

**DOCUMENTATION OF LAKE STURGEON
HABITAT ON
PLAYGREEN LAKE**

A Report Prepared
for
Manitoba Hydro

by

Paul G. Graveline

1996

North/South Consultants Inc.
2-1475 Chevrier Blvd.
Winnipeg, Manitoba
R3T 1Y7

ABSTRACT

A study was conducted on Playgreen Lake, during the summer and fall of 1995, to provide preliminary data on lake sturgeon habitat. The areas studied were identified by residents of Norway House during the arbitration procedures under Northern Flood Claim #110 (domestic fishing) and Claim #95 (recreation). Efforts were concentrated on four sites in the following three areas: 1) Paupanekis Point; 2) Playgreen Point; and 3) Warren Landing.

Habitat was classified as it related to the general spawning and habitat requirements of lake sturgeon. Direct, on site observations were made of shoreline and substrate characteristics, and water depth. Ponar dredge samples were taken to determine substrate composition.

Of the four sites sampled, Paupanekis Point and Warren Landing offered the most suitable habitat for lake sturgeon spawning. The former area provides extensive areas of rock outcroppings, while the latter is characterized by shallow, fast moving water. Playgreen Point was characterized by soft substrate and aquatic macrophytes and, compared to other areas in the region, may offer enhanced foraging opportunities for lake sturgeon.

ACKNOWLEDGMENTS

The author would like to thank Manitoba Hydro, particularly Ms. J. Kohnats, Mr. L. Stefaniuk, and Mr. D. Rogalsky, for providing the funding and support necessary to conduct this project.

Special thanks are extended to Messrs. Norman Apetagon Jr. and Percy Dixon for their field assistance in the collection of these data. Mr. Don Macdonald, Manitoba Fisheries Branch, is also thanked for his assistance.

TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	1
1.1 STUDY AREA	2
1.2 LAKE STURGEON HABITAT REQUIREMENTS	2
2.0 METHODS	4
3.0 RESULTS AND DISCUSSION	5
3.1 TWO-MILE CHANNEL AREA	5
3.1.1 Site Description	5
3.1.2 Habitat Characteristics	5
3.2 PAUPANEKIS POINT	6
3.2.1 Site Description	6
3.2.2 Habitat Characteristics	6
3.3 PLAYGREEN POINT	6
3.3.1 Site Description	6
3.3.2 Habitat Characteristics	7
3.4 WARREN LANDING	7
3.4.1 Site Description	7
3.4.2 Habitat Characteristics	7
4.0 SUMMARY	9
5.0 REFERENCES	10

LIST OF TABLES

Table 1.	Physical characteristics of areas on Playgreen Lake where lake sturgeon have historically been known to congregate	11
Table 2.	Composition of sediment samples collected from Playgreen Lake, 1995. . .	13

LIST OF FIGURES

Figure 1.	Lake sturgeon habitat study area, Playgreen Lake, 1995	14
Figure 2.	Location of Ponar sample sites on Playgreen Lake, 1995	15

LIST OF APPENDICES

Page

Appendix 1. Photographs of study area sites 16

1.0

INTRODUCTION

Manitoba Hydro has been actively participating with federal and provincial government departments to focus research efforts on lake sturgeon (*Acipenser fulvescens*) in Manitoba. Under the Northern Flood Agreement, Manitoba Hydro and the Province of Manitoba are jointly funding a ten year program aimed at the conservation and enhancement of sturgeon stocks in the Nelson River area through education, co-management initiatives, and mitigative works such as stocking. The program, which was initiated in 1993, is managed by the Nelson River Sturgeon Co-management Board, with representatives from Norway House, Cross Lake, Wabowden, Thicket Portage, Pikwitonei, and Split Lake, in co-operation with Manitoba Fisheries Branch.

Lake sturgeon were historically abundant throughout Lake Winnipeg and the outlet lakes region, but more recently have become scarce and may be nearing extirpation (Harkness 1980, Green 1987, Houston 1987). Areas on Playgreen Lake where lake sturgeon were traditionally known to congregate, or were caught with some frequency, have been identified through community testimony during arbitration procedures under Northern Flood Claim #110 (domestic fishing) and Claim #95 (recreation). The areas identified were: Playgreen Point; Nelson River west channel between Ballard Point and Hart Point; Whiskey Jack Rapids; Paupanekis Point; the mouth of Warren Landing; Sepastik Bay; and Menow Bay (indicated with an asterisk in Fig. 1).

As part of Manitoba Hydro's continuing involvement with lake sturgeon research, a study was conducted during the summer and fall of 1995 to document the existing conditions at the sites known to be historically important to lake sturgeon. The objective of the study, which was conducted by North/South Consultants Inc., was to provide preliminary data on lake sturgeon habitat identified by the community.

1.1 STUDY AREA

Playgreen Lake is located in north central Manitoba (Fig. 1). It straddles the transition between the Manitoba Lowland Plain and the Canadian Shield, and lies in an area known as the Nelson Trough (Weins and Rosenberg 1991). Hilderman et al. (1983) classified shoreline on Playgreen Lake by dividing it into three distinct areas (south, channel, and north basins). The majority of the south basin shoreline was classified as treed muskeg, with poorly drained organic material on a bed of silts and clays. Only 14% of the south basin shoreline was considered bedrock controlled. In contrast, the north basin and channel basin shorelines were classified as 54% and 44% bedrock controlled, respectively. In the north basin of Playgreen Lake, the shoreline becomes more predominantly shield like, consisting of bedrock headlands, rock cliffs, and shallow low lying marshy bays (Hilderman et al. 1983).

Playgreen Lake is part of the Nelson River Section of the Boreal Forest Region of Canada (Koshinsky 1973, Weins and Rosenberg 1991). The predominant vegetative cover in this region is black spruce (*Picea mariana*), co-existing with tamarack (*Larix laricina*), and white spruce (*Picea glauca*) (Koshinsky 1973).

Playgreen Lake is the largest of the eight outlet lakes of Lake Winnipeg, having a surface area of approximately 674 km² (Koshinsky 1973) and a shore length of roughly 400 km (Ayles 1973, Koshinsky 1973, Hilderman et. al. 1983). It is dotted with approximately 250 small islands, 138 of which are in the south basin. The lake has a mean depth of just 3 m (Ayles 1973, Koshinsky 1973), and is characterized by large littoral zones and shallow offshore bottom areas that are rich in life forms and excellent for fish productivity (Hilderman et. al. 1983).

1.2 LAKE STURGEON HABITAT REQUIREMENTS

In general, lake sturgeon is considered a shallow water fish, concentrating in areas where benthic organisms occur in the highest frequency. Preferred foraging habitat includes productive shoals of lakes and rivers with substrates consisting of a mixture of mud and gravel (Harkness and Dymond 1961, Scott and Crossman 1979). Although the general migratory patterns of the lake sturgeon are not well documented, they appear to prefer shallow bays during the summer, and move to deeper holes during winter (Sunde 1961, Scott and Crossman 1979).

The majority of freshwater fish select a hard substrate for the purpose of reproduction, and the availability of that substrate for spawning affects the distribution and abundance of many species (Hynes 1970). This is particularly true for lake sturgeon, as its reproductive and basic habitat requirements generally limits this species to very few areas (Harkness 1980). Sturgeon prefer to spawn in swift flowing water in rivers or at the base of rapids where the substrate consists of large rocks. Organic matter or fine clays and silts are generally considered not suitable substrate for sturgeon spawning. Distribution may even be limited by the type of rocky substrate present. Harkness and Dymond (1961) noted that lake sturgeon were absent from the western shores of Lake Winnipeg, and lakes Manitoba and Winnipegosis, and questioned whether it was because these areas are underlain by sedimentary rocks. Where lake sturgeon are generally more abundant in Manitoba (i.e., east side of Lake Winnipeg) the waters are underlain by Archaen, igneous rocks. It may be that in areas of sedimentary substrates, conditions are generally not as suitable for sturgeon spawning as in areas of igneous rock substrate.

When river spawning conditions are unavailable, as in the lower Great Lakes, sturgeon choose to spawn over shallow beach areas, or the rocky wind-swept shorelines of islands (Koshinsky 1973, Scott and Crossman 1979). Since few swiftly flowing, turbulent tributaries flow into Playgreen Lake, sturgeon in this area are most likely lake or large river spawners.

Generally, lake sturgeon spawn from late May to early June, in water depths ranging from 0.6 to 4.6 metres (Harkness and Dymond 1961, Sunde 1961, Scott and Crossman 1979). The eggs are scattered during the spawning act and immediately adhere to rocks and logs where they remain until hatching approximately eight days later.

2.0

METHODS

Sampling efforts were concentrated in three main areas, those being: 1) Paupanekis Point (from Two-Mile Channel northwest to Weasel Point); 2) Playgreen Point (from Namayo Point north west to Playgreen Point); and 3) Warren Landing (Fig. 2). Mr. Nelson Scribe, an elder with the Norway House community, stated in Koshinsky (1973) that "...sturgeon spawn in a relatively restricted area on the west shore of Playgreen Lake opposite the entrance to the East Channel". Although this does not pinpoint a specific spawning area it roughly refers to the area in and around Paupanekis Point. To ensure that all potential sturgeon habitat was documented, the area from Two-Mile Channel southeast to Mud Point was sampled (Fig. 2), in addition to the three areas listed above.

Sampling was conducted from June 2-10, 1995 and on September 16, 1995. Habitat characteristics, as they related to sturgeon, were documented at each site. These included: water depth; substrate composition; shoreline characteristics; and the occurrence/presence of aquatic macrophyte beds. Water depths were measured with a sounding line marked in metre increments. Shoreline was classified based on dominant features, including extent and type of forest cover and bank texture (clay, silt, sand, gravel, compact, eroding). Photographs were taken at each site.

Substrate samples were collected with a Ponar dredge. Entire samples were frozen individually and returned to the laboratory. The samples were then thawed, mixed, and a subsample was extracted. The subsample was weighed (using a Mettler PM100 digital scale), ashed, and weighed again to determine total organic carbon. The remaining ponar sample was then passed through a series of three sieves (2 mm, 1 mm, and 500 μm) to determine particle size. Sizes were categorized as medium, fine, and very fine sand and silt (<0.5 mm), coarse sand (0.5-1.0 mm), very coarse sand (1.0-2.0 mm), and gravel (2.0-16.0 mm). Any particles found in the sample > 16 mm in diameter were classified as stones.

3.0

RESULTS AND DISCUSSION

Location of ponar sample sites on Playgreen Lake are indicated in Fig. 2. Habitat characteristics for each site sampled are provided in Table 1, and sediment analysis results are presented in Table 2. A discussion of the characteristics documented at each site, as they relate to lake sturgeon, are provided in the following sections.

3.1 TWO-MILE CHANNEL AREA

3.1.1 Site Description

The shoreline in the Two-Mile Channel area consists mostly of spruce and willow trees on a base of sand/clay/silt. The area contains a few small islands and rocky outcrops, particularly toward the northeast near Goose Island. No aquatic vegetation was observed at this site. Photographs of the Two-Mile Channel area are presented in Appendix 1.

3.1.2 Habitat Characteristics

Twelve sites were sampled in and around the Two-Mile Channel area (Fig. 2). The average depth at these sites was 3 m, but areas up to 10 m deep were measured (Table 1). Two attempts to collect Ponar samples (#7 and #8, Table 1) were unsuccessful due to deep water. Three of ten Ponar samples revealed a hard substrate of rock or compacted sand. Medium sand and finer material comprised more than 70% of six of the Ponar samples, while one Ponar sample was comprised of 30% gravel (Table 1). The average organic content in the Two-Mile Channel area was 1.5%, and ranged from 1% to 3% (Table 2). Particulate analysis revealed that, on average, 84% of each Ponar sample collected contained particles <0.5 mm in diameter. Numerous bivalve shells were found in two of the Ponar samples taken in the area. The relatively deep water and the relative paucity of rocky shorelines in this area are generally uncharacteristic of lake sturgeon spawning areas.

3.2 PAUPANEKIS POINT

3.2.1 Site Description

The shoreline around Paupanekis Point is wooded, with sandy, gradual sloping beaches. No aquatic vegetation was observed in the area. There are a number of rock outcroppings surrounding Paupanekis Point, including Whitefish Islands to the east and Jackfish Islands to the northeast. These windswept islands are situated such that they are exposed to extensive wave action, conditions which may provide ideal lake spawning habitat for sturgeon. Photographs for this area are presented in Appendix 1.

3.2.2 Habitat Characteristics

Fourteen sites were surveyed in the Paupanekis Point area (Fig. 2) in water depths ranging from 1-3 m (Table 1). At seven of the 14 sites sampled, Ponar grabs could not be collected due to hard substrate. At the remaining seven sites, Ponar samples were comprised primarily of medium sand and smaller particles (Table 2). One sample was comprised of 14% gravel (particles 2-16 mm) and 27% stones (particles >16 mm). Organic content of Ponar samples ranged from 0.4% to 2.0%, and averaged 0.9%. This was the lowest average organic content of all three sites sampled (Table 2). On average, 85% of the substrate collected in each Ponar grab was <0.5 mm in diameter. The abundance of rocky outcroppings, relatively shallow depth, and low organic content of the substrate suggest that the Paupanekis Point area may provide the appropriate conditions for successful sturgeon spawning

3.3 PLAYGREEN POINT

3.3.1 Site Description

The shoreline in the Playgreen Point area is wooded (spruce and willow) with rock/gravel beaches. The area also is dotted with numerous rock outcroppings and small islands which may provide the necessary requirements for sturgeon spawning. Photographs of the Playgreen Point area are presented in Appendix 1.

3.3.2 Habitat Characteristics

Five sites were sampled in the Playgreen Point area (Fig. 2). The average water depth at these sites ranged from 2-3 m and averaged 2.3 m (Table 1). Although total organic content and particulate analysis were not conducted on samples from this site, all five Ponar samples yielded soft substrate comprised of clay/silt/sand (Table 1).

Playgreen Point was the only location visited where aquatic macrophytes were evident. This may be related in part to the sampling schedule, since Playgreen Point was sampled during late summer and all other locations were visited during early summer. The soft substrate in this area and the presence of aquatic macrophytes suggests that Playgreen Point may provide sturgeon foraging habitat rather than spawning habitat.

3.4 WARREN LANDING

3.4.1 Site Description

The majority of the shoreline at Warren Landing is composed of willow, with low lying swampy areas. This is most evident along the shore by Wuskwi Island, which is north of Purvis Island, and along Duck Point, which is situated directly southwest of Wuskwi Island. Near Lake Winnipeg, the dominant vegetative cover is again willow, but on a base of gradual sloping sand. Numerous rock outcroppings are situated throughout the entire Warren Landing area. Photographs are presented in Appendix 1.

3.4.2 Habitat Characteristics

Nine sites were sampled in the Warren Landing area, situated throughout the designated boating channel (Fig. 2). Sampling site depths ranged from 1.8-10.0 m and averaged 6.0 m (Table 1). Depths at the sampling sites are not indicative of the Warren Landing area, which is generally shallow with a relatively fast current.

Substrate in the Warren Landing area is primarily comprised of rocks and boulders. Despite the hard bottom, Ponar samples were taken at eight of nine sampling sites (Table 2). Most of the Ponar samples were comprised of medium sands and smaller particles, but one

sample (#32) was comprised of 60.0% stones. The percent of organics ranged from 0.8% to 3.7%, and averaged 1.6%. (Table 2). On average, 83% of the substrate collected in each Ponar grab was <0.5 mm in diameter. No aquatic vegetation was observed in the area. Based on the abundance of rocky outcroppings and the relatively shallow fast water, the Warren Landing area may provide the habitat characteristics necessary for successful lake sturgeon spawning.

4.0

SUMMARY

Rocky outcroppings in Playgreen Lake near Two-Mile Channel may provide the necessary requirements for sturgeon spawning. However, this area has relatively deep water and high concentrations of organics in the substrate - two characteristics not normally associated with lake sturgeon spawning habitat.

Paupanekis Point appears to offer the most suitable habitat characteristics for lake sturgeon spawning. This location has extensive areas of rocky outcroppings and islands typical of lake sturgeon spawning habitat. Wave action off these areas may provide the required water movement for egg incubation. Paupanekis Point also had the lowest average proportion of organics of all areas surveyed.

Playgreen Point offers rocky outcroppings that could be used by spawning sturgeon. However, soft substrate coupled with the presence of aquatic macrophytes - two habitat characteristics not usually associated with sturgeon spawning areas - suggest that this area more likely provides lake sturgeon with foraging habitat.

Warren Landing may also provide adequate spawning areas for sturgeon since it is generally shallow, has a relatively fast current, and has some rocky outcroppings. However, the substrate at Warren Landing may not be suitable for spawning sturgeon, since it had the highest proportion of organics of the areas surveyed.

5.0

REFERENCES

- ALLAN, J.D. 1995. Stream Ecology. Structure and function of running waters. Chapman and Hall. 388 p.
- AYLES, H. A. 1973. The limnology-fisheries of Playgreen and Kiskittogisu Lakes, Manitoba. Part II, morphometry, biology, and fisheries. A report prepared for Manitoba Hydro System Planning Division. 55 p.
- GREEN, D.J. 1987. Summary of fish population data from Sipiwesk and Cross Lakes, 1987. Man. Dept. Nat. Res. MS Rep. No. 88-12:90 p.
- HARKNESS, W.J.K. 1980. Report on the sturgeon situation in Manitoba. Man. Dept. Nat. Res. MS Rep. No. 80-3. 18 p.
- HARKNESS, W.J.K. and J.R. DYMOND. 1961. The Lake Sturgeon. The history of its fishery and problems of conservation. Ont. Dept. Lands For. 120 p.
- HILDERMEN, WITTY, CROSBY, AND HANNA. 1983. Report on Playgreen Lake. 94 p.
- HOUSTON, J.J. 1987. Status of the lake sturgeon, *Acipenser fulvescens*, in Canada. Can. Field Nat. 101(2):171-185.
- HYNES, H.B.N. 1970. The ecology of running waters. Univ. of Toronto Press. (cited by ALLAN 1995).
- KOSHINSKY, G.D. 1973. The limnology-fisheries of the outlet lakes area: present conditions and implications of hydroelectric development. The Lake Winnipeg, Churchill and Nelson Rivers Study Board. App. 5, Vol. 2. 156 p.
- SCOTT, W.B. and E.J. CROSSMAN. 1979. Freshwater fishes of Canada. Bull. Fish. Res. Board Can. 184:966 p.
- SUNDE, L.A. 1961. Growth and reproduction of the lake sturgeon (*Acipenser fulvescens* Rafinesque) of the Nelson River in Manitoba. Master's Thesis, Univ. of British Columbia. 93 p.
- WEINS, A.P., and D.M. ROSENBERG. 1991. Surveys of the benthic macroinvertebrates in Playgreen and Kiskittogisu lakes, northern Manitoba. Can. Tech. Rep. Fish. Aquat. Sci. 1814: iv + 21 p.

Table 1. Physical characteristics of areas on Playgreen Lake where lake sturgeon have historically been known to congregate.

Location	Sample	Date	Depth (m)	Distance fr. shore (m)	Shoreline	Substrate	# of ponar grabs	Photos	Comments
2-Mile Channel Area	1	02-Jun	1-2	500	sandy	sand	1		Sample taken
2-Mile Channel Area	7	03-Jun					1		No sample, water to deep
2-Mile Channel Area	8	03-Jun		500			1		No sample, water to deep
2-Mile Channel Area	9	03-Jun	8-10			silt/sand/algae	1		Sample taken
2-Mile Channel Area	19	04-Jun	1.75	200	wooded/sandy	hard	4	yes	No sample, 1 rock
2-Mile Channel Area	20	04-Jun	1.75	200	wooded/sandy	hard	4	yes	No sample, some sand
2-Mile Channel Area	21	04-Jun	1.75	200	wooded/sandy	hard sand	3	yes	Sand sample
2-Mile Channel Area	22	04-Jun	1		wooded/sandy	hard sand	1	yes	No sample, same as E22
2-Mile Channel Area	23	04-Jun	2	400-500		soft bottom	1		Sample taken
2-Mile Channel Area	24	04-Jun	2.5	1000		sand/silt	1		Sample taken
2-Mile Channel Area	25	04-Jun	2.75			sand/silt	1		Sample taken
2-Mile Channel Area	26	04-Jun	6			silt	1		Sample taken
Paupanekis Pt.	2	02-Jun	1-2	500	wooded	hard	2		No sample
Paupanekis Pt.	3	02-Jun	1-2	500		hard	2		No sample, 1 rock
Paupanekis Pt.	4	02-Jun	1-2	350-400	wooded/sandy	hard sand	2		1 small lump of sand
Paupanekis Pt.	5	02-Jun	1-2	300	wooded/sandy	silt/sand	1		Sample taken
Paupanekis Pt.	6	02-Jun	1-2	200	wooded/sandy	hard	3		No sample
Paupanekis Pt.	10	03-Jun	2.25	100	sandy	sand	1	yes	Sample taken
Paupanekis Pt.	11	03-Jun	2.25			sand	1		Sample taken
Paupanekis Pt.	12	03-Jun	2	150-200		sand	1		Sample taken
Paupanekis Pt.	13	03-Jun	2.5	500-750	wooded	silt/clay/sand	2		No sample
Paupanekis Pt.	14	03-Jun	1	100-150	willow/sand	sand	1	yes	Sample taken
Paupanekis Pt.	15	03-Jun	1.5	150-200	willow/sand	hard	2	yes	No sample, 1 rock/sand
Paupanekis Pt.	16	03-Jun	1	150-200	wooded/sandy	sand/gravel	1		Sample taken
Paupanekis Pt.	17	03-Jun	2	100	willow	hard sand	2	yes	No sample, some sand
Paupanekis Pt.	18	03-Jun	3			hard sand	2	yes	No sample
Playgreen Point	36	16-Sep	2	50	wooded/aqu.veg	sand/silt	1		No sample
Playgreen Point	37	16-Sep	2.2	50	wooded/aqu.veg	sand/silt	1		No sample

Table 1. (continued)

Location	Sample	Date	Depth (m)	Distance fr. shore (m)	Shoreline	Substrate	# of ponar grabs	Photos	Comments
Playgreen Point	38	16-Sep	2.2	50	wooded/aqu.veg	silt/clay	1		No sample
Playgreen Point	39	16-Sep	3			clay/silt	1		No sample
Playgreen Point	40	16-Sep	2.2	100		sand/clay	1		No sample
Warren Landing	27	10-Jun	6	75	sandy	sand	1		Sample taken
Warren Landing	28	10-Jun	5			silt/mud/sand	1		Sample taken
Warren Landing	29	10-Jun	3	75	willow/sand	mud/silt	1		Sample taken
Warren Landing	30	10-Jun	9		Mid Channel	mud/silt	1		Sample taken, stratified
Warren Landing	31	10-Jun	6		Mid Channel	hard	4		No sample
Warren Landing	32	10-Jun	6	100	Mid Channel	hard	4		Rock/clay sample taken
Warren Landing	33	10-Jun	10	150	willow	mud/silt	1		Sample taken
Warren Landing	34	10-Jun	7		Mid Channel	mud/silt	1		Sample taken
Warren Landing	35	10-Jun	1.75			mud/silt	1		Sample taken

Table 1. (continued)

Location	Sample	Date	Depth (m)	Distance fr. shore (m)	Shoreline	Substrate	# of ponar grabs	Photos	Comments
Playgreen Point	38	16-Sep	2.2	50	wooded/aqu.veg	silt/clay	1		No sample
Playgreen Point	39	16-Sep	3			clay/silt	1		No sample
Playgreen Point	40	16-Sep	2.2	100		sand/clay	1		No sample
Warren Landing	27	10-Jun	6	75	sandy	sand	1		Sample taken
Warren Landing	28	10-Jun	5			silt/mud/sand	1		Sample taken
Warren Landing	29	10-Jun	3	75	willow/sand	mud/silt	1		Sample taken
Warren Landing	30	10-Jun	9		Mid Channel	mud/silt	1		Sample taken, stratified
Warren Landing	31	10-Jun	6		Mid Channel	hard	4		No sample
Warren Landing	32	10-Jun	6	100	Mid Channel	hard	4		Rock/clay sample taken
Warren Landing	33	10-Jun	10	150	willow	mud/silt	1		Sample taken
Warren Landing	34	10-Jun	7		Mid Channel	mud/silt	1		Sample taken
Warren Landing	35	10-Jun	1.75			mud/silt	1		Sample taken

Table 2. Composition of sediment samples collected from Playgreen Lake, 1995.

Location	Sample #	% Organic	% dried weight (including organics)				General composition, appearance and texture of substrate
			(>2mm)	(2mm-1mm)	(1mm-0.5mm)	(<0.5mm)	
2-Mile Channel Area	1	1.7	5.6	8.3	12.1	74.0	mixed sand, silt/clay
2-Mile Channel Area	9	2.2	30.6	9.5	5.3	54.6	moss, fine silt/clay
2-Mile Channel Area	21	0.2	2.1	1.0	1.1	95.7	fine, dark sand
2-Mile Channel Area	23	1.1	1.5	1.8	2.6	94.0	soft clay/silt, numerous bivalve shells
2-Mile Channel Area	24	0.9	0.7	3.3	12.9	83.0	soft clay/silt, numerous bivalve shells
2-Mile Channel Area	25	1.1	1.8	3.0	10.1	85.1	fine clay/silt
2-Mile Channel Area	26	3.1	0.0	0.1	0.3	99.7	fine clay/silt
Paupanekis Pt.	5*	1.4	14.3	2.4	1.9	54.5	soft silt/clay, fine sand, some gravel
Paupanekis Pt.	10	0.7	0.5	0.3	1.0	98.2	soft silt/clay, fine sand
Paupanekis Pt.	11	2.0	0.5	0.8	1.6	97.1	fine to medium sand, clay/silt
Paupanekis Pt.	12	0.6	5.6	4.5	8.2	81.6	silt/clay, fine sand, shells, live snails
Paupanekis Pt.	14	0.4	0.3	0.4	1.3	98.0	mostly medium sand
Paupanekis Pt.	16**	0.4	5.8	0.8	1.8	81.8	mostly medium sand, some gravel
Warren Landing	27	0.8	0.7	0.3	0.7	98.2	fine sand, clay/silt
Warren Landing	28	1.0	8.0	5.1	7.7	79.1	fine sand, clay/silt
Warren Landing	29	3.7	0.5	0.1	0.3	99.1	fine silt/clay, fine sand
Warren Landing	30	2.2	0.8	1.7	13.1	84.4	fine sand, clay/silt, some moss
Warren Landing	32***	0.8	7.9	2.6	3.7	25.9	clay/silt, sand, large gravel, some live bivalves
Warren Landing	33	2	2.2	2.2	2.2	93.4	fine sand, silt/clay
Warren Landing	34	1.2	8.6	4.6	5.4	81.3	silt/clay, medium sand, some gravel omitted
Warren Landing	35	1.2	0.1	0.1	0.1	99.7	medium sand, clay/silt

NOTE: In three cases large stones were removed from the sample

* sample was 27.0% stones

** sample was 10.0% stones

*** sample was 60.0% stones

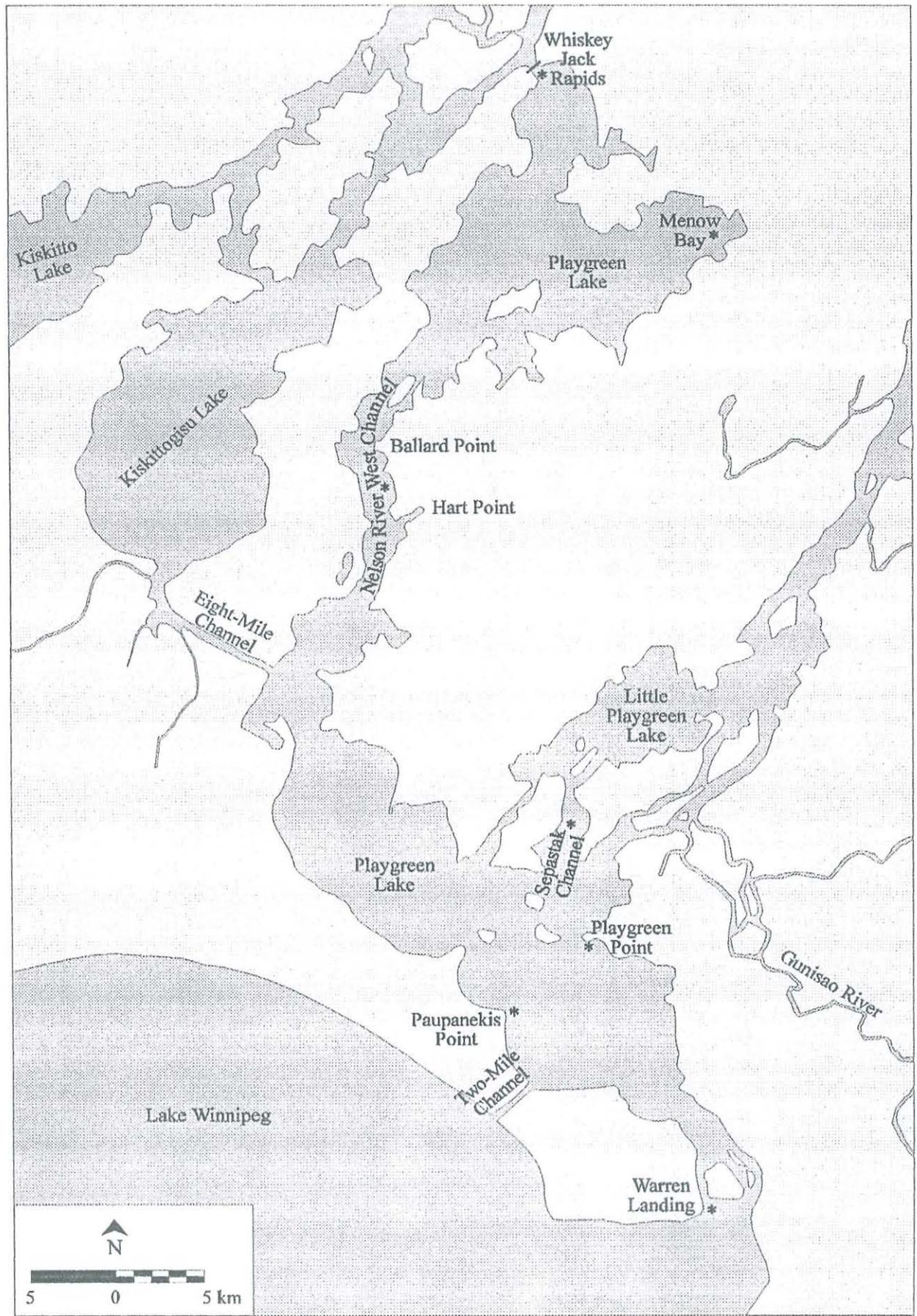


Figure 1. Lake sturgeon habitat study area, Playgreen Lake, 1995.

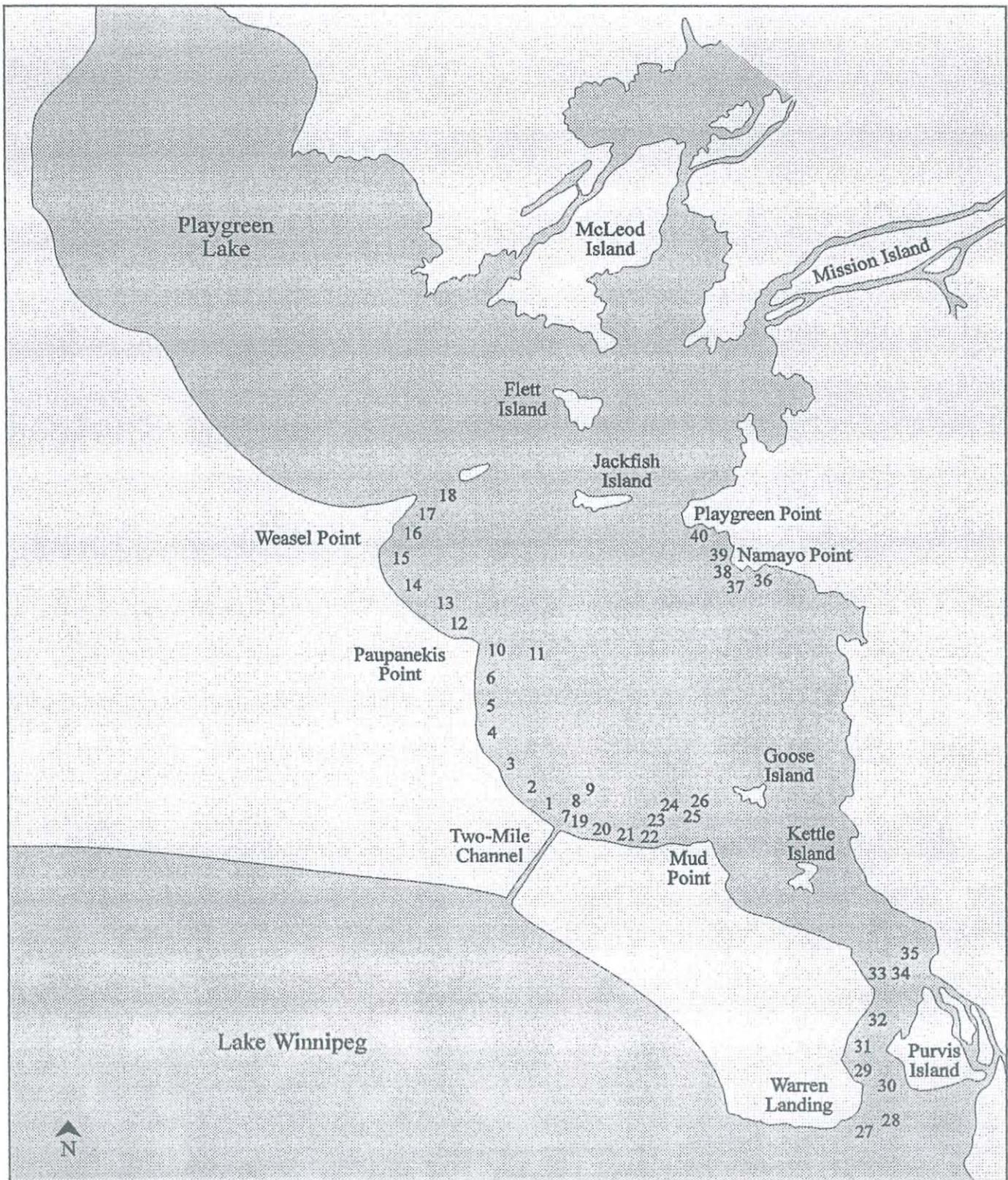


Figure 2. Location of ponar sample sites on Playgreen Lake, 1995.

APPENDIX 1



Photo 1. Shoreline at Two-Mile Channel, sample 19.

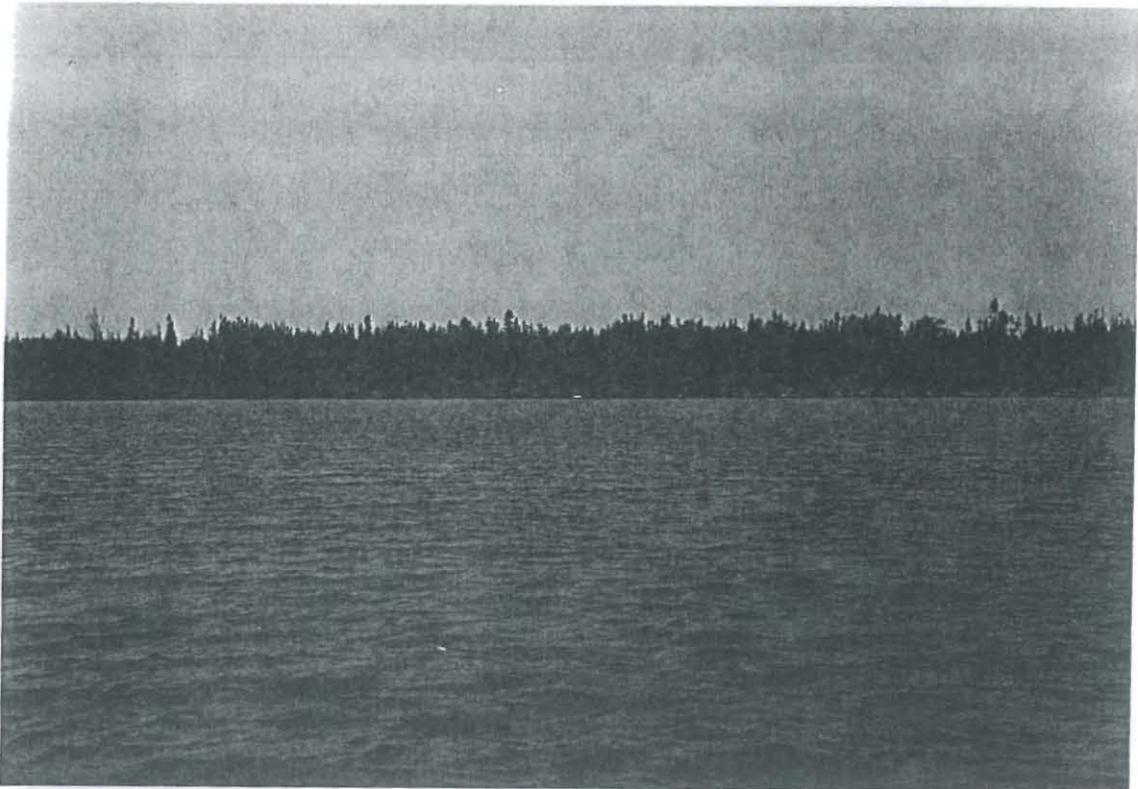


Photo 2. Shoreline between Two-Mile Channel and Mud Point, sample 20.



Photo 3. Shoreline between Two-Mile Channel and Mud Point, sample 21.



Photo 4. Shoreline between Two-Mile Channel and Mud Point, sample 22.



Photo 5. Shoreline at Paupanekis Point, sample 10.

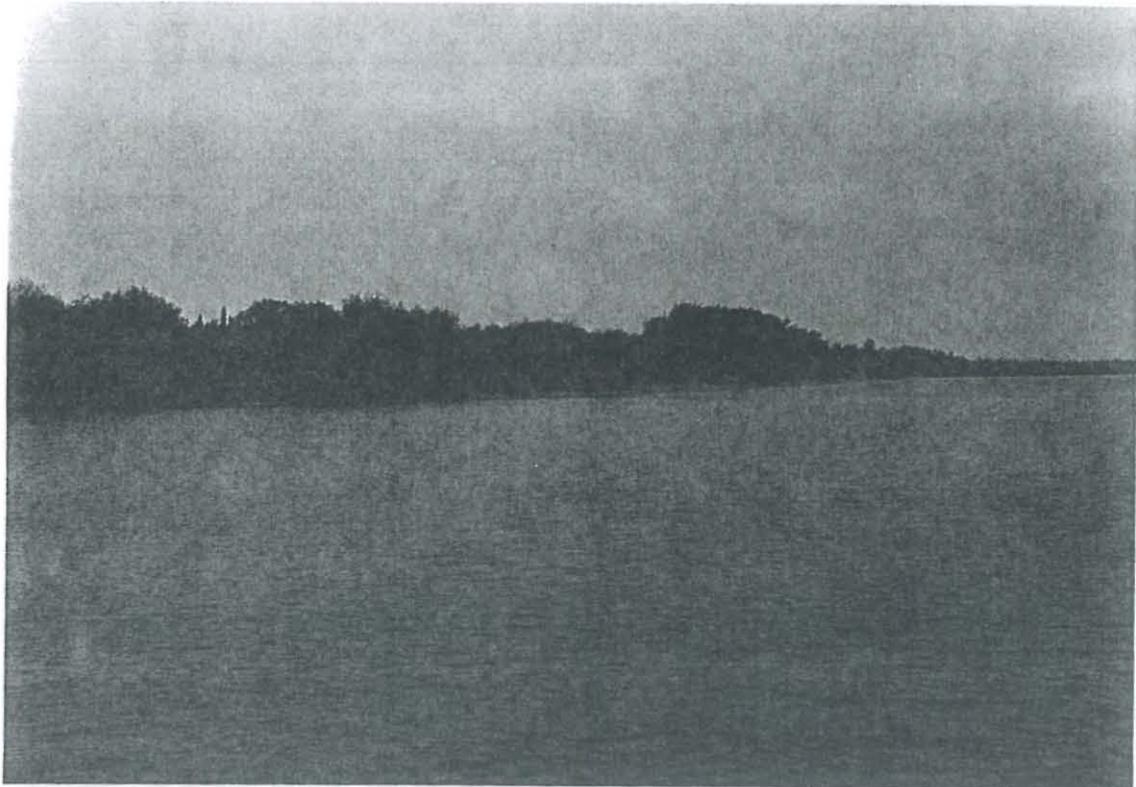


Photo 6. Shoreline at Paupanekis Point, sample 10.

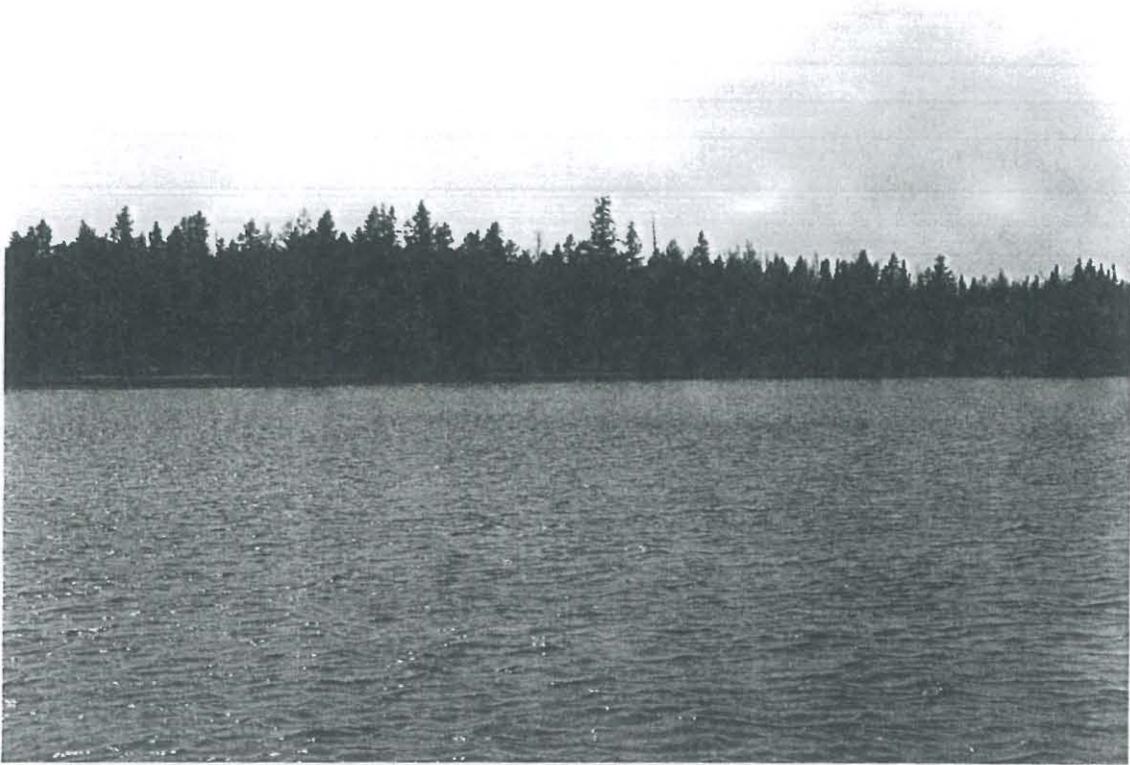


Photo 7. Shoreline between Paupanekis Point and Weasel Point, sample 14.



Photo 8. Shoreline between Paupanekis Point and Weasel Point, sample 15.



Photo 9. Shoreline at Weasel Point, sample 17.

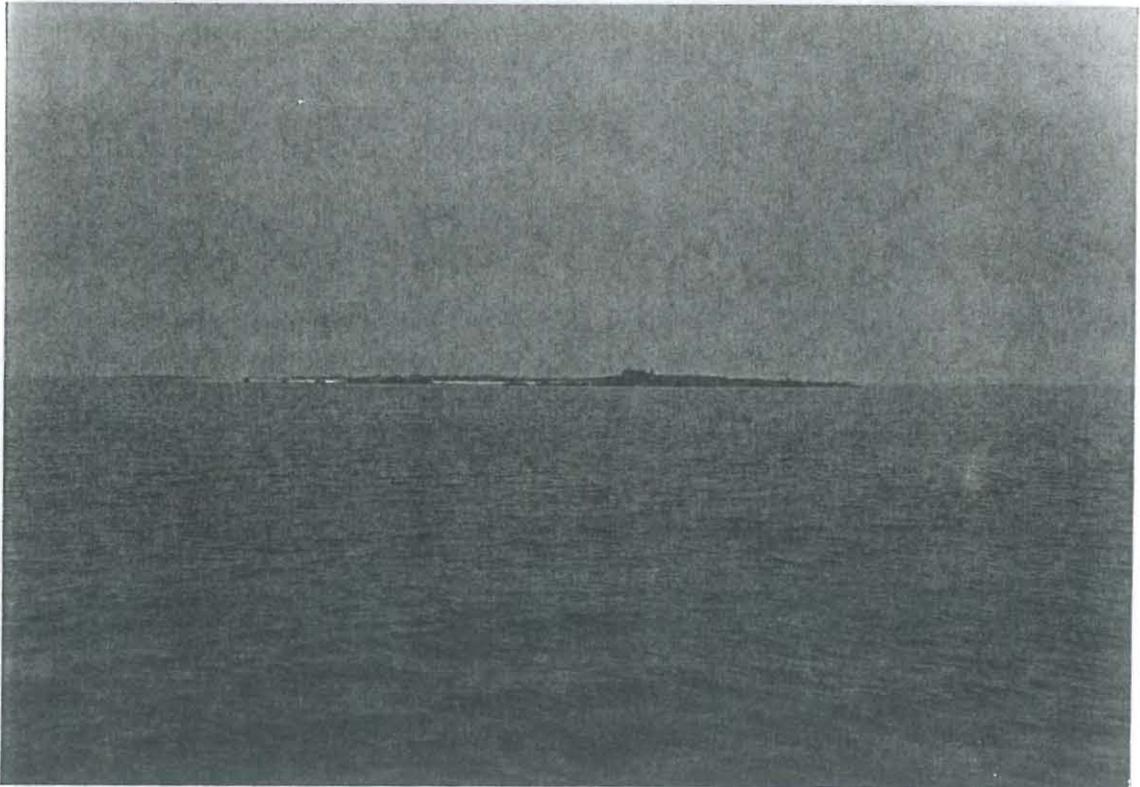


Photo 10. Island just off Weasel Point, sample 18.



Photo 11. Shoreline between Paupanekis Point and Two-Mile Channel.



Photo 12. Shoreline between Paupanekis Point and Two-Mile Channel.



Photo 13. Shoreline between Paupanekis Point and Two-Mile Channel.



Photo 14. Shoreline and rocky outcroppings between Playgreen Point and Namayo Point.

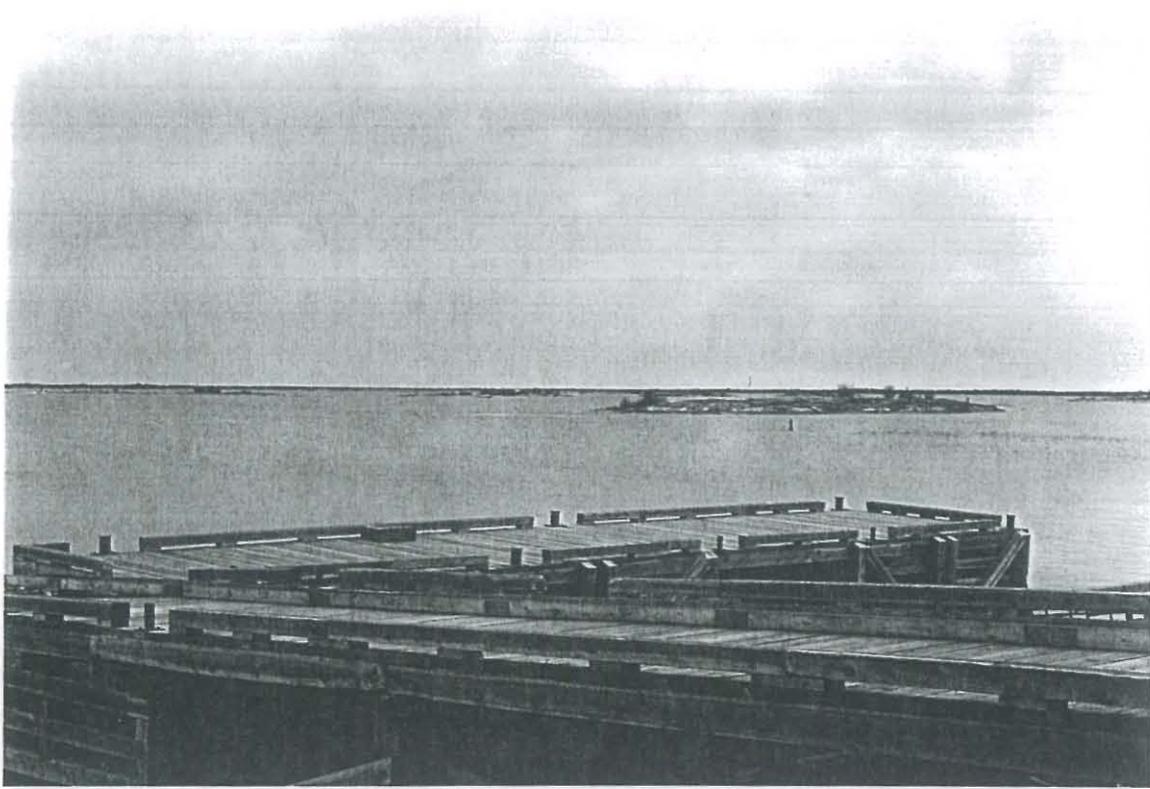


Photo 15. Rocky outcroppings in the Playgreen Point area.



Photo 16. Rocky outcroppings in the Playgreen Point area.

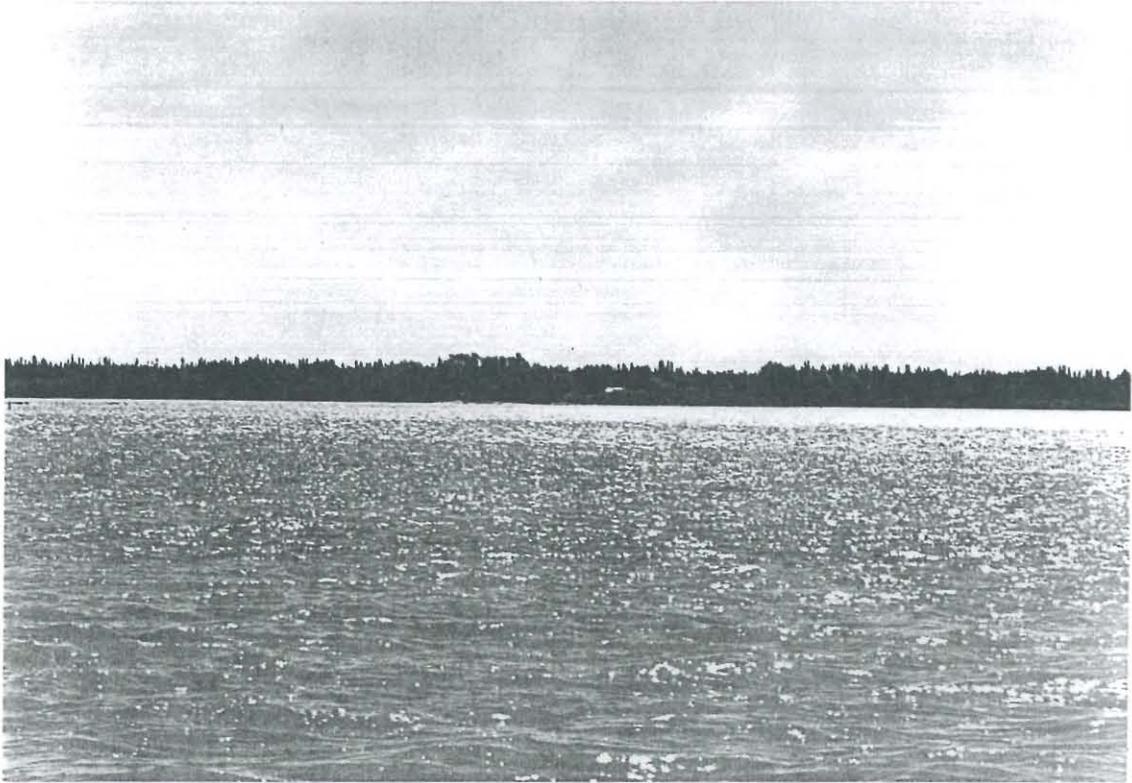


Photo 17. Warren Landing.

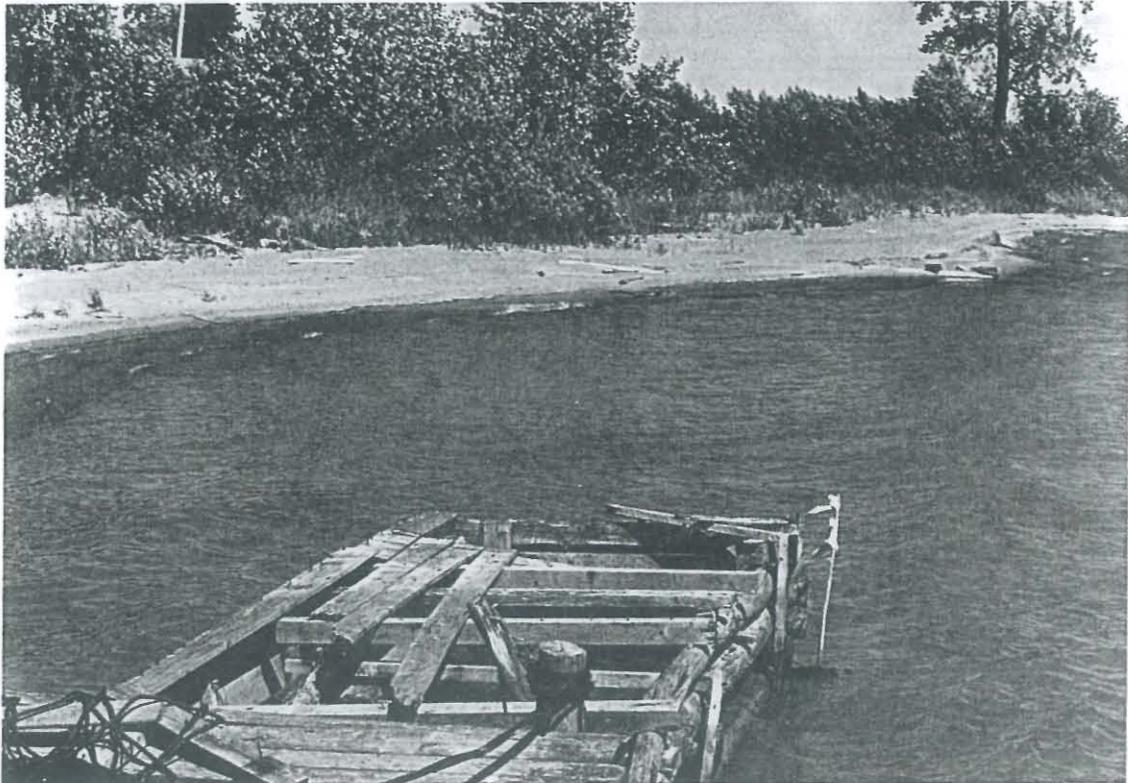


Photo 18. Shoreline at Warren Landing.