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IDENTIFICATION AND EVALUATION OF LAKE WHITEFISH AND HERRING SPAWNING GROUNDS IN THE ST. MARYS RIVER AREA

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The spawning season of coregonines in the St. Marys River along the west shore of Sugar Island and in the West Neebish Channel was monitored with graded-mesh gill nets.

Of 216 coregonines collected, 208 were ciscoes (Coregonus artedii) and 8 lake whitefish (Coregonus clupeaformis). Spent fish first appeared in the samples November 7 and essentially all fish collected November 28 had spawned.

Pumping was used to collect coregonine eggs and locate spawning grounds. A cisco spawning ground was located at study site I, below the rock cut in the West Neebish Channel; a total of 29 cisco eggs were collected. Six eggs (four lake whitefish and two cisco) were collected at study site A, offshore of Sugar Island about 1.5 miles north of 9 - mile point.

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An additional lake whitefish egg was collected near Shingle Bay, Sugar Island. However, extensive searching near Shingle Bay and south of Shingle Bay failed to produce additional eggs; therefore spawning in this area remains unconfirmed.

IDENTIFICATION AND EVALUATION OF LAKE WHITEFISH AND HERRING SPAWNING GROUNDS IN THE ST. MARYS RIVER AREA

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An additional lake whitefish egg was collected near Shingle Bay, Sugar Island. However extensive searching near Shingle Bay and south of Shingle Bay failed to produce additional eggs; therefore spawning in this area remains unconfirmed.

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INTRODUCTION

A potential environmental impact of winter navigation on the St. Marys River is reduction in hatching success of fish eggs that incubate during the winter months. Fall or winter spawners that occur in the St. Marys River include whitefishes (subfamily Coregoninae) and the burbot (*Lota lota*). The lake whitefish (*Coregonus clupeaformis*) and lake herring (*Coregonus artedii*) are the most important species from a commercial or sport-fishing standpoint. No commercial fishing has occurred for these species in the recent past but some netting by native Americans is presently occurring and is likely to occur in the future. Sportfishing for these species includes a spear fishery during the winter in the vicinity of Neebish Island, and a hook and line fishery, especially for lake herring, in the Lime Island area.

Gleason et. al. (1979) discussed the spawning of lake whitefish and lake herring, and the potential detrimental effects of sedimentation, or egg disturbance, that could result from winter navigation; only a brief summarization will be given here. Whitefish generally spawn in November and December. The lake whitefish is reported to spawn a week or two prior to the lake herring (Scott and Crossmann 1973). The eggs are generally deposited on a rock or gravel bottom in relatively shallow water, but spawning over silt and vegetation has been reported (Bryan and Kato 1975), and can occur in deep water or pelagically at mid-depths (Dryer and Beil 1964). Eggs normally incubate throughout the winter and usually hatch in April and May.

Navigation during the period of egg incubation might increase egg mortality by covering the eggs with sediment and preventing oxygen from reaching the embryos. Also, localized current alterations, or vessel-induced pore pressure responses could move and agitate the eggs since they are only slightly heavier than water. Eggs lifted out of crevices between rocks are susceptible to predation by various fishes and several invertebrates.

The objective of this study was to locate whitefish spawning grounds by collection of whitefish eggs during or after the spawning season. Gleason et. al. (1979) had identified potential whitefish spawning areas by interviewing local fishermen. They also attempted unsuccessfully to collect eggs; however, the attempts were made months after spawning had occurred. The present study began in early November, 1979, before spawning began, giving us much greater odds for successfully collecting eggs.

Michigan State University cooperated in this project and their facilities at the Dunbar Field Station provided our "home base" facilities.

METHODS

Fish Collection

Fish were collected with 6 ft deep graded-mesh gill nets consisting of 50 ft each of 1 5/8-in, 1 3/4-in, and 2-in mesh (square measure) gill netting; the total length of each net was 150 ft. Nets were lifted within 24 h when weather permitted, but on some occasions were not lifted for 48 or 72 h. The nets were set over varying bottom types in depths ranging from 4 to 30 ft. Because of the limited duration of the spawning season, nets were moved frequently to locate concentrations of spawning fish. A crude measure of relative fish abundance was calculated as catch per unit effort with a unit of effort defined as a gill net set for 24 h. Length, sex and spawning condition were recorded for all Coregonines.

Egg Collection

Pumping for eggs began November 19, 1979, shortly after spent fish appeared in the netting samples, and continued through December 6, 1979. Two gasoline powered centrifugal pumps were used: one with a 2-in intake hose, and the other a 3-in intake hose. The ends of the intake hoses consisted of approximately 15 inches of galvanized steel pipe. Steel mesh was welded to the end of the galvanized pipe to prevent larger rocks and vegetation from entering the pumps. (The mesh openings were diamond-shaped with the long axis measuring 3/8 in.) The suction of the pump caused vegetation and debris to collect on the mesh and clog the intake. To help solve this problem, four 3/4-in steel straps were attached around the end of each intake. The straps extended 3 to 4 in past the end of the intake and kept the mesh from direct contact with the bottom; this helped to prevent clogging and made it possible to operate the pumps for longer periods before cleaning the intakes.

The outflow of the pumps was filtered through a cone made of fiberglass window screen; the water and fine materials pass back into the river.

(Fiberglass screen has a mesh size of about 1.0 mm; much of the sediment passed through the screen, but whitefish eggs and larger sediments and debris were retained.) A receptacle at the end of each cone collected the filtered material. Preliminary examination of the material for the presence of whitefish eggs was made in the field (the eggs can be seen with the naked eye; but live eggs are very translucent). Since cold temperatures created difficult working conditions, the material was usually placed into 10% formalin and subsequently examined at the laboratory.

A typical "pumping run" lasted several minutes with the intake hose towed slowly behind or beneath the boat. The run was terminated when the outflow was reduced by clogging of the intake hose. The pump was then stopped, the filtered material collected from the receptacle, and the duration and location of the run were recorded. The intake hose was lifted on deck and the mesh cleaned of debris before another run began. Cold working conditions, rough seas, and equipment malfunctions, all accounted for considerable amount of field time compared to the actual pumping time.

A single day of effort, after ice-out, was spent towing a small, homemade trawl in area I (Fig. 1) in search of eggs. The trawl had a circular opening with a trash can lid attached in front and created a vortex to stir up the bottom. The eggs were lifted off the bottom and caught in the net (Figure 2). Without the trash can lid the opening of the net dug into the bottom and filled with sediment and detritus;

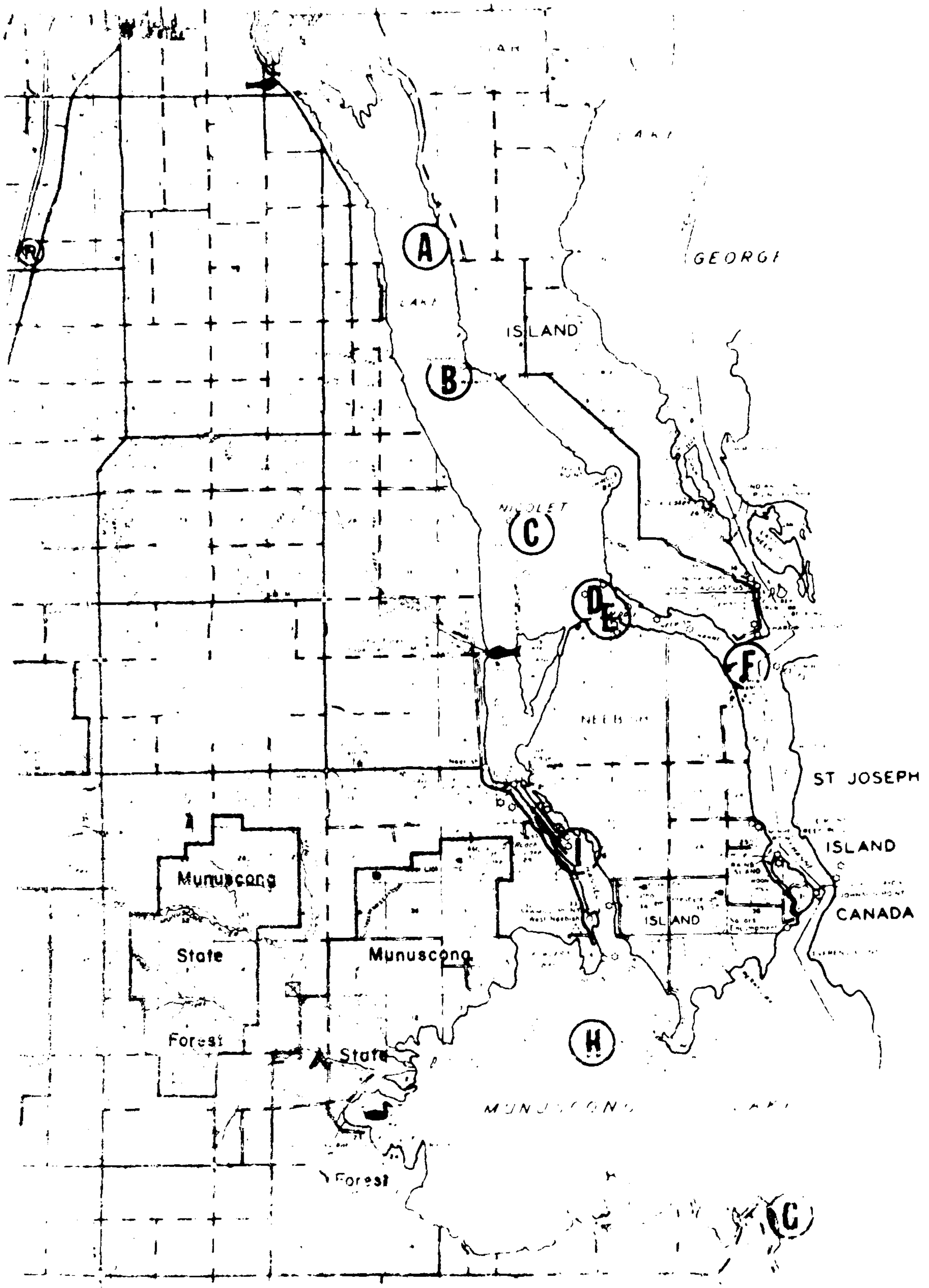


Figure 1. Tentative coregonine spawning areas identified by Gleason et al. (1979).

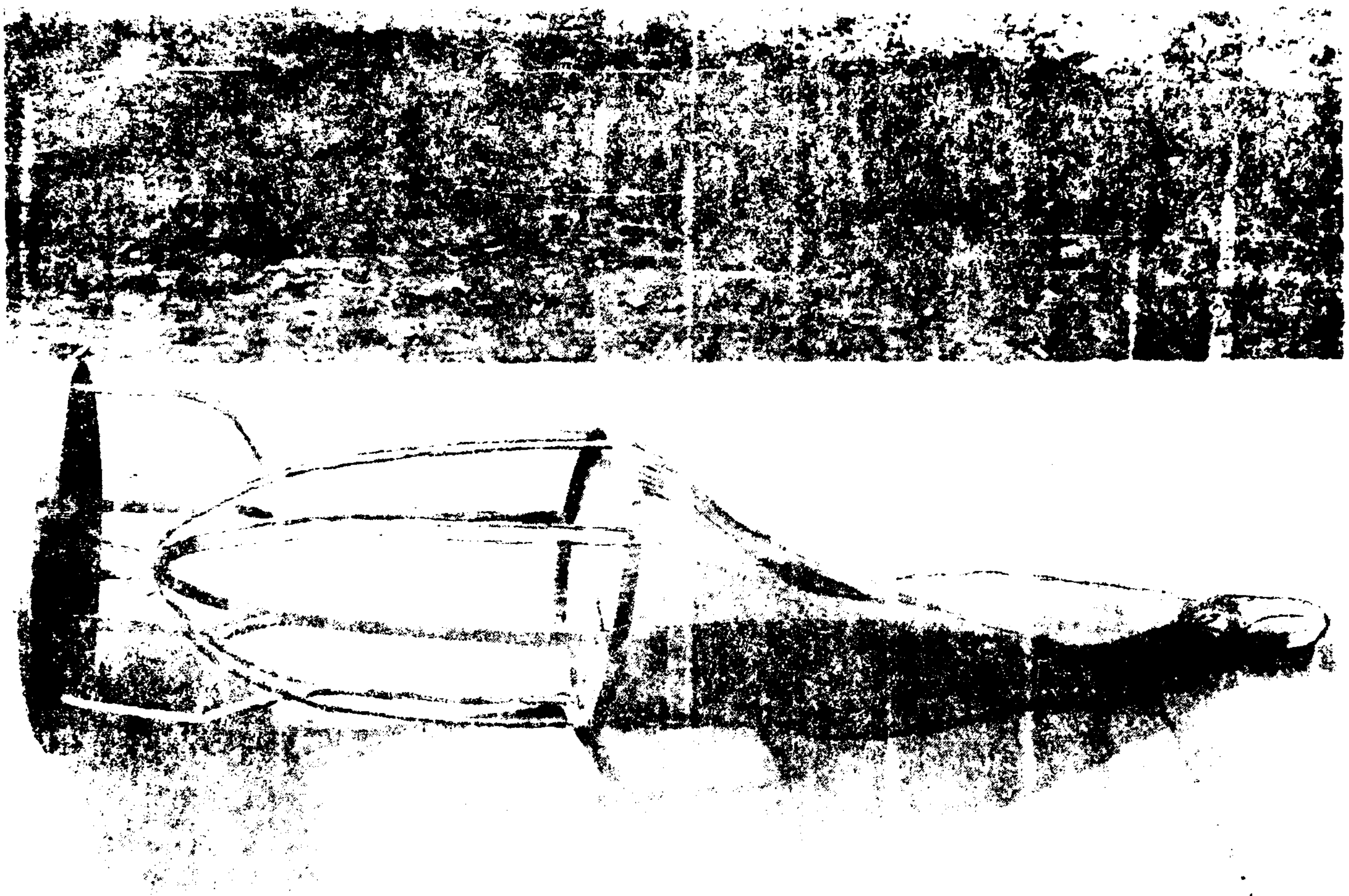


Fig. 2. A homemade trawl used for the collection of coregonine eggs.

along with the lid a float was attached to the top of the net to hold the net opening slightly off bottom.

STUDY AREAS

Areas tentatively identified as whitefish spawning grounds by Gleason et. al. (1979) are shown in Figure 1. They used pumping to search for eggs at sites F and I during February and March 1979, and pumping with the aid of scuba divers to search part of site D in April, 1979. The emphasis in the present study was the investigation of areas B, D, and I as spawning sites, with the search expanding to other areas as time permited.

Some of the general areas designated by letters in Figure 1 are divided into smaller areas in this study. The same letters with subscripts or superscripts are used to denote more specific locations.

Netting sites are shown in Figures 3 to 6, except for the Jone's Bay site (northwest shore of Neebish Island). A single gill net set was [illegible] the mouth of Jone's Bay (between Sand Island and Neebish Island) [illegible] West Neebish Channel (see Figure 1). Egg collection sites are [illegible] Figures 8 to 11.

RESULTS AND DISCUSSION

[illegible]

[illegible] to ciscoes and lake whitefish, 12 other fish species were [illegible] (Table 1). A total of 208 ciscoe were taken, but only 8 lake [illegible] (Table 2) [illegible] round whitefish (*Prosopium cylindraceum*) were

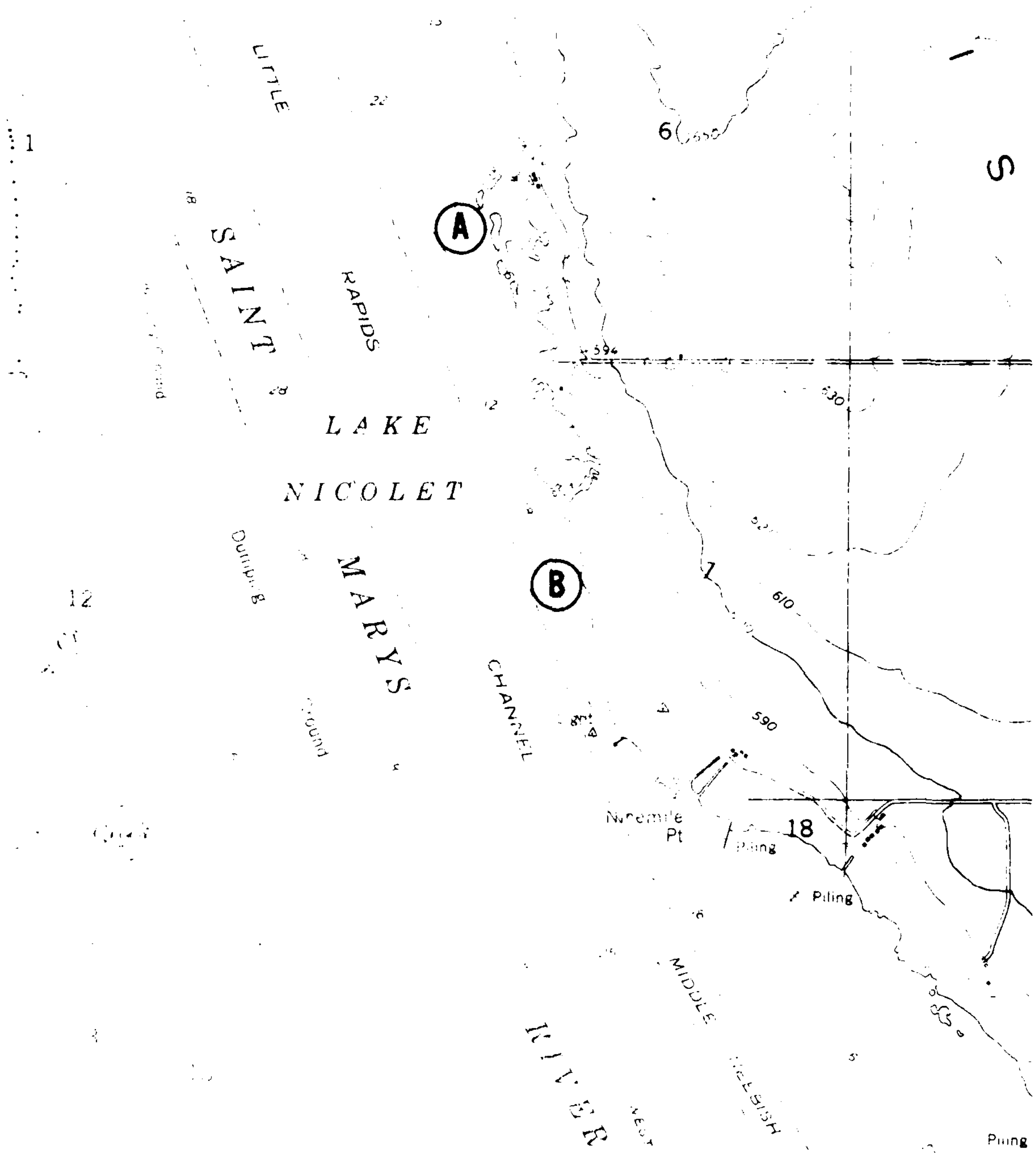


Figure 3. Netting sites A and B. Four sets were made at site A (November 6 & 9, 1979).

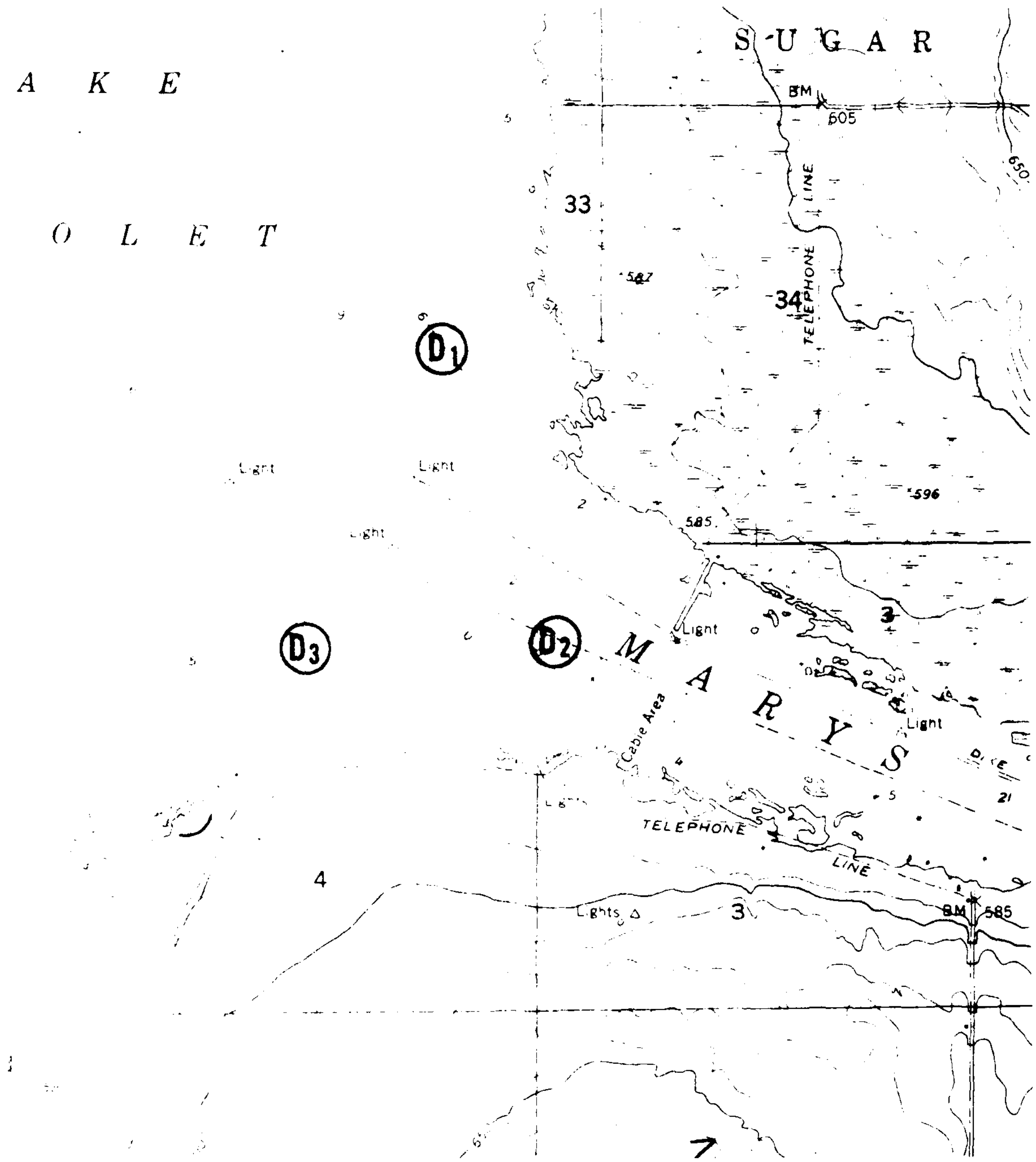


Figure 4. Netting sites D1, D2, and D3. A single gill net set was made at each site (November 6 - 29, 1979).

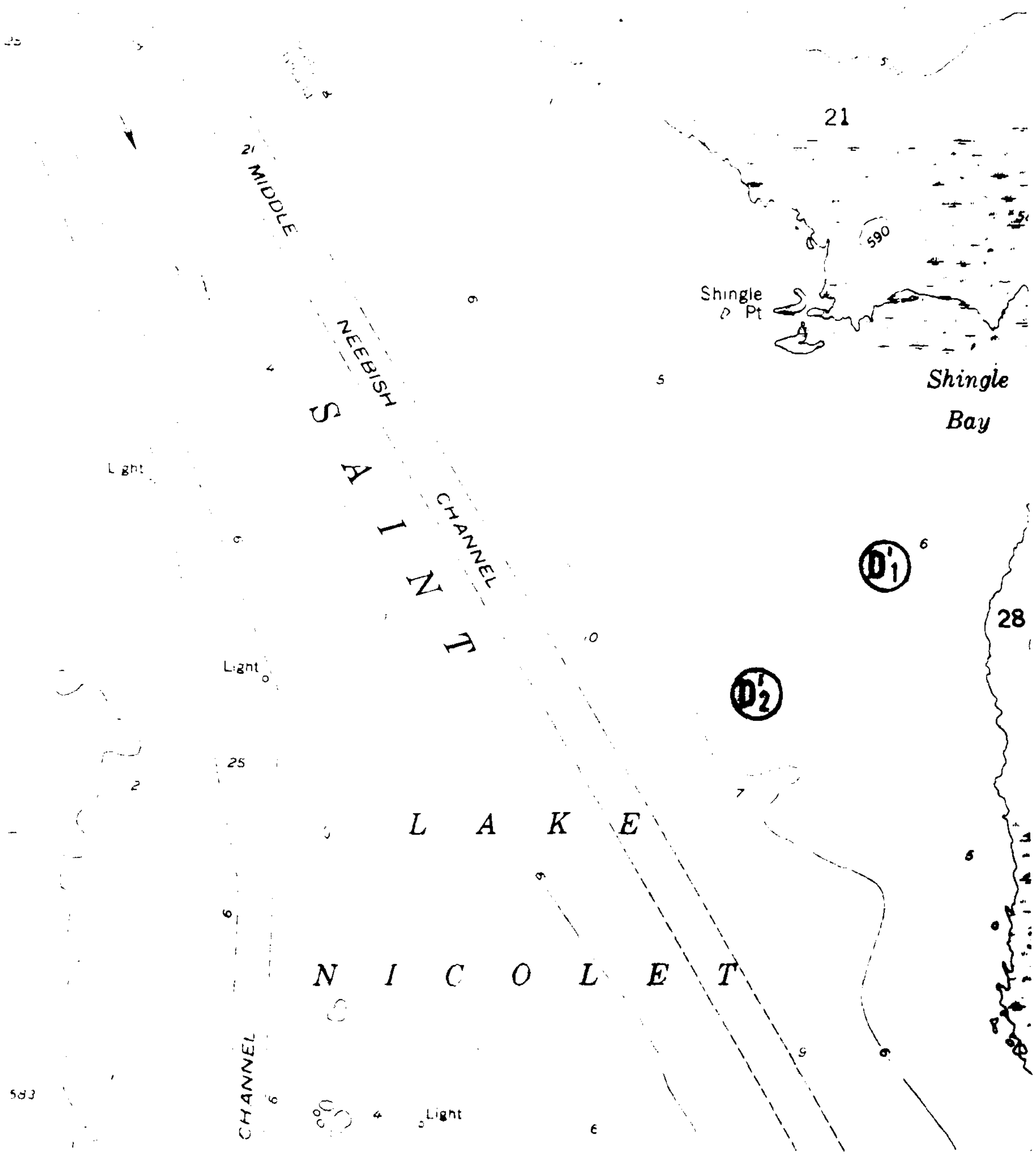


Figure 5. Netting sites D'_1 and D'_2. Two sets were made at site D'_1 (November 14 and 16, 1979), and three sets at site D'_2 (November 14-20, 1979).

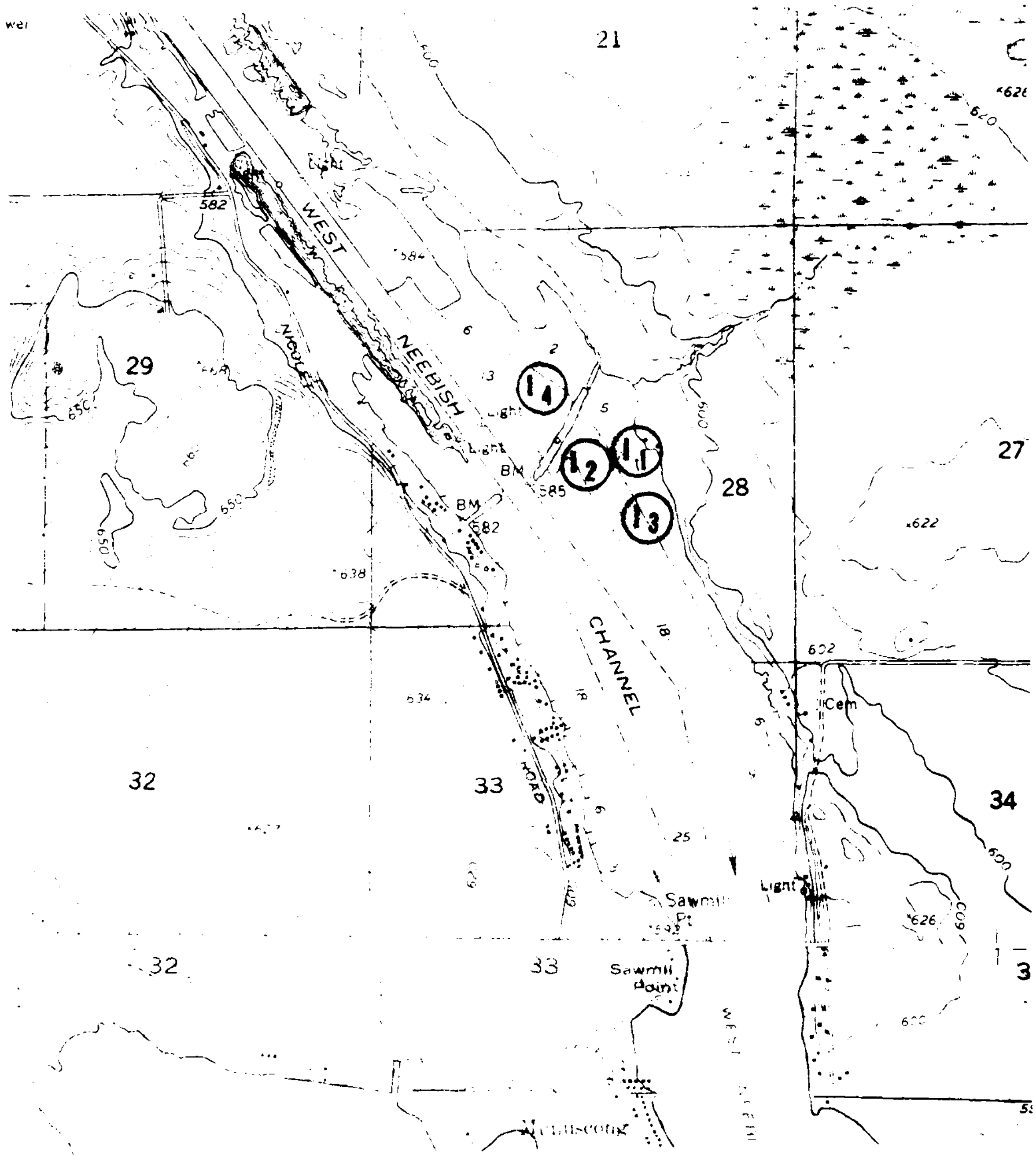


Figure 6. Netting sites I1, I2, I3, and I4. A total of 10 sets were made at these sites (November 6-28, 1979)

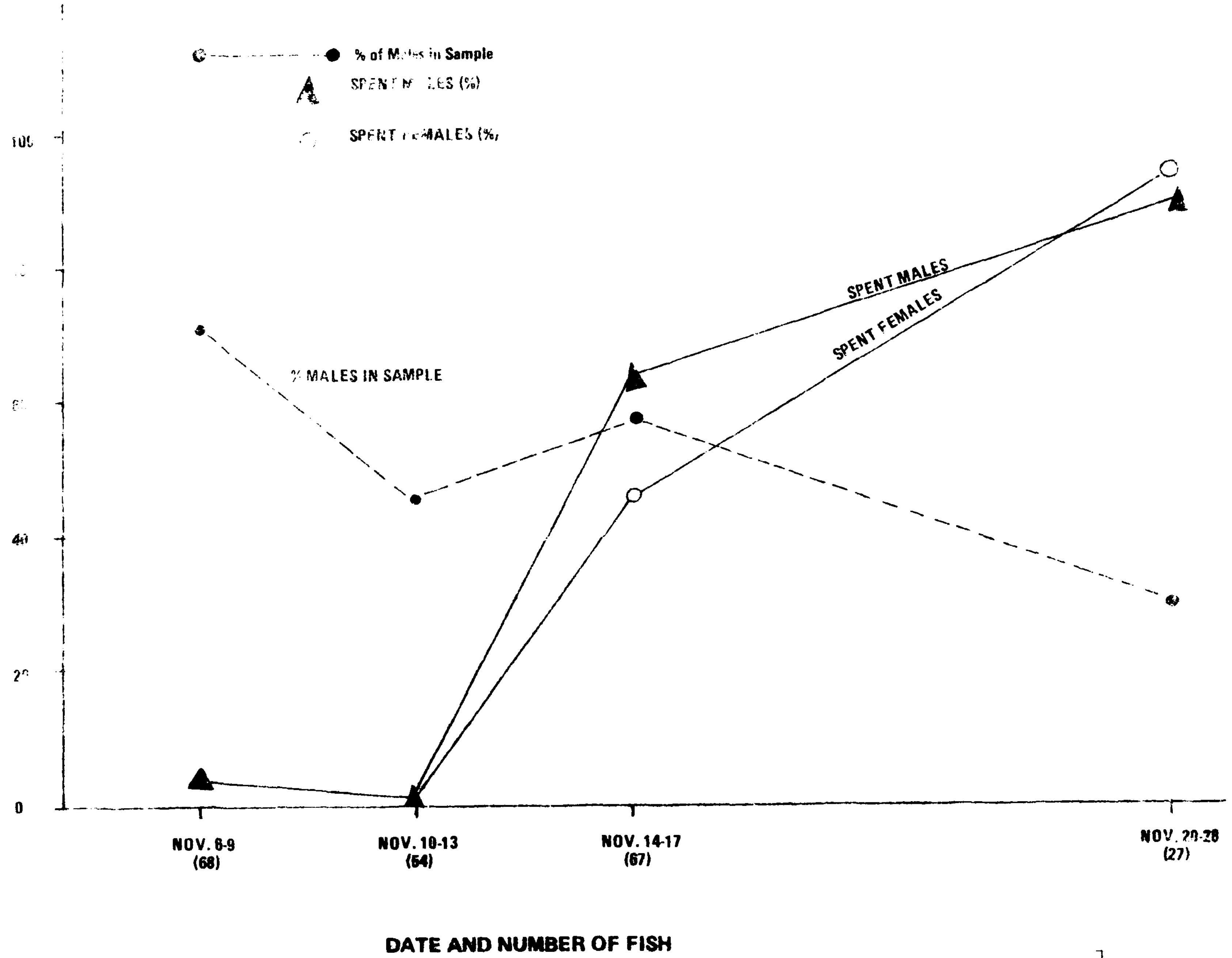


Figure 7. Change in sex ratio and state of maturity of coregonines during the spawning period, St. Mary's River, 1979. The 216 fish represented include 208 ciscoes and 8 lake whitefish.

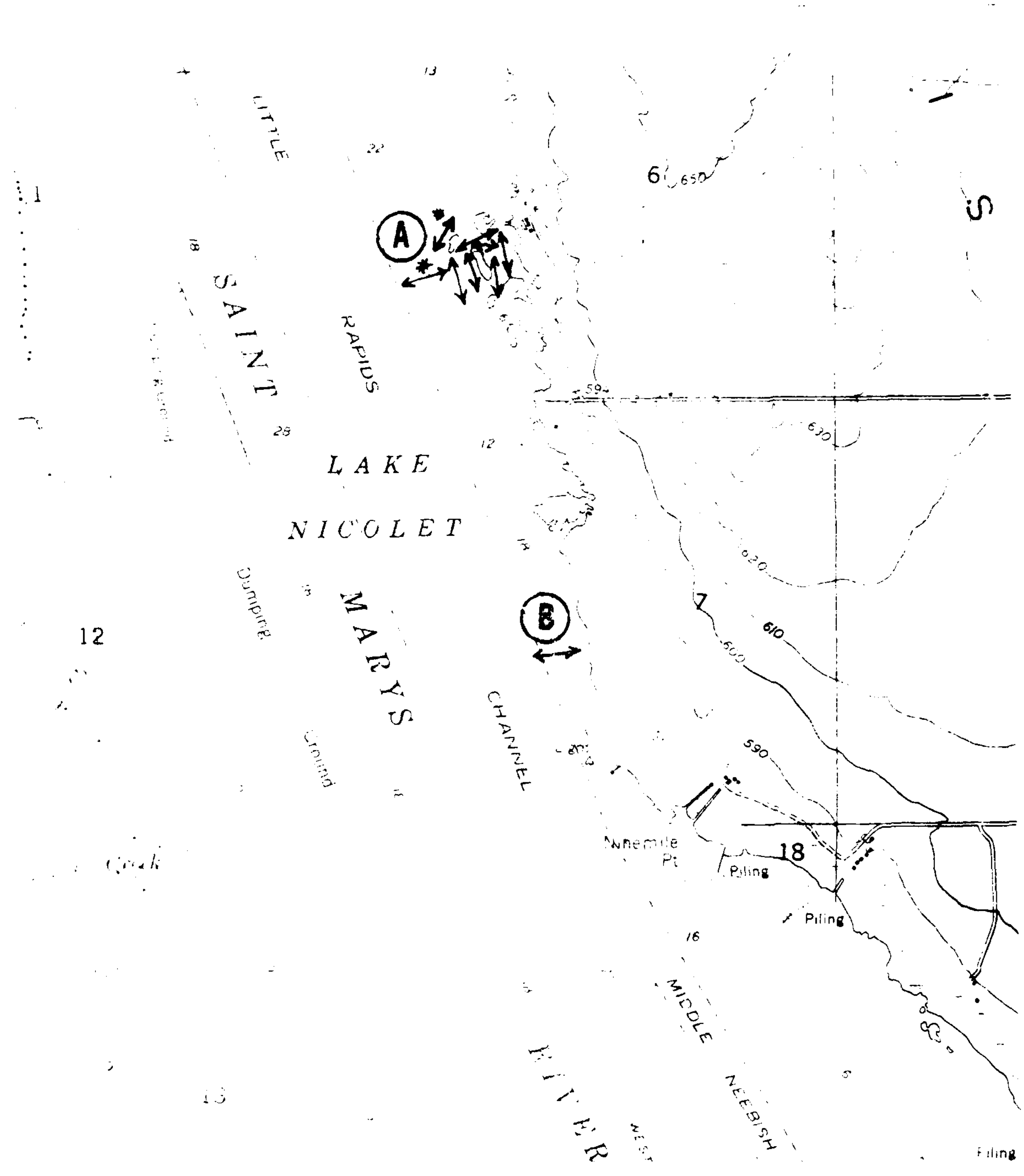
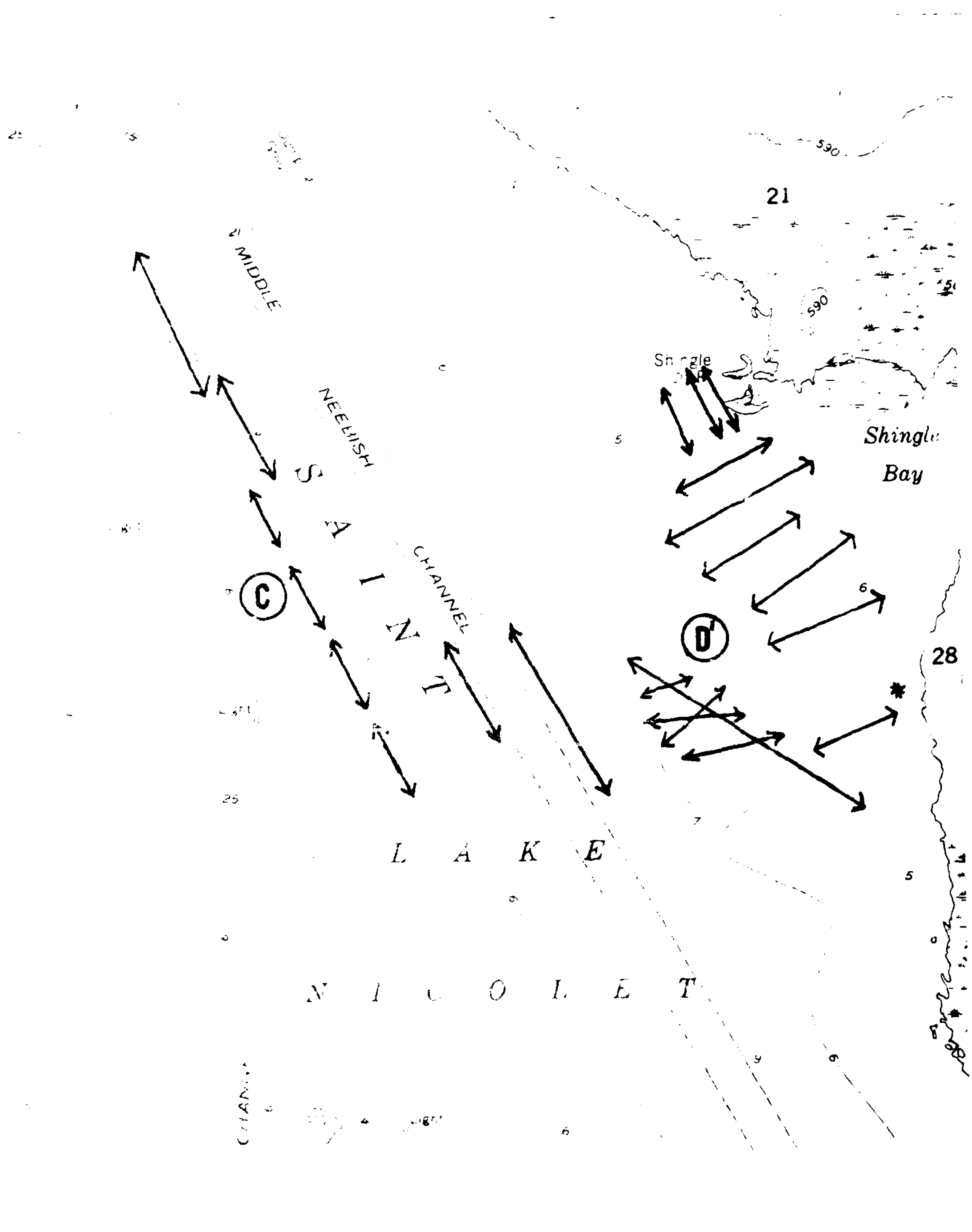


Figure 8. [illegible] A and B for coregonine eggs. Arrows indicate approximate [illegible] Asterisks indicate [illegible] runs.



[illegible] Arrows indicate approximate [illegible] run indicated with an asterisk.

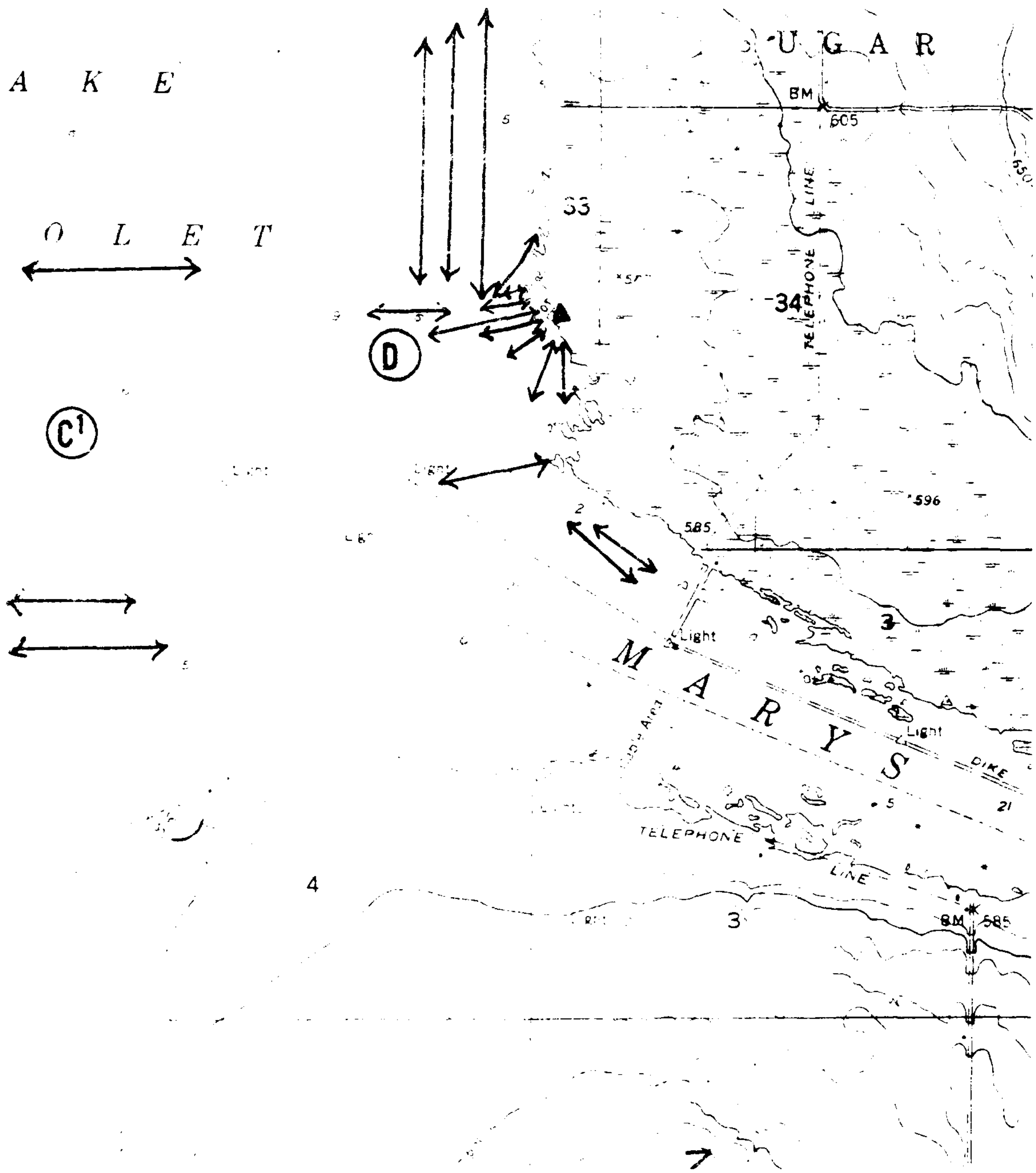
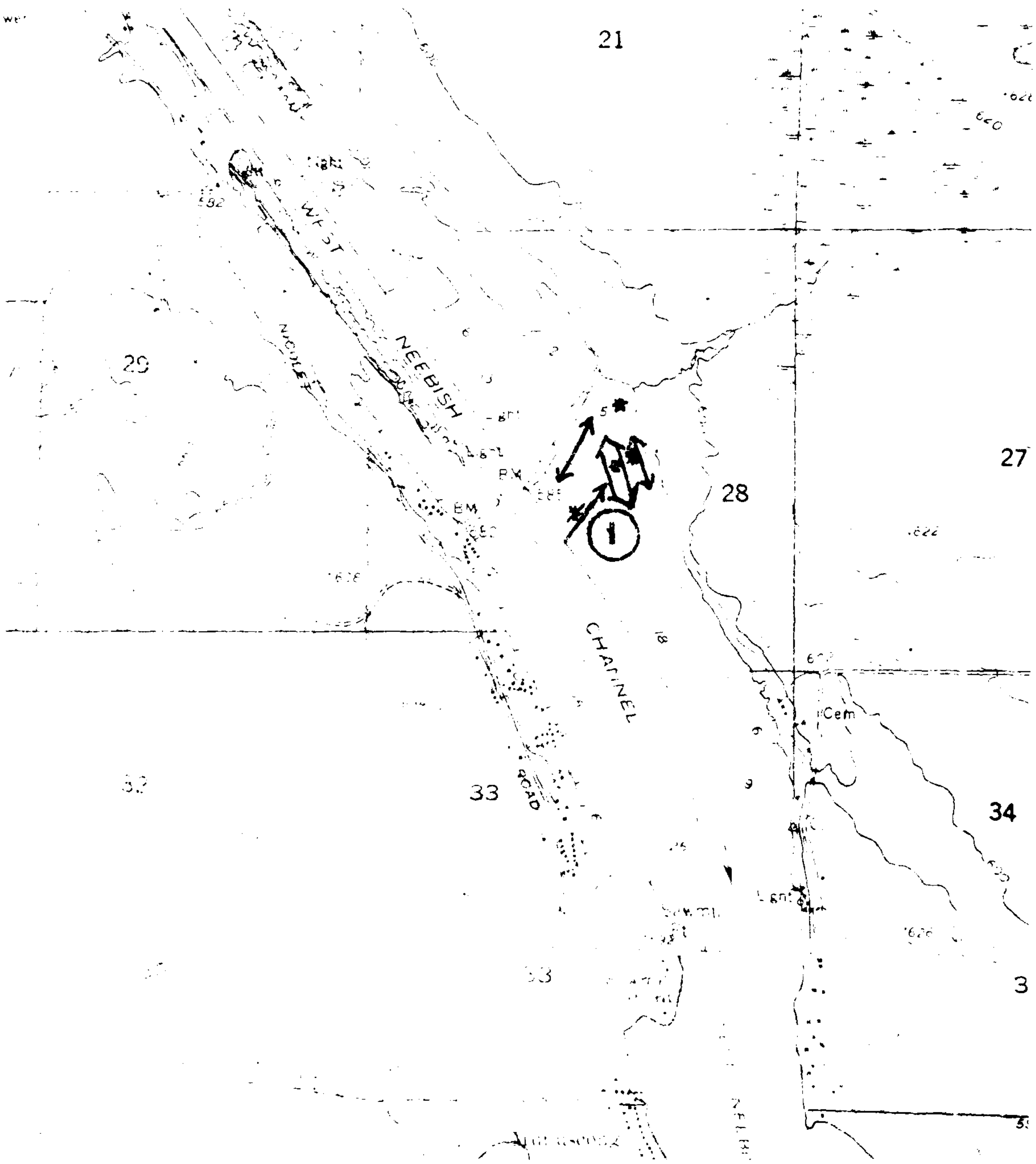


Figure 10. Sites pumped at areas C^1 and D for coregonine eggs. Arrows indicate approximate pumping runs. No eggs were collected.



[illegible] dicate approximate [illegible]

Table 1. Total catch and average catch per unit of effort (c/e) of species other than coregonines. A unit of effort is a graded-mesh gill net set for 24 hours. Refer to Figures 3 to 6 for exact locations.

	Location											
	A		B		D_1'		D_2'		I		Other	
Species	Total Catch	c/e	Total Catch	c/e	Total Catch	c/e	Total Catch	c/e	Total Catch	c/e	Total Catch	c/e
[illegible] sucker ([illegible])	16	2.8	25	6.2	2	0.5	3	0.5	37	3.5	34	6.0
[illegible] Pike ([illegible])	19	3.3	5	1.2	4	1.0	6	1.0	11	1.1	9	1.5
[illegible]rbot ([illegible])							4	0.6	6	0.5	1	0.1
[illegible]	6	1.5	2	0.5					1	0.1		
[illegible]							4	0.6			2	0.3
[illegible]					3	0.7					29	5.2
[illegible]									1	0.1		
[illegible]											3	0.5
[illegible]									1	0.1		
[illegible]									1	0.1		
[illegible]									1	0.1		
[illegible]												
[illegible]	[illegible]	[illegible]										

[illegible]

[illegible]

[illegible]

netted. A complete table of netting results for ciscoes and lake whitefish [illegible] Appendix [illegible].

The [illegible] and state of maturity of the coregonines were monitored [illegible] spawning period based on the netting results (Fig. 7). [illegible] early in the season, but at the end of the spawning [illegible] females dominated the catch of 27 fish (Fig. 7). [illegible] males on the spawning grounds has been noted by [illegible] and Bell 1964). We concentrated on netting [illegible] started to appear the the samples. Emphasis then changed [illegible]. A few nets were set near the close of the spawning [illegible] spawning ended. Of the 15 fish captured the last [illegible] 14 were spent and 1 partly spent; [illegible] however.

[illegible] effectiveness was apparent between the 2-in pump [illegible] therefore data from both pumps were combined [illegible] of effort was not made at each location. The [illegible] made this area a doubtful [illegible] effort was expended there. When eggs [illegible] our search to other areas. Thus areas [illegible] were not searched as extensively as other [illegible] indicate that the pumping method was effective [illegible] present, 57.5% of night runs were successful [illegible] effort and success for collection of coregonine eggs at [illegible] sites on the St. Marys River, 1979. Refer to Figures [illegible] for exact location of pumping runs.

	Location						
	[illegible]	B	C	C'	D	D'	I
[illegible]	40	10	100	45	135	220	45
[illegible]	8	1	[illegible]	6	15	18	6
[illegible]	3	0	0	0	0	1	4
[illegible]	[illegible]	0	0	0	0	5.5	50
[illegible]	6	0	[illegible]	0	0	1	26

50% of eight runs were successful at area I.

... also collected at area I on 19 April 1980 with our ... This area is undoubtedly a cisco spawning area. However, ... eggs were found here nor were any lake whitefish netted ...

... was based on measurements of egg diameters (Table ... reported the diameter of water-hardened lake whitefish ... to 3.2 mm. Booke (1970) reported mean diameters of ... eggs to be 2.95 for lake whitefish and 2.10 for ciscoes. ... whitefish eggs were 3.10 to 3.31 mm in diameter, and the cisco ... 2.11 to 2.69 mm. These diameters are greater than previously ... probably at least in part, due to the preservation of the ... before measurement. Although round whitefish eggs might ... with lake whitefish eggs, Bryan and Kato (1975) ... round whitefish to be larger than lake whitefish ... from the two species overlapping. ... round whitefish; therefore we concluded that ... whitefish

... collected ... (Dead eggs turn ... One of the eggs collected on 19 April ... difficult to judge the viability of eggs ... embryonic development had occurred. ... are generally translucent and dead eggs white and ... the six eggs collected at area A were alive. The

Table 4. Egg diameters of coregonine eggs collected from sites in the St. Marys River, 1979. Measurements were made only of eggs that were not deformed or fragmented.

Location	Number of eggs collected	Number of eggs measured	Average diameter and range in diameters (mm)
A	6[a]	3[a]	3.17[a] (3.10-3.31)
D'	1	1	3.10
I	26	16	2.51 (2.21-2.69)

[a]Only 3 of the 6 eggs collected were suitable for accurate measurements; examination of the eggs led to the conclusion that 4 were lake whitefish eggs and 2 cisco eggs. The 3 measured were lake whitefish eggs.

It is difficult to assess areas A and D relative to coregonine spawning since few eggs were collected and the eggs could have drifted considerable distances from where they were laid. Walter Duffy, Michigan State University, reported coregonine eggs in 2 of 15 bottom samples taken from near the middle of Lake Nicolet. The eggs were dead and not believed to have been spawned at the collection sites.

Area A appears to be a coregonine spawning area since 37.5% of the pumping runs were successful. It may be used by both lake whitefish and ciscoes. Of the six eggs collected, four were lake whitefish eggs and two cisco eggs. However, since only six eggs were collected, it remains possible that they drifted into the area from upstream. Although a single lake whitefish egg was collected at area D', this egg could have drifted into the area.

Bottom Types and Spawning Depths

Area I appears to be a cisco spawning area. Pumping for eggs was conducted in 3 to 15 ft of water with most eggs found at depths of approximately 8 to 10 ft. The bottom consisted of some boulders and a small percentage of rock and gravel; most of the bottom consisted of clay and sand with a considerable amount of vegetation. We initially expected to find eggs on rocky bottoms. Scott and Crossman (1973) state that ciscoes may spawn over any kind of bottom but usually spawn over gravel or stones. The fact that coregonines may spawn over soft, vegetated bottoms was confirmed by Bryan and Kato (1975) who found lake whitefish eggs spawned mostly over silt and the aquatic plant Potomogeton. However in another recent study (Bidgood 1974), lake whitefish reportedly spawned over boulders, gravel, and sand.

The eggs collected at area A came from depths of 5 to 15 ft and a rocky bottom. The variable depth of the water made it impossible to know the exact depth where eggs were collected. This area is apparently an old dumping ground of dredged rock and contains numerous small rocky reefs.

Failure to collect eggs at other locations cannot simply be attributed to different bottom types or depths. Area D', west of Shingle Bay, contained considerable vegetation with the bottom mostly sand or clay. The point sampled at the north end of Shingle Bay had a rocky bottom. Area C was predominately sand bottom with some vegetation. Water depth averaged less than five feet. Area D contained mostly rock and gravel bottom with very little vegetation; some current was noticeable. Various depths were searched unsuccessfully for eggs.

With the diversity of bottom type in the St. Marys River, and the finding of previous studies that coregonines may utilize a variety of bottom types for spawning, knowledge of bottom type alone seems to offer little help in locating spawning areas.

LIMITATIONS OF THE PRESENT STUDY AND RECOMMENDATIONS FOR FUTURE STUDY

Late funding made it difficult to properly plan and gear-up for the study. Preliminary testing of apparatus and surveying of field study areas would result in more efficient use of research time during the spawning period (November and December).

The 3-in pump was large and unwieldly, and did not result in more egg collections than the 2-in pump. Pumping in general presents special problems during the cold months when whitefish spawn. Care must be taken so that pumps do not freeze, and ice formation on equipment or samples makes field work cold and difficult. Also, most boat launch facilities become ice-covered in late November. Only the facility at Jen's Resort, West Neebish Channel, was satisfactory for leaving a boat in the water, but the ice remained a problem when the vessel was removed at the end of the project. Facilities to remove a boat from the water at the end of the project should be made available for future studies because boat launch sites may be frozen and unuseable.

In future studies more egg collection attempts should be made with trawls rather than pumps. Anderson and Smith (1971) successfully collected cisco eggs by trawling. Time to experiment with various designs, before the spawning season begins, would be desirable.

Future studies should attempt to answer two important questions: how large are whitefish spawning areas; and how far do eggs normally drift from the site of spawning? If spawning areas are small and eggs do not drift far, search for eggs must be very thorough. Pumping runs or trawling runs may have to be conducted every 100 m or closer to effectively locate spawning areas. Considering the size of the St. Marys River, this would be a large task.

With the documentation, by egg collection, of definite spawning sites, an extensive program should be undertaken to determine the effects of vessel-induced sedimentation on coregonine egg survival. Field studies could be conducted to monitor survival throughout the incubation period and correlate it with sedimentation. Laboratory studies would be helpful in relating egg mortality to accruately measured amounts of sediment, and also in determining the stages of embryo development that are most susceptible to mortality from sediments.

ACKNOWLEDGEMENTS

The cooperation of Michigan State University and use of their equipment [illegible] at the Dunbar Field Station is greatly appreciated. We [illegible] [illegible]ther Frankenstein, CRREL, for the use of the craft "Beaver". [illegible] seaworthy vessel proved indispensable especially in rough, inclement weather.

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Appendix 1. Detailed Coregonine Capture Results.

Location	Date	Set Time	Species	Length Range (cm)	Sex and Number		Maturity G	R	PS	S[a]
7 mile (A)	11/10/79	24 hr.	Cisco	32.5-58.0	F	9	-	9	-	-
					M	8	-	8	-	-
			Lk. Whitefish	48.5-58.0	F	1	-	1	-	-
					M	1	-	1	-	-
7 mile (A)	11/13/79	72 hr.	Cisco	32.2-42.5	F	8	-	8	-	-
					M	6	-	6	-	-
			Lk. Whitefish	54.3	F	1	-	1	-	-
7 mile (A)	11/14/79	24 hr.	Cisco	41.0-37.0	F	2	-	-	-	2
7 mile (A)	11/15/79	17 hr.	Cisco	36.5-45.0	F	6	-	4	-	2
					M	3	-	2	1	-
9 mile (B)	11/6/79	24 hr.	Cisco	25.0-42.5	F	1	-	1	-	-
					M	3	1	2	-	-
			Lk. Whitefish	27.0-50.5	F	2	2	-	-	-
					M	1	1	-	-	-
9 mile (B)	11/9/79	72 hr.	Cisco	35.5-42.0	F	4	-	4	-	-
					M	4	-	3	1	-
Shingle Bay (D'_1)	11/7/79	24 hr.	Cisco	36.5-66.5	F	3	3	-	-	-
					M	2	-	2	-	-
Single Bay (D'_1)	11/10/79	72 hr.	Cisco	32.5-48.0	F	8	-	8	-	-
					M	7	-	7	-	-
Bouy 68 (D'_2) (upbound)	11/14/79	24 hr.	Cisco	32.0-51.0	F	4	1	3	-	-
					M	25	-	9	15	1
Bouy 68 (D'_2)	11/16/79	24 hr.	No Coregonids Captured							
Bouy 68 (D'_2)	11/20/79	24 hr.	Cisco	39.5	F	1	-	1	-	-
			Lk. Whitefish	49.8	F	1	-	1	-	-
Bouy 64 (D_1) (upbound)	11/6/79	24 hr.	Cisco	36.3-41.0	F	3	1	2	-	-
					M	2	-	2	-	-
Bouy 59 (D_2)	11/15/79	16 hr.	Cisco	38.0-41.0	F	2	-	-	-	2
					M	1	-	-	1	-
North Neebish(D_3)	11/20/79	24 hr.	No Coregonids Captured							
Jones Bay	11/13/79	48	Cisco	33.0	F	1	1	-	-	-
			Lk. Whitefish	45.2	M	1	-	1	-	-
Rock Cut (I_1)	11/6/79	24 hr.	Cisco	33.6-43.3	F	0				
					M	10	-	10	-	-
Rock Cut (I_1)	11/7/79	24 hr.	Cisco	30.5-41.0	F	4	-	3	-	1
					M	8	-	7	-	1
Rock Cut (I_1)	11/8/79	24 hr.	Cisco	32.5-40.0	F	2	-	2	-	-
					M	19	-	19	-	-
Rock Cut (I_2)	11/15/79	72 hr.	Cisco	36.0-40.0	F	1	-	1	-	-
					M	2	-	2	-	-

Location	Date	Set Time	Species	Length Range (cm)	Ave	Sex and Number		Maturity[a] G	R	PS	S
Rock Cut (I_3) (100 yds. South)	11/14/79	24 hr.	Cisco	35.0-40.0		F	2	-	2	-	-
						M	2	-	2	-	-
Rock Cut (I_1)	11/15/79	18 hr.	Cisco	34.1-43.0		F	9	-	4	-	5
						M	7	-	-	7	-
Rock Cut (I_4)	11/16/79	24 hr.	Cisco	-	-	F	2	-	-	-	2
Rock Cut (I_1)	11/20/79	24 hr.	Cisco	33.5-46.2		F	6	-	1	5	-
						M	2	-	1	1	-
Rock Cut (I_1)	11/21/79	24 hr.	Cisco	36.0-40.1		F	1	-	-	1	-
						M	2	-	-	2	-
Rock Cut (I_1)	11/28/79	24 hr.	Cisco	35.8-44.7		F	12	-	-	1	11
						M	4	-	-	-	4
Totals	11/6/79	795 hr.	Cisco	25.0-66.5	38.4	F	91	6	53	7	25
						M	117	1	82	28	6
			Whitefish	27.0-58.0	53.5	F	5	2	3	-	-
						M	3	1	2	-	-

[a]G = green or immature
R = ripe
PS = partly spent
S = Spent