

AD-A213 838

2

EFFECTS OF VESSEL-INDUCED WAVES ON THE
COMPOSITION AND AMOUNT OF DRIFT IN AN
ICE ENVIRONMENT IN THE ST. MARYS RIVER

Thomas P. Poe and Thomas A. Edsall

ADMINISTRATIVE REPORT 82-6

September 1982

U.S. Fish and Wildlife Service
Great Lakes Fishery Laboratory

1451 Green Road

Ann Arbor, Michigan 48105

DTIC
ELECTE
OCT 26 1989
S B D

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

89 10 26 083

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
1a. REPORT SECURITY CLASSIFICATION Unclassified			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution unlimited		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE					
4. PERFORMING ORGANIZATION REPORT NUMBER(S)			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION U.S. Fish and Wildlife Service		6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION		
6c. ADDRESS (City, State, and ZIP Code) Great Lakes Fishery Laboratory 1451 Green Road Ann Arbor, MI 48105			7b. ADDRESS (City, State, and ZIP Code)		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION U.S. Army Corps of Engineers		8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER NCE-IA-80-003 EK		
8c. ADDRESS (City, State, and ZIP Code) Detroit District P.O. Box 1027 Detroit MI 48231			10. SOURCE OF FUNDING NUMBERS		
PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.		
11. TITLE (Include Security Classification) Effects of Vessel - Induced Waves on the Composition and Amount of Drift in an Ice Environment in the St. Marys River					
12. PERSONAL AUTHOR(S) Poe, T.P., T.A. Edsall					
13a. TYPE OF REPORT Final		13b. TIME COVERED FROM _____ TO _____		14. DATE OF REPORT (Year, Month, Day) September 1982	
15. PAGE COUNT 45					
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	ice cover with/without vessel traffic, ice free drift nets		
19. ABSTRACT (Continue on reverse if necessary and identify by block number) This study was conducted to determine how the composition and amounts of drift vary with the following conditions: 1) ice cover with vessel traffic; 2) ice cover without vessel traffic; 3) ice free with vessel traffic. Samples were taken with drift nets anchored at four locations (Brush Point, Frechett Point, Lake Nicolet, and West Neebish) in the littoral waters of the St. Marys River during January 30 - February 1, February 16-17, and March 22-23, under conditions of ice cover without vessel traffic, and on April 29 - May 1, under ice free conditions with vessel traffic. Samples were also taken at these four locations and with drift nets towed in the navigation channel during April 29 - May 1 under the ice free conditions with vessel traffic.					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a. NAME OF RESPONSIBLE INDIVIDUAL Jimmie L. Glover			22b. TELEPHONE (Include Area Code) (313) 226-7590		22c. OFFICE SYMBOL CENCE-PD-EA

Abstract

We conducted this study to determine how the composition and amounts of drift vary with the following conditions: 1) ice cover with vessel traffic; 2) ice cover without vessel traffic; and 3) ice free with vessel traffic. Samples were taken with drift nets anchored at four locations (Brush Point, Frechette Point, Lake Nicolet, and West Neebish) in the littoral waters of the St. Marys River during January 30-February 1, February 16-17, and March 22-23, under conditions of ice cover without vessel traffic, and on April 29-May 1, under ice free conditions with vessel traffic. Samples were also taken at these four locations and with drift nets towed in the navigation channel during April 29-May 1 under the ice free conditions with vessel traffic.

The results were as follows:

1. Macroinvertebrate drift in the littoral waters was less under conditions of ice cover without vessel traffic than it was after ice cover had broken up and vessel traffic had resumed.
2. The average density and biomass of the macroinvertebrate component of drift was higher in the navigation channel than in the littoral waters at all four locations.
3. The amount of macrophyte material in the drift under conditions of ice cover without vessel traffic was much lower than that observed in a similar study we conducted in 1979 at the same location under conditions of ice cover with vessel traffic.
4. Zooplankton biomass was higher in the navigation channel than in littoral waters at all sampling locations.
5. Detrital biomass was higher in the navigation channel than in adjacent littoral waters at all locations except West Neebish.

The data from this study and the study in 1979 indicate that the drift rates for all components were considerably higher under conditions of ice cover with vessel traffic than under conditions of ice cover without vessel traffic or ice free with vessel traffic. These data also suggest that frequent vessel passage through the St. Marys River during the period of ice cover may cause considerable amounts of detritus, macrophytes, zooplankton, and macroinvertebrates to be transported out of the system. Because of biota and detritus represented in our drift net catches probably reflect an energy resource that is important to production in the St. Marys River system, the accelerated transport of this material through the system in winter, when biological production reaches the annual minimum, may result in a significant loss to the system.

DATE TAB		☒
Unannounced		☐
Justification		☐
By _____		
Distribution _____		
Availability Codes		
Dist	Avail and/or	
	Special	
A-1		

Introduction

In response to requests from the U.S. Fish and Wildlife Service's Division of Ecological Services (FWS-ES) and the U.S. Army Corps of Engineers (COE), the Great Lakes Fishery Laboratory (GLFL) conducted a COE-funded study during January-April 1979 (Poe et al. 1980) at selected sites in the St. Marys River, the connecting waterway between Lakes Superior and Huron. The study was performed in connection with the COE's Winter Navigation Season Extension program and was designed to permit preliminary evaluation of the effects on fishery resources of vessel-induced, under-ice surge and drawdown waves, created by vessel traffic during the period of ice cover. Included in the study was sampling designed to permit preliminary evaluation of the effect of vessel traffic on the under-ice translocation (drift) of biota and organic detritus that serve as the base of the fishery food chain in the river. That evaluation indicated vessel passage during the period of solid ice cover greatly increased drift; it also indicated that vessel passage caused greater increases in drift during solid ice cover than during the period of unconsolidated ice cover.

The report concluded that the significance of the observed vessel-induced drift could not be demonstrated with the available data, but expressed the concern that the biota and detritus represented in the drift net catches constituted an energy resource that was important to fish production in the St. Marys River. Because of this concern, the COE funded the present study, designed to permit a further evaluation of the effects of vessel-induced, under-ice drift in a broader segment of the St. Marys system than was studied in 1979.

The objective of the present study was to determine how the composition and amount of drift varies with the following conditions: (1) ice cover with vessel traffic; (2) ice cover without vessel traffic; and (3) ice free with vessel traffic. We were unable to conduct sampling for conditions of ice cover with vessel traffic, because traffic ceased for the winter before solid ice cover formed and the resumption of traffic in the spring coincided with ice break-up.

Materials and Methods

Sampling was conducted at four locations in the U.S. waters of the St. Marys River system. Those locations, shown in Fig. 1, were (1) Brush Point, at the head of the St. Marys River; (2) Frechette Point, at the head of Lake Nicolet; (3) Lake Nicolet, proper; and (4) West Neebish, at the head of the West Neebish Channel. Four stations were established along a transect at each of these locations; stations 1-3 were in the littoral waters between the shoreline and the navigation channel, and station 4 was in the navigation channel proper (Figs. 2-4). At each location, we attempted to establish station 1 on the 1-m depth contour, station 3 on the 3-m depth contour (immediately adjacent to the navigation channel), and station 2 midway between stations 1 and 3. But differences in ice thickness at the various locations, and other local conditions beyond our control, necessitated some minor changes in the depths at

which the stations in the littoral waters were finally established (see Figs. 2-4). Station 4 was established at all locations, as planned, near the middle of the navigation channel.

Samples of drift were collected at stations 1-4 with standard cone-shaped plankton (drift) nets, 30 cm in diameter with 571 μ m mesh. At stations 1-3, these drift nets were anchored in the current with a metal rod. The lower end of the rod was driven into the river bed and the other end of the rod extended above the surface of the ice or water. The net was attached to the rod in a manner that allowed it to fish just above the river bed and to swing freely from side to side in response to changes in the direction of the current (see Appendix 1 for details). Anchored drift nets were fished for 24 hr at stations 1-3 at all four locations during the January 30-February 1, February 17-22, March 8-10, March 22-24, and April 28-May 5 sampling periods, except at Frechette Point where unstable ice conditions prevented sampling during March 22-24. We believe these nets sampled the drift in a manner that was closely similar to that employed in 1979 and described earlier (Poe et al. 1980).

At station 4 in the navigation channel, the drift nets were towed from a small boat with a cable to which a net depressor had been attached (see Appendix 1 for details). Three 15-min tows were made at station 4 at each of the 4 locations during April 29-May 1; one tow was made at the surface, a second tow was made just above the channel bottom, and a third tow was made at a depth midway between the surface and bottom. This sampling was conducted in the navigation channel because we suspected the drift in this portion of the system would exceed that in the littoral waters. We had also planned to deploy anchored nets at station 4 at all four locations during the period of ice cover, but the mild winter created unstable ice conditions in the navigation channel that would not permit safe access on foot to station 4 at any of the four locations.

Whenever we collected a sample of drift, we also measured the current velocity with a Marsh-McBurney electromagnetic flow meter (Model 201)^{1/} on station at the depth the net was fished (Appendix 2) to permit estimation of the volume of water filtered by the net and expression of the net catch as density (numbers or biomass) per unit volume of water filtered (1000 m³). Current velocity measurements were made for each anchored net immediately before the net was set and immediately after the net was lifted; the two current velocity measurements for each net were usually very similar and were averaged to provide a single value from which the volume filtered by the net could be calculated. A single current velocity measurement was made for each towed net after the net had reached the predetermined towing depth and the towing cable angle had stabilized.

Calculation of the volume of water filtered by each net was as follows:

$$\text{Volume filtered} = (\text{area of net opening}) \times (\text{current velocity}) \times (\text{time net fished})$$

^{1/} Use of trade names or manufacturers' names does not imply Government endorsement of any commercial product.

The density of each major component of drift in the net catch was then calculated by dividing the catch (number or biomass) by the volume of water filtered.

Each drift net catch was rinsed into a sample jar, labeled, preserved with 10% formalin, and taken to the laboratory for processing and analysis. In the laboratory, macroinvertebrates, fish larvae, and fish eggs were first extracted from each sample, identified to the lowest practical level, and enumerated using a dissecting microscope. Dry weights and ash-free dry weights were then determined for these three components following the methods described by the EPA (1973). Macrophytes were next sorted from the samples and identified. The extracted macrophyte material was quantified by measuring the surface area of each fragment with a Li-cor leaf area meter LI-3000¹/, using a method developed by GLFL staff (C. Brown, pers. comm.); dry weights and ash-free dry weights of macrophytes were then determined following the methods described by EPA (1973). The remaining portion of the samples was composed of zooplankton and detritus. No acceptable method was found to completely extract either the zooplankton or the detritus components of the samples for direct quantification, so we estimated the weights of the zooplankton and detritus components in each sample according to the following equation:

$$\begin{array}{lcl} \text{Total weight of zooplankton} & \text{Total weight} & \\ \text{and detritus in sample} & \text{of detritus +} & \left[\left(\frac{\text{Number of}}{\text{zooplankters in sample}} \right) \times \left(\frac{\text{Weight of average}}{\text{zooplankters in sample}} \right) \right] \end{array}$$

The equation yielded the estimated zooplankton weight per sample and that value was subtracted from the measured total sample weight (zooplankton and detritus combined) to determine the estimated weight of the detritus in each sample.

Values for solution of the equation were obtained as follows:

The number of zooplankters in each sample -- Samples containing low densities of zooplankton were placed in a counting wheel where all of the organisms were counted under a dissecting microscope. Samples with higher zooplankton densities were diluted and stirred with a Hensen-Stempel pipet until the zooplankters appeared to be homogeneously distributed throughout the sample; a 10-ml subsample was then withdrawn from the center of the sample container and transferred to a counting wheel, where the zooplankters were counted under a dissecting microscope. If fewer than 150 zooplankters were present in the 10-ml subsample, additional 10-ml subsamples were taken (following the above procedure) until a minimum of 150 organisms had been counted. This counting procedure was performed three times for each sample and the results were averaged to provide an estimate of the total number of zooplankters in the sample.

The weight of the average zooplankter in each sample -- The average weight in each sample was based on the average weight of 1000 zooplankters selected randomly from six of the samples collected during the study (Appendix 6). Taxonomic composition of zooplankton was determined by examining 200 specimens

randomly selected from the sample taken at station 2 at all locations for each sampling trip. Identifications of the crustacean zooplankton were based on keys by Edmonson (1959), Pennak (1979), and Torke (1974).

A series of univariate, one-way ANOVA tests were performed to determine if the density or biomass of macroinvertebrates, zooplankton, or detritus varied significantly among locations or sampling dates. All tests were run on the log transformed data ($\log [n + 1]$) to improve normality. Multiple comparison tests (Scheffe) were also performed for each test (ANOVA) to indicate the direction of differences for each parameter.

Results and Discussion

Macroinvertebrates

The taxonomic composition of the macroinvertebrates in the anchored drift nets fished in the littoral waters of the river at all four locations, January 30-May 1, 1980 (Table 1), was similar to that found in an earlier study (Poe et al. 1980) conducted in the St. Marys River. Of the 36 macroinvertebrate taxa represented in the catches, 18 were aquatic insects (Table 1). Blackfly larvae (Simuliidae), midge larvae (Chironomidae), and opossum shrimp (*Mysis relicta*) were most abundant and these three taxa combined usually made up over 75% of the total number of macroinvertebrates taken (Appendix 4).

The number of macroinvertebrate taxa collected ranged from 0 to 7 (average 3.3) at each location during January 30-March 3, the period of ice cover with no vessel traffic, and from 5 to 21 taxa (average 13.8) at each location during April 29-May 1, when ice cover had broken up and vessel traffic had resumed (Appendices 3 and 4). The increased number of macroinvertebrate taxa present in the drift net catches on April 29-May 1 was probably caused by the resumption of vessel passage; similar increases in the number of taxa recorded in the drift as a result of vessel passage (during a period of ice cover) were reported earlier by Poe et al. (1980). The absence of ice cover during the April 29-May 1 sampling period also may have contributed to the observed increase in macroinvertebrate drift, but no data are available to support this conclusion.

Catches of macroinvertebrates in anchored drift nets in the littoral waters were generally much lower at Brush Point than elsewhere, except during the January 30-February 1 sampling period at the Lake Nicolet and West Neebish locations and during the April 29-May 1 period at the Lake Nicolet location (Table 2). Catches were also generally lowest during the April 29-May 1 sampling period.

ANOVA results indicated that both density and biomass differed significantly ($P \leq 0.05$) among locations and sample dates. Multiple comparison tests (Scheffe) further indicated that macroinvertebrate density and biomass at Brush Point differed most from the other three locations, and that macroinvertebrate density and biomass values for January 30-February 1 and April 29-May 1 were significantly different from each other and from values for the other 3 sampling periods.

The data of Table 2 and the results of the statistical analyses reported above support two major conclusions: (1) density and biomass of macroinvertebrates in the littoral drift were generally lower at the head of the St. Marys River than at the sampling locations further downstream, and (2) density and biomass of macroinvertebrates in the littoral drift were generally lower during the period of ice cover and no vessel traffic than after ice cover had broken up and vessel traffic had resumed. The lower density and biomass values measured at the head of the river suggest that the benthic macroinvertebrate population at the Brush Point location (and in lotic areas immediately upstream) is smaller than at the other locations where more suitable substrate is available. The increase in density and biomass of macroinvertebrates in the littoral drift during the April 29-May 1 sampling period is probably due to the heavy vessel traffic that occurred in the study area April 28-May 1.

Macroinvertebrates of 12 taxa were collected in towed drift nets fished at all four locations in the St. Marys River navigation channel, April 29-May 1 (Table 3, Appendix 5). Dipteran larvae (including Chironomidae, Simuliidae, and unidentified Diptera) and Hydra were the most abundant macroinvertebrates taken in the navigation channel; collectively they made up over 80% of the total number of macroinvertebrates caught in the towed nets. The number of taxa collected in the navigation channel ranged from 4 at Brush Point near the head of the river to 9 taxa at the West Neebish location in the lower part of the river (Appendix 5).

The density and biomass of macroinvertebrates in the towed drift net catches from the navigation channel were lower at Brush Point than at any of the other three locations (Table 4). Macroinvertebrate density was higher in the surface tows at all locations except Brush Point, but biomass varied without apparent trend. Statistical analyses were not performed on the towed drift net catch data because the data set was small and direct interpretation could be made with confidence.

Comparison of the anchored drift net catches of macroinvertebrates in the littoral waters with towed drift net catches of macroinvertebrates in the navigation channel during April 29-May 1 (Tables 2 and 4; Appendices 4 and 5) revealed the taxonomic composition of the macroinvertebrates drift differed considerably between the two areas. Many more macroinvertebrate taxa were collected at all locations in the littoral waters (total of 29 taxa) than in the navigation channel (total of 12 taxa) during April 29-May 1, but the same taxa (dipteran larvae, Hydra, and Mysis relicta) dominated the catch in both the littoral waters (Appendix 4) and the navigation channel (Appendix 5), except at the West Neebish location where a large number of ostracods were taken. The greater sampling effort expended in the littoral waters (72 net fishing hours per location in the littoral waters vs. 45 minutes in the navigation channel) may have resulted in the capture of a greater number of uncommon or rare taxa in those waters. The larger number of taxa caught in the littoral waters may also reflect the fact that drift nets were fished only during the daylight hours in the navigation channel.

Comparison of the average density and biomass of macroinvertebrate drift in the navigation channel (surface, mid-depth, and bottom catches in Table 4 pooled and averaged for each location) for April 29-May 1 with those of the

adjacent littoral waters (catches in Table 2 for stations 1-3 pooled and averaged for each location) indicated density was higher in the navigation channel at all locations; biomass was also higher in the navigation channel at all locations except Brush Point:

	<u>Littoral waters</u>		<u>Navigation Channel</u>	
	<u>Density</u>	<u>Biomass</u>	<u>Density</u>	<u>Biomass</u>
Brush Point	16.0	0.92	59.9	<0.01
Frechette Point	64.0	11.27	182.4	53.67
Lake Nicolet	12.4	1.03	162.5	81.09
West Neebish	214.1	21.01	314.3	24.25

The higher macroinvertebrate density and biomass in the drift in the navigation channel suggests that macroinvertebrates remain in the water column longer in the channel than in the littoral waters because settling times are inherently greater in the deeper waters of the channel, and because the likelihood of resuspension is greater in the channel where natural and vessel-induced turbulence appear to be higher than in the littoral waters.

Macrophytes

Very little macrophytic material was present in the drift samples (Appendix 4). All identified macrophytic material was Elodea spp. Trace amounts of unidentified filamentous algae and charophytes were also present in the samples. The largest macrophyte catch (100.45 mg/1000³) was made at the Lake Nicolet location on March 8-9 under the conditions of ice cover without vessel traffic. There were too few biomass or surface area data to analyze statistically. However, we may conclude that the amount of macrophyte drift under conditions of ice cover without vessel traffic was much lower than the amount of drift under conditions of ice cover with vessel traffic as reported by Poe et al. (1980).

Zooplankton

Zooplankton of 6 species were collected in drift samples taken from the four locations in the St. Marys River, January 30 through May 1, 1980 (Appendix 6). The large calanoid copepod Limnocalanus macrurus dominated the catch in all but the April 29-May 1 sampling period, when Diaptomus spp. dominated at Brush Point and Frechette Point. Other species of zooplankton, caught only occasionally, included Senecella calanoides, Cyclops vernalis, C. bicuspidatus thomasi, and Bosmina coregoni.

The zooplankton biomass was higher than that of any of the other major components of drift in almost all samples (Appendix 4). Biomass of zooplankton was usually lower at Brush Point than at the other three locations and was lower during April 29-May 1 than during the preceding four sampling periods (Table 5). ANOVA indicated that there were significant ($P \leq 0.05$) differences in zooplankton biomass among locations and among sampling periods, and multiple comparison tests (Scheffe) indicated that zooplankton biomass was significantly lower at Brush Point than at the other locations. The multiple comparison test also indicated that zooplankton biomass during the April 29-May 1 sampling

period differed most among all sampling periods. The unexpected finding that zooplankton biomass was lower at Brush Point than at the other locations farther downriver cannot be explained with the available data; generally, the zooplankton population in a river draining a lake would be expected to be highest in the portion of the river nearest the lake and would decrease with distance from the lake (Cushing 1963). The decrease in zooplankton biomass in April 29-May 1 is consistent with the decrease in zooplankton biomass observed in April in the St. Marys River by Selgeby (1975).

Representatives of four species of zooplankton were present in the towed lift net catches from the navigation channel at all four locations in the St. Marys River, April 29-May 1 (Appendix 6). The calanoid copepod, Diaptomus spp., dominated the catch at all locations. Zooplankton biomass in the navigation channel was usually lower at Brush Point than at the other three locations and was highest at Frechette Point (Table 6). There was no consistent relation between biomass values and sampling depth at the various locations.

Comparison of catches of zooplankton in the littoral waters during April 29-May 1 with those in the navigation channel during the same period revealed no major difference in species composition, although two species (Cyclops bicuspidatus and Bosmina coregoni) taken in the littoral waters were not collected in the navigation channel (Appendix 6). Comparison of the average biomass of zooplankton in the navigation channel during April 29-May 1 (surface, mid-depth and bottom catches in Table 6 pooled and averaged for each location) during the same period indicates that biomass was higher in the navigation channel at all locations:

	<u>Littoral Waters</u>	<u>Navigation Channel</u>
Brush Point	13.85	575.38
Frechette Point	129.94	2,259.71
Lake Nicolet	42.03	1,598.18
West Neebish	42.05	889.69

The higher zooplankton biomass in the navigation channel is generally consistent with the hypothesis that Lake Superior is the source of most of the zooplankton present in the portion of the St. Marys River covered by this study; that natural mortality causes a decrease in the numbers and biomass of the zooplankton being transported through the river; that the amount of decrease varies directly with the amount of time the zooplankton is in transit from Lake Superior; and that the transport of zooplankton is more rapid in the navigation channel than in the littoral waters. The low biomass at Brush Point, the location closest to the source, is inconsistent with this hypothesis, as discussed earlier in this report.

Detritus

The detritus collected in the anchored drift nets fished in the littoral waters of the river (Table 7, Appendix 4) was composed primarily of plant material of unidentified origin. Detrital biomass was generally lower at Brush Point and Lake Nicolet than at the Frechette Point and West Neebish locations (Table 7). Detrital biomass was also higher in the January 31-February 1 and

April 29-May 1 sampling periods than the other times. ANOVA verified that there were significant ($P \leq 0.05$) differences in detrital biomass among locations and sampling periods and multiple comparison tests (Scheffe) verified the trend described above. The data collected during January 31-March 23, when there was ice cover and no vessel traffic, indicate that the amount of detritus in the drift is often less than 0.01 g ash-free dry weight per 1000 m³ of river water.

Detrital biomass in the drift samples from the navigation channel was lower at Brush point and West Neebish than at Frechette Point and Lake Nicolet and was highest at Frechette Point (Table 8; Appendix 5). There was no consistent relation between detrital biomass values and sampling depth at the various locations.

Comparison of the average biomass of detritus (April 29-May 1) in the navigation channel (surface, mid-depth and bottom catches in Table 7 pooled and averaged for each location) with those of the adjacent littoral waters (catches in Table 8 for stations 1-3 pooled and averaged for each location) indicated that detrital biomass is higher in the navigation channel than in the littoral waters at all locations except West Neebish:

	<u>Littoral Waters</u>	<u>Navigation Channel</u>
Brush Point	20.10	140.62
Frechette Point	320.74	3,025.83
Lake Nicolet	10.82	1,120.92
West Neebish	966.63	301.23

The generally higher detrital biomass values observed in the navigation channel suggest that this component of drift remains in the water column longer in the navigation channel than in the littoral waters because settling times are inherently greater in the deeper waters of the channel and because the likelihood of resuspension is greater in the channel, where natural and vessel-induced turbulence appear to be higher than in the littoral waters.

Fish Larvae and Eggs

A total of 2 fish larvae and 58 fish eggs were taken in the drift nets; with the exception of one egg collected at Frechette Point on February 17, all were taken at Frechette Point and West Neebish during the April 29-May 1 sampling period (Appendix 4). We were unable to identify the fish larvae; the eggs collected April 19-May 1 were tentatively identified as rainbow smelt eggs. The small number of fish eggs and larvae in our samples is not surprising. Although lake whitefish, lake herring, and burbot spawn in the St. Marys River in the fall-winter, their eggs are demersal and would not be expected to be present in large numbers in the drift under conditions of ice cover without vessel traffic. The absence of larger numbers of fish larvae in the drift was also not surprising because eggs from fishes that spawned in the fall and winter probably had not hatched before we concluded our sampling.

CONCLUSIONS

The objective of this study was to determine how the composition and amount of drift varies with the following conditions: (1) ice cover with vessel traffic; (2) ice cover without vessel traffic; and (3) ice free with vessel traffic. Unfortunately, we were unable to conduct sampling for conditions of ice cover with vessel traffic because traffic ceased for the winter in 1980 before solid ice cover formed, and because the resumption of traffic in the spring coincided with ice break-up. Comparison of the drift among the three periods is possible, however, if data collected in 1979 (Poe et al. 1980) and 1980 (present study) are used. The data sets collected from anchored drift nets at Frechette Point in these studies best describe the effects of vessel passage on drift. Included are data taken in 1979 on February 15-17 (solid ice cover without vessel traffic, and solid ice cover with vessel traffic), and April 20-21 (floe ice cover with vessel traffic) and in 1980 on February 16-17 (solid ice cover without vessel traffic) and April 29-May 1 (ice free with vessel traffic):

Component of drift	With solid ice cover			Without solid ice cover	
	with vessel traffic	without vessel traffic		floe ice with vessel traffic	ice-free with vessel traffic
	(1979)	(1979)	(1980)	(1979)	(1980)
Macroinvertebrates (no/hr)	8.4-14.0 _a /	0.0-0.2 _a /	3.7 _b /	0.0 _c /	3.0 _d /
Macrophytes (cm ³ /hr)	7.3-42.2	0.0	0.0	0.0	0.0
Detritus and zooplankton (g dry wt/hr)	0.2-5.4	<0.1	0.1	0.0	0.1

a/ Data in column from Table 5 of Poe et al. (1980) for station 7.

b/ Data in column from Appendix 4 of present study for station 1; values were divided by 24 to yield catch per hour.

c/ Data in column from Appendix 2 of Poe et al. (1980) for station 7.

d/ Data in column from Appendix 4 of present study for station 1; values were divided by 24 to yield catch per hour.

Collectively, the results of these two studies indicate (1) vessel traffic during the period of solid ice cover greatly increased the drift of biota and detritus over that which occurred under solid ice cover in the absence of vessel traffic, and (2) drift which occurred under solid ice cover in the absence of vessel traffic did not appear to differ markedly from that which

occurred in the presence of vessel traffic when ice cover had disappeared or when only floe ice cover remained. We believe the increased drift under conditions of solid ice cover with vessel traffic resulted from vessel-induced vertical displacement of littoral sediments and associated water turbulence as measured in the study area under conditions of solid ice cover by Alger (1979).

As stated earlier (Poe et al. 1980), the significance of the observed vessel-induced drift cannot be demonstrated with the available data. We believe, however, that the biota and detritus represented in our drift net catches constitute an energy resource that is important to biological production in the St. Marys River. We also believe that since the accelerated transport of this energy resource through the river is in winter when the opportunity for its use in biological production processes is at the annual minimum, a considerable loss of productive potential in those portions of the river from which the material was displaced may result.

Literature Cited

- Cushing, C. E., Jr. 1963. Filter feeding insect distribution and planktonic food in the Montreal River. *Trans. Am. Fish. Soc.* 92(3): 216-219.
- Edmondson, W. T. (ed). 1959. *Freshwater biology*, by Henry Baldwin Ward and George Chandler Whipple, 2nd ed. Wiley, New York, NY. 1248 pp.
- Pennak, R. W. 1978. *Freshwater invertebrates of the United States*, 2nd ed. Wiley, New York, NY. 803 pp.
- Poe, T. P., T. A. Edsall, and J. K. Hiltunen. 1980. Effects of ship-induced waves in an ice environment on the St. Marys River Ecosystem. U.S. Fish Wildl. Serv., Great Lakes Fishery Laboratory. Admin. Rep. 80-6, 125 pp.
- Selgeby, J. H. 1975. Life histories of crustacean zooplankton in the outlet of Lake Superior, 1971-72. *J. Fish. Res. Board Can.* 32(4): 461-470.
- Torke, B. G. 1974. An illustrated guide to the identification of the planktonic crustacea of Lake Michigan with notes on their ecology. Center for Great Lakes studies, Special Rept. No. 17. University of Wisconsin, Milwaukee. 42 pp.
- U.S. Environmental Protection Agency. 1973. *Biological field and laboratory methods*. U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, OH. 165 pp.

Table 1. Macroinvertebrates collected in anchored drift nets fished at the Brush Point, Frechette Point, Lake Nicolet, and West Neebish locations in the St. Marys River, January 30-May 1, 1980.

Hydrozoa	Siphonuridae
Hydridae	<u>Siphonurus</u> spp.
<u>Hydra</u>	Baetidae
	<u>Baetis</u> spp.
Cestoidea	
	Coleoptera
Nematoda	Hydrophilidae
	<u>Helophorus</u> spp.
Turbellaria	
	Lepidoptera
Oligochaeta	
	Trichoptera
Ostracoda	Hydropsychidae
	<u>Cheumatopsyche</u> spp.
Amphipoda	<u>Hydropsyche</u> spp.
Gammaridae	Lepidostomatidae
<u>Gammarus</u> spp.	<u>Lepidostoma</u> spp.
Talitridae	Leptoceridae
<u>Hyalella azteca</u>	<u>Mystacides</u> spp.
	Hydroptilidae
Isopoda	<u>Oxyethira</u> spp.
Assellidae	Phryganeidae
<u>Lirceus</u> spp.	<u>Phryganea</u> spp.
	Polycentropodidae
Mysidacea	<u>Polycentropus</u> spp.
Mysidae	
<u>Mysis relicta</u>	
	Hemiptera
Insecta	Corixidae
	Acarina
Diptera	
Ceratopogonidae	Gastropoda
Chironomidae	Hydrobiidae
Empididae	<u>Amnicola</u> spp.
Simuliidae	Lymnaeidae
	<u>Lymnaea</u> spp.
	Planorbidae
Plecoptera	<u>Gyraulus</u> spp.
Perlodidae	Valvatidae
<u>Isoperla</u> spp.	<u>Valvata tricarinata</u>
Ephemeroptera	Pelecypoda
Ephemeridae	Sphaeriidae
<u>Ephemera</u> spp.	<u>Pisidium</u> spp.
Leptophlebiidae	<u>Sphaerium</u> spp.
<u>Leptophlebia</u> spp.	

Table 2. Density and biomass of macroinvertebrates taken in anchored drift nets in the littoral waters of the St. Marys River. [Density and biomass values are expressed respectively as the number, and the mg ash-free dry weight of organisms per 1000 m³ of water.]

Location	Station	Sampling Periods							
		Jan. 31-Feb. 1		Feb. 16-17		March 8-9		March 22-23	
		Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass
Brush Point	1	0.0	0.00	0.0	0.00	5.7	7.43	0.0	0.00
	2	5.5	<0.01	0.0	0.00	0.0	0.00	2.8	<0.01
	3	11.2	3.98	0.0	0.00	0.0	0.00	0.0	0.00
Frechette Point	1	23.0	5.60	85.9	12.83	21.3	16.57	-	-
	2	9.9	<0.01	74.4	31.89	21.5	3.11	-	-
	3	43.4	7.31	115.2	23.10	32.4	7.91	-	-
Lake Nicolet	1	0.0	0.00	14.2	(228.48)	5.6	<0.01	0.0	0.00
	2	0.0	0.00	5.7	0.99	11.2	13.68	16.6	4.09
	3	7.1	0.38	20.9	4.47	14.3	17.93	61.0	5.15
West Neebish	1	0.0	0.00	5.6	18.81	16.3	27.05	-	-
	2	1.3	0.66	11.1	39.33	37.4	25.89	31.6	12.62
	3	2.5	3.26	4.6	2.80	26.8	52.51	31.2	21.48
								87.9	12.03
								220.1	26.51
								334.3	24.49

Table 3. Macroinvertebrates collected in towed drift nets fished in the navigation channel at the Brush Point, Frechette Point, Lake Nicolet, and West Neebish locations in the St. Marys River, April 29-May 1, 1980.

Hydrozoa
Hyridae
Hydra

Oligochaeta

Mysidacea
Mysidae
Mysis relicta

Insecta

Diptera
Chironomidae

Coleoptera
Hydrophilidae
Helophorus spp.

Lepidoptera

Trichoptera
Hydropsychidae
Cheumatopsyche spp.

Hemiptera
Corixidae

Acarina

Table 4. Density and biomass of macroinvertebrates taken in towed drift nets at the surface, middle, and bottom depth levels in the navigation channel of the St. Marys River, April 29-May 1. [Density and biomass values are expressed respectively as the number, and the mg ash-free dry weight of organisms per 1000 m³ of water.]

Location	Surface		Middle		Bottom	
	Density	Biomass	Density	Biomass	Density	Biomass
Brush Point	0	0.00	67.4	<0.01	112.3	<0.01
Frechette Point	235.8	43.81	176.8	67.58	134.7	49.62
Lake Nicolet	179.6	26.04	176.8	136.15	131.0	<u>1/</u>
West Neebish	449.0	39.74	314.3	5.16	179.6	27.84

1/ Sample destroyed before weighing.

Table 5. Biomass of zooplankton taken in anchored drift nets in the littoral waters of the St. Marys River. [Biomass values are expressed as mg ash-free dry weight per 1000 m³ of water.]

Location	Station	Sampling Period				
		Jan 31-Feb 1	Feb 16-17	Mar 8-9	Mar 22-23	Apr 29-May 1
Brush Point	1	201.79	37.58	60.03	22.09	28.83
	2	451.55	84.66	122.98	44.61	9.88
	3	693.95	97.73	24.84	74.03	2.84
Frechette Point	1	952.70	1178.11	463.38	-	71.18
	2	254.13	1282.90	501.31	-	93.53
	3	1176.43	1340.97	688.04	-	225.10
Lake Nicolet	1	123.53	261.09	426.59	43.66	68.63
	2	321.77	238.38	613.26	85.98	41.54
	3	133.84	493.11	233.82	79.22	15.91
West Neebish	1	387.82	538.59	1046.51	-	9.49
	2	361.27	388.94	675.74	727.43	82.04
	3	340.99	756.14	933.15	564.42	35.21

Table 6. Biomass of zooplankton taken in towed drift nets in the navigation channel of the St. Marys River. [Biomass values are expressed as ash-free dry weight per 1000 m³ of water.]

Location	Surface	Mid-depth	Bottom
Brush Point	467.74	442.07	816.34
Frechette Point	3,208.25	1,500.97	2,024.92
Lake Nicolet	<u>1/</u>	1,306.09	1,890.26
West Neebish	283.34	1,423.00	962.73

1/ Sample destroyed before weighing.

Table 7. Biomass of detritus taken in anchored drift nets in the littoral waters of the St. Marys River. [Biomass values are expressed as mg ash-free dry weight per 1000 m³ of water.]

Location	Station	Jan 31-Feb 1	Feb 16-17	Mar 8-9	Mar 22-23	Apr 29-May 1
Brush Point	1	27.93	18	<0.01	<0.01	36.80
	2	193.95	< 0.01	<0.01	10.05	-
	3	230.91	<0.01	2.90	28.67	3.39
Frechette Point	1	201.73	340.10	82.56	-	337.32
	2	135.51	265.48	168.20	-	372.07
	3	99.25	114.28	80.46	-	252.82
Lake Nicolet	1	16.60	<0.01	5.67	<0.01	16.23
	2	51.42	<0.01	<0.01	<0.01	-
	3	7.30	89.57	170.32	9.14	5.40
West Neebish	1	57.15	<0.01	<0.01	-	594.75
	2	<0.01	<0.01	6.96	107.87	1,041.07
	3	156.24	119.21	-	67.23	1,264.07

Table 8. Biomass of detritus taken in towed drift nets in the navigation channel of the St. Marys River. [Biomass values are expressed as mg ash-free dry weight per 1000 m³ of water.]

Location	Surface	Mid-depth	Bottom
Brush Point	<0.01	<0.01	421.87
Frechette Point	1,292.14	3,185.66	4,599.69
Lake Nicolet	<0.01	2,624.95	737.82
West Neebish	762.01	28.96	112.71

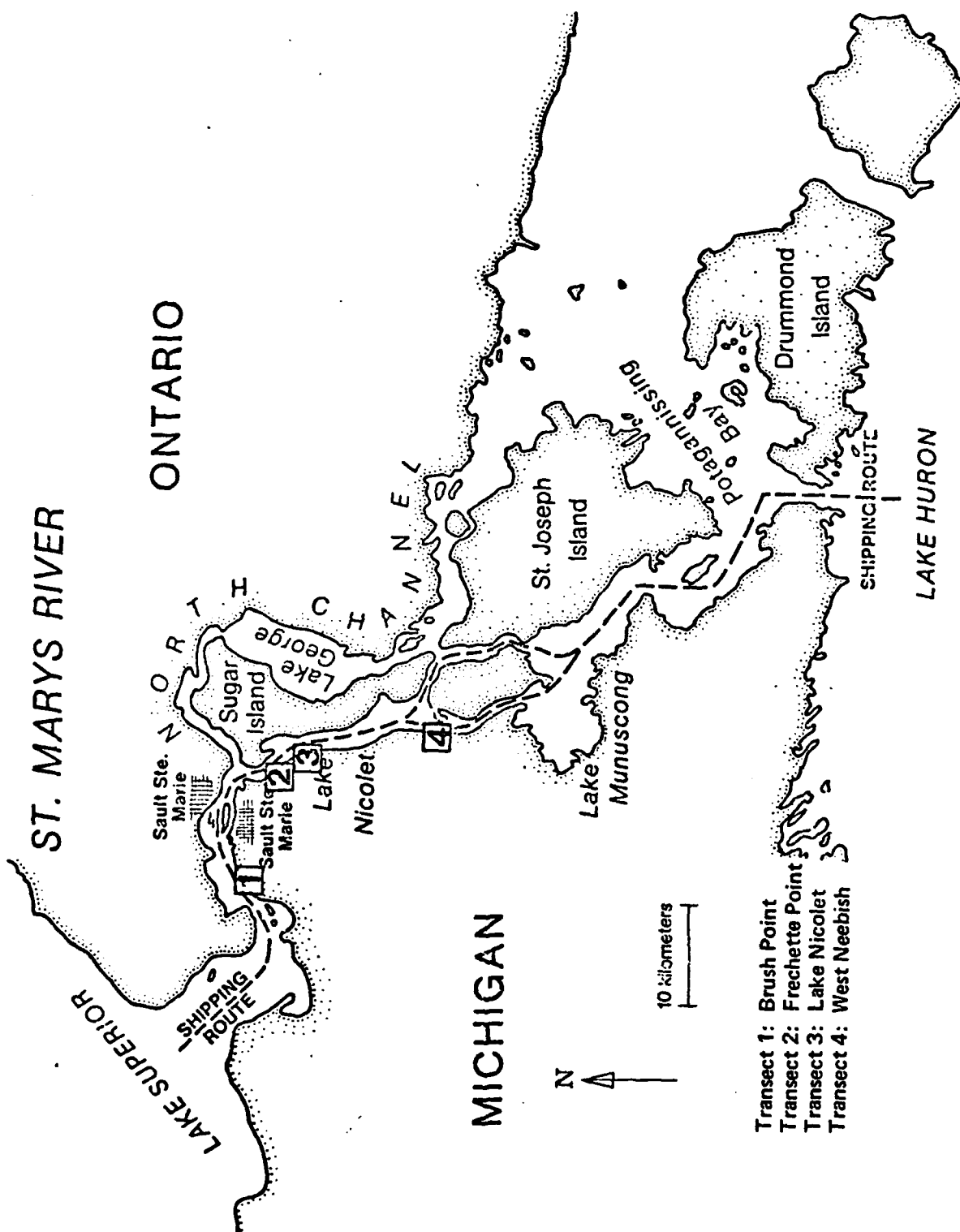


Figure 1. Sampling locations.

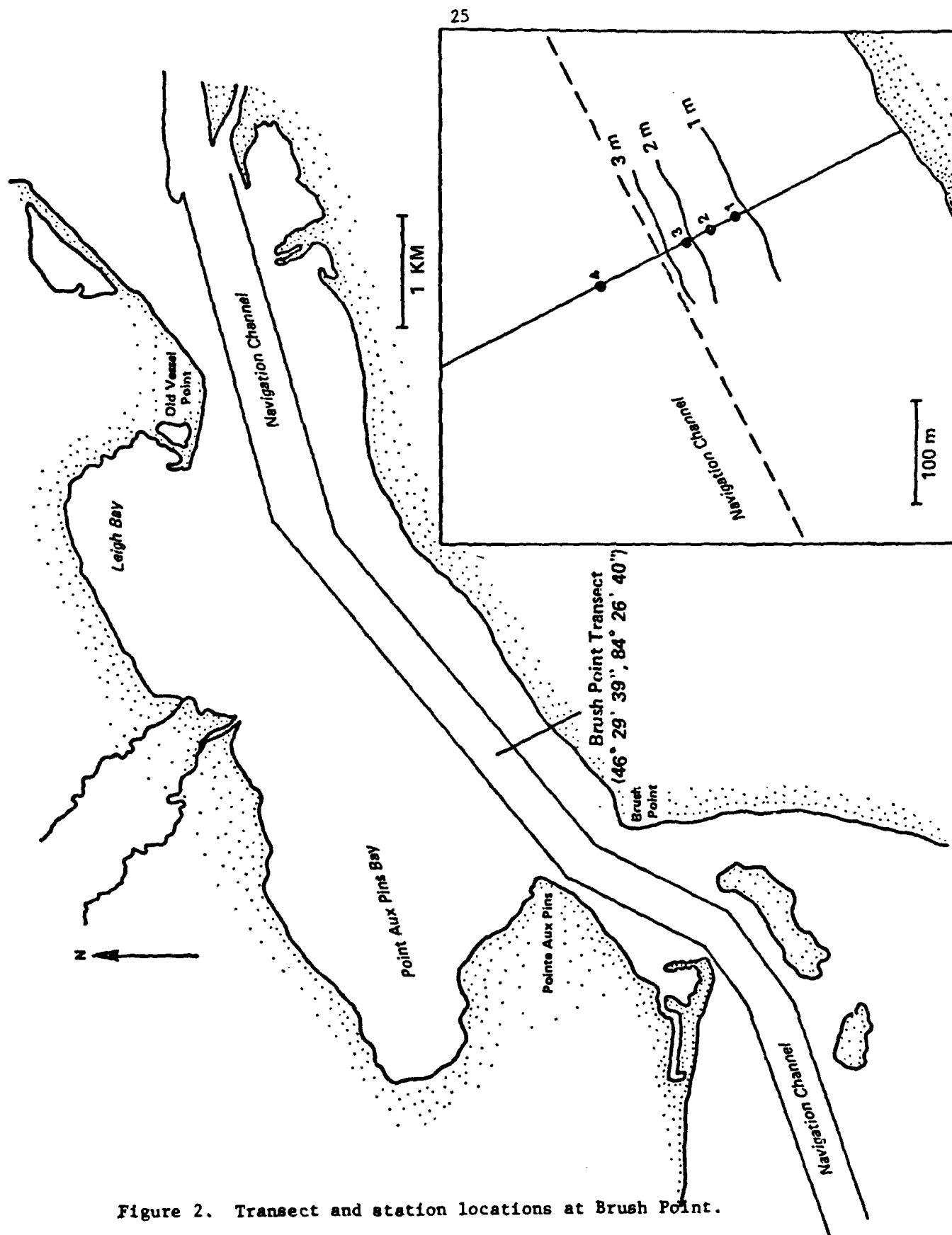


Figure 2. Transect and station locations at Brush Point.

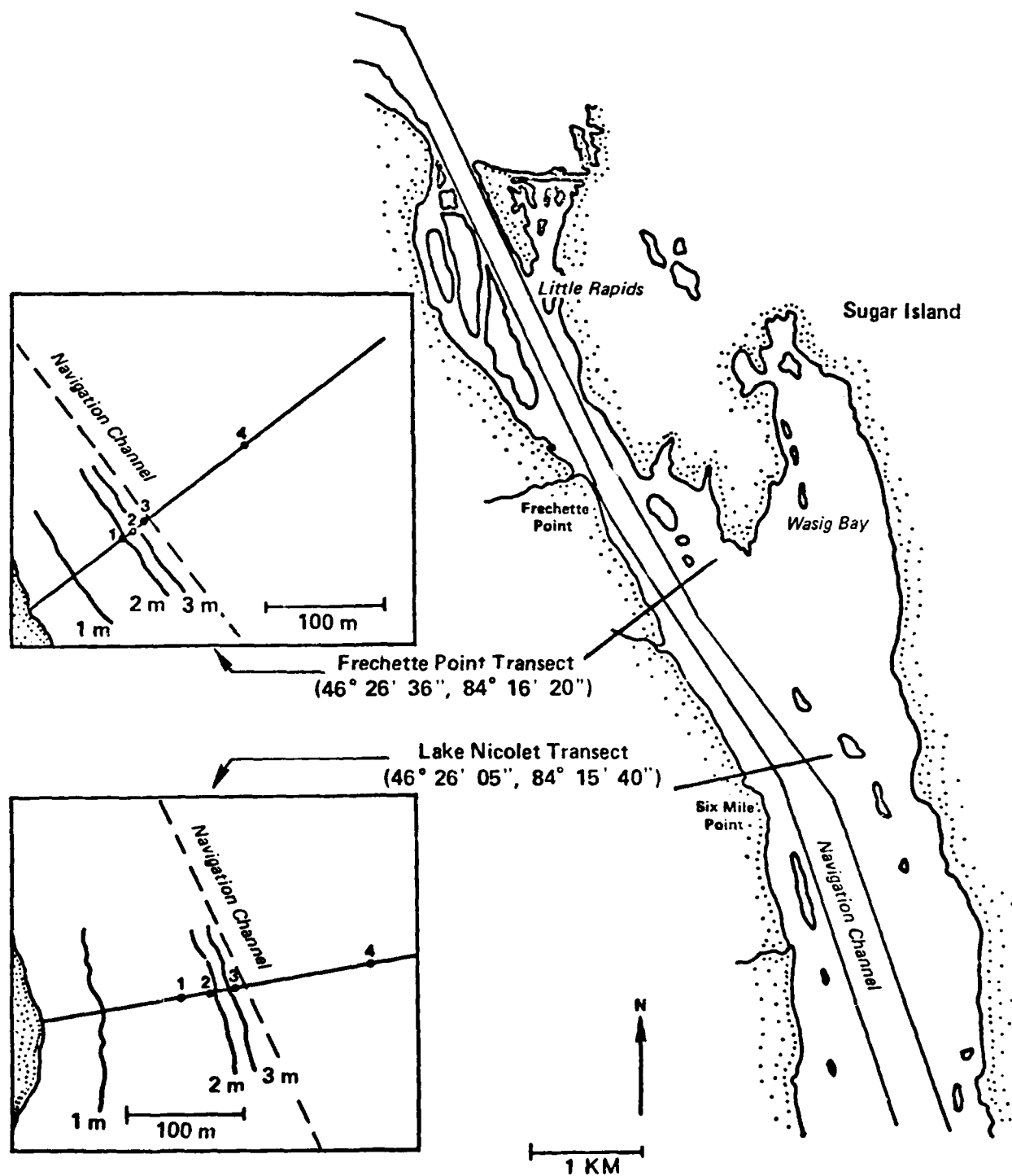


Figure 3. Transect and station locations at Frechette Point and Lake Nicolet.

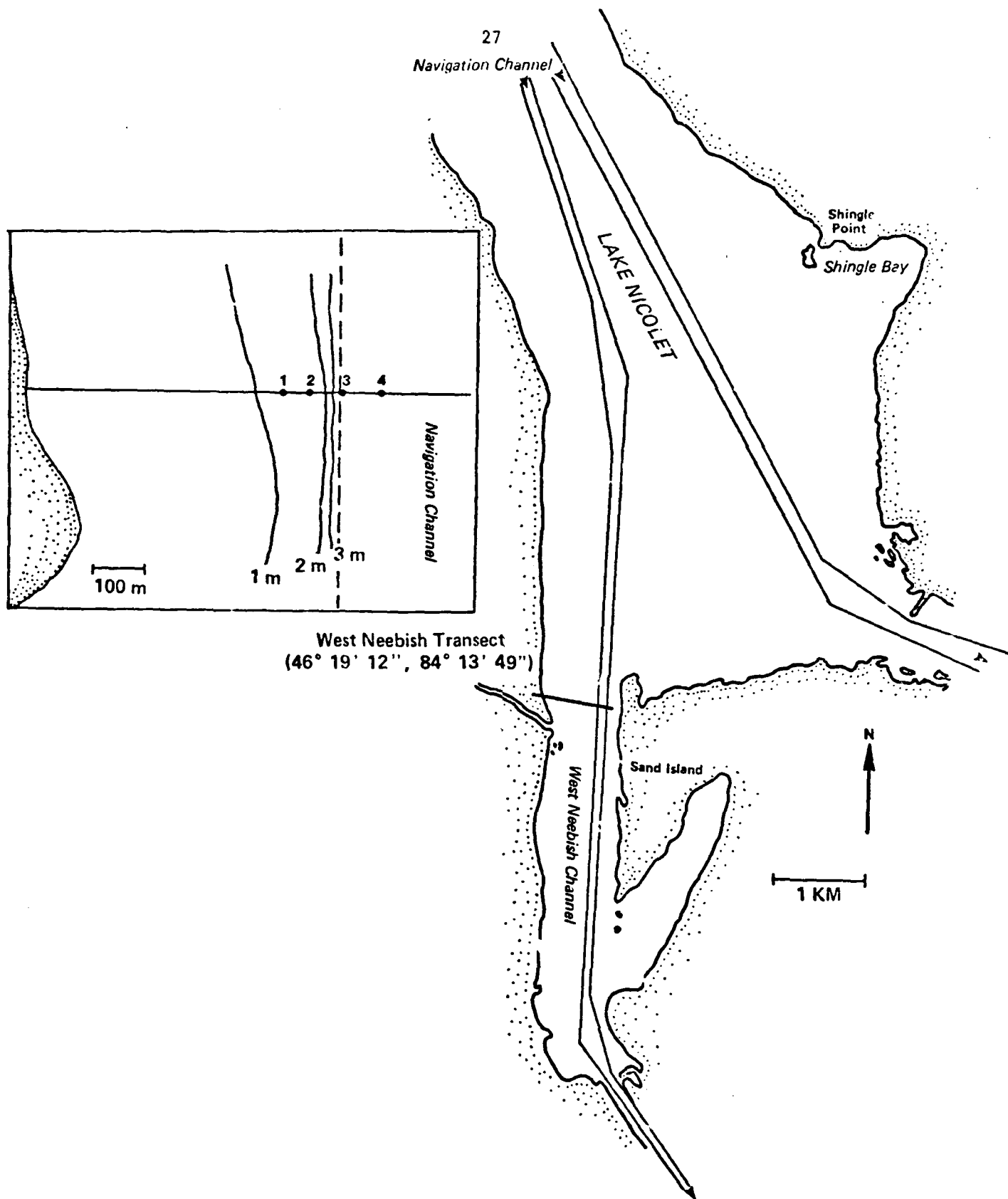


Figure 4. Transect and station locations at West Neebish.

Appendix 1

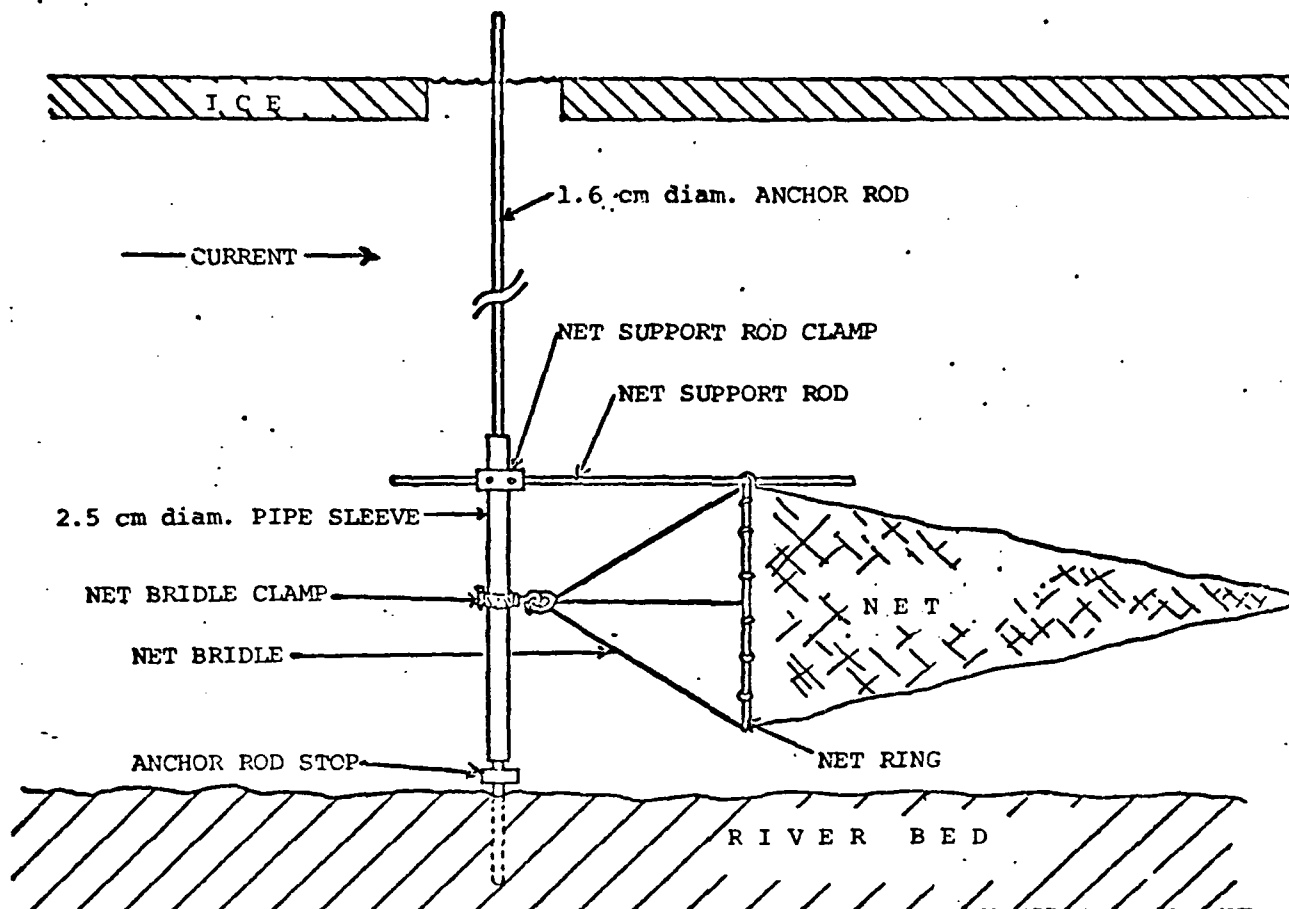
Anchoring and towing details for nets used to sample drift.

Anchored Nets

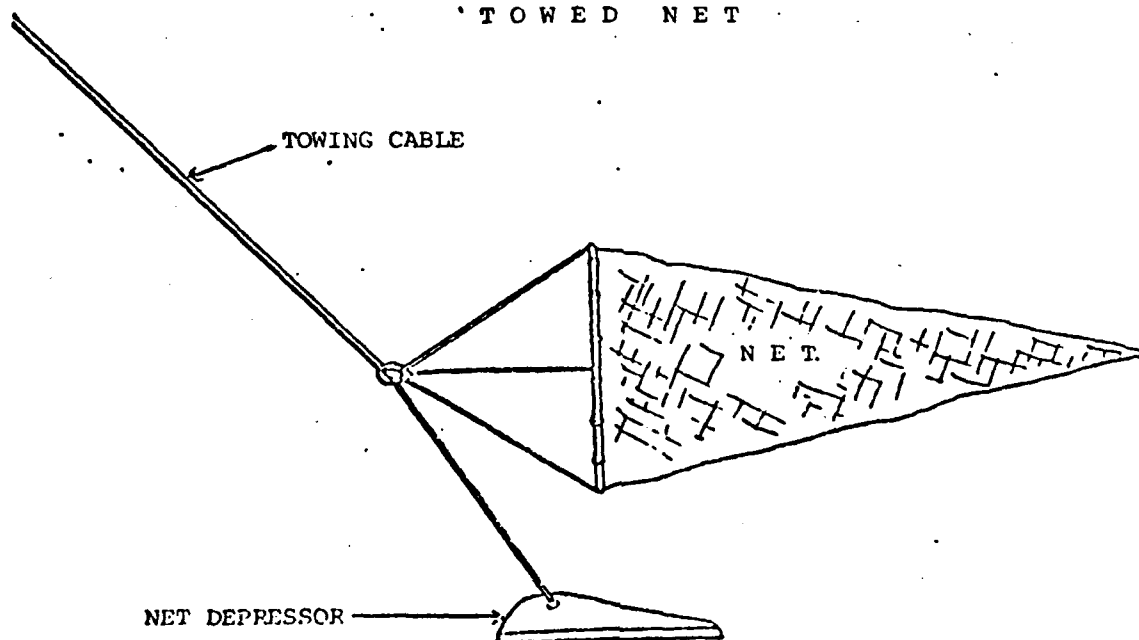
Each net was anchored in the current with a 1.6 cm diameter (anchor) rod; one end of the anchor rod was driven into the river bed and the other end extended above the surface of the ice and water. The net was attached to a 2.5 cm diameter, 50 cm long PVC pipe sleeve with a bridle clamp. A net support rod was also clamped to the PVC pipe sleeve to hold the net ring in the vertical position. The PVC sleeve fit loosely around the anchor rod and allowed the net assembly to swing laterally in response to changes in current direction. An anchor rod stop was used to position the PVC sleeve and net so that the bottom of the net ring was about 5 cm above the river bed.

ANCHORED NET

Appendix 1



TOWED NET



Appendix 2

Current velocity measurements at drift net
fishing stations

Current velocity measurements (m/sec) taken to determine the volume of water filtered by the anchored drift nets immediately before the net was set and immediately after the net was lifted.

Location	Station	Jan 31-Feb 1 ^{1/}			Feb 16-17			Mar 8-9			Mar 22-23			Apr 29-May 1		
		Net	Set	Lifted	Net	Set	Lifted	Net	Set	Lifted	Net	Set	Lifted	Net	Set	Lifted
Brush Point	1	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.05	0.03	0.03	0.03
	2	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.06	0.06	0.05	0.09	0.09	0.03
	3	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.09	0.09	0.08	0.15	0.15	0.06
Frechette Point	1	0.16	0.16	0.16	0.17	0.17	0.17	0.16	0.16	0.13	-	-	-	0.24	0.24	0.27
	2	0.16	0.16	0.16	0.18	0.18	0.17	0.16	0.16	0.11	-	-	-	0.30	0.30	0.21
	3	0.18	0.18	0.18	0.21	0.21	0.16	0.19	0.17	0.17	-	-	-	0.30	0.30	0.27
Lake Nicolet	1	0.06	0.06	0.06	0.08	0.08	0.05	0.05	0.06	0.06	0.03	0.03	0.06	0.09	0.09	0.09
	2	0.07	0.07	0.07	0.08	0.08	0.08	0.05	0.07	0.07	0.05	0.05	0.05	0.09	0.09	0.21
	3	0.09	0.09	0.09	0.11	0.11	0.09	0.06	0.08	0.08	0.06	0.06	0.06	0.18	0.18	0.21
West Neebish	1	0.11	0.11	0.11	0.11	0.11	0.12	0.11	0.07	0.07	0.12	0.12	0.12	0.24	0.24	0.18
	2	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.09	0.09	0.11	0.11	0.11	0.21	0.21	0.21
	3	0.15	0.15	0.15	0.15	0.15	0.18	0.14	0.11	0.11	0.12	0.12	0.12	0.21	0.21	0.18

^{1/} Flow meter not available; current velocity was estimated for this sampling period by averaging the current velocity measurements taken Feb. 16-17 and Mar. 8-9.

Current velocity measurements (m/sec) taken at Station 4, April 29-May 1, 1980, to estimate the volume of water filtered by the towed drift nets after the net had reached the predetermined towing depth.

Location	Surface Tow	Mid-depth Tow	Bottom Tow
Brush Point	0.55	0.67	0.67
Frechette Point	0.76	0.79	0.73
Lake Nicolet	0.73	0.79	0.61
West Neebish	0.67	0.67	0.67

Appendix 3

Vessel Passage Records

Information on vessel traffic (included in this Appendix) in the St. Marys River in the winter of 1979-80 was obtained from the U.S. Coast Guard at Sault Saint Marie. Vessel traffic ceased on January 19, 1980, and commenced on March 24, 1980. The only other vessel movements in the St. Marys River during this period were several passages of U.S. Coast Guard icebreakers and these occurred at times when no drift nets were being fished.

Record of vessel passage made through the St. Marys River for January 9-19, March 24-25, and April 29-May 1 AM, 1980.

[U.S. Coast Guard Radio Log data provided during visit to Sault Ste. Marie, Coast Guard Station, May 1, 1980.]

Vessel name	Date	Direction	Time at Checkpoint				
			Birch Point	Brush Point	Mission Point	Six Mile Point	Nine Mile Point
UNGAVA	01-09-80	Downbound			1137	1159	1217
Amoco Wisconsin	01-09-80	Downbound			1919	1951	2051
Philip R. Clarke	01-09-80	Upbound	0600		0356	0325	0307
Algobay	01-09-80	Upbound		0700			
Amoco Wisconsin	01-09-80	Upbound			1100	1027	1008
Herbert	01-10-80	Upbound	1045			0642	0616
Gott	01-10-80	Upbound	1513			0949	0927
Cason J. Calloway	01-11-80	Upbound	0920			0632	0515
Enders M. Vorhees	01-12-80	Upbound	1420			0117	0058
John G. Munson	01-12-80	Upbound	1824			1625	1509
Roger Blough	01-13-80	Downbound		0847		1310	1335
Philip R. Clarke	01-13-80	Downbound		0913		1416	1437
Algobay	01-13-80	Downbound		1626			
Yankcannuk	01-13-80	Upbound				1248	1228
Cason J. Calloway	01-14-80	Downbound		2135			
	01-15-80	Downbound				0015	0036
Algobay	01-14-80	Upbound	0430				
Gott	01-15-80	Downbound		0311		0843	0907
E. S. Olds	01-15-80	Downbound		0447		0915	0937
Yankcannuk	01-15-80	Downbound				1010	1029
Enders M. Vorhees	01-15-80	Downbound		1609		1838	1901
Algobay	01-16-80	Upbound	1603				
St. Marie II	01-16-80	Upbound				1757	1746
Algobay	01-16-80	Upbound		0507			
Algobay	01-18-80	Downbound		1452			
Yankcannuk	01-19-80	Upbound				0654	0635
Algobay	03-24-80	Upbound	0803				
Frontenac	03-25-80	Downbound		0912			
V. W. Scully	03-25-80	Upbound		1942		1630	1618
Algoso	03-25-80	Upbound		2018		1657	1637

Vessel name	Date	Direction	Time at Checkpoint				Lookout 4
			Brush Point	Mission Point	Six Mile Point	Nine Mile Point	
Texaco Wisconsin	04-28-80	Upbound			2344	2326	
	04-29-80	Upbound		0024			
Cliffa Victory	04-29-80	Upbound		0424	0350	0331	
William A. Reiss	04-29-80	Upbound		0706	0632	0610	
George M. Carl	04-29-80	Upbound		1043	1008	0950	
Philip D. Block	04-29-80	Upbound		2010	1942	1921	
Louis Wilson Foy	04-29-80	Upbound		2036	2004	1941	
William P. Snyder	04-28-80	Downbound		2245			
	04-29-80	Downbound					0021
Canadien Enterprise	04-29-80	Downbound		0004			0144
Jupiter	04-29-80	Downbound		0103			0238
Courtney Burton	04-29-80	Downbound	0011	0321			0503
Fred R. White	04-29-80	Downbound	0121	0414			0559
Stadacona	04-29-80	Downbound	0320				
Algosoo	04-29-80	Downbound		0550			0725
Sewell Avery	04-29-80	Downbound	0611	0841			1020
Fort Chambly	04-29-80	Downbound	0743	0925			1047
Edward L. Ryerson	04-29-80	Downbound	1030	1235			1414
Herbert C. Jackson	04-29-80	Downbound	1247	1505			1643
Indiana Harbor	04-30-80	Upbound		1407	1329	1304	
Quetico	04-30-80	Upbound		1505	1425	1407	
Reserve	04-30-80	Upbound		1419	1340	1321	
Marilyn O	04-30-80	Upbound		1654	1613	1556	
Walter A. Sterling	04-30-80	Upbound		1625	1553	1534	
Wm. Clay Ford	04-30-80	Upbound		1703	1624	1602	
John Dykstra	04-30-80	Upbound		1809	1732	1710	
Homer D. Williams	04-30-80	Upbound		1844	1807	1743	
Joseph H. Thompson	04-30-80	Upbound		2018	1945	1924	
V. W. Scully	04-30-80	Upbound		2028	1955	1935	
Cason J. Calloway	04-30-80	Upbound		2115	2044	2024	
Enders M. Vorhees	04-30-80	Upbound		2212	2140	2117	
Ernest R. Breech	04-30-80	Upbound		2324	2254	2234	
Fontiac	04-30-80	Upbound		2354	2322	2259	
Irving S. Olds	04-29-80	Downbound	2010				
	04-30-80	Downbound		1012			1207

Vessel name	Date	Direction	Time at Checkpoint				Lookout 4
			Brush Point	Mission Point	Six Mile Point	Nine Mile Point	
UNGAVA	04-29-80	Downbound	2007				
	04-30-80	Downbound		1002			1144
Benjamin Fairless	04-29-80	Downbound	2024				
	04-30-80	Downbound		1034			1224
Charles White	04-30-80	Downbound	1023	1245			1426
Cadillac	04-30-80	Downbound	1044	1331			1506
Ralph H. Watson	04-30-80	Downbound	1106	1413			1552
J. L. Antle	04-30-80	Downbound	1116	1427			1607
Armco	04-30-80	Downbound	1139	1507			1645
T. R. McLagen	04-30-80	Downbound	1157	1521			1633
Rimouski	04-30-80	Downbound	1229	1548			1730
Frank A. Sherman	04-30-80	Downbound	1237	1629			1805
D. C. Everst	04-30-80	Downbound	0942	1125			1258
Carbreeze	04-30-80	Downbound	1426	1710			1849
Carol Lake	04-30-80	Downbound	1434	1746			1925
John A. France	04-30-80	Downbound	1650	1855			2032
Scott Misener	04-30-80	Downbound	1658	1943			2124
James R. Barker	04-30-80	Downbound	1810	2141			2337
Johnstown	04-30-80	Downbound	1838	2153			2354
Stadacona	04-30-80	Downbound	1824				
Algolake	04-30-80	Downbound			2359	2339	
	05-01-80	Upbound		0034			
N.Y. News	05-01-80	Upbound		0141	0111	0045	
Murray Bay	05-01-80	Upbound		0206	0127	0100	
Edward B. Green	05-01-80	Upbound		0214	0135	0108	
Amoco Wisconsin	05-01-80	Upbound		0158	0121	0053	
London Viscount	05-01-80	Upbound		0347	0309	0246	
John Sherwin	05-01-80	Upbound		0434	0403	0345	
Hilda Marjanne	05-01-80	Upbound		0806	0735	0715	
Eugene P. Thomas	05-01-80	Upbound		0850	0814	0750	
L. E. Block	05-01-80	Upbound		1215	1139	1116	
Leon Falk Jr.	05-01-80	Upbound		1145	1110	1048	
Jean Parisen	05-01-80	Upbound		1203	1128	1107	
Thomas W. Lamont	05-01-80	Upbound		1227	1149	1128	

Vessel name	Date	Direction	Time at Checkpoint				Lookout 4
			Brush Point	Mission Point	Six Mile Point	Nine Mile Point	
William G. Mather	05-01-80	Upbound		1344	1303	1246	
Olympic Harmony	05-01-80	Upbound		1400	1318	1257	
Philip R. Clarke	04-30-80	Downbound	1909	2227			
	05-01-80	Downbound					0022
Presque Isle	04-30-80	Downbound	1917	2336			
	05-01-80						0136
Tarantau	04-30-80	Downbound	1951	2249			
	05-01-80	Downbound					0048
Macarena	04-30-80	Downbound	1956	2349			
	05-01-80	Downbound					0143
Ontadoc	04-30-80	Downbound	2034				
	05-01-80	Downbound		0019			0159
Roger Blough	04-30-80	Downbound	2140				
	05-01-80	Downbound		0059			0237
Champlain	04-30-80	Downbound	2215				
	05-01-80	Downbound		0111			0250
Golden Hind	04-30-80	Downbound	2305				
	05-01-80	Downbound		0134			0316
Robert S. Pierson	04-30-80	Downbound	2323				
	05-01-80	Downbound		0230			0415
Lake Winnepeg	05-01-80	Downbound	0052	0326			0508
Doan Transport	05-01-80	Downbound	0102	0301			0430
Robert C. Stanley	05-01-80	Downbound	0124	0428			0608
William S. Boyer	05-01-80	Downbound	0151	0516			0717
Middletown	05-01-80	Downbound	0223	0512			0656
Samuel Mather	05-01-80	Downbound	0317	0613			0753
Leon Fraser	05-01-80	Downbound	0330	0603			0740
Gott	05-01-80	Downbound	0343	0755			0946
Artic	05-01-80	Downbound	0442	0813			1019
Canadien Leader	05-01-80	Downbound	0538	0836			1041
Crigeta Zuzoril	05-01-80	Downbound	0600	0906			1112
Eugene W. Pargny	05-01-80	Downbound	0624	0952			1138
Alstaire Guthrey	05-01-80	Downbound	0642	0935			1127
Texaco Warrior	05-01-80	Downbound	0649	0859			1110
Amoco Wisconsin	05-01-80	Downbound		0805			0950
Cliffs Victory	05-01-80	Downbound	0833	1044			1222

Appendix 4

Anchored drift net catches in
littoral waters
(Stations 1-3)

Component of catch	Dates and stations fished														
	Jan. 31-Feb. 1			Feb. 16-17			March 8-9			March 22-23			April 29-May 1		
	Station number			Station number			Station number			Station number			Station number		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Macroinvertebrates															
Hydra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Nais felicta	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Chironomidae	0	1	1	0	0	0	0	0	0	0	0	0	0	3	2
Siauliidae	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Isoptera	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Corixidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total number	0	1	2	0	0	0	1	0	0	0	1	0	0	4	9
Total dry wt (mg)	0	<0.01	0.97	0	0	0	1.77	0	0	0	<0.01	0	<0.01	5.81	0
Total ash-free wt (mg)	0	<0.01	0.71	0	0	0	1.31	0	0	0	<0.01	0	<0.01	1.00	0
Macrophytes															
Surface area (cm^2)	0	0	0	0	0	0	0	0	0	0	<0.01	0	0	0	0
Dry wt (mg)	0	0	0	0	0	0	0	0	0	0	<0.01	0	0	0	0
Total ash-free wt (mg)	0	0	0	0	0	0	0	0	0	0	<0.01	0	0	0	0
Zooplankton															
Estimated number	1032	2,234	3,555	187	418	518	590	785	123	373	461	1148	143	102	57
Dry wt (mg)	38.24	*86.47	131.71	6.93	14.93	18.67	10.59	23.11	4.56	9.57	17.08	42.53	5.30	3.78	2.11
Ash-free wt (mg)	35.98	81.37	123.94	6.52	14.57	16.80	10.59	21.41	4.29	7.98	16.07	40.02	4.99	3.56	1.99
Detritus															
Total dry wt (mg)	4.98	35.51	42.15	3.98	<0.01	<0.01	<0.01	<0.01	0.90	<0.01	4.38	16.33	33.25	26.34	22.59
Total ash-free wt (mg)	4.98	34.95	41.24	3.14	<0.01	<0.01	<0.01	<0.01	0.50	<0.01	3.62	15.50	6.37	*	2.37
vol. water filtered (m^3)	178.3	180.2	178.6	173.5	172.1	171.9	176.4	174.1	172.7	361.2	360.2	540.6	173.1	360.2	699.9

• sample lost

Component of catch	Dates and stations fished															
	Jan. 31-Feb. 1			Feb. 16-17			March 8-9			March 22-23*			April 29-May 1			
	Station number	1	2	3	Station number	1	2	3	Station number	1	2	3	Station number	1	2	3
Macroinvertebrates																
Hydra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nematoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ostracoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hyallela asteca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lirceus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myis relicta	1	1	0	0	2	3	2	1	3	0	0	0	0	0	0	0
Simuliidae	18	8	32	82	73	106	16	13	23	0	0	0	0	0	0	0
Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomidae	4	0	11	4	1	8	1	3	3	0	0	0	0	0	0	0
Other Diptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptonhebia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phlebotomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydropsyche	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Polycentropus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acarina	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acanthocyclops	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Girardinus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnoria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valvata tricarinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planidium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaerium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Macrophytes																
Total number	23	10	44	88	76	118	19	19	34	0	0	0	0	0	0	0
Total dry wt (mg)	6.29	<0.01	10.45	18.15	33.37	34.87	19.45	7.74	11.68	0	0	0	0	0	0	0
Total ash-free wt (mg)	5.60	<0.01	7.41	13.15	32.56	23.86	14.76	2.75	8.30	0	0	0	0	0	0	0
Zooplankton																
Estimated number	27,313	7,333	34,213	34,627	37,567	39,737	11,840	12,700	20,720	0	0	0	0	0	0	0
Total dry wt (mg)	1011.95	271.69	1267.59	1282.93	1391.86	1472.25	438.67	470.54	767.68	0	0	0	0	0	0	0
Total ash-free wt (mg)	952.22	255.65	1192.78	1207.21	1309.71	1385.36	412.78	442.76	722.37	0	0	0	0	0	0	0
Detritus																
Total dry wt (mg)	270.07	143.79	392.28	441.89	322.91	405.82	96.68	214.68	151.34	0	0	0	0	0	0	0
Total ash-free wt (mg)	201.63	136.32	100.63	348.50	271.03	118.06	73.54	148.55	84.47	0	0	0	0	0	0	0
Fish larvae and eggs																
Total no. of eggs	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Total no. of larvae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vol. water filtered (m³)																
	999.5	1,006.0	1,013.9	1,024.7	1,020.9	1,033.1	890.8	883.2	1,049.9	0	0	0	0	0	0	0
										5	25	25	25	25	25	25
										1	0	0	0	0	0	0

*Samples could not be collected due to unstable ice.

аррелла 4

sample lost

Catches in drift nets fished at West Weebiah, January 31-May 1, 1980.

Component of Catch	Dates and stations fished											
	Jan. 31-Feb. 1			Feb. 16-17			March 8-9			March 22-23		
	1	2	3	1	2	3	1	2	3	1*	2	3
	Station number			Station number			Station number			Station number		Station number
Macroinvertebrates												
Hydra	0	0	0	0	0	0	0	0	0	17	7	56
Turbellaria	0	0	0	0	0	0	0	0	0	0	0	185
Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	150
Ostracoda	0	0	0	0	0	0	0	0	0	0	0	1
Gammarus	0	0	0	0	0	0	0	0	0	0	0	2
Hyalella asteca	0	0	0	0	0	0	1	1	0	0	0	35
Liriacus	0	0	0	0	0	0	0	0	0	0	0	208
Myias relicta	0	0	1	2	7	2	4	4	10	0	0	1
Sawillidae	0	0	1	1	1	3	0	2	6	4	0	22
Chironomidae	0	0	0	0	0	0	0	0	0	0	0	5
Ephemera	0	0	0	0	0	0	0	0	0	0	0	1
Leptochlebia	0	1	0	0	0	0	0	1	0	0	0	2
Siphonurus	0	0	0	0	0	0	0	0	0	0	0	18
Hystrax/che	0	0	0	0	0	0	0	0	0	0	0	7
Polycertronus	0	0	0	0	0	0	0	0	0	0	0	0
Leptodonta	0	0	0	0	0	0	0	0	0	0	0	0
Oxythira	0	0	0	0	0	0	0	0	0	0	0	1
Corixidae	0	0	0	1	1	0	0	0	0	0	0	1
Acerina	0	0	0	0	0	0	0	0	0	0	0	0
Gyraulid	0	0	0	0	0	0	0	0	0	0	0	2
Valvata tricarinata	0	0	0	0	0	0	0	0	0	0	0	1
Pisidium	0	0	0	0	0	0	0	0	0	0	0	0
Sphaerium	0	0	0	0	0	0	0	0	0	0	0	0
Total number	0	1	2	4	10	5	9	27	19	23	23	112
Total dry wt (mg)	0	1.13	3.11	15.86	37.23	5.82	16.69	23.70	45.96	15.33	23.69	46.60
Total ash-free wt (mg)	0	0.52	2.59	13.51	35.49	3.02	14.90	18.70	37.26	9.17	15.81	15.46
Zooplankton												
Estimated number	8,650	8,660	7,767	11,720	10,267	23,400	17,640	14,000	18,993	15,167	11,917	350
Total dry wt (mg)	320.48	303.89	287.77	404.26	367.71	866.97	627.41	518.70	703.69	561.94	441.52	12.97
Total ash-free wt (mg)	301.57	282.91	270.78	386.87	350.94	815.80	576.52	488.09	662.16	528.77	415.47	12.20
Detritus												
Total dry wt (mg)	45.12	0	127.74	<0.01	<0.01	139.10	<0.01	49.27	22.66	81.50	66.23	2881.76
Total ash-free wt (mg)	44.44	0	124.07	<0.01	<0.01	128.62	<0.01	5.03	0.11	78.31	50.96	764.55
Fish larvae and eggs												
Total no. of eggs	0	0	0	0	0	0	0	0	0	0	0	1
Total no. of larvae	0	0	0	0	0	0	0	0	0	0	0	0
Vol. water filtered (m³)	777.6	781.1	794.1	718.3	902.3	1,078.9	550.9	722.3	709.6	726.9	736.1	1,285.5
												1,285.5
												1,762.3

*sample spoiled

Appendix 5

Towed drift net catches in the
navigation channel

(Station 4)

Catches in drift nets fished at station 4 at all four locations, April 29 - May 1, 1980.

Component of Catch	Brush Point			Frechette Point			Lake Nicolet			West Neebish		
	Surface	Mid-depth	Bottom	Surface	Mid-depth	Bottom	Surface	Mid-depth	Bottom	Surface	Mid-depth	Bottom
Macroinvertebrates												
Hydra	0	3	2	2	7	3	0	8	2	3	0	2
Oligochaeta	0	0	1	0	0	0	0	0	0	0	0	0
Isopoda	0	0	0	0	0	0	0	0	0	0	0	1
Mysis relicta	0	0	0	0	1	1	0	0	1	0	2	1
Chironomidae	0	0	1	1	1	1	3	0	1	0	0	2
Simuliidae	0	0	0	0	0	1	1	0	1	15	12	0
Other Diptera	0	0	0	6	0	0	3	1	0	1	0	0
Helophorinae	0	0	0	1	0	0	0	0	0	1	0	0
Other Coleoptera	0	0	0	0	0	0	0	0	0	0	0	0
Lepidoptera	0	0	0	1	0	0	0	0	0	0	0	0
Chenmatopsyche	0	0	0	0	0	0	1	0	0	0	0	0
Oxyethira	0	0	0	0	0	0	0	0	0	0	0	1
Corixidae	0	0	0	0	0	0	0	0	0	0	0	1
Arcarina	0	0	1	1	0	0	0	0	0	0	0	0
Total number	0	3	5	12	9	6	8	9	5	20	14	8
Total dry wt (mg)	0	<0.01	<0.01	5.28	9.61	9.09	4.56	16.83	-	10.07	5.44	5.04
Total ash-free wt (mg)	0	<0.01	<0.01	2.23	3.44	2.21	1.16	6.93	-	1.77	0.23	1.24
Zooplankton												
Estimated number	572	7.05	1,043	4,684	2,257	2,587	4,160	1,907	2,070	362	1,818	1,230
Total dry wt (mg)	21.19	26.12	38.64	173.54	83.62	95.85	154.12	70.65	76.6 ^c	13.41	67.36	45.57
Total ash-free wt (mg)	15.17	19.69	36.36	163.30	78.69	90.19	-	66.48	72.	12.62	63.38	42.88
Detritus												
Total dry wt (mg)	4.09	5.24	36.96	107.74	205.79	282.63	<0.01	149.81	95.90	33.94	19.89	34.70
Total ash-free wt (mg)	<0.01	<0.01	18.79	65.77	162.15	204.87	<0.01	133.61	28.17	3.47	1.29	5.02
Fish Larvae and Eggs												
Total number of eggs	0	0	0	5	5	10	5	16	57	0	0	0
Fish Larvae:												
Myoxocephalus	0	0	0	0	0	1	0	0	1	0	0	0
Coregonus	0	0	0	0	0	0	0	1	0	0	0	0
Volume of Water Filtered (m ³)	31.8	44.5	44.5	50.9	50.9	44.5	44.5	50.9	38.2	44.5	44.5	44.5

Appendix 6
Taxonomic Composition and Relative
Abundance of Zooplankton

Taxonomic composition and relative abundance (as determined by examination of 200 zooplankters from each location) of zooplankton taken in drift nets in the St. Marys River. A towed drift net was used to collect the samples on April 29-May 1; the other samples were collected in anchored drift nets.

Date and Species	Brush Point	Frechette Point	Lake Nicolet	West Neebish
Jan. 30-Feb. 1				
<u>Limnocalanus macrurus</u>	182	187	190	192
<u>Diaptomus spp.</u>	3	12	2	1
<u>Senecella calanoides</u>	15	1	8	7
Feb. 16-17				
<u>Limnocalanus macrurus</u>	184	166	176	181
<u>Diaptomus spp.</u>	12	29	8	16
<u>Senecella calanoides</u>	4	5	16	2
<u>Cyclops bicuspidatus</u>	0	0	0	1
Mar. 8-9				
<u>Limnocalanus macrurus</u>	195	175	195	187
<u>Diaptomus spp.</u>	5	15	3	11
<u>Senecella calanoides</u>	0	9	2	2
<u>Cyclops bicuspidatus</u>	0	1	0	0
Mar. 22-23				
<u>Limnocalanus macrurus</u>	197	-	175	175
<u>Diaptomus spp.</u>	1	-	23	23
<u>Senecella calanoides</u>	2	-	1	2
<u>Cyclops vernalis</u>	0	-	1	0
Apr. 29-May 1				
<u>Limnocalanus macrurus</u>	96	88	165	114
<u>Diaptomus spp.</u>	101	97	26	77
<u>Senecella calanoides</u>	3	13	8	7
<u>Cyclops vernalis</u>	0	1	0	1
<u>Cyclops bicuspidatus</u>	0	1	0	0
<u>Bosmina coregoni</u>	0	0	0	1
Apr. 29-May 1				
<u>Limnocalanus macrurus</u>	93	33	21	72
<u>Diaptomus spp.</u>	105	167	178	121
<u>Senecella calanoides</u>	2	0	1	1
<u>Cyclops vernalis</u>	0	0	0	6