The Distribution and Abundance of the Mink Frog in Itasca State Park, Minnesota

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INTRODUCTION

The mink frog, Rana septentrionalis, is a medium sized (Wright and Wright 1949), aquatic (Schmid 1965), boreally distributed (Conant 1975) frog known for the musky odor it emits when handled (Appendix A). This species is most commonly found in areas of slow moving water with abundant aquatic vegetation (Breckenridge 1944) and is common in the Lake Itasca region.

Various sites on and around Lake Itasca in northwestern Minnesota were "spot-censused" at night (in 1981) for vocalizing males to locate the densest breeding populations. This was done in order to maximize the number of behavioral interactions observed during a behavioral ecology project. The area with the densest population of calling males resulted in the capture of only 35 individuals (Tenneson in prep.). A review of mink frog literature and communications with various investigators familiar with this species indicated that current population densities were much smaller than previously had been reported in the area.

Specific objectives of this study are to 1) determine the current abundance of mink frogs at various localities in Itasca State Park, 2) establish baseline population data at several sites for future studies, 3) utilize population data from previous years to determine population trends, and 4) report previously unpublished records of mink frog sitings

in Minnesota.

MATERIALS AND METHODS

The study was initiated on 18 June 1982 and was terminated on 27 August 1982. Mark-recapture data were gathered on a total of 24 nights; all after dark and until those areas to be sampled for that night were visited. Few samples were taken in July due to a time conflict with an ongoing behavioral ecology project (Tenneson in prep.).

This study was performed within the boundaries of Itasca State Park in northwestern Minnesota (Figure 1). Twelve localities were chosen as potential study sites based on previous mink frog population estimates and their ease of access (Figure 2). These sites are (in alphabetical order):

1) Bog D, Hubbard County: A small (approx. 125 sq. m.) body of open water surrounded by floating bog located at SE1/4 SE1/4 NW1/4 section 30, T143N, R35W.

2) Deming Lake, Hubbard County: A medium sized (approx. 360 sq. m.) lake surrounded by mesic deciduous forest typical of the region located at SW1/4 SW1/4 section 30, T143N, R35W.

3) Enclosure site, Clearwater County: A medium sized (aprrox. 100 m. of shoreline) bay on the east shore of Lake Itasca. Adjacent to mesic

deciduous forest. This site was where an enclosure was constructed to facilitate observation of mink frog social interactions and is located at SW1/4 SE1/4 SE1/4 section 2, T143N, R36W.

4) East Twin Lake, Hubbard County: A medium sized (approx. 300 sq. m.) lake surrounded by floating bog located at SW1/4 NE1/4 SW1/4 section 30, T143N, R35W.

5) Floating Bog Bay, Clearwater County: A large (approx. 800 m. of shoreline) bay on Lake Itasca bound by floating bog and choked by wild rice (Zizania aquatica) located at SE1/4 NE1/4 section 11, T143N, R36W.

6) French Creek Bay, Clearwater County: A large (approx. 550 m. of shoreline) bay on Lake Itasca bound by floating bog, choked by wild rice, and located at S1/2 SW1/4 section 2, T143N, R36W.

7) Schoolcraft Island, Clearwater County: The only island on Lake Itasca. In past studies the mink frog was found most abundantly along approximately 80 m. of the northwest shoreline of the island. This portion of the island is bound by floating bog and choked with wild rice. It is located at NE1/4 NW1/4 section 11, T143N, R36W.

8) South Deming Pond, Hubbard County: A small (approx. 100 sq. m.) body of water surrounded by mesic deciduous forest located at NE1/4 SW1/4 section 30, T143N, R35W.

9) South Entrance Pond, Hubbard County: A medium sized (approx. 250 sq. m.) body of water surrounded by floating bog and located at NE1/4 SE1/4 section 31, T143N, R35W.

10) South French Creek Bay, Clearwater County: A medium sized (approx. 300 m. of shoreline) Lake surrounded by floating bog and choked with wild rice. Located at NW1/4 NW1/4 NW1/4 section 11, T143N, R36W.

11) West Arm Bay, Clearwater County: A small (approx. 300 m. of shoreline) bay on Lake Itasca surrounded by mesic deciduous forest and floating bog. Choked with wild rice and located at NE1/4 SE1/4 section, 15, T143N, R36W.

12) West Twin Lake, Hubbard County: A medium sized Lake (approx. 125 sq. m.) surrounded by floating bog located at SW1/4 NW1/4 section 30, T143N, R35W.

Of these 12 sites, 6 were chosen as locations of mark-recapture studies based on apparent high frog densities and ease of individual frog capture. It was not possible to see

frogs in dense wild rice. Thus, these areas were eliminated from the study. The 6 sites chosen for study were Bog D, Deming Lake, Schoolcraft Island, South French Creek Bay, West Arm Bay, and West Twin Lake (Figure 3).

Each study area was sampled once per night. Either a truck or motorboat were used to transport a canoe to and from the various study sites. Investigators used headlamps and hand-lanterns to spot frogs, which were captured by hand. All frogs were toe-clipped for future identification using a technique similar to that employed by Martof (1956; Appendix A and Figure 4). Snout-vent length (with animal pressed flat) and tympanum diameter were also measured (Appendix A). Animals were then weighed (Appendix A) using a Pesola scale and plastic bag. Handling time was 1-2 min./frog and animals were released immediately after they were weighed. The calculations employed by Schnabel (1938) and Seber (1973) were utilized to calculate population densities based on mark-recapture data.

RESULTS

A total of 314 mink frogs were captured during the course of this study. Of these, 47 (15%) were males (10 males were captured as the result of non-random sampling and have been eliminated from the following discussion), 64 (21%) were females, and the rest (193 or 63%) were juveniles. Individuals were sexed in the following manner (Hedeen 1970):

> Males: All animals with a snout-vent length greater than or equal to 49 mm. and tympanun diameter/snout-vent length ratio greater than or equal to 0.1 were classified as males.
>
> Females: All animals with a snout-vent length greater than or equal to 49 mm. and tympanum diameter/snout-vent length ratio less than 0.1 were classified as females.
>
> Juveniles: All other animals were classified as juveniles of an unknown sex.

Frogs were observed at 11 of the 12 original sites (none were found at Floating Bog Bay) in the park. Figure 5 shows the frequency distribution of each sex at each capture site. The overall sex ratio based on the total number of animals captured was 1.0:1.4 (males:females). The sex ratio varied significantly ($X^2=53.9$, $n<.001$) between capture sites

from no males captured (sex ratio=0.0:1.0) at Bog D, Schoolcraft Island, West Arm Bay, and West Twin Lake to 1.0:1.0 at the enclosure site (Table 1).

Table 2 shows population estimates and confidence intervals for those study sites (Deming Lake, South French Creek Bay, West Arm Bay, West Twin Lake) where enough recaptures were obtained to justify use of the Schnabel Index to estimate population size. The population of South Deming Pond was estimated by a total removal technique. Deming Lake had the largest population (178) and West Arm Bay had the smallest population (16).

Comparison of data from this study with previous reports is found in Table 3. Figure 6 illustrates the decline of mink frog abundance from a high in 1956 of 176 (Schnabel Index; MacDonald 1959) to a current low of 12 (total number captured; present study) on Schoolcraft Island. A similar trend is indicated by data for South French Creek Bay where the population was estimated by Hedeen (1970) to be between 50 and 100 individuals and was found to have only 27 individuals in 1982 (Figure 7). In 1967, West Twin Lake was estimated to have at least 1480 mink frogs present, but the current study indicates that there were only 42 individuals present in 1982 (Table 3).

Mean snout-vent length (SVL) varied considerably between capture sites (Kruskal-Wallis 1-Way ANOVA, $p < .001$; Figure 8); from a high mean SVL at the enclosure site (65

mm.) to a low mean SVL (44.08 mm.) at West Twin Lake (Figure 9). Mean weight also varied significantly between capture sites (Kruskal-Wallis 1 Way ANOVA, $p<.0001$; Figure 10). The site with the highest mean weight was the enclosure site (23.38 g.) and the site with the lowest mean weight was West Twin Lake (7.27 g.).

A total of 19% of all captured frogs showed signs of redleg (presumed to be Aeromonas hydrophila). Juvenile frogs were infected more often with redleg than either adults ($X^2=20.96$, $p<.001$). Smaller frogs (based on snout-vent length) were infected by redleg significantly more often than large frogs (KolmogirovSmirnof One-Sample Test, p .01). The number of animals infected by redleg at each site (Figure 11) varied significantly ($X^2=11.35$, $p<.05$), with West Arm Bay and the enclosure site eliminated from this analysis due to small sample sizes. Deming Lake had the greatest proportion of infected frogs (26%), and South Demming Pond had the lowest proportion of infected animals (0%).

Investigation of the mink frog literature revealed a much wider species distribution in the state of Minnesota than indicated by the 1979 DNR report on reptile and amphibian distributions in the state (DNR 1979). The localities previously listed were Beltrami, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Kandiyohi, Itasca, Pine , Ramsey, and St. Louis Counties. Hedeen (1970)

visited many other localities throughout the state (Appendix B) and found Rana septentrionalis at these additional localities: Aitkin, Anoka, Becker, Benton, Chisago, Cook, Isanti, Kanabec, Mahnomen, Mille Lacs, Morrison, Sherburne, Todd, and Wadena counties .

DISCUSSION

The abundance of the mink frog has declined drastically in the last two decades (Table 3, Figures 6 and 7). A similar decline has been noted in the leopard frog (Rana pipiens) in the upper Midwest (Hine et al. 1981; Hird et al. 1981). Several factors have been proposed as possible causes of the leopard frog decline. These include loss of wetland habitat, toxicity due to pesticides and other chemicals (Hine et al. 1981), redleg disease (Anonymous 1973), and renal adenocarcinoma (McKinnel 1980). The disease "redleg" was found in 19% of all mink frogs captured during the course of this study, and was found to infect juveniles significantly more than either adult males or females. Animals infected by Aeromonas hydrophila die unless moved to uninfested water and maintained at cold temperatures (Emerson and Norris 1905). Apparently mink frog juveniles are more susceptible to infection than adults; similar results as found by Hird et al. (1981) for the leopard frog. The results of this study also indicate that the rate of infestation of frogs varied considerably between sites; possibly a result of temperature or other environmental differences between sites. To eliminate the confounding effect of age to the variable effect of redleg between capture sites, a Kendall Tau Correlation Coefficient was calculated between the proportion of frogs with redleg and the proportion of juveniles at each site. A value of

.500 for Tau (p=.10) indicates that the high proportion of juveniles is not responsible for the variation in proportion of infected individuals at each site. Hird et al. (1981) found that A. hydrophila could be isolated from both healthy appearing and obviously ill frogs, and felt that the effect of redleg on the declining abundance of leopard frogs is at most secondary to some as of yet undetermined primary factor. Data from this study do not provide adequate evidence that redleg is the primary cause of the mink frog decline during the last two decades.

There are several possible explanations for the observed sex ratio of 1.0:1.4. First, this observed sex ratio may not be a reflection of reality as the result of bias in the sampling methodology. Males were found more often in deeper water (resting or calling) than either females or juveniles which were most frequently found in dense vegetation near shore. The variability of vegetation cover between study sites could very likely have resulted in one or the other sex having a greater probability of capture. Animals in open water were much more easily captured than those in areas of thick vegetation. As a result, animals that preferred open water (males) could well have been captured in higher proportions than animals (juveniles and females) that were more behaviorally cryptic.

On the other hand, if this sex ratio is real, there are at least two possible explanations. One proposed by

Hedeen (1970) is based on the assumption that terrritorial males may be more susceptible to predation than females. Hedeen (1972) observed great blue herons (Ardea herodia) feeding on mink frogs, but there are no data indicating that males are taken preferntially over females. Male mink frogs are much more active than females during all times of the day during the breeding season (late June through early August; Tenneson in prep.). These active males would likely attract the attention of diurnal predators while establishing/maintaining their territories. A second possible explanation has been proposed by Kramek and Stewart (1980) based on color pattern differences between the sexes. The dorsal color pattern is significantly darker in females than males; a possible result of different selection pressures as the result of different habitat preferences. It is conceivable that the occupation of different microhabitats could result in differential predation pressures, which in turn might alter the sex ratio. Hedeen (1970) found that the age classes (juveniles, females, males) exhibited different movement patterns during the post-breeding season (mid-August until first ice). Males either remained at the breeding sites (most) or dispersed to other aquatic habitats (few). Females usually occupied shallow non-breeding habitats, and juveniles were much less predictable in habitat preference. Juveniles were observed to emigrate in large numbers from Deming Lake in 1967, while no corresponding emigration occurred at West Twin Lake.

Hedaen proposed several possible stimuli for differential juvenile migration between lakes including overcrowding, food shortage, and negative response to open water. Apparently juveniles prefer areas of low population density, abundant food, and little open (non-vegetated) water. These sex related habitat preferences may also explain the unequal sex ratios between study sites.

The variation in weight and SVL between capture sites can be explained by the variation of sex ratios between sites. Weight and SVL are significantly correlated (Pearson Correlation Coefficient=.799, $p<.0001$). Sex explains the variability of weight and SVL between capture sites for males and juveniles, but not females (Table 4). This result for females is probably due to the highly variable weights and SVLs of females and the small sample size.

This study has demonstrated that it is of great importance to determine the abundance of the mink frog at various sites in Minnesota (Appendix B) outside of Itasca State Park This will determine whether this is a local or regional phenomenon. The areas sampled in this study included several distinct populations over a fairly wide area, data indicate that the population decline may indeed be occurring over a wider area. It is recommended that sites outside of Itasca State Park (Appendix B) and those sites sampled within the Park be periodically censused using mark-recapture techniques. This should aid in the

evaluation of this species' stability in Minnesota.

ACKNOWLEDGEMENTS

I would like to express my appreciation for the very able assistance in the fieldwork performed for this study by Charlie Wellenstein, who kept me awake many a night "on the bog".

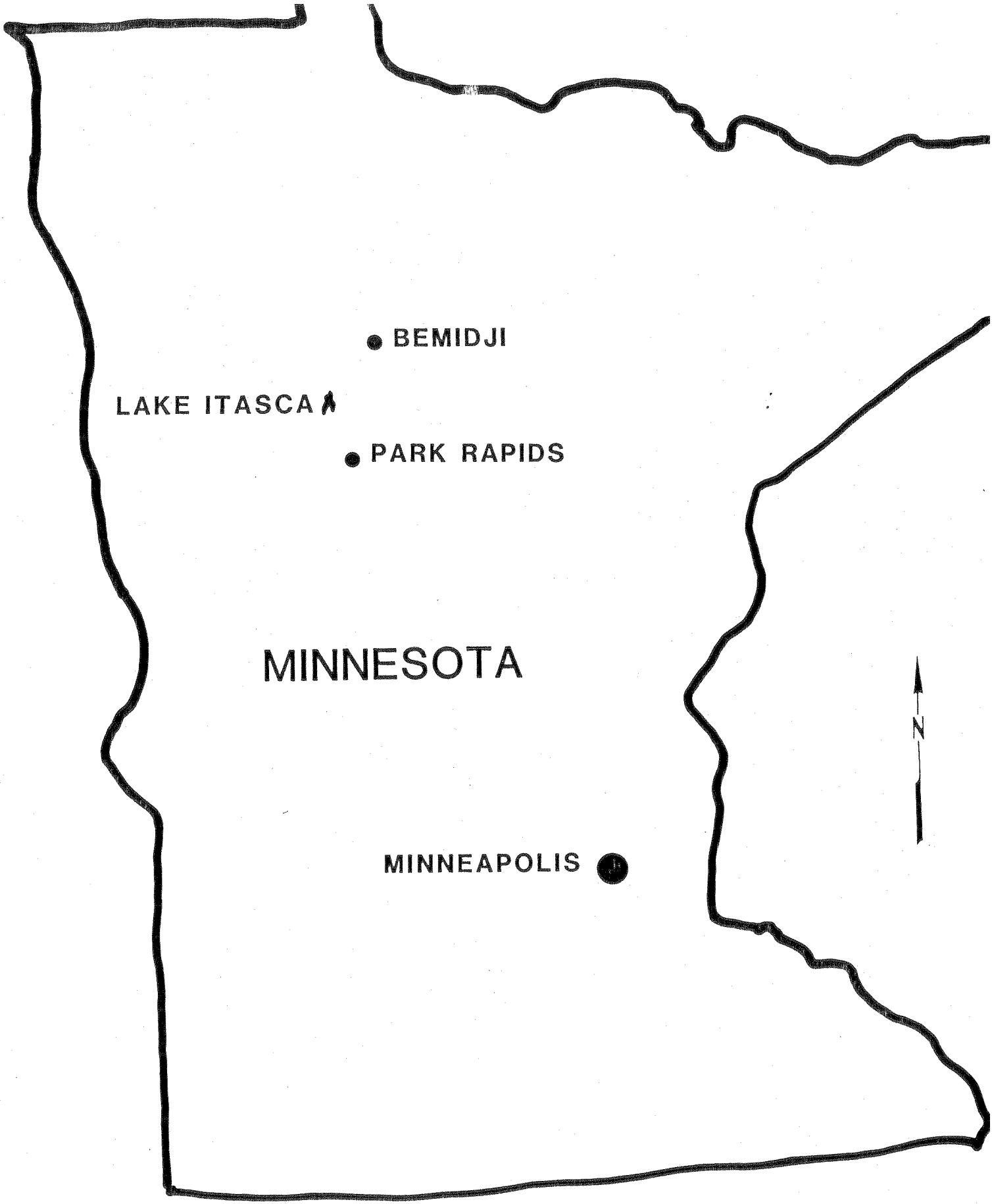

Figure 1- Map of Lake Itasca in northwest Minnesota.

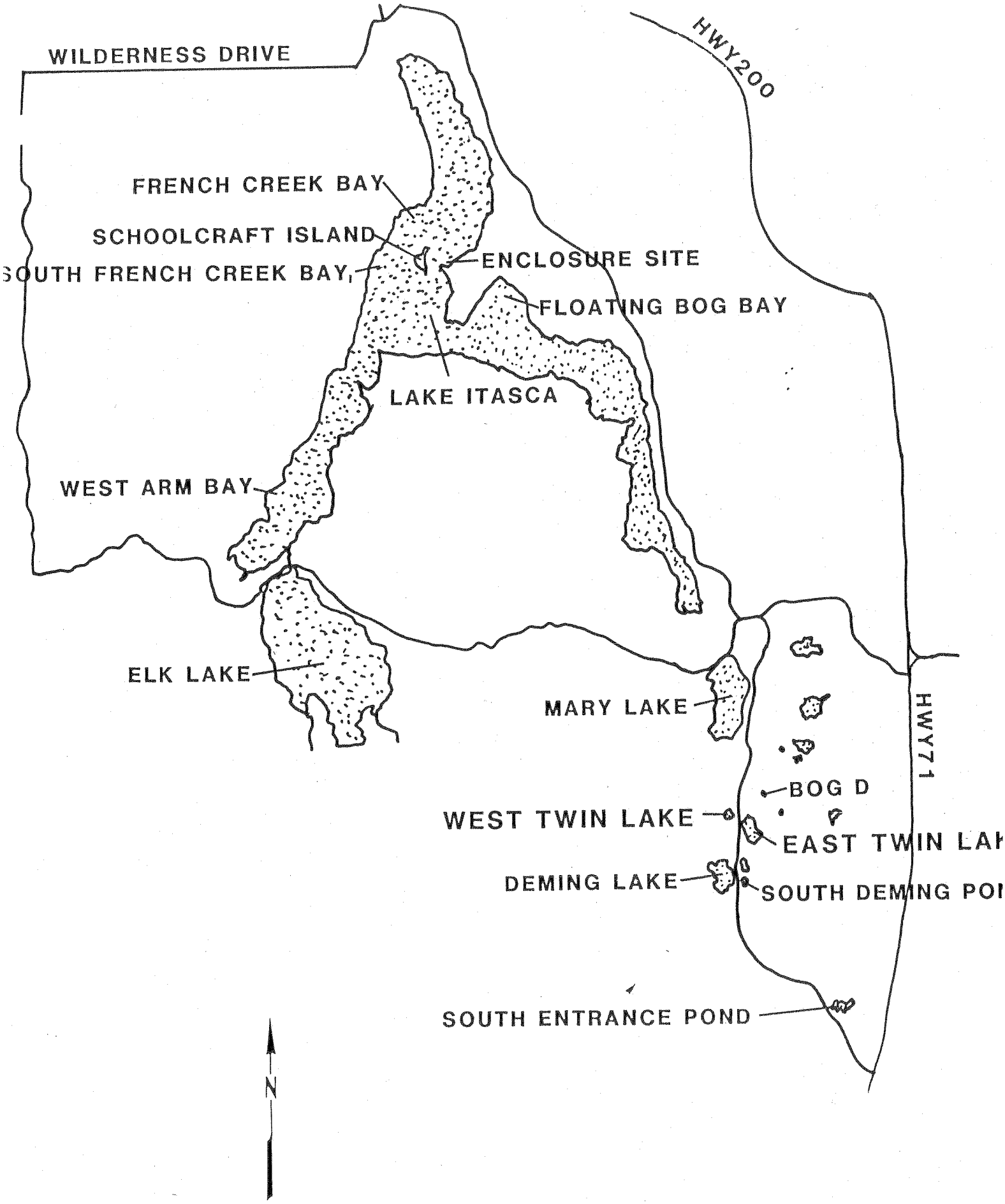

Figure 2- Map of 11 initial study sites in Itasca State Park, northwestern Minnesota.

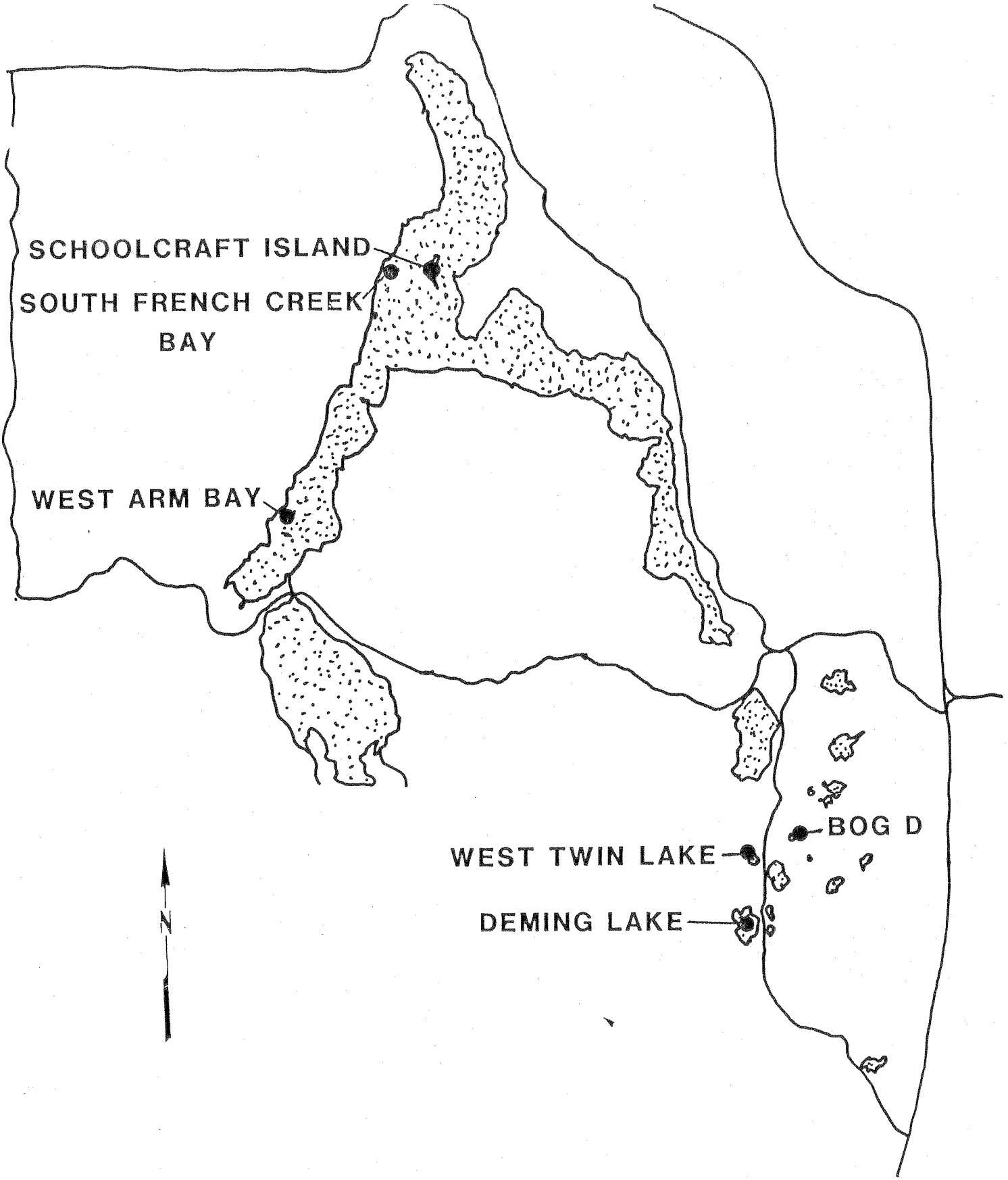

Figure 3- Map of the 6 sites in Itasca State Park suitable for mark-recapture studies.

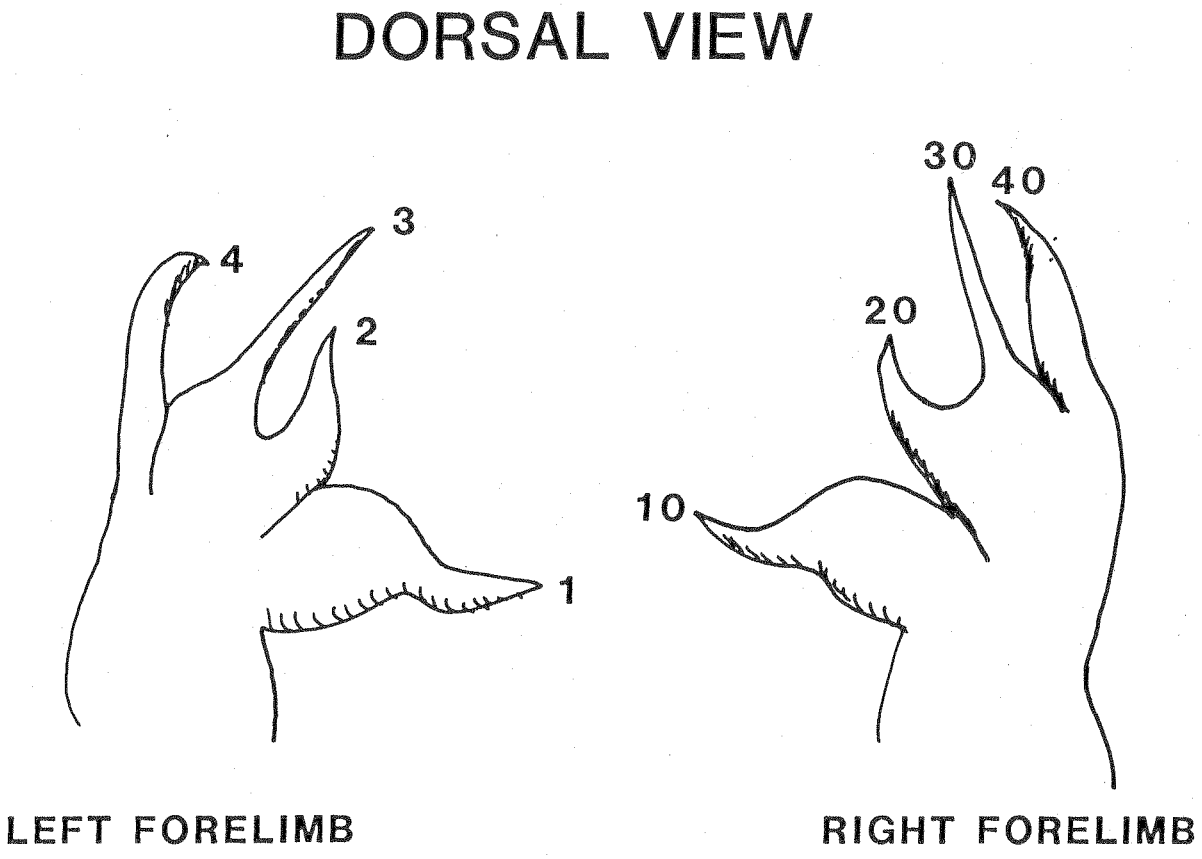

Figure 4- Mink frog forelimb showing numbering sequence for toe-clipping.

Table 1- Percent of total of each sex for each capture site.

% OF TOTAL

	BD	DL	ES	FCB	SDP	SFCB	SI	WAB	WTL
MALES	0	16	50	100	31	24	0	0	0
FEMALES	44	04	50	0	69	34	08	20	04
JUVENILES	56	80	0	0	0	42	92	80	96

Table 2- Schnabel population estimates with associated confidence intervals for four capture sites.

	SCHNABEL	95% CONFIDENCE INTERVALS
WAB	15.5	45.51 2.72
WTL	42.02	61.25 22.50
DL	177.80	256.86 134.07
SFCB	27.24	36.64 18.90

Table 3- Mink frog population estimates for various localities in Itasca State Park, Minnesota.

SITE	YEAR	NUMBER	METHOD OF ESTIMATE	RESEARCHER
Bog D	1967	40	# sighted along 300' transect	Hedeen 1970
	1982	4	same	Tenneson 1982
	1982	16	total # captured	Tenneson 1982
Deming Lake	1982	178	Schnabel	Tenneson 1982
School-craft Island	1955	162	Schnabel	MacDonald 1959
	1956	176	" "	" " "
	1958	94	" "	Lemmerman 1958
	1959	122	total # observed	MacDonald 1959
	1962	71	" " "	McKenzie 1962
	1969	90	Schnabel(?)	Wunderle 1961
	1970	70	" "	" " "
	1971	21	total # observed	Peacock 1971
	1981	4	total # observed	Tenneson 1982
	1982	12	total # observed	Tenneson 1982
South Deming Pond	1982	37	total # removed	Tenneson 1982
South French Creek Bay	1970	50-100	total # observed	Hedeen 1970
	1973	4-5	#obs/unit shore	Preimer 1973
	1976	15	total # observed	Caponi 1976
	1982	27	Schnabel	Tenneson 1982
West Arm Bay	1981	35	total # captured	Tenneson 1982
	1982	16	Schnabel	Tenneson 1982
West Twin Lake	1966	242	total # sighted	Hedeen 1970
	1967	1480	" " "	" " "
	1982	42	Schnabel	Tenneson 1982

Table 4- Kruskall-Wallis 1-Way ANOVA showing the relationship between sex and weight and snout-vent length.

	MALES	FEMALES	JUVENILES
WEIGHT	p=.0002	p=.7749	p=.0083
SVL	p=.0098	p=.0889	p=.0001

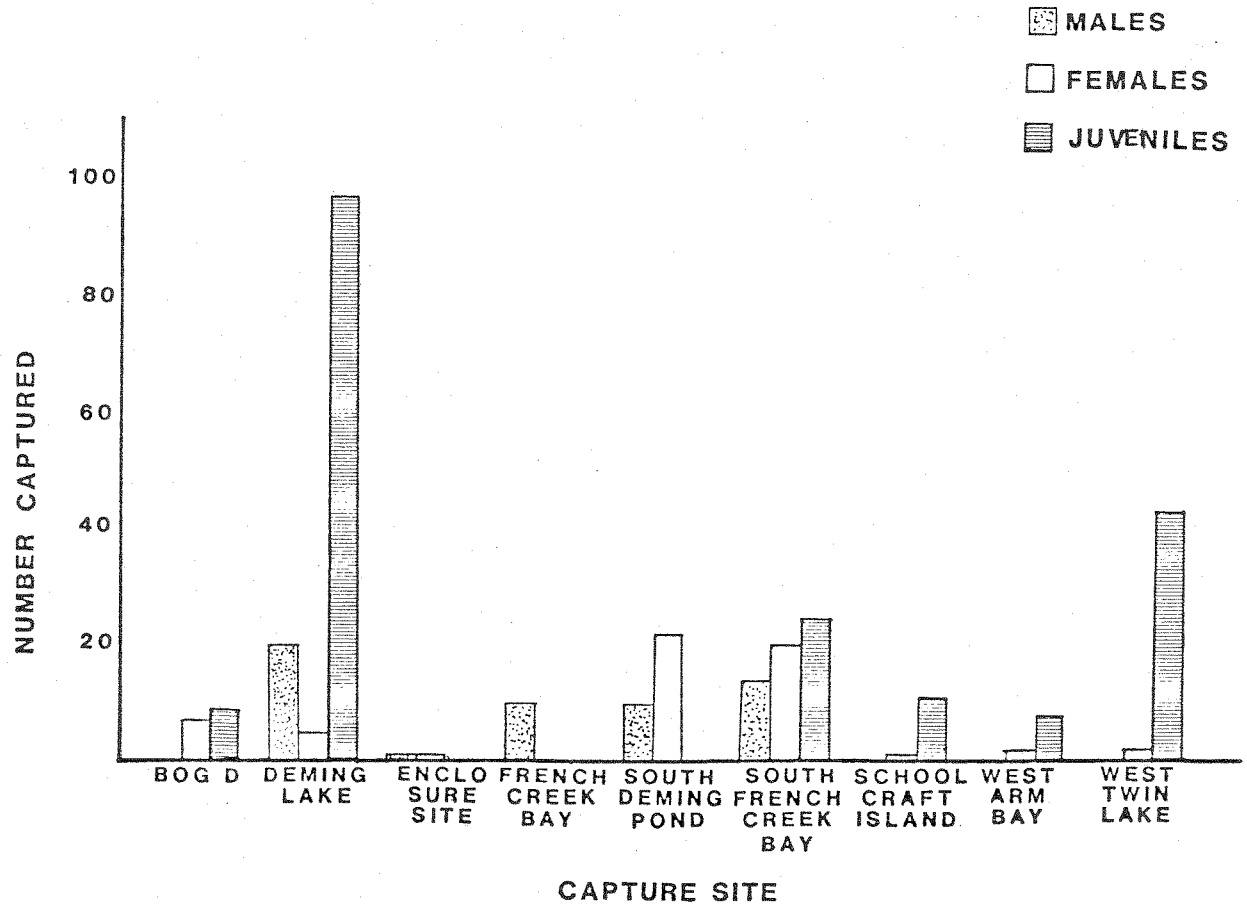

Figure 5- Number of animals captured of each sex for each capture site.

Figure 6- Graph of N (est.) vs. year for Schoolcraft Island.

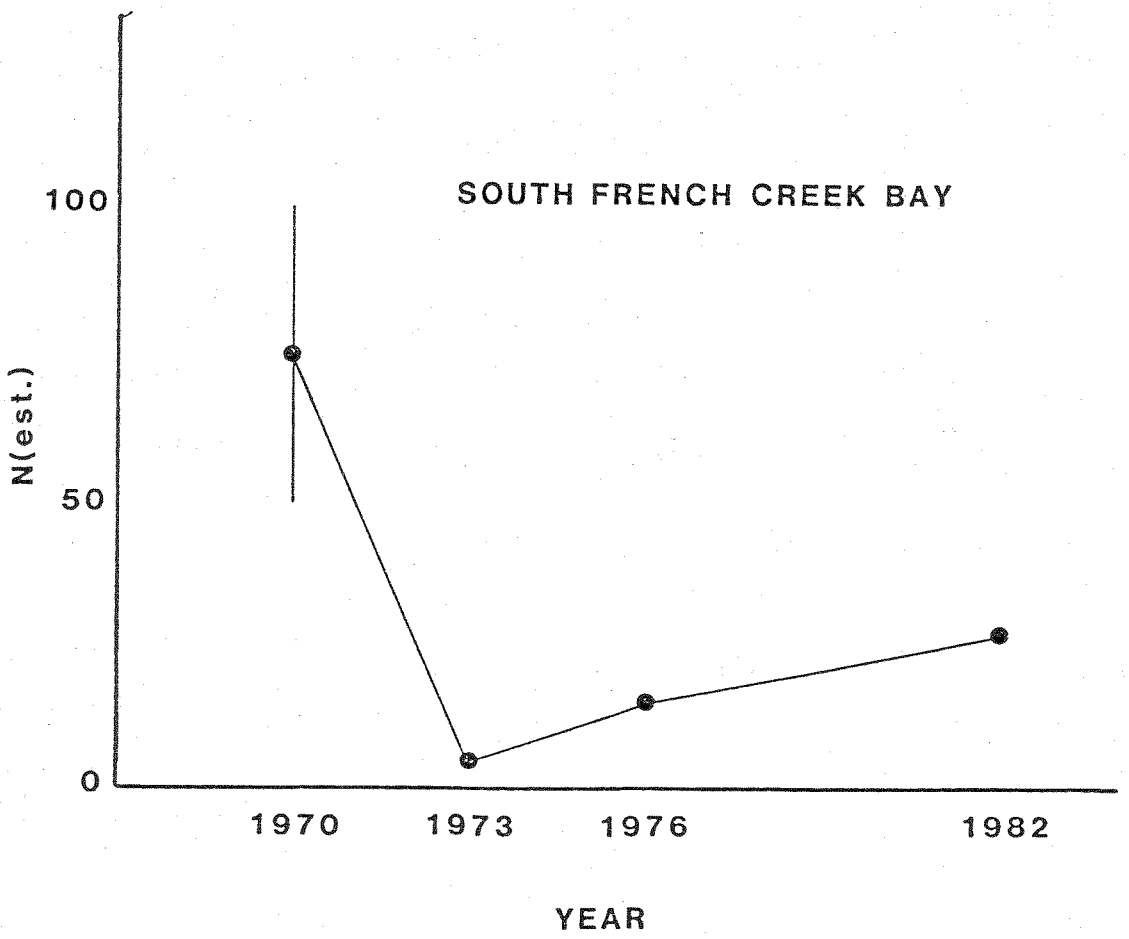

Figure 7- Graph of N (est.) vs. year for South French Creek Bay.

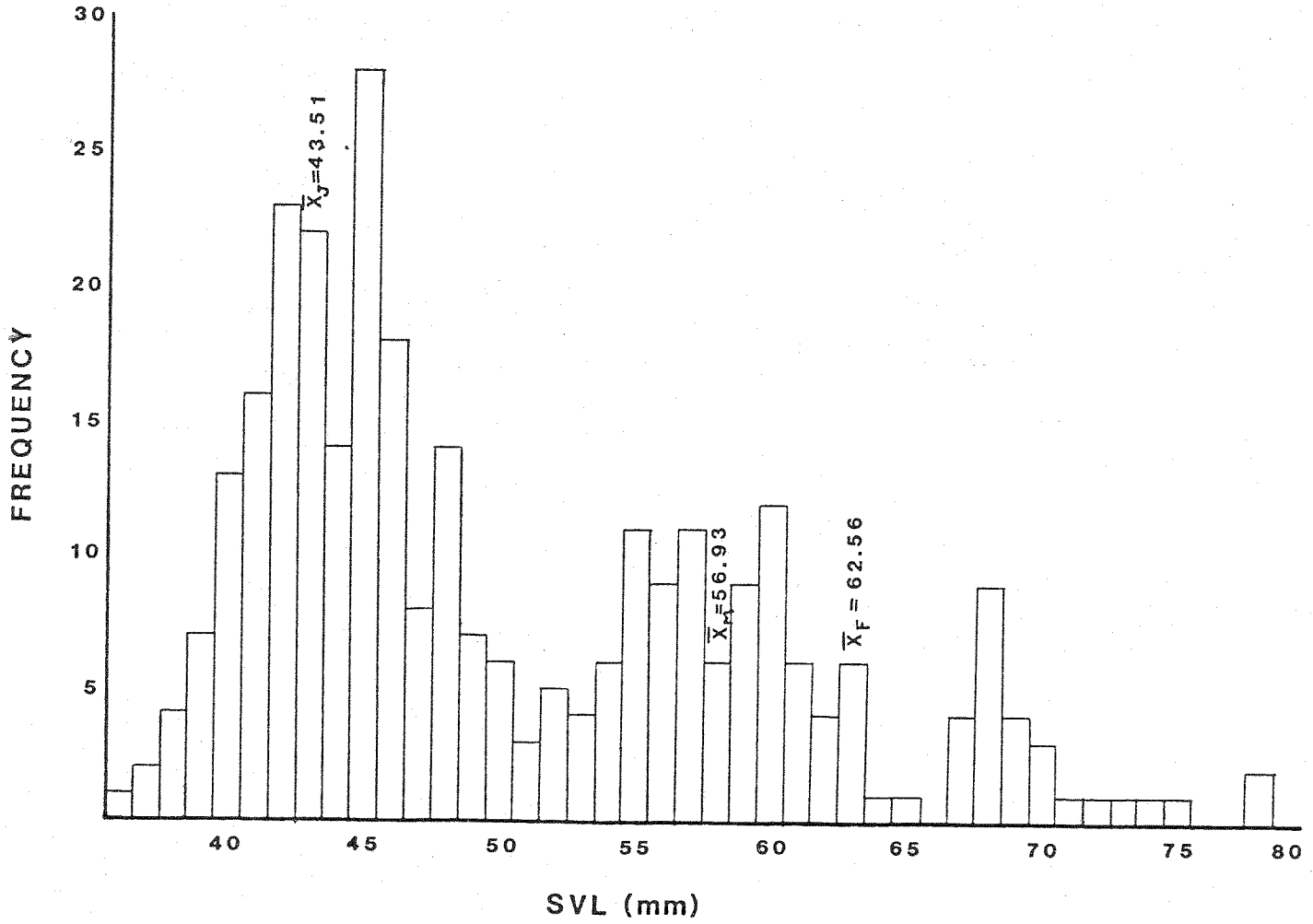

Figure 8- Frequncy distribution of snout-vent length for all animals captured.

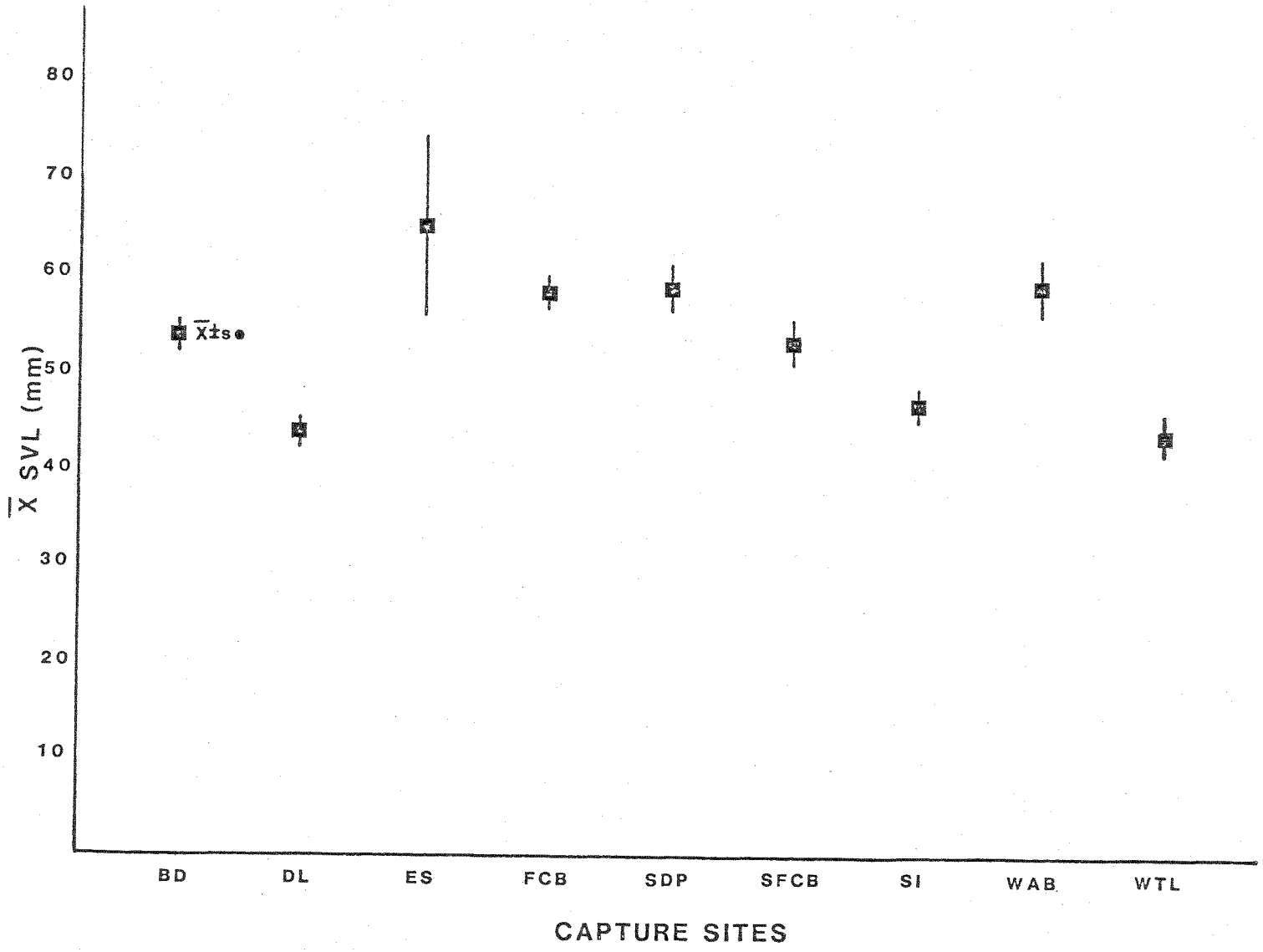

Figure 9- Graph of mean SVL (mm.) vs. capture sites showing standard errors.

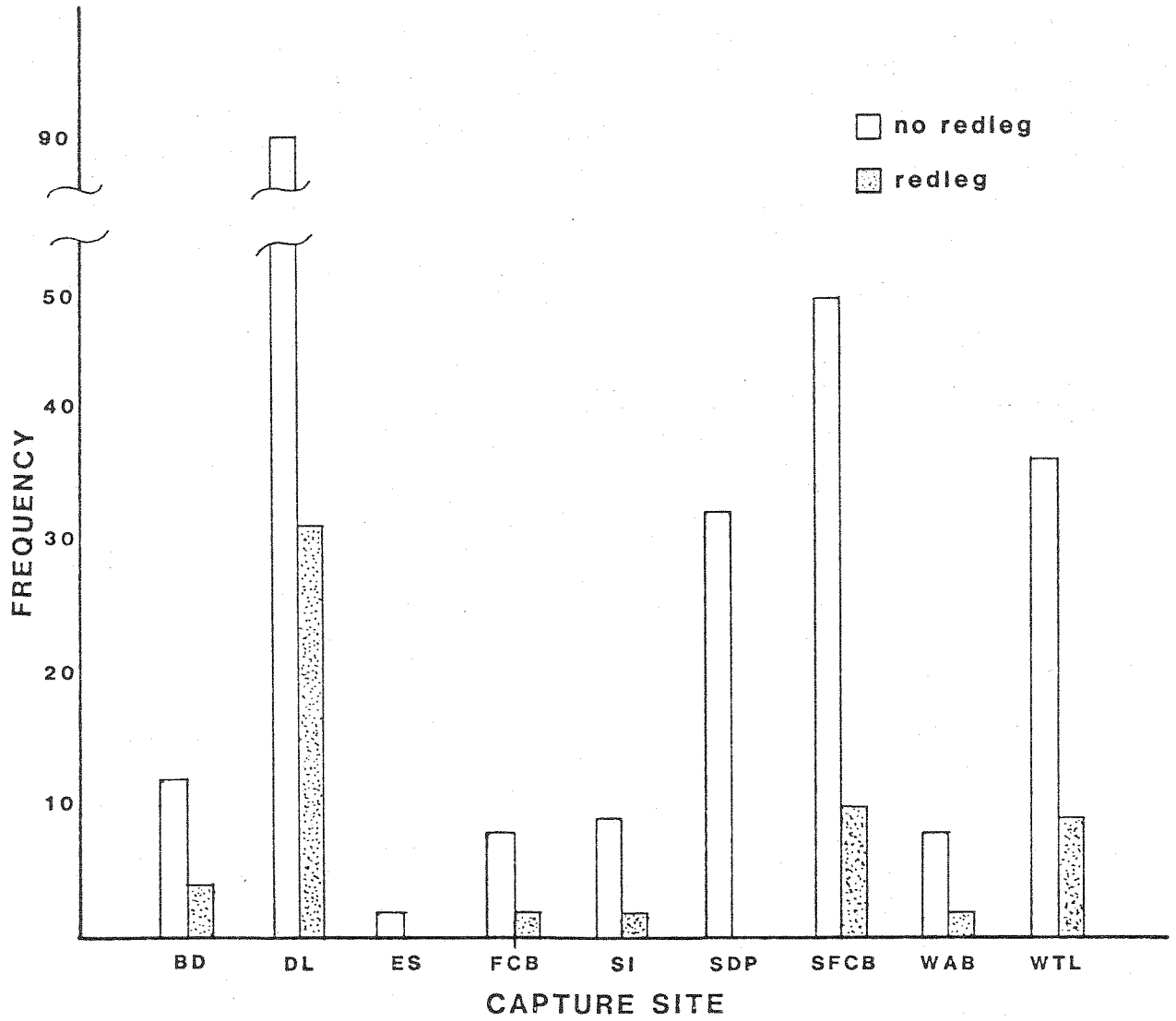

Figure 11- Frequency distribution of animals infected with redleg and those not for each capture site.

APPENDIX A

Slide Transparencies

1) Mink frog (*Rana septentrionalis*).

2) Toe-clipping.

3) Measuring snout-vent length.

4) Measuring weight using Pesola scale.

APPENDIX B

Minnesota counties in which mink frogs were recorded during the years 1966, 1967, and 1968. All collected frogs are deposited at the James Ford Bell Museum of Natural History, Minneapolis, Minnesota (from Hedeen 1970).

Cook Co.....Three juveniles collected from a small lake a the base of Mt. Josephine on Hat Point, 0.5 mi. northwest of Co. 73, on 22 August 1967.

L. County....Several frogs were taken from Baptism R. next to Co. 7, 4 mi. north of Finland, on 21 Aug. 1967.

Clearwater Co..Several frogs were heard and collected during 1966, 1967, and 1968 at many localities in Itasca State Park. Frogs were also heard at Upper and Lower Rice L., Heart L., and Roy L.

Hubbard Co.....Several frogs were heard and collected during 1966, 1967, and 1968 at many localities in Itasca State Park. Frogs were also heard at L. Alice, L. George, Lac Mer, Island L., and Potato L..

Becker Co.....Six adults were collected from Hay Creek near the Co. 32 Bridge on 17 July 1967. Frogs were heard at Two-Island L., Bad Medicine L., Juggler L., Elbow L., and Tulaby L. on 9 and 20 July 1967.

Wadena Co.....One juvinile was taken from Shell R. near the Co. 23 bridge on 14 Sept. 1967.

Cass Co.....Seven juveniles were collected from a roadside ditch along the south side of State 34, 7.2 mi. west of State 84, on 2 Sept. 1967.

Aitkin Co.....Three adults were collected from a pond along State 65, 5.7 mi. north of Libby, on 2 Sept. 1967.

Mille Lacs Co..Two adults were taken from Rum R. next to U.S. 169, 4 mi. north of Onamia, on 12 Sept. 1967.

Anoka Co.....One transforming frog was taken from Cedar Bog L. on 5 July 1968. Frogs were heard at Fish L. on 3 July 1968.

Morrison Co....Two females were observed in a small pond along the west side of U.S. 10, 2.6 mi. south of Lincoln, on 12 Sept. 1967.

Kanabee Co.....One female was observed in a stream at State 1.0 mi. north of Woodland, on 2 Sept. 1967.

Chisago Co.....Frogs were heard in the Carlos Avery Game Refuge 0.5 mi. east of Stacey on 4 July 1968.

Isanti Co.....Frogs were heard at Beckman L. on 4 July 1968.

Sherburne Co...Frogs were heard at a pond on the east side of U.S. 169, 2.3 mi. north of Fremont City, on 9 July 1968.

Benton Co.....Frogs were heard at Little Rock L. on 9 July 1968.

Todd Co.....Frogs were heard at Lawrence L. and Pine Island L. on 9 July 1968.

Mahnomen Co. ...Frogs were heard at McCranrey L., Capon L., Fowl L., Hart L., and at a pond along the south side of State 113, 0.4 mi. west of Co. 3, on 20 July 1967.

LITERATURE CITED

Anonymous. Where have all the frogs gone? Modern Med. 41:20-24; 1973.

Breckenridge, W.S. Reptiles and amphibians of Minnesota. Univ. Minn. Press., Minneapolis, Minnesota. 220 pp.; 1944.

Caponi, C.R. Behavioral study of a population of male mink frogs (Rana septentrionalis Baird) making up a breeding chorus on Lake Itasca, Minnesota. Itasca Biol. Ses. Pap. (#unknown) on file at the Univ. Min.. Forest. Biol. Stn., Lake Itasca, Minn.; 1976.

Conant, R. Field guide to the reptiles and amphibians of eastern and central North America. Houghton and Mifflin, Boston. 407 pp.; 1975.

Department of Natural Resources, Minnesota. Guide to the reptiles and amphibians of Minnesota. Prelim. Guide.; 1979.

Emerson, H.; Norris, C. "Red-leg"--an infectious disease of frogs. Jnl. Exp. Med. 7:32-58; 1905.

Hedeen, S.E. Escape behavior and cause of death of the mink frog, Rana septentrionalis. Herpetologica 28:261-262; 1972.

Hedeen, S.E. The ecology and life history of the mink frog, Rana septentrionalis, Baird. Ph.D. Dissertation, Univ. Minn.; 1970.

Hine, R.L.; Les, B.L.; Hellmich, D.F.; et al.; Preliminary report on leopard frog (Rana pipiens) populations in Wisconson. Wisc. Dept. Natur. Resc. Report 81; 1975.

Hird, D.W.; Diesch, S.L.; McKinnel, R.G.; Gorham, E.; Martin, F.B.; Kurtz, S.W.; Dubrovlny, C. Aeromonas hydrophila in wild-caught frogs and tadpoles (Rana pipiens) in Minnesota. Lab. Anim. Sci. 31(2):166-169; 1981.

Krameck, W.C.; Stewart, M.M. Ontogenetic sexual differences in the pattern of Rana septentrionalis. J. Herp. 14(4):369-375; 1980.

Lemmerman, R.; White, O.; Life history and population study of the mink frog Rana septentrionalis-Baird on Schoolcraft Island. Itasca Biol. Ses. Pap. 87 on file at the Univ. Minn. Forest. Biol. Stn., Lake Itasca, Minn.; 1958.

Martof, B. Factors influencing size and composition of populations of Rana clamitans. Am. Midl. Natur. 56(1):224-245; 1956.

McDonald, J.; Engebretson, C. Life history, population and breeding readiness study of the mink frog (Rana septentrionalis) on

Schoolcraft Island. Itasca Biol. Ses. Pap. 140 on file at the Univ. Minn. Forest. Biol. Stn., Lake Itasca, Minn.; 1959.

McKenzie, D.S. A further study of the mink frog (Rana septentrionalis Baird) population on Schoolcraft Island. Itasca Biol. Ses. Pap. 211 on file at the Uni. Minn. Biol. Stn., Lake Itasca, Minn.; 1962.

McKinnel, R.G. Continued diminished prevalence of the Lucke renal adenocarcinoma in Minnesota leopard frogs. Am. Midl. Natur. 104(2):402-404; 1980.

Peacock, B.; Drake, B. Notes on the bio-acoustic behavior of the mink frog (Rana septentrionalis Baird) at Lake Itasca, Minnesota. Itasca Biol. Ses. Pap. 746 on file at the Univ. Minn. Forest. Biol. Stn., Lake Itasca, Minn?; 1971.

Priemer, L.C.; Strand, F.C.; Wichmann, A.K. Spacial arrangements, homing, aggression, and notes on amplexus in the mink frog, Rana septentrionalis. Itasca Biol. Ses. Pap. 765 on file at the Univ. Minn. Forest. Biol. Stn., Lake Itasca, Minn.; 1973.

Schmid, W.D. Some aspects of water economies of nine species of amphibians. Ecology 46(3):261-269; 1965.

Schnabel, Z.E. The estimation of the total fish population of a lake. Am. Math. Mon. 45:348-352; 1938.

Seber, G.A.F. The estimation of animal abundance and related parameters. Griffin, London: 506 pp.; 1973.

Wright, A.H.; Wright,A.A. Handbook of frogs and toads of the United States and Canada. Comstock Publ. Co., Ithaca, N.Y.: 740 pp.; 1949.

Wunderle, J.; Wenstrom, B. Some notes on the breeding behavior of the mink frog (Rana septentrionalis Baird) at Lake Itasca, Minnesota. Itasca Biol. Ses. Pap. 755 on file at the Univ. Minn. Forest. Bio?. Stn., Lake Itasca, Minn.; 1970.