P. arundinacea but did have an extensive area comprised of several species of grasses and sedges (not identified). Further, several plants were collected at Sucker Creek (and the other ISP sites) that did not occur in the LABS tract (see Tables 8 and 12). These data suggest that specific plant species are not a prime factor in determining shrew distribution, but rather, is dependent upon some other attribute of the environment.

DISCUSSION

The purpose of this study was to obtain a better understanding of the biology of the water shrew, Sorex palustris. The original proposal which emphasized trapping water shrews in Central Minnesota, was amended to provide an opportunity to trap areas (Itasca State Park) in which water shrews had previously been reported. This change was recommended by the proposal reviewers. As a consequence of conducting a larger portion of this study in northern Minnesota the original proposal was slightly modified to compensate for additional travel and lodging and board for field assistants.

Two areas in Minnesota, one each in the southern and the northern portion of the range of water shrews, were trapped. Numerous small mammals were trapped in both locations during the course of this investigation. However, few water shrews were captured. Sorex palustris was uncommonly trapped by the methods employed in this study and suggests that this species is not common in Minnesota. Wrigley et al. (1979) also observed that water shrews were among the least common shrews captured in a thorough study of Manitoba wetlands.

The occurrence of water shrews in distinctly different vegetation zones (coniferous forest - ISP, deciduous forest - LABS) indicates that this species is not restricted to the coniferous region of Minnesota, which is generally considered to be their prime habitat. Further, the selection of a suitable site by water shrews must not be dependent on the specific vegetation since they occur in markedly different habitats.

Although the species of plants in the site does not appear to be important, several other factors do seem important. The features common to the sites in which water shrews were trapped (LABS - 1,2,3; ISP - 5) include: (1.) aquatic habitats with a moving stream; (2.) an abundance of grasses and sedges frequently occurring in clumps or hummocks; and (3.) mud flats formed from the drainage of adjacent lowlands after periods of high water. Periodic flooding may also be important. For example, water levels in the LABS tract fluctuated greatly during the course of this study and appear to be following a similar pattern this spring (1984).

Water shrews have consistently been observed in aquatic habitats as observed in #1 above. In this study, five of seven water shrews were captured within 15 cm. of water and the others were within 2 meters along mud flats in tall grass. Wrigley et al. (1979) reported that 92% of the water shrews they trapped occupied hydric communities. None occurred in xeric habitats and 8% were found in mesic sites (and water courses ran through many of these). Hazard (1982) and Jackson (1961) also state that water shrews are seldom far from water, especially running water.

The association of water shrews with grassy marshes (#2 above) noted in this study supports observations by other investigators. In Manitoba, 54% and 47% of the water shrews trapped in hydric environments were taken in grass-sedge marshes and willow-alder alder fens, respectively (Wrigley et al., 1979). Jackson (1961) reports that water shrews occur in marshes and suggests that the presence of trees and shrubs is also important. Trees and shrubs were in close proximity to all traps in this study; however, our data do not seem to support an intimate correlation between woody plants and shrew activity.

In contrast, Whitaker and Schmeltz (1979) report that none of the 28 water shrews they trapped in St. Louis County, Minnesota were near a stream or major body of water. Although a satisfactory explanation for this contradiction is lacking, it is possible that the water shrews were trapped during a rainy period which appears to correlate with water shrew activity (Table 6).

Beaver activity may be another ingredient for the formation of water shrew habitat. Wrigley *et al.* (1979) and Jackson (1961) report an apparent association between water shrews and beaver or muskrat lodges. Although no beaver activity was observed in the LABS tract sites during summer 1983, cuttings and an old dam were present in site 3 (which was the site of the greatest number of shrews trapped). This spring (1984) beaver activity was observed adjacent to the study sites. At ISP, failure to capture water shrews after extensive trapping in several sites (1,2,3,4) prompted exploratory trapping in other sites (5,6,7) with evidence of beaver activity (in addition to the criteria specified above). These efforts were rewarded with the capture of two water shrews in site 5 (Sucker Creek); one just above a beaver dam and the other below. Thus, all the water shrews taken during this study were trapped near recent beaver activity.

Water shrews captures were also associated with the meadow jumping mouse (*Zapus hudsonicus*). This mammal was captured in relatively large number in every site that water shrews were found. These data suggest that these species occupy similar habitats and that capture of *Z. hudsonicus* in "ideal" water shrew habitat (i.e. moving stream, grass marsh, beaver activity) may indicate the presence of the less common water shrews. Wrigley *et al.*(1979) also observed a correlation between captures of *Z. hudsonicus* and *S. palustris*.

In contrast, *Peromyscus* spp. is typically an upland species (Hazard, 1982; Jackson, 1961) and their presence in an area may indicate an unsuitable habitat (too dry) for water shrews. *Peromyscus* spp. was uncommon in the

LABS tract (only two were taken) but was more abundant in ISP sites (14 total). They did not occur in Sucker Creek, the only site where S. palustris was trapped.

It is interesting to note that Sorex cinereus was found in several sites at ISP (1,2,3,4) but S. palustris was not trapped in any of these sites. Sorex cinereus, although a more upland species than S. palustris can occur in semi-aquatic sites (Hazard, 1982; Jackson, 1981). However, its ability to occupy sites of frequent flooding is questionable. Water levels in sites 1-4 at ISP were stable throughout the summer, unlike the LABS tract sites. The appearance of S. cinereus and Peromyscus spp. in a habitat may thus be a negative indicator for optimal S. palustris habitat.

Traditional trapping methods (continuous-selective and saturation) were the most effective means used in this study to survey S. palustris populations. Floating traps proved ineffective or were fraught with technical difficulties. Careful trap placement increases trapping success for S. palustris (Conaway, 1952; Wrigley et al., 1979). The higher success ratio for continuous-selective trapping strategies for all species (Table 3) and S. palustris in particular (Table 4) may relate to "learned path" habits (Lorenz, 1952). Lorenz (1952), in observing water shrew behavior, found these nearly blind mammals to be "as strictly bound to their foraging paths as a railway engine to its track and unable to deviate from them". Randomly placed saturation traps are thus less likely to intersect path habits of rodents in general and particularly the paths frequented by nearly blind insectivores. It is surprising no water shrews were taken by floating traps considering their aquatic nature.

Our captures of S. palustris did not provide an adequate body of data to compare the efficacy of different baits. Water shrews did not appear to demonstrate a significant preference for either a standard, anise or arthropod bait.

SUMMARY

In conclusion, this study has demonstrated that:

1. Water shrews occur in a wet marsh in Central Minnesota (LABS tract) and in northern Minnesota (ISP).

2. Water shrews were more commonly trapped in the LABS tract than at ISP. This observation was surprising considering ISP is within the prime range of this species but the LABS tract is on the margin of the reported range for this species.

3. Water shrews occur in aquatic habitats in a deciduous or coniferous forest.

4. Water shrews were uncommonly trapped in the LABS tract and ISP.

5. Water shrews appear to be associated with moving streams bordered by a grass-sedge marsh that periodically floods and has occasional mud flats.

6. Water shrews appear to be associated with beaver activity.

7. Water shrews were most effectively trapped by continuous-selective trapping in undercut stream banks, along mud flats, etc.

8. Water shrews typically occupy aquatic habitats and apparently forage in this area.

9. Hummocks formed by dense grasses such as *P. arundinacea* may provide cover/runways etc. necessary for water shrew activity.

10. Rainy weather appears to be a period of high water shrew activity.

11. Meadow jumping mice (*Z. hudsonicus*) occupied every site in which water shrews were trapped.

12. *Sorex cinereus* and *Peromycus* sp. may indicate a site unfavorable to water shrews.

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Table 1: Trapping dates and total available trap nights by method for each site in this study. Available trap nights are calculated as the number of traps set minus the number missing or snapped times 0.5.

			Available Trap Nights		
Area	Site	Dates Trapped	Saturation	Continuous	Floating
	1	6-3, 6-4, 6-5	417	138	206
		7-15, 7-16	429.5	75.5	57
LABS	2	6-7, 6-8, 6-9	435	171.5	110.5
		8-11, 8-12, 8-13	401.5	84.5	58
	3	6-11, 6-12, 6-13	401	57	0
		8-16, 8-17	403.5	80	50
		TOTAL	2496.5	606.5	481.5
	1	6-22, 6-23, 6-24	425	188.5	169.5
	2	6-22, 6-23, 6-24	415.5	251	230.5
		7-30, 7-31, 8-1	429	87	89
	3	6-27, 6-28, 6-29	422.5	26.5	0
ISP		7-30, 7-31, 8-1	411	84	84.5
	4	6-29, 6-30, 6-31	434.5	29	29.5
	5	8-2, 8-3, 8-4	353.5	0	0
	6	8-3, 8-4, 8-5	0	188.5	0
	7	8-4, 8-5	0	188.5	0
		TOTAL	2891.0	1069.5	603

Table 2: Animals captured in LABS tract or Itasca State Park study sites by three trapping strategies (Saturation-continuous selective-floating; N=method not used) during summer 1983. Site locations are provided in the methods section.

Species	LABS Sites				ISP Sites							
	1	2	3	Total	1	2	3	4	5	6	7	Total
Zapus hudsonicus	14-2-0	9-10-1	4-2-0	27-14-1	1-5-1	2-4-0	3-1-0	6-2-0	3-N-N	N-5-N	N-9-N	15-26-1
Microtus pennsylvanicus	4-5-0	6-1-0	3-3-0	13-9-0	2-1-0	4-3-0	5-1-0	1-0-0	1-N-N	N-2-N	N-1-N	13-8-0
Blarina brevicauda	0-0-0	3-0-0	0-0-0	3-0-0	1-0-0	8-0-0	0-3-0	0-0-0	2-N-N	N-1-N	N-0-N	11-4-0
Peromyscus maniculatus *P. leucopus*	2-0-0	0-0-0	0-0-0	2-0-0	1-0-0	3-1-0	14-4-0	0-0-0	0-N-N	N-0-N	N-0-N	18-5-0
Eutamias minimus	0-0-0	0-0-0	0-0-0	0-0-0	0-0-0	0-0-0	0-0-0	0-0-0	0-N-N	N-1-N	N-1-N	0-2-0
Synaptomys cooperi	0-0-0	0-0-0	0-0-0	0-0-0	0-0-0	0-1-0	0-0-0	0-0-0	0-N-N	N-0-N	N-0-N	0-1-0
Condylura cristata	0-0-0	0-0-0	0-0-0	0-0-0	0-0-0	0-1-0	0-0-0	0-0-0	0-N-N	N-0-N	N-0-N	0-1-0
Sorex cinereus	0-0-0	0-0-0	0-0-0	0-0-0	1-0-0	2-0-0	3-0-0	1-1-0	0-N-N	N-0-N	N-0-N	7-1-0
Sorex arcticus	0-0-0	0-0-0	0-0-0	0-0-0	0-0-0	0-0-0	0-0-0	0-0-0	0-N-N	N-1-N	N-0-N	0-1-0
Sorex palustris	1-0-0	0-1-0	2-1-0	3-2-0	0-0-0	0-0-0	0-0-0	0-0-0	2-N-N	N-0-N	N-0-N	2-0-0
			TOTAL:	48-25-1							TOTAL:	66-49-1

Table 3. Index of trapping success for all small mammals trapped by one of three methods at the LABS tract or Itasca State Park sites summer 1983. Index was calculated by dividing the number of captures by the available trap nights.

Area	Method: Saturation	Continuous-Selective	Floating
LABS	.019	.041	.002
ISP	.022	.045	.001
MEAN:	.021	.043	.001

Table 4: Index of trapping success for water shrews based on trapping method or total captures per area at LABS tract or Itasca State Park. Each index was calculated by dividing the number of shrews captured by the available trap nights.

	Index of Trapping Success			
Area	Saturation	Continuous	Floating	Total
LABS	.0012	.0033	.0000	.0016
ISP	.00069	.0000	.0000	.0005

Table 5: Bait preference of water shrews captured at LABS tract and Itasca State Park during summer 1983.

Bait	Shrews captured
Standard	2
Anise	2
Arthropod	3

Table 6: Precipitation data for water shrews capture dates during summer 1983. LABS tract data are provided by US Weather Service, St. Cloud and the ISP data were monitored at the University of Minnesota Biological Field Station, Lake Itasca.

Area	Date	Precipitation (inches)
	6-13	0.40
	6-18	trace
LABS tract	7-16	0.30
	8-16	2.07
	8-17	trace
	8-3	0.16 (thunderstorms)
ISP	8-4	0

TABLE 7: Description of the locations in which water shrews were trapped at LABS tract and Itasca State Park during the summer of 1983

	Site	Date	Capture Site
LABS	3	6-13	Under log approx. 3 in. from stream
	2	6-18	Muddy inlet-less than 6 in. from stream
	1	7-16	In tall grass near mud inlet-close to a beaver dam
	3	8-16	In tall grass approx. 6 in. from inlet of stream
	3	8-17	On muddy flat bank directly adjacent to stream
ISP	5	8-3	Just below beaver dam less than 1/2 ft. from shore
	5	8-4	Just above beaver dam in tall grass with rivulets of running water

Table 8: Plants collected in the LABS tract study sites (1, 2, & 3) during Summer, 1983

Acer negundo L.

Alnus rugosa (DuRoi) Spreng.

Anacharis canadensis (Michx.) Rich.

Convolvulus sepium L.

Cornus amomum Mill.
C. stolonifer Michx.

Echinocystis lobata (Michx.) T. & G.

Equisetum palustre L.

Fraxinus americana L.
F. pennsylvanica Marsh
F. pennsylvanica Marsh. var. *subinteggerima* (Vahl.) Fern.

Galium triflorum Michx.

Geranium maculatum L.

Impatiens biflora Walt.

Onoclea sensibilis L.

Phalaris arundinacea L.

Quercus palustris Muenchh.

Ribes americanum Mill
R. odoratum Wendl.

Rumex spp.

Salix discolor Muhl.
S. interior Rowlee

Thalictrum polygamum Muhl.

Tragopogon dubious Scop.

Ulmus americana L.

Urtica dioica L.

Table 9: Average cover, abundance and relative frequency of vascular plants in the LABS tract site 1, 22 July, 1983, determined in five, 0.5 m^2 quadrats.

Habit	Species	Cover value	Abundance value	Relative Frequency
Grasses/sedges	*Phalaris arundinacea*	4.6	4.2	1.0
Forbs	*Impatiens biflora*	0.6	1.0	0.6
	Urtica dioica	0.2	0.2	0.2
	Ribes spp.	0.2	0.2	0.2
Trees/shrubs	*Salix interior*	0.2	0.2	0.2

Table 10: Average cover, abundance and relative frequency of plants in the CSB LABS tract, Site 2, determined on 26 July, 1983, from seven, 0.5 m^2 quadrats.

Habit	Species	Cover	Abundance	Relative frequency
Grass/Sedge	Phalaris arundinacea	5.0	5.0	1.0
Forbs	Impatiens biflora	0.7	2.0	0.57
	Ribes spp.	0.3	0.3	0.29
	Urtica diocia	0.9	1.3	0.71
Trees/shrubs	Salix discolor	0.7	1.0	0.71
	Salix interior	0.6	0.7	0.29
	Fraxinus pennsylvanica	0.4	0.1	0.14

Table 11: Average cover, abundance and relative frequency of plants collected in the LABS tract, site 3, 16 August, 1983, in five, 0.5^2 m quadrats.

Habit	Species	Cover	Abundance	Relative Frequency
Grasses/Sedges	*Phalaris arundinacea*	5.0	5.0	1.0
	Impatiens biflora	0.4	0.6	0.4
Forbs	*Ribes* spp.	0.2	0.4	0.2
	Urtica dioica	0.2	0.2	0.2
Trees/shrubs	*Salix interior*	1.6	0.4	0.4
	Cornus stolonifer	0.6	0.4	0.4

Table 12: Plants collected at Itasca State Park, Sucker Creek (Site 5); Summer 1983.

Alnus rugosa (DuRoi) Spreng.

Aralia nudicaulis L.

Asarum canadense L.

Caltha palustris L.

Cornus stolonifera Michx.
Cornus spp.

Corylus americana Walt

Equisetum fluviatile L.

Galium spp.

Melilotus alba Desr.

Pontederia cordata L.
Ribes spp.

Viburnum acerifolium L.

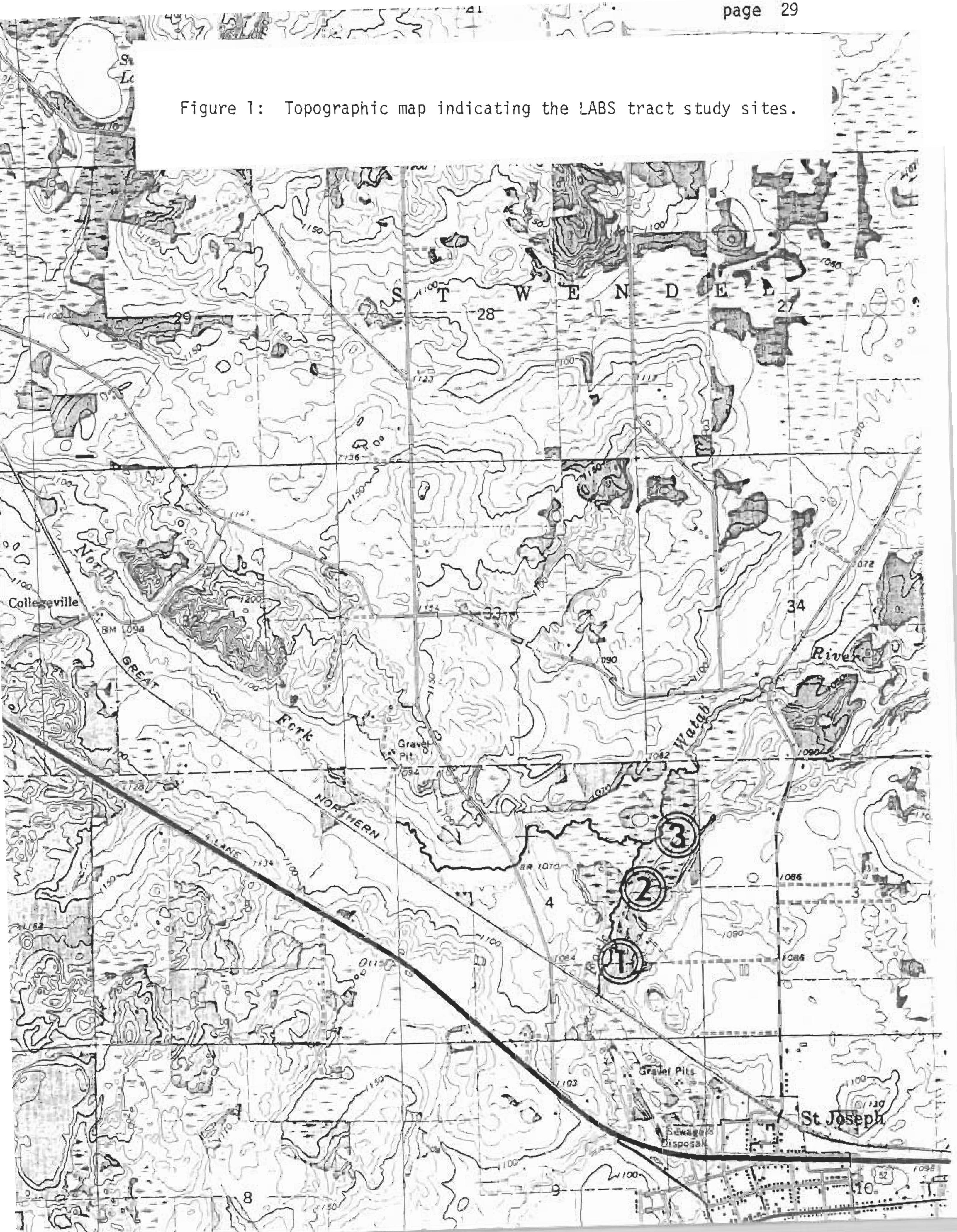


Figure 1: Topographic map indicating the LABS tract study sites.

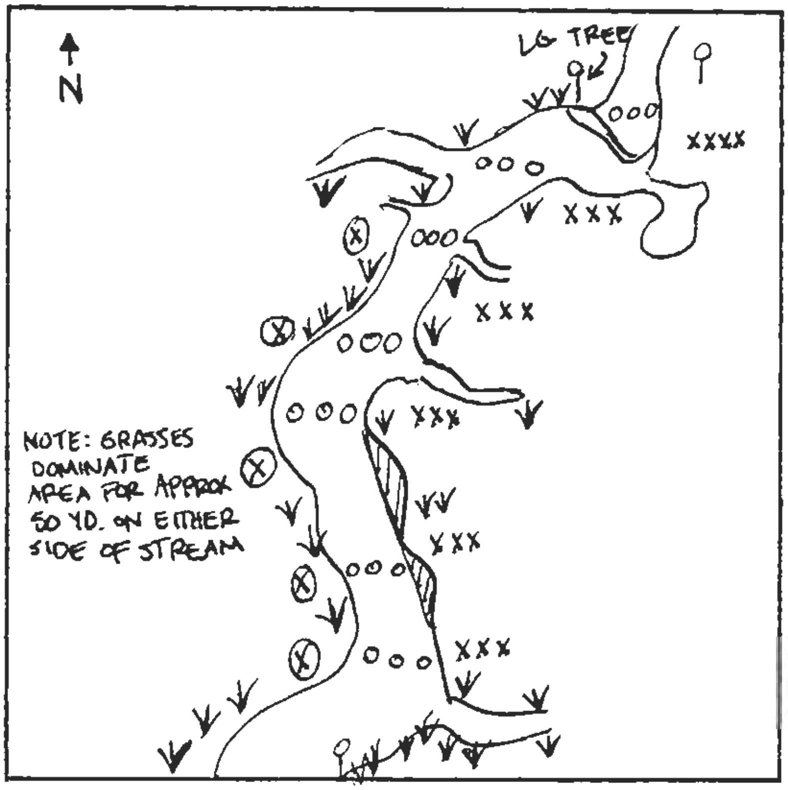
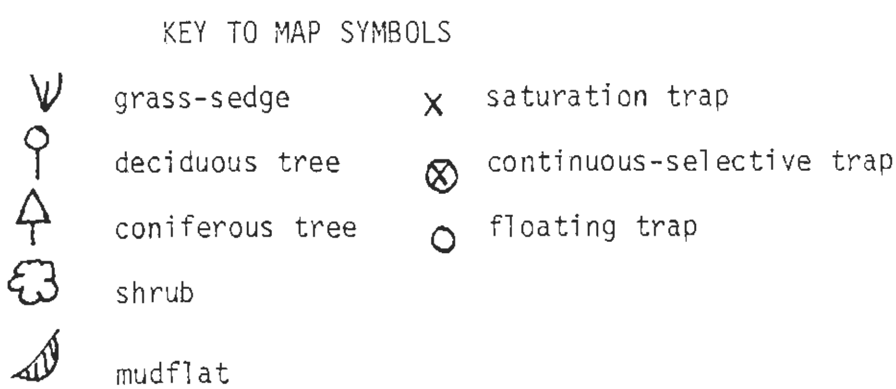


Figure 2: Diagram of the LABS tract study site #1.



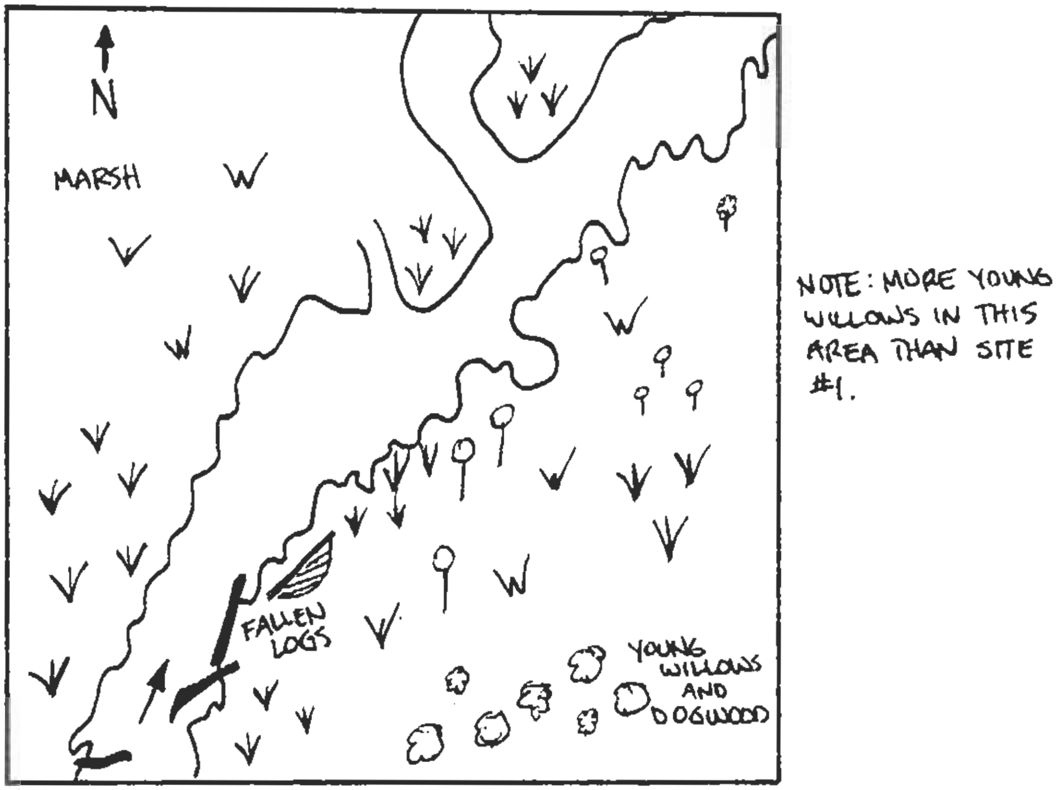


Figure 3: Diagram of the LABS tract study site #2. For a key to symbols see Fig. 2.

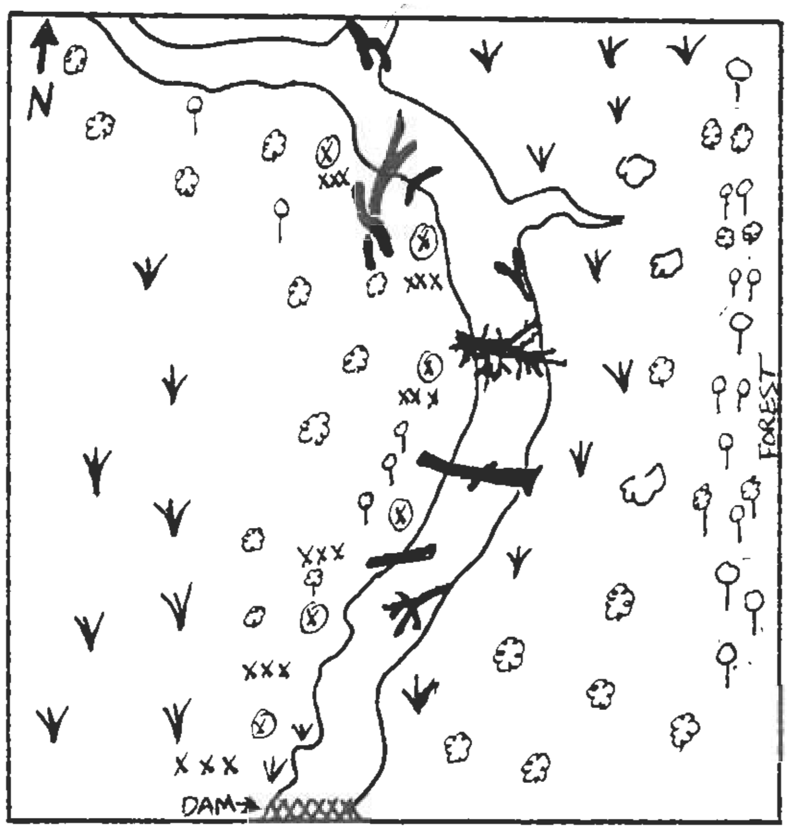
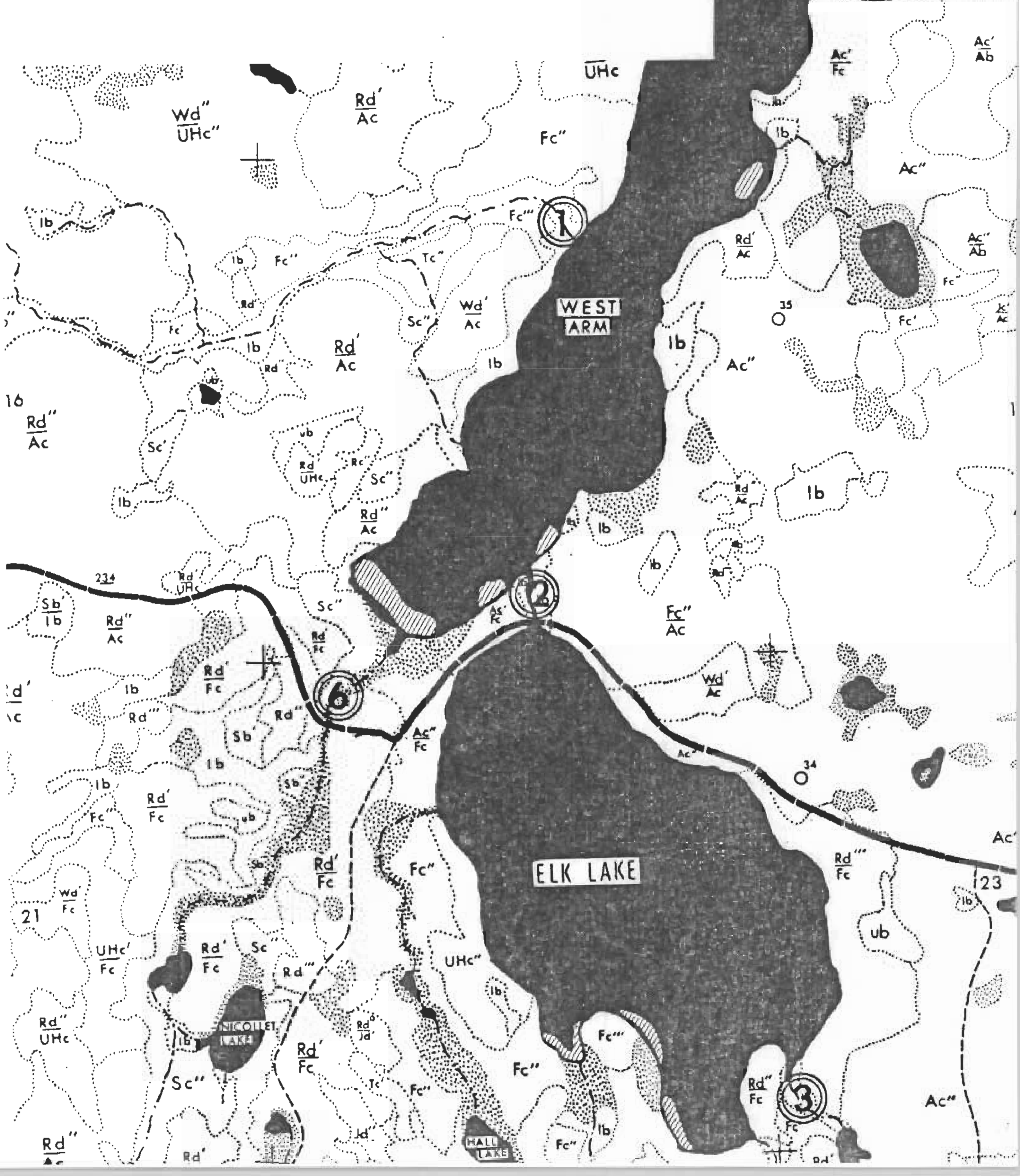


Figure 4: Diagram of the LABS tract study site #3. For a key to map symbols see Fig. 2.

Figure 5: Map indicating the location of Itasca State Park study sites 1, 2, 3 and 6.



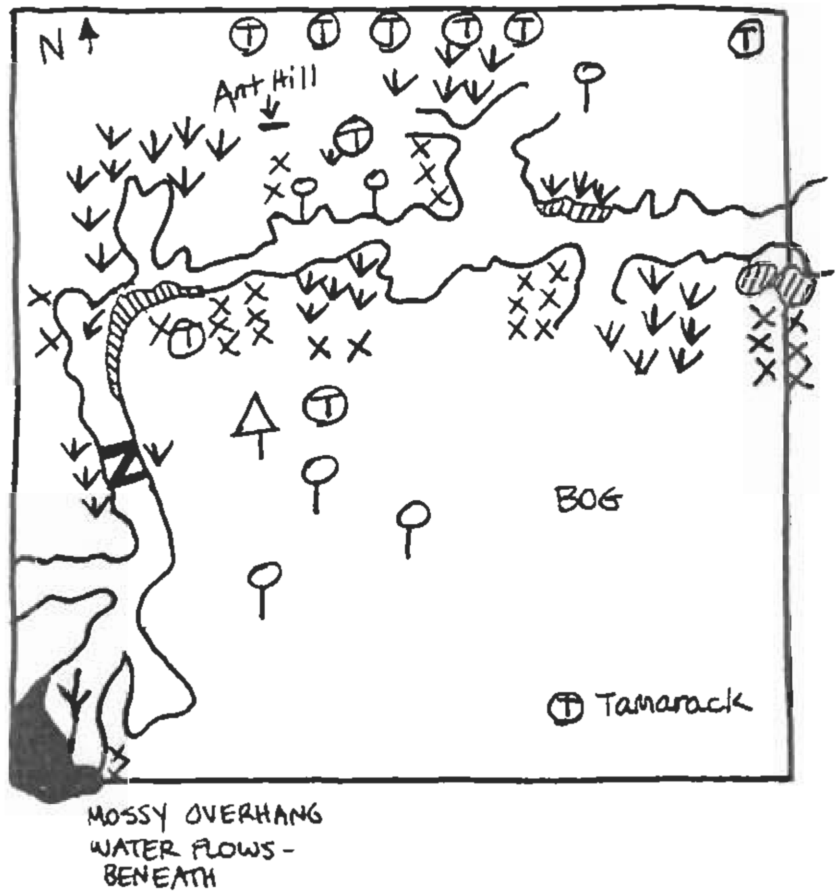


Figure 6: Diagram of Itasca State Park study site #1 - Boutwell Creek. For a key to map symbols see Fig. 2.

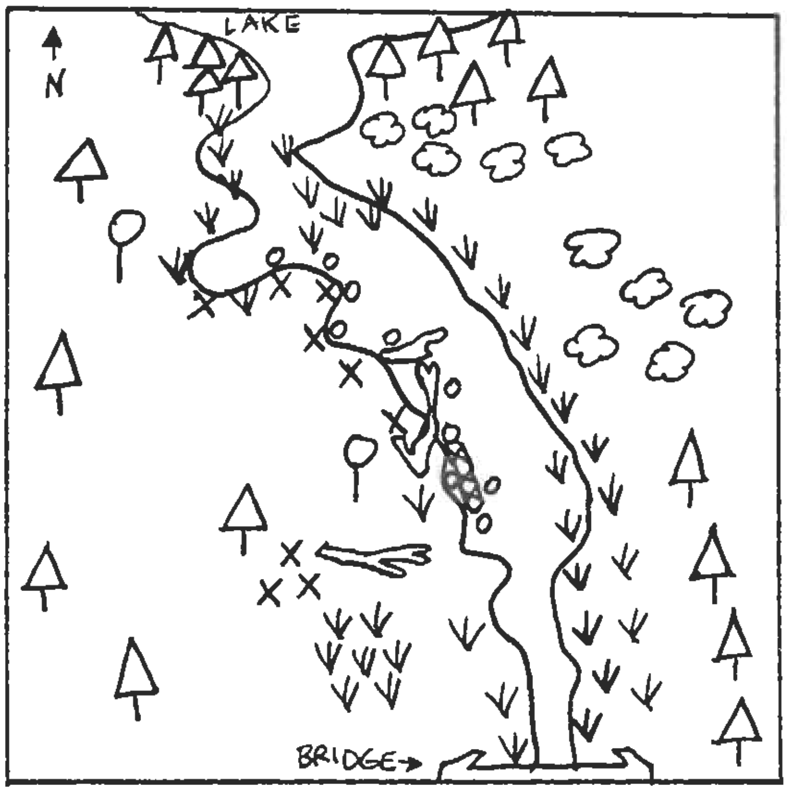


Figure 7: Diagram of Itasca State Park study site #2 - Chambers Creek.
For a key to map symbols see Fig. 2.

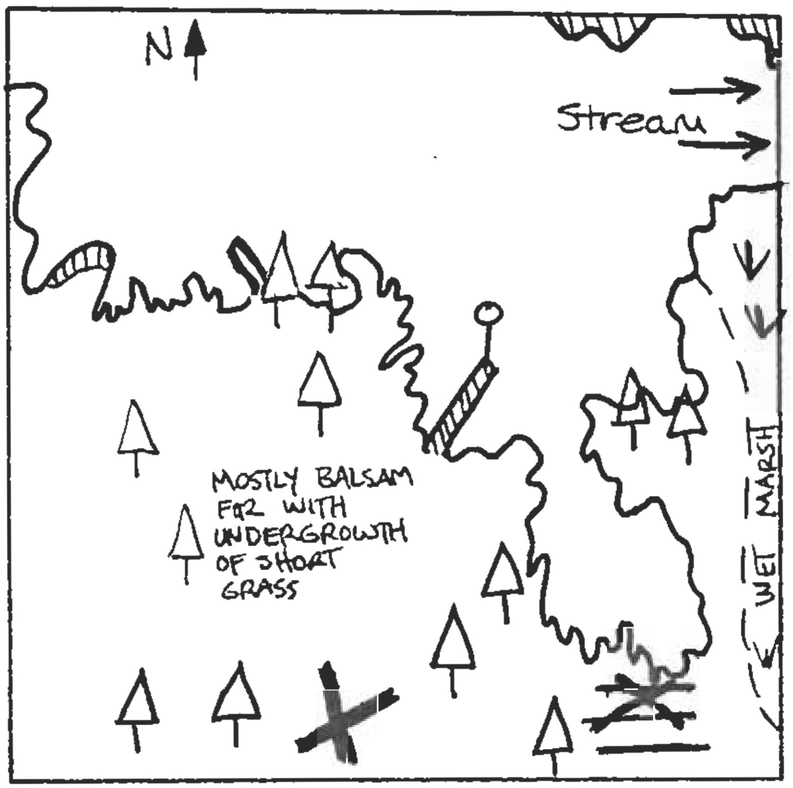


Figure 8: Diagram of Itasca State Park study site #3 - Elk Lake.
For a key to map symbols see Fig. 2.

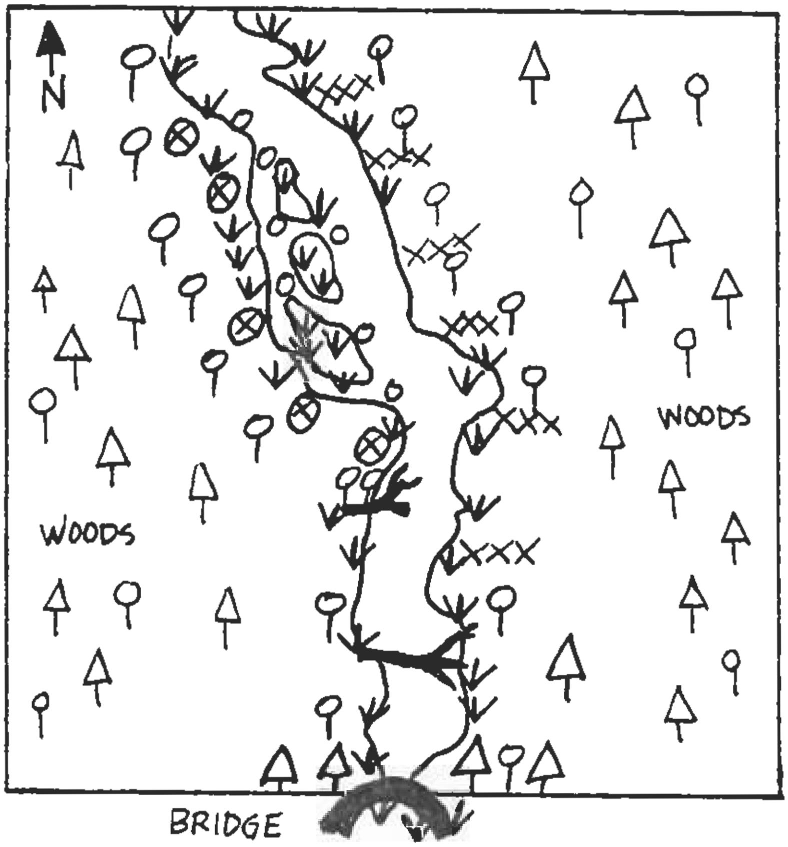


Figure 9: Diagram of Itasca State Park study site #4 - Mississippi River.
For a key to map symbols see Fig. 2.

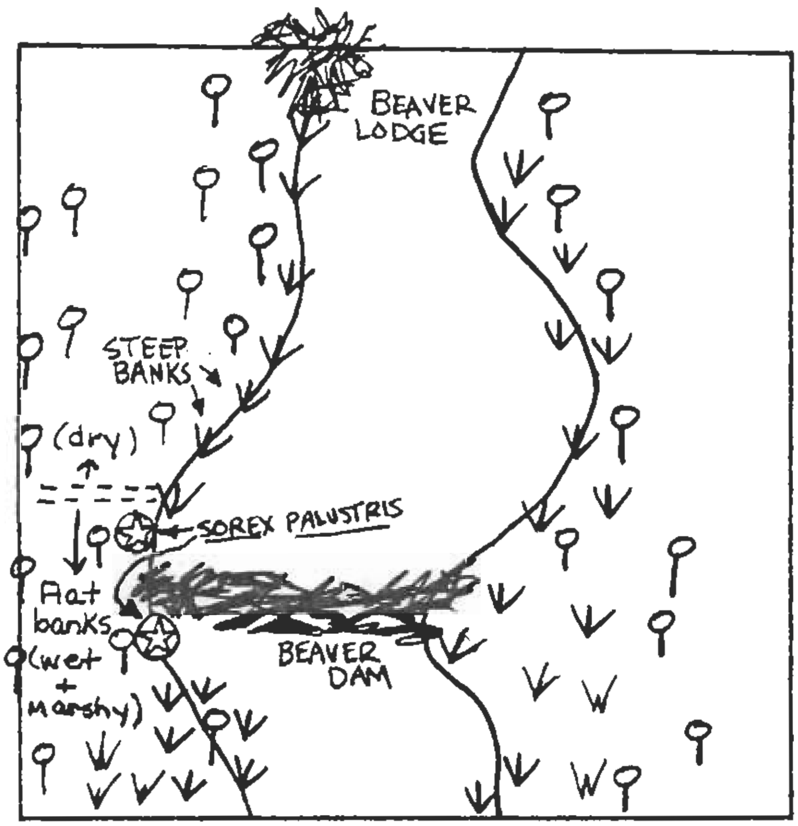


Figure 10: Diagram of Itasca State Park study site #5 - Sucker Creek.
For a key to map symbols see Fig. 2.

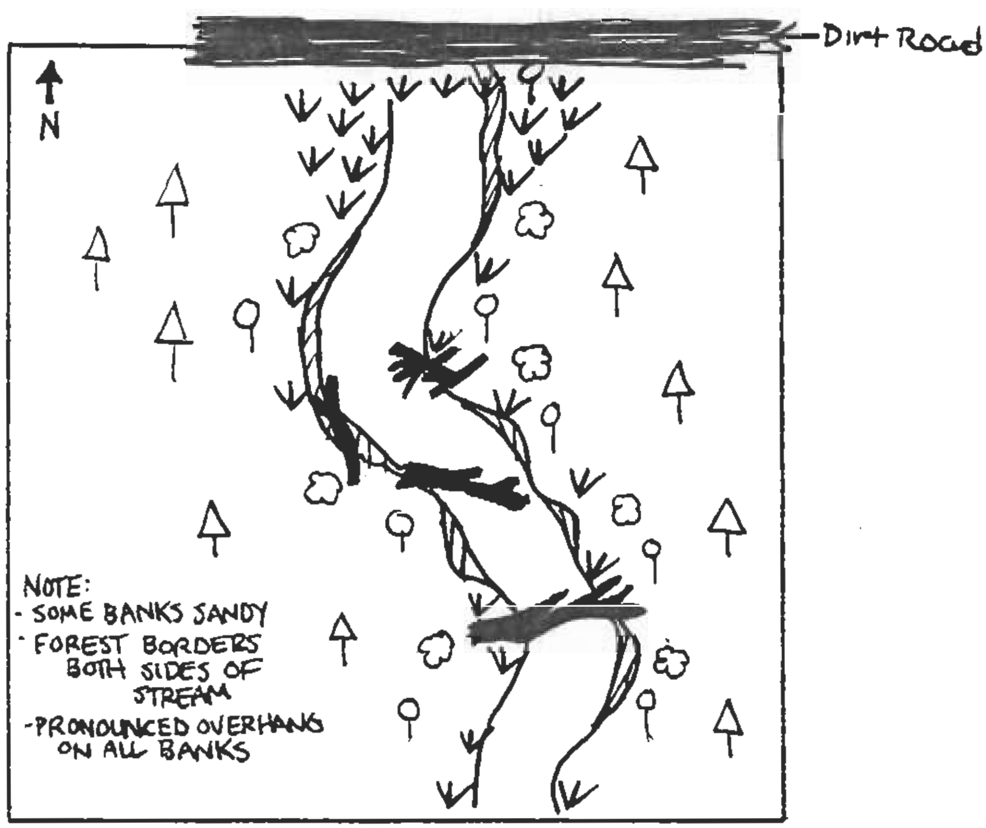


Figure 11: Diagram of Itasca State Park study site #6 - LaSalle Creek. For a key to map symbols see Fig. 2.