DISTRIBUTION AND ABUNDANCE OF MACROZOOBENTHOS IN THE DETROIT RIVER AND LAKE ST. CLAIR, 1977

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Abstract

In this study of the macrozoobenthos in the Detroit River and Lake St. Clair (including Anchor Bay) in April and July 1977, we identified a total of 71 invertebrate taxa, 46 of which were common to both the river and the lake. Some fauna, including the Oligochaeta, chironomid larvae, and the polychaete worm, Manayunkia speciosa, were widely distributed throughout both water bodies. Other taxa, such as Hyalella azteca, Asellus sp., and Lirceus sp. were found primarily in Anchor Bay. Between 1963 and 1977, the density of oligochaetes increased in parts of Anchor Bay while the density of sphaeriid clams declined throughout the lake.

In the Detroit River, the macrozoobenthos in Ontario waters included pollution-intolerant ephemeropterans and was, in general, more diverse than that in Michigan waters. The low diversity of macrozoobenthos and the high percent composition (93%) of pollution-tolerant oligochaetes in Michigan waters of the river indicated that these waters were severely impacted by pollution. Comparison of oligochaete densities reported in earlier surveys of Michigan waters of the Detroit River with those found in the present study, showed that one area just above the mouth of the Ecorse River (station 301) was more heavily polluted in 1977 than it was in 1957 but that there had been little change in the percent composition of oligochaetes elsewhere in the river during this period.

The number of benthic invertebrate taxa in open waters of Lake St. Clair (56), and in Anchor Bay of Lake St. Clair (57), was higher than in the Detroit River (49). The Oligochaeta was the most abundant group in the lake (including Anchor Bay) but the low relative abundance of this group there (25-49% of the total by number), indicated that the benthic environment in the lake was relatively unpolluted. Immature insects, a preferred food of many fish in the Great Lakes, were relatively abundant and widely distributed throughout the lake.

Introduction

The St. Clair-Detroit River ecosystem supports a valuable recreational fishery that serves large numbers of people in the vicinity of metropolitan Detroit. About two million angler days (48% of all non-salmonid fishing effort in Michigan waters of the Great Lakes) were recorded in 1975 for the U.S. portion of Lake St. Clair (Jaworski and Raphael 1978). Factors responsible for the apparent high production of fish populations in this connecting waterway (Robert Haas, personal communication) are not completely known, but undoubtedly include the high quality of water entering from Lake Huron and the presence of substrates that support a rich benthic food supply (Dawson 1975; Hiltunen 1971)--an important component in the diet of many fish in these waters (Great Lakes Fishery Laboratory, unpublished data).

In 1977, we conducted the present study in the Detroit River and Lake St. Clair (including Anchor Bay) to provide a current description of the distribution and abundance of macrozoobenthos. Results of our study were compared with those of surveys made 15-20 years earlier, to determine whether any qualitative or quantitative changes in the benthos had occurred in the intervening period. Because the composition and abundance of macrozoobenthos are indices of water quality conditions, changes in water quality in the study area were also deduced from this comparison. Supplemental sampling was also done to provide information about distribution and density of macrozoobenthos in areas that had not been previously studied.

Methods and Materials

In April and July 1977, we collected samples of macrozoobenthos at 11 stations in the Detroit River, at 36 stations in Anchor Bay of Lake St. Clair, and in open waters of the lake proper (Fig. 1; Appendix 1). With few exceptions, we sampled at each station in April and July (Appendix 2). Stations in the Detroit River were established downstream of the Detroit-Windsor metropolitan region in areas that had been sampled previously by Surber (1956) or Vaughan and Harlow (1965), or that were believed to be representative of previously unstudied sections of the river where sediments accumulate. Channels of the river were avoided as sampling locations, because the hard, current-swept bottom could not be sampled effectively with a Ponar grab. Moreover, ENCOTEC (1974) had recently published a description of the macrozoobenthos in the mid-channel of the river. Stations in Lake St. Clair proper were located at intervals of 5.6 km (3.5 miles) on a rectilinear grid. Hard bottom in the southern portion of the lake prevented sample collection in that area. We also sampled at stations 208, 223, 226, 227, 229, and 230 in Lake St. Clair proper, where macrozoobenthos had been collected previously (Hiltunen 1971; MDNR 1975). In Anchor Bay, the relatively small area of offshore waters did not accommodate the station-grid interval we used in Lake St. Clair proper, so we located the stations in the bay at about 2-km intervals along three ranges on compass bearings of 85°, 205°, and 245° from station 101 (Fig. 1). Stations 100, 101, and 102 coincided with locations where macrozoobenthos was sampled in previous studies (Hiltunen 1971; MDNR 1975).

During each visit to a station, three replicate bottom samples were collected with a Ponar grab that sampled an area of 484 cm^2; these samples where examined as they were removed from the grab and the substrate composition or bottom type was recorded (Appendix 3). Each sample was washed through a U.S. Standard No. 30 (0.65 mm) wire-mesh sieve. The residue containing the macrozoobenthos was bottled and preserved in 10% formalin. In the laboratory, the macrozoobenthos was extracted with forceps from the residue with the aid of a dissecting microscope. All animals were identified to the lowest feasible taxonomic rank. All organisms in each sample were counted individually except the sponges and bryozoans, which live as colonial masses and were recorded merely as present. The mean number of macrozoobenthic organisms per grab was converted to mean number of individuals per square meter by multiplying by 20.66, the fraction of one square meter of surface area taken by the Ponar grab in one sample.

Results

Macrozoobenthos in Anchor Bay, in the remainder of Lake St. Clair, and in the Detroit River was composed of 71 or more invertebrate taxa (Table 1). The majority of these organisms could be included in nine taxomonic groups: Nematoda, Oligochaeta, Polychaeta, Amphipoda, Isopoda, Diptera, Ephemeroptera, Gastropoda, and Pelecypoda. The percent composition, by number, of these groups in the total fauna in April and July combined was 99% in the Detroit River, 94% in Anchor Bay, and 97% in the remainder of Lake St. Clair proper (Table 2).

The distribution and density of the Nematoda was about the same in April and July (Figs. 2 and 3). In both months, the density of nematodes was highest in Anchor Bay and lowest in the Detroit River, (Tables 3 and 4).

The Oligochaeta (worms) were found at every station in April and July (Figs. 4 and 5) and were the most numerous of the nine taxonomic groups. In the Detroit River, Anchor Bay, and Lake St. Clair proper, oligochaetes were 92.6, 28.8, and 40.8 percent of the total invertebrate fauna, respectively, (Table 2). In the Detroit River, at station 301, we found an average of 87,390 oligochaetes/m^2 in April (Fig. 4) and 115,760 oligochaetes/m^2 in July (Fig. 5). Although identification of the oligochaetes beyond the sub-class level was not generally feasible, two species, Chaetogaster diaphanus and Stylaria lacustris, were noted in some samples when the fauna were sorted from the residue.

The Polychaeta (worms) consisted entirely of Manayunkia speciosa and were less abundant in parts of Anchor Bay and the western side of the Detroit River than elsewhere (Figs. 6 and 7). In Anchor Bay and Lake St. clair, the density of M. speciosa was lower in July (Table 4) than in April (Table 3).

The Amphipoda (scuds) included Hyalella (H. azteca) and Gammarus. Hyalella was present in high density throughout Anchor Bay, but was scarce in Lake St. Clair and the Detroit River (Figs. 8 and 9). No large differences in density were found between April and July; a few individuals were collected in the Detroit River in July but none was taken there in April. Gammarus was

distributed throughout much of Lake St. Clair (including Anchor Bay) and the Detroit River in April and July (Figs. 10 and 11). The highest density of Gammarus was found in Anchor Bay in July (Fig. 11).

The Isopoda (sowbugs) were represented by the genera, Asellus and Lirceus. The Isopoda were largely confined to Anchor Bay (Figs. 12-15), where they were 6.8% of the macrozoobenthos by number (Table 2).

Among the immature forms of insects collected (Table 1), the Diptera were most abundant. The group was composed primarily of Chironomidae (Appendix 2) which were distributed over the entire study area, except at station 305 in July (Figs. 16 and 17). Diptera were collected in greatest abundance in April in Anchor Bay (Tables 3 and 4).

The Ephemeroptera (mayflies) were found throughout the study area (Figs. 18 and 19) but, their density was low relative to those of the other eight taxonomic groups (Table 2). Seven genera composed the Ephemeroptera (Table 1). Except for two specimens of Hexagenia (Appendix 2), no Ephemeroptera were found in Michigan waters of the Detroit River.

The Gastropoda (snails) were distributed throughout the study area and were present in high density in Anchor Bay and at some stations in the Detroit River (Figs. 20 and 21). Generally, greater numbers of gastropods were found in July (Table 4) than in April (Table 3), and the percent composition of gastropods was highest in April in Anchor Bay (Tables 3 and 4). Eleven genera were represented in the group (Table 1).

The Pelecypoda (fingernail clams and mussels), were composed largely of the fingernail clams, Pisidium and Sphaerium (Appendix 2). Pisidium were found at nearly all stations (Figs. 22 and 23), whereas Sphaerium were encountered only infrequently (Figs. 24 and 25). No major differences in density were found between April (Table 3) and July (Table 4). Pelecypods were most abundant in July in Lake St. Clair (Tables 3 and 4).

Component taxa representing the following, less abundant groups, Cnidaria, Rhabdocoela, Nemertinea, Hirudinea, Ostracoda, Coleoptera, Trichoptera, Lepidoptera, Hemiptera, Odonata, and Acarina, were found sporadically. Among these, the Trichoptera were relatively numerous and were represented by the largest number (13) of genera (Table 1). Trichoptera were distributed throughout most of the study area (Figs. 26 and 27). None of these groups exceeded 2.5% of the total macrozoobenthos (by number) in our samples.

Discussion

Historical Record

Historical information on macrozoobenthos in the St. Clair-Detroit River system is scant. The earliest accounts of benthic fauna were incidental notations by Smith (1874a, b, c) and Verrill (1874) on various species in the Detroit River that were academically noteworthy to the collectors. Smith (1874a) collected a leech (Clepsine papillifera = Helobdella papillata) and the crustacean Asellus off Ecorse, Michigan. He also reported Asellus, Acarina,

Lymnaea, and Corixidae, in the stomach contents of whitefish caught in the same vicinity (Smith 1874b, c). Twenty years later, Jacob Reighard (1894) reported that the diversity of benthic invertebrate species was high in Michigan waters of Lake St. Clair; however, he presented no density estimates. At about the same time, Whiteaves (1895) listed site records of several species of mussels (Pelecypoda) in the Detroit River. Wright (1955) demonstrated that pollution from tributary streams, including the Detroit River, had contributed to an undesirable change in the composition of macrozoobenthos in western Lake Erie in 1929-30. Surber (1956) measured the degree of deterioration in the quality of the bottom fauna at a few sites in the Detroit River. In 1955-56, Hunt (1962) conducted a more extensive benthological study in the lower Detroit River to determine the quality and quantity of benthic invertebrates which could serve as food for waterfowl. More recently, surveys of bottom fauna in the river were conducted by the U.S. Public Health Service (Vaughan and Harlow 1965) and ENCOTEC (1974). Hiltunen (1971) carried out the first lake-wide survey of the bottom fauna in Lake St. Clair. A few years later the Michigan Department of Natural Resources (1975), conducted a similar survey in Michigan waters of the lake. Data from the MDNR survey were used by Dawson (1975) to show that benthic flora and fauna in Anchor Bay were used extensively as food by waterfowl.

Detroit River

The relationship between diversity (number) of macrozoobenthic taxa and their relative abundance is commonly employed as a criterion of environmental quality (APHA 1980). In habitats where the quality of the water or sediments is impaired by pollution, the diversity of macrozoobenthos is low but pollution-tolerant forms are present in higher abundance than they are in unpolluted habitats. In polluted habitats, because they are pollution-tolerant, the density and percent composition of some tubificid Oligochaeta ("sludge worms") have served as a measure of benthic environmental quality (Cairns and Dickson 1971). Goodnight and Whitley (1960) maintained that a benthic environment is probably polluted when, numerically, the oligochaetes compose 60% or more of the total benthic fauna. Their standard of 60% in polluted waters is based on the fact that these organisms can be very abundant, often exceeding 10,000/m^2. Because of its utility, the standard of Goodnight and Whitley (1960) has been recognized as one of the better indices by which pollution of benthic environments can be measured in the Great Lakes (Howmiller and Scott 1977).

When Surber (1956) sampled macrozoobenthos at various sites in the Detroit River to determine the degree of deterioration in the quality of the benthic environment, he employed oligochaete density as an indicator of water quality. He discovered that pollution-tolerant oligochaetes composed about 98% of the invertebrate fauna by number, and that they attained a density of 2,051,530/m^2. About 10 years later, the U.S. Public Health Service (Vaughan and Harlow 1965) found similarly high numbers (65,000 to 2,051,700/m^2) of oligochaetes in the river; the densities of all other forms was relatively low, ranging from none to 14,000/m^2. Still later, ENCOTEC (1974) found over 411,500 oligochaetes/m^2 (99% composition in the river) in November 1973. In the present study, the density of oligochaetes in the river ranged from 1,280 to 87,390/m^2 in April (Fig. 2) and from 1,240 to 115,765/m^2 in July 1977 (Fig. 3). We found highest oligochaete densities on both dates at the site (Station 301) where earlier the

U.S. Public Health Service found the greatest number of oligochaetes. This site is about 1 km from the station where ENCOTEC found the highest number of oligochaetes in their survey. According to the standard of Goodnight and Whitley (1960), the high relative abundance of oligochaetes (about 93% of the total fauna by number) and the high oligochaete density found in the Detroit River in the present study indicate that portions of the Detroit River were highly polluted in 1977, as they have been for many years (U.S. Public Health Service 1962).

In the Detroit River we found the greatest taxonomic diversity among the macrozoobenthos in Ontario waters at stations 313, 315, and 317 which were located near the middle of the river where the relatively clean waters from Lake St. Clair flow. Moreover, a number of pollution-intolerant Ephemeroptera and Trichoptera were also present at these stations (Appendix 2). Many of the organisms representing these two groups in our study were reported earlier by ENCOTEC (1974). The appearance of those forms was not unexpected because ENCOTEC sampled primarily in the deep channels of the river where the greater flow provides more desirable habitat for these rheophilic trichopteran larvae.

Lake St. Clair.

The density of most macrozoobenthos in Lake St. Clair appears to have changed little between 1963 and 1977 (Tables 5-12); however, the abundance of oligochaetes was noticeably higher in Anchor Bay in April and July 1977 than in earlier years, except at station 230 (Table 5). Between 1963 and 1977, the density of sphaeriid clams declined (Table 12). The density of other taxa varied between 1963 and 1977 (Tables 6-11), but the variations in density were not consistent among stations and dates, except that nearly all the density estimates made by the MDNR (1975) were lower than those reported before and after their survey.

The richness of the benthic fauna in Lake St. Clair is evident in the high diversity of taxa we found in Anchor Bay and elsewhere in Lake St. Clair (Tables 1 and 2). The total number of taxa in Anchor Bay and in the remainder of the lake was closely similar but, the density of macrozoobenthos was higher in Anchor Bay than elsewhere in the lake (cf. data from stations 100-119 and stations 200-230, Appendix 2). The high diversity of macrozoobenthos, together with the moderate abundance of oligochaetes, indicated that the quality of the benthic environment was high throughout Lake St. Clair, including Anchor Bay. The mean percent composition of the pollution-tolerant oligochaetes ranged from 25.5 in Anchor Bay to 49.0 elsewhere in the lake (Tables 4 and 5). These values are far below Goodnight and Whitley's (1960) standard of 60% oligochaetes in polluted environments. The presence of pollution-intolerant Ephemeroptera and Trichoptera in substantial numbers (Appendix 2) further supports our conclusion that, overall, the benthic environment of Lake St. Clair is not severely impaired by pollution.

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Table 1. Macrozoobenthic taxa collected in the Detroit River and Lake St. Clair (including Anchor Bay) in 1977, April and July data combined. [+ indicates presence]

Taxon	Detroit River	Lake St. Clair	
		Anchor Bay	Open lake
Porifera	+		+
Cnidaria	+	+	+
Rhabdocoela	+	+	+
Tricladida	+	+	+
Nemertinea	+	+	
Nematoda	+	+	+
Bryozoa			+
Hirudinea			
Erpobdellidae	+	+	
Glossiphoniidae			
Glossiphonia complanata	+	+	+
G. heteroclita		+	
Helobdella elongata	+	+	+
H. stagnalis	+	+	+
H. triserialis		+	
Placobdella montifera	+	+	
Oligochaeta			
Chaetogaster diaphanus	+	+	
Stylaria lacustris	+	+	+
Others	+	+	+
Polychaeta			
Manayunkia speciosa	+	+	+
Ostracoda	+	+	+
Amphipoda			
Gammarus sp.	+	+	+
Hyalella azteca	+	+	+
Isopoda			
Asellus sp.	+	+	+
Lirceus lineatus		+	+
Diptera			
Ceratopogonidae	+	+	+
Chironomidae	+	+	+
Culicidae			
Chaoborus sp.		+	+
Ephemeroptera			
Baetisca sp.	+		+
Brachycercus sp.		+	+
Caenis sp.	+	+	+
Ephemera sp.		+	+

Table 1. continued.

Ephemerella sp.			+
Ephoron sp.	+		
Hexagenia sp.	+	+	+
Coleoptera			
Dubiraphia sp.		+	
Haliplus cribrarius			+
Lepidoptera	+	+	+
Trichoptera			
Ceraclea sp.		+	
Cheumatopsyche sp.	+		+
Hydropsyche sp.	+		+
Hydroptila sp.			+
Molanna sp.			+
Mystacides sp.	+	+	+
Nectopsyche sp.	+	+	+
Neureclipsis sp.	+	+	+
Oecetis sp.	+	+	+
Polycentropus sp.		+	+
Psychomyia sp.	+	+	
Setodes sp.		+	+
Triaenodes sp.		+	+
Hemiptera			
Corixidae		+	+
Odonata			
Coenagrionidae		+	
Gomphidae			
Dromogomphus sp.	+		
Acarina	+	+	+
Gastropoda			
Amnicola sp.	+	+	+
Bithynia tentaculata	+	+	+
Campeloma sp.		+	
Elimia livescens	+	+	+
Ferissia sp.	+		
Gyraulus sp.	+	+	+
Helisoma sp.	+	+	
Lymnaea sp.		+	+
Physa sp.	+	+	+
Valvata sincera	+	+	+
V. tricarinata	+	+	+
Pelecypoda			
Sphaeriidae			
Pisidium spp.	+	+	+
Sphaerium corneum	+	+	+
Unionidae			
Anodonta grandis		+	
Fusconaia flava			+
Lampsilis radiata siliquoidea	+	+	+
Leptodea sp.	+		+
Ligumia nasuta	+		+
Proptera alata		+	+
Total taxa	49	57	56

Table 2. Percent composition (by number) and mean density (number of individuals/m^2) of the nine major taxa of macrozoobenthos collected in the Detroit River, Anchor Bay of Lake St. Clair, and the open waters of Lake St. Clair in April and July 1977.

Taxa	Detroit River		Lake St. Clair Anchor Bay		Lake St. Clair Open lake	
	Percent composition	Density	Percent composition	Density	Percent composition	Density
Nematoda	0.8	179	9.7	795	11.4	511
Oligochaeta	92.6	19,900	28.8	2,350	40.8	1,826
Polychaeta	1.9	399	7.7	631	19.5	874
Amphipoda	0.2	52	11.8	967	4.1	182
Isopoda	<0.1	1	6.8	555	0.3	12
Diptera	0.9	199	12.5	1,023	8.8	395
Ephemeroptera	0.2	53	1.9	151	2.6	118
Gastropoda	1.2	262	11.2	917	1.8	82
Pelecypoda	0.9	190	3.4	276	7.9	355
Percent of total	98.7		93.8		97.2	

Table 3. Percent composition (by number) and mean density (number of individuals/m^2) of the nine major taxa of macrozoobenthos collected in the Detroit River, Anchor Bay of Lake St. Clair, and the open waters of Lake St. Clair in April 1977.

Taxa	Detroit River		Lake St. Clair: Anchor Bay		Lake St. Clair: Open lake	
	Percent composition	Density	Percent composition	Density	Percent composition	Density
Nematoda	1.5	230	11.3	931	11.7	601
Oligochaeta	93.6	13,963	32.0	2,632	35.2	1,818
Polychaeta	0.4	63	10.1	829	28.5	1,469
Amphipoda	0.1	11	6.9	566	2.1	110
Isopoda	<1.1	1	1.6	135	0.0	0
Diptera	1.2	175	18.2	1,497	9.2	476
Ephemeroptera	0.6	85	2.7	225	3.6	188
Gastropoda	0.5	69	6.7	555	1.4	70
Pelecypoda	0.9	131	4.1	336	5.8	299
Percent of total	98.9		93.6		97.5	

Table 4. Percent composition (by number) and mean density (number of individuals/m^2) of the nine major taxa of macrozoobenthos collected in the Detroit River, Anchor Bay of Lake St. Clair, and the open waters of Lake St. Clair, July 1977.

Taxa	Detroit River		Lake St. Clair: Anchor Bay		Lake St. Clair: Open lake	
	Percent composition	Density	Percent composition	Density	Percent composition	Density
Nematoda	0.4	121	8.1	660	11.1	415
Oligochaeta	92.0	26,716	25.5	2,068	49.0	1,834
Polychaeta	2.7	784	5.4	434	6.5	244
Amphipoda	0.3	99	16.9	1,369	6.9	257
Isopoda	<0.1	2	12.0	976	0.7	25
Diptera	0.8	227	6.8	548	8.3	309
Ephemeroptera	0.1	15	1.0	78	1.2	45
Gastropoda	1.7	484	15.8	1,279	2.5	94
Pelecypoda	0.9	257	2.7	216	11.1	415
Percent of total	99.0		94.2		97.3	

Table 5. Mean density (number/m^2) of Oligochaeta in Lake St. Clair at 10 stations sampled on 3-5 occasions between May 1963 and July 1977.

Hiltunen[a]				MDNR[b]		Present study		
Station	Date			Station	Date	Station	Date	
	May 1963	July 1963	July 1965		July 1973		April 1977	July
Anchor Bay								
12		1,026		20	789	100	1,419	1,295
13	810					101	1,040	1,012
14		1,521		14	775	102	3,636	3,905
Southern Lake St. Clair								
1		837		1	72	223	2,004	578
Eastern Lake St. Clair								
6		504	2,282			225		5,943
7		1,696				226	682	1,109
Mid-Lake St. Clair								
8		1,705	1,276			227	303	220
Western Lake St. Clair								
9		495		6	732	228	2,038	510
10		1,359		28	1,923	229	2,376	1,012
11		900	1,615	26	5,081	230	1,370	1,123

[a]Hiltunen (1971).

[b]Michigan Department of Natural Resources (1975).

Table 6. Mean density (number/m^2) of Amphipoda in Lake St. Clair at 10 stations sampled on 3-5 occasions between May 1963 and July 1977.

Hiltunen[a]				MDNR[b]		Present study		
Station	Date			Station	Date	Station	Date	
	May 1963	July 1963	July 1965		July 1973		April 1977	July 1977
Anchor Bay								
12		77		20	445	100	565	1,295
13	607					101	544	1,901
14		113		14	201	102	647	1,914
Southern Lake St. Clair								
1		598		1	29	223	90	48
Eastern Lake St. Clair								
6		0	324			225		0
7		1,615				226	0	124
Mid-Lake St. Clair								
8		40	7			227	0	14
Western Lake St. Clair								
9		112		6	14	228	69	1,212
10		118		28	0	229	0	7
11		93	41	26	14	230	34	14

[a]Hiltunen (1971).

[b]Michigan Department of Natural Resources (1975).

Table 7. Mean density (number/m^2) of Isopoda in Lake St. Clair at 10 stations sampled on 3-5 occasions between May 1963 and July 1977.

Hiltunen[a]				MDNR[b]		Present study		
Station	Date			Station	Date	Station	Date	
	May 1963	July 1963	July 1965		July 1973		April 1977	July
Anchor Bay								
12		0		20	0	100	34	131
13	58					101	165	559
14		31		14	373	102	28	358
Southern Lake St. Clair								
1		0		1	0	223	0	0
Eastern Lake St. Clair								
6		0	0			225		0
7		112				226	0	0
Mid-Lake St. Clair								
8		0	0			227	0	0
Western Lake St. Clair								
9		0		6	0	228	0	7
10		0		28	0	229	0	0
11		9	0	26	0	230	0	0

[a]Hiltunen (1971).

[b]Michigan Department of Natural Resources (1975).

Table 8. Mean density (number/m^2) of Chironomidae in Lake St. Clair at 10 stations sampled on 3-5 occasions between May 1963 and July 1977.

Hiltunen[a]				MDNR[b]		Present study		
Station	Date			Station	Date	Station	Date	
	May 1963	July 1963	July 1965		July 1973		April 1977	July
Anchor Bay								
12		531		20	158	100	1,370	475
13	860					101	1,673	241
14		1,327		14	746	102	1,081	1,302
Southern Lake St. Clair								
1		135		1	100	223	778	131
Eastern Lake St. Clair								
6		450	209			225		441
7		1,683				226	110	152
Mid-Lake St. Clair								
8		797	270			227	289	243
Western Lake St. Clair								
9		270		6	545	228	413	365
10		657		28	186	229	227	262
11		1,876	810	26	1,076	230	551	289

[a]Hiltunen (1971).

[b]Michigan Department of Natural Resources (1975).

Table 9. Mean density (number/m^2) of Ephemeroptera in Lake St. Clair at 10 stations sampled on 3-5 occasions between May 1963 and July 1977.

Hiltunen[a]				MDNR[b]		Present study		
Station	Date			Station	Date	Station	Date	
	May 1963	July 1963	July 1965		July 1973		April 1977	July 1977
Anchor Bay								
12		149		20	0	100	186	55
13	229					101	124	41
14		45		14	43	102	103	193
Southern Lake St. Clair								
1		18		1	0	223	76	0
Eastern Lake St. Clair								
6		72	20			225		21
7		70				226	0	14
Mid-Lake St. Clair								
8		18	0			227	489	28
Western Lake St. Clair								
9		71		6	57	228	399	103
10		38		28	0	229	0	14
11		149	18	26	158	230	41	14

[a]Hiltunen (1971).

[b]Michigan Department of Natural Resources (1975).

Table 10. Mean density (number/m^2) of Trichoptera in Lake St. Clair at 10 stations sampled on 3-5 occasions between May 1963 and July 1977.

Hiltunen[a]				MDNR[b]		Present study		
Station	Date			Station	Date	Station	Date	
	May 1963	July 1963	July 1965		July 1973		April 1977	July 1977
Anchor Bay								
12		45		20	0	100	172	83
13	18					101	165	186
14		36		14	72	102	28	83
Southern Lake St. Clair								
1		14		1	14	223	7	7
Eastern Lake St. Clair								
6		4	14			225		14
7		153				226	0	103
Mid-Lake St. Clair								
8		0	0			227	14	14
Western Lake St. Clair								
9		32		6	0	228	34	62
10		76		28	0	229	7	7
11		17	41	26	0	230	14	7

[a]Hiltunen (1971).

[b]Michigan Department of Natural Resources (1975).

Table 11. Mean density (number/m^2) of Gastropoda in Lake St. Clair at 10 stations sampled on 3-5 occasions between May 1963 and July 1977.

Hiltunen[a]				MDNR[b]		Present study		
Station	Date			Station	Date	Station	Date	
	May 1963	July 1963	July 1965		July 1973		April 1977	July 1977
Anchor Bay								
12		1,057		20	86	100	461	1,226
13	753					101	96	1,557
14		1,754		14	29	102	262	909
Southern Lake St. Clair								
1		1,358		1	43	223	592	937
Eastern Lake St. Clair								
6		653	621			225		7
7		1,038				226	21	28
Mid-Lake St. Clair								
8		534	209			227	14	48
Western Lake St. Clair								
9		372		6	0	228	90	96
10		372		28	0	229	7	14
11		62	49	26	0	230	28	117

[a]Hiltunen (1971).

[b]Michigan Department of Natural Resources (1975).

Table 12. Mean density (number/m^2) of Sphaeriidae in Lake St. Clair at 10 stations sampled on 3-5 occasions between May 1963 and July 1977.

Hiltunen[a]				MDNR[b]		Present study		
Station	Date			Station	Date	Station	Date	
	May 1963	July 1963	July 1965		July 1973		April 1977	July 1977
Anchor Bay								
12		504		20	27	100	234	358
13	144					101	241	69
14		297		14	29	102	7	55
Southern Lake St. Clair								
1		2,893		1	574	223	475	1,136
Eastern Lake St. Clair								
6		952	243			225		158
7		3,537				226	193	434
Mid-Lake St. Clair								
8		681	284			227	124	90
Western Lake St. Clair								
9		557		6	27	228	138	234
10		1,769		28	0	229	96	269
11		1,216	301	26	0	230	1,391	647

[a]Hiltunen (1971).

[b]Michigan Department of Natural Resources (1975).

Hiltunen & MANNY (1982)

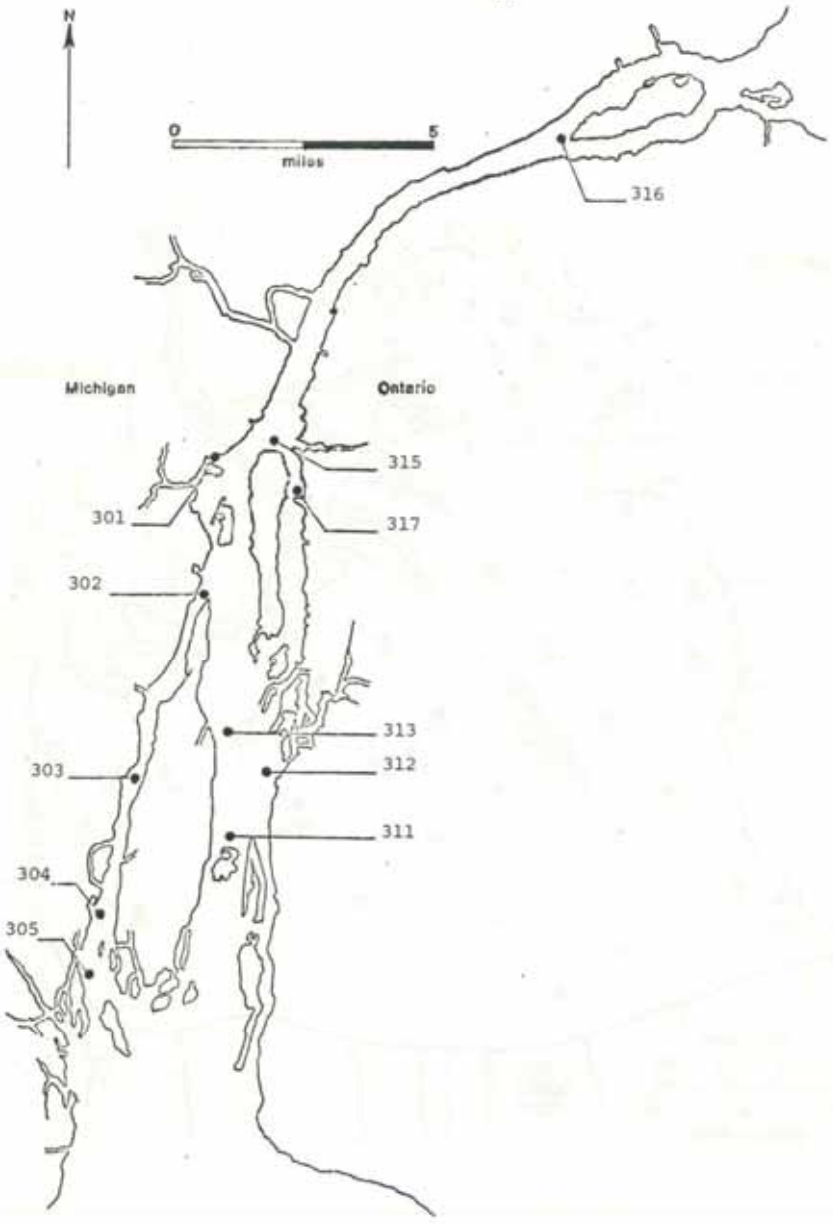
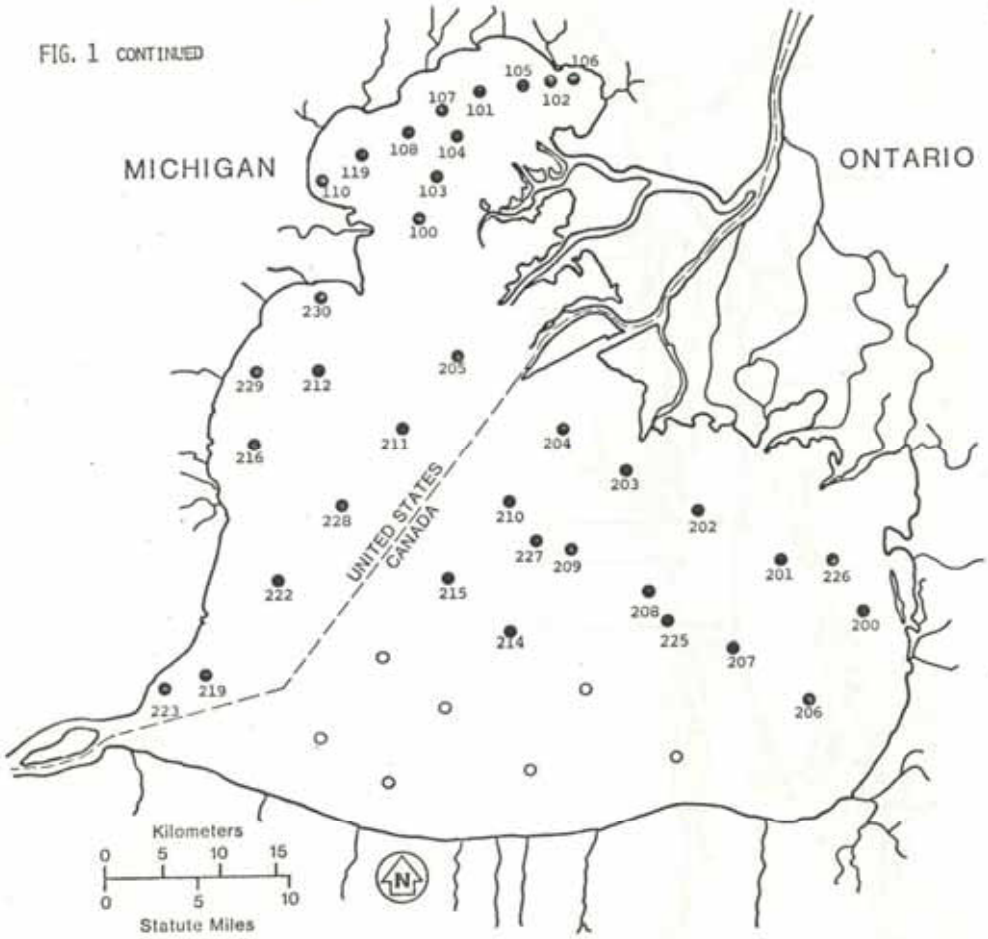


Figure 1. Location of stations in the Detroit River and Lake St. Clair, including Anchor Bay, where the macrozoobenthos was sampled in April, or July, or both, 1977. Open circles indicate sites where quantitative samples could not be collected.

Hiltunen & Manny 1982

FIG. 1 CONTINUED



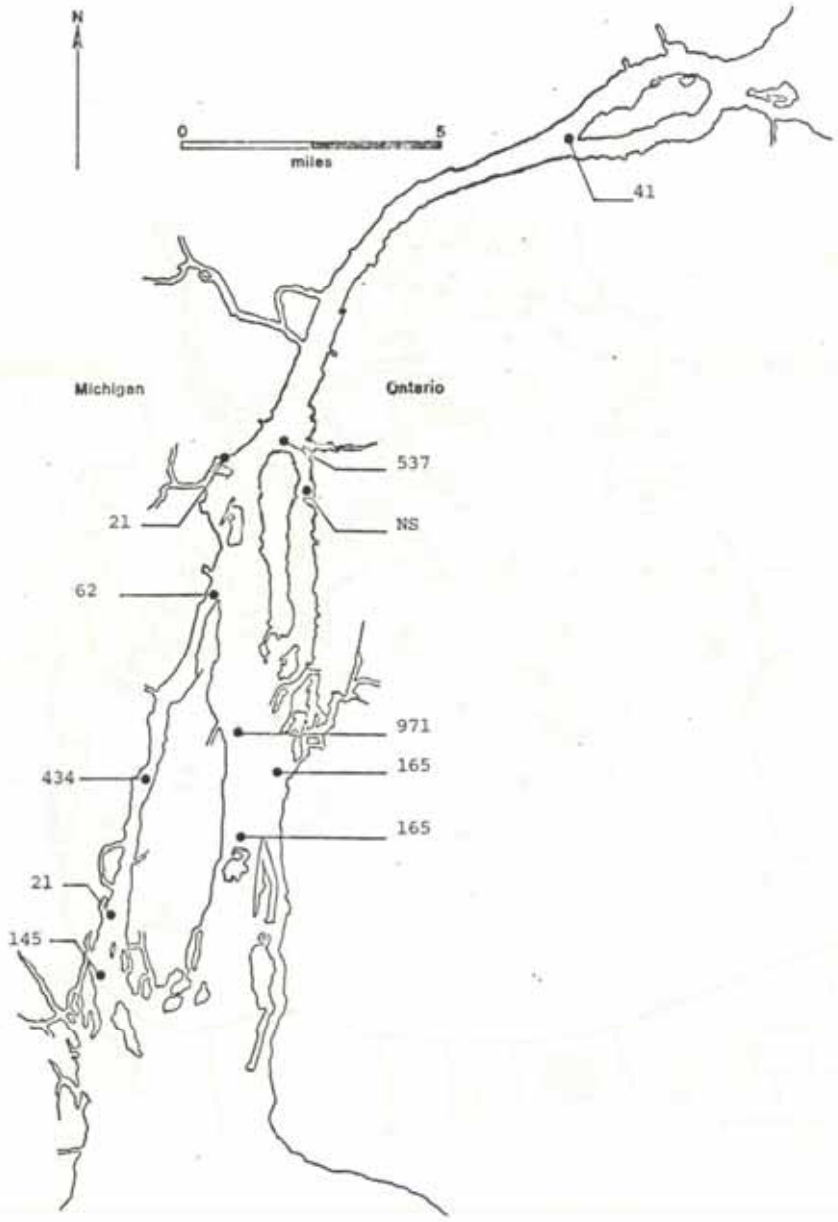
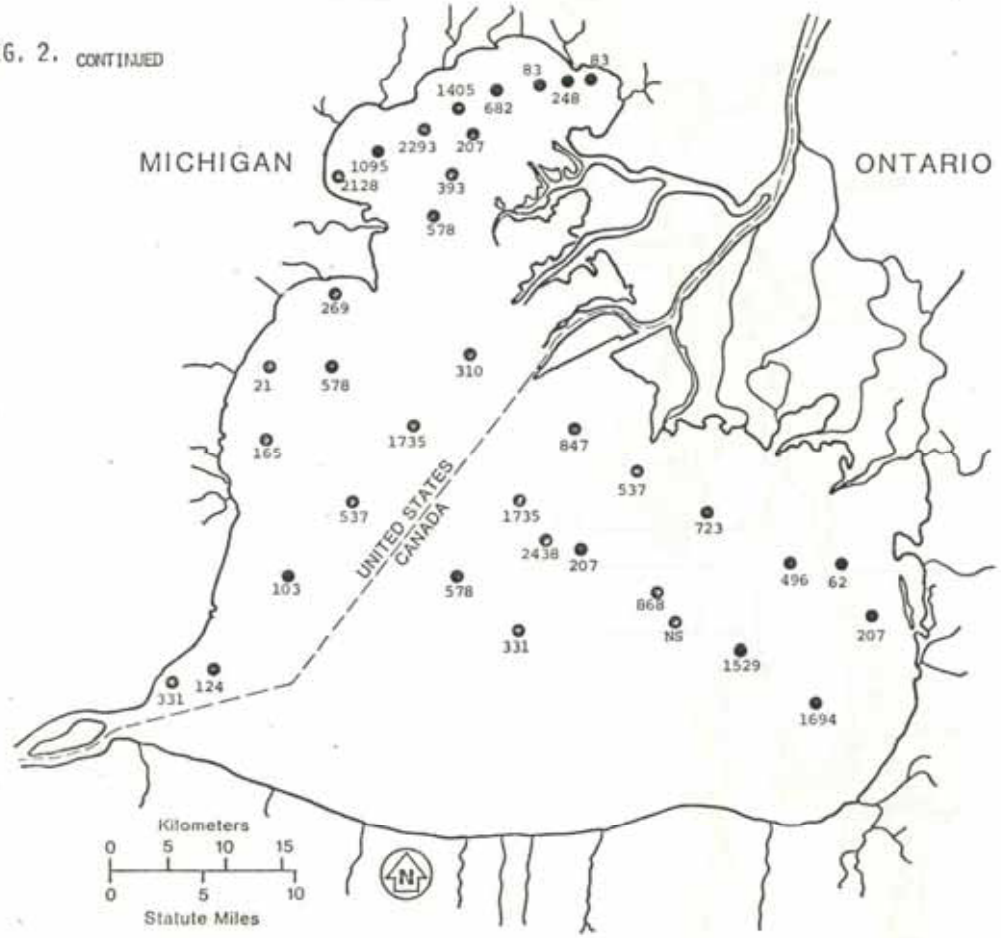


Figure 2. Distribution and density (mean number per square meter) of Nematoda in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

FIG. 2. CONTINUED



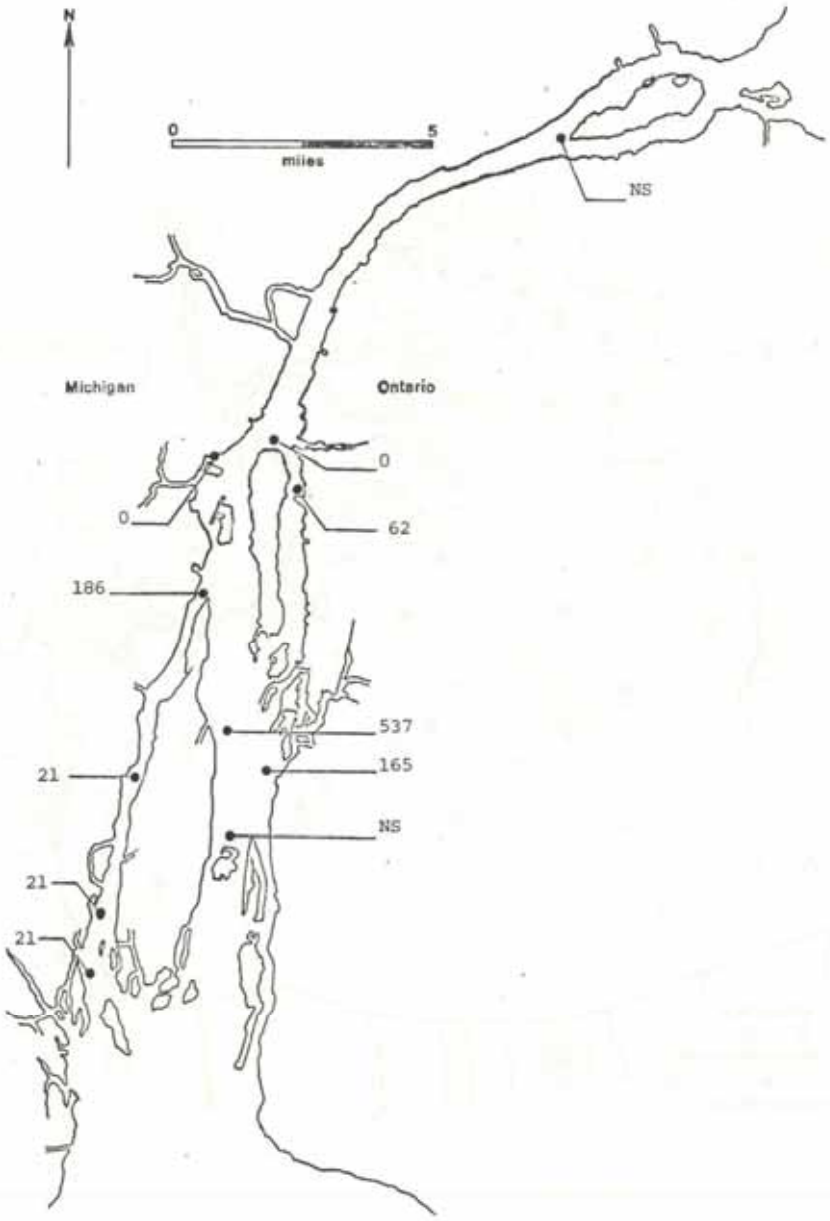
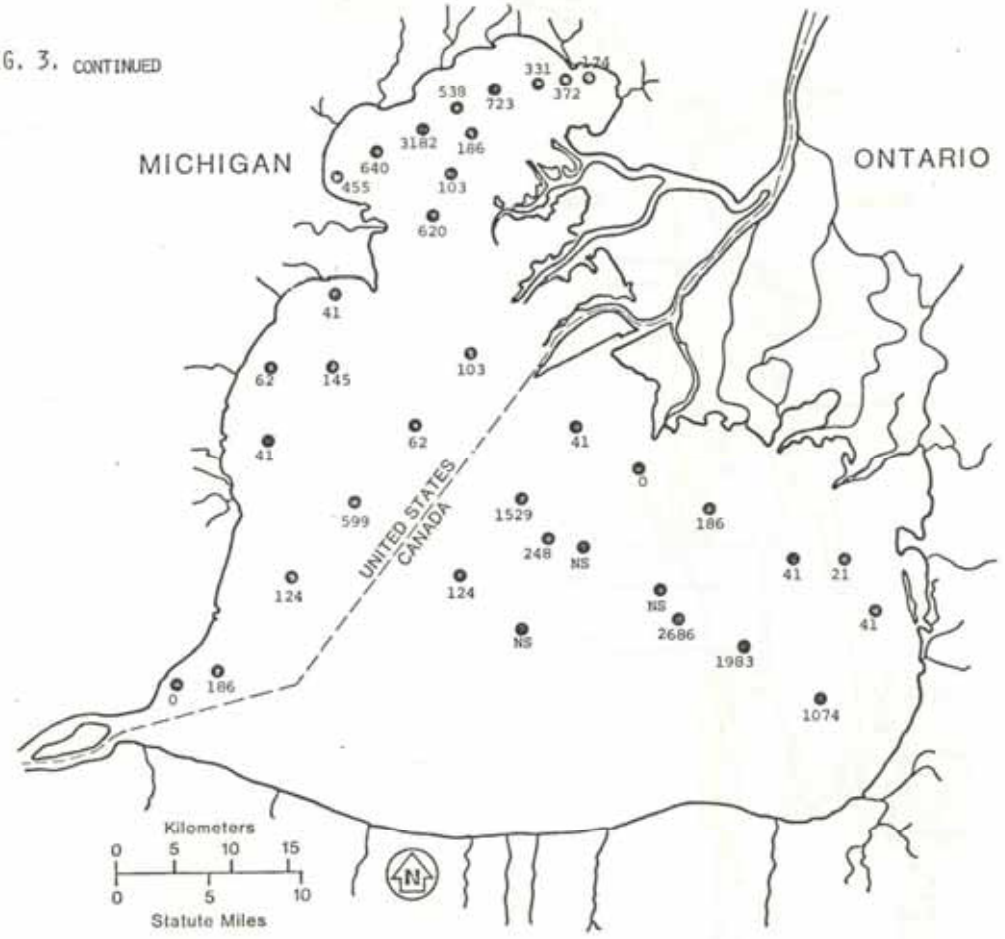


Figure 3. Distribution and density (mean number per square meter) of Nematoda in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 3. CONTINUED



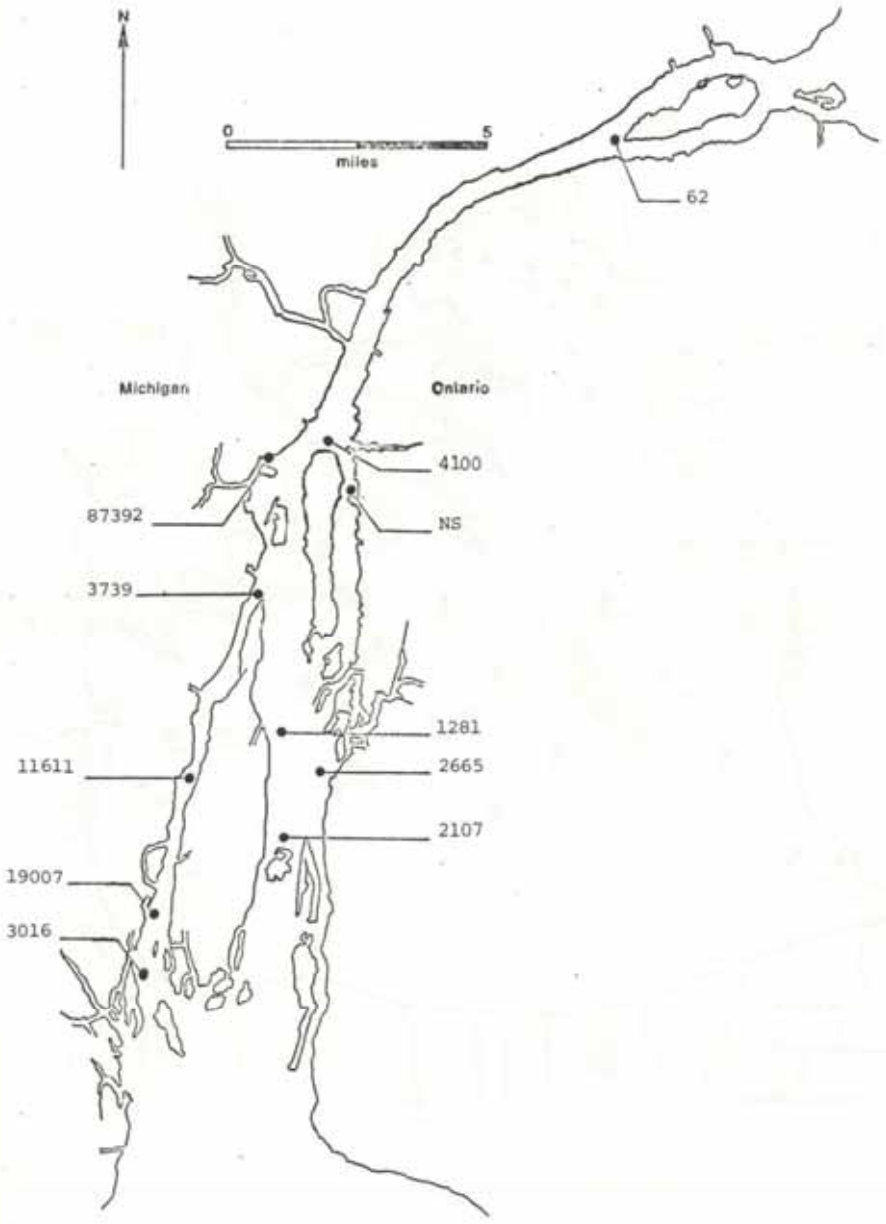
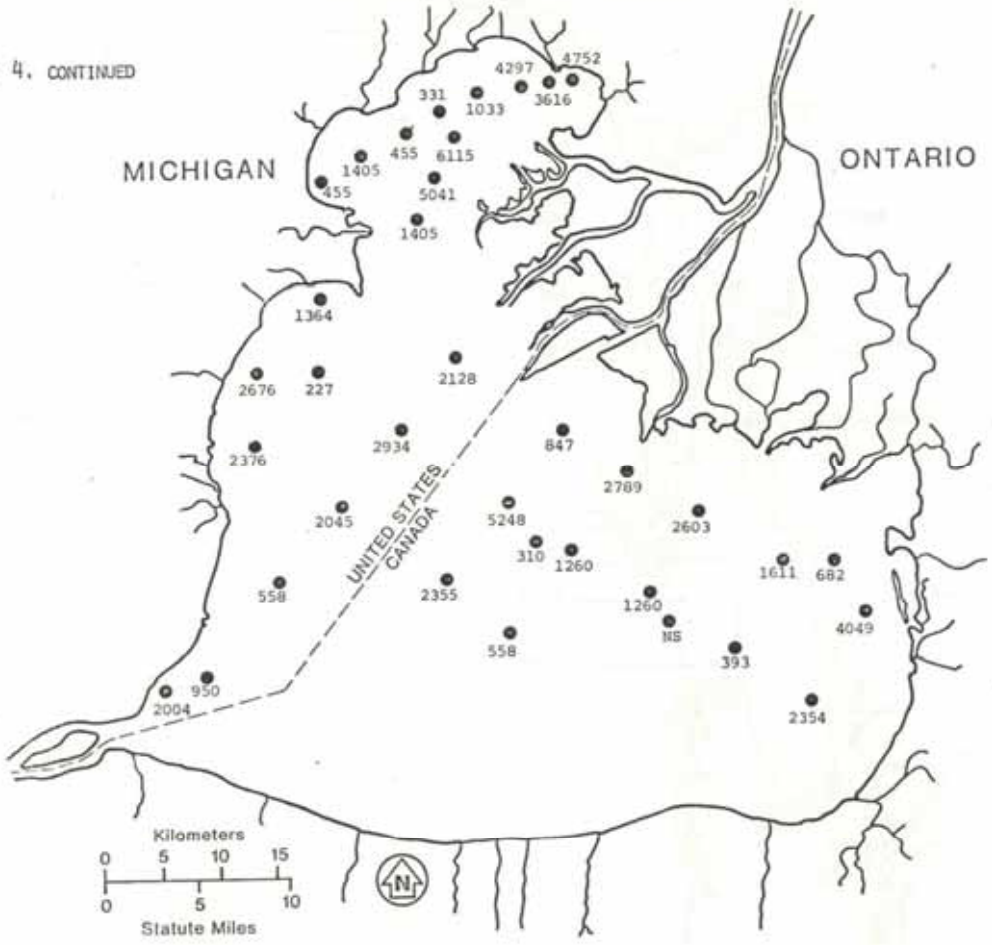


Figure 4. Distribution and density (mean number per square meter) of Oligochaeta in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

FIG. 4. CONTINUED



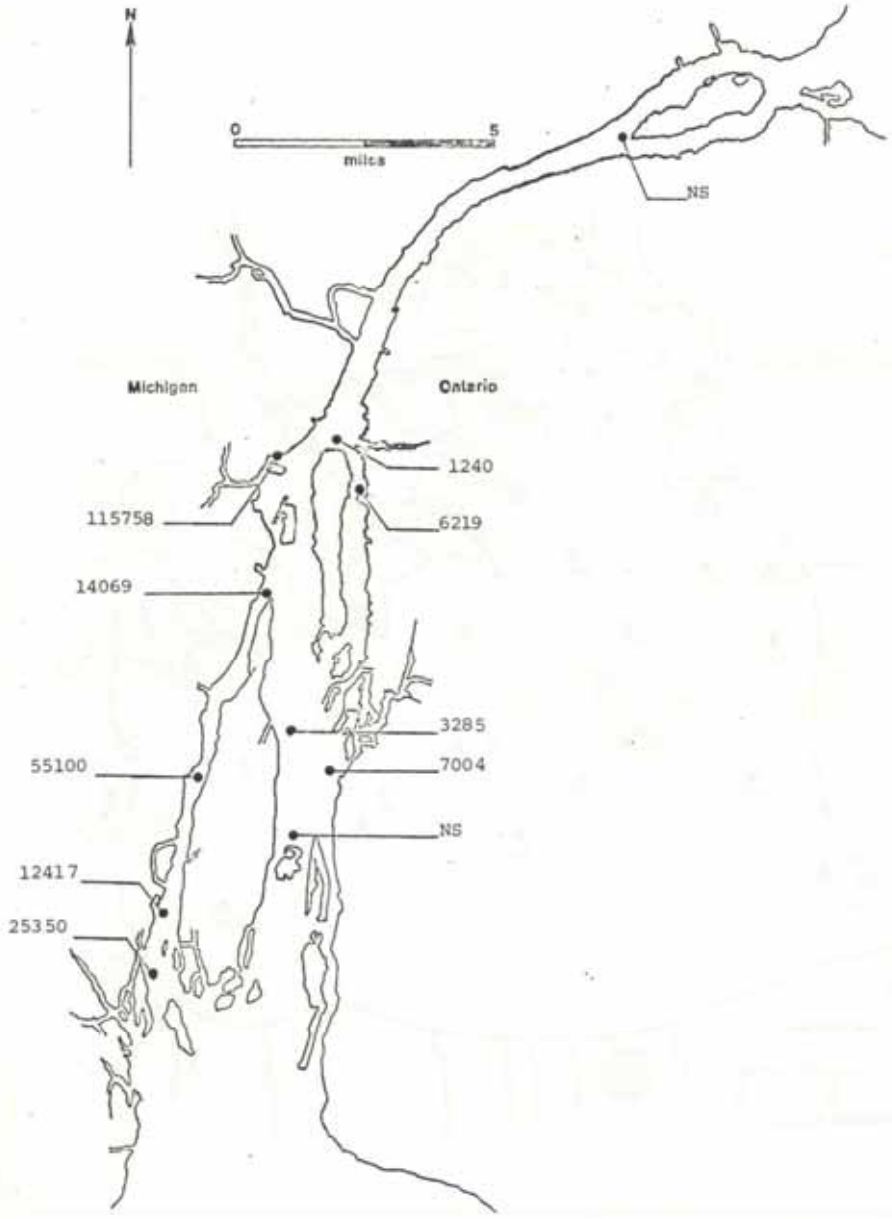
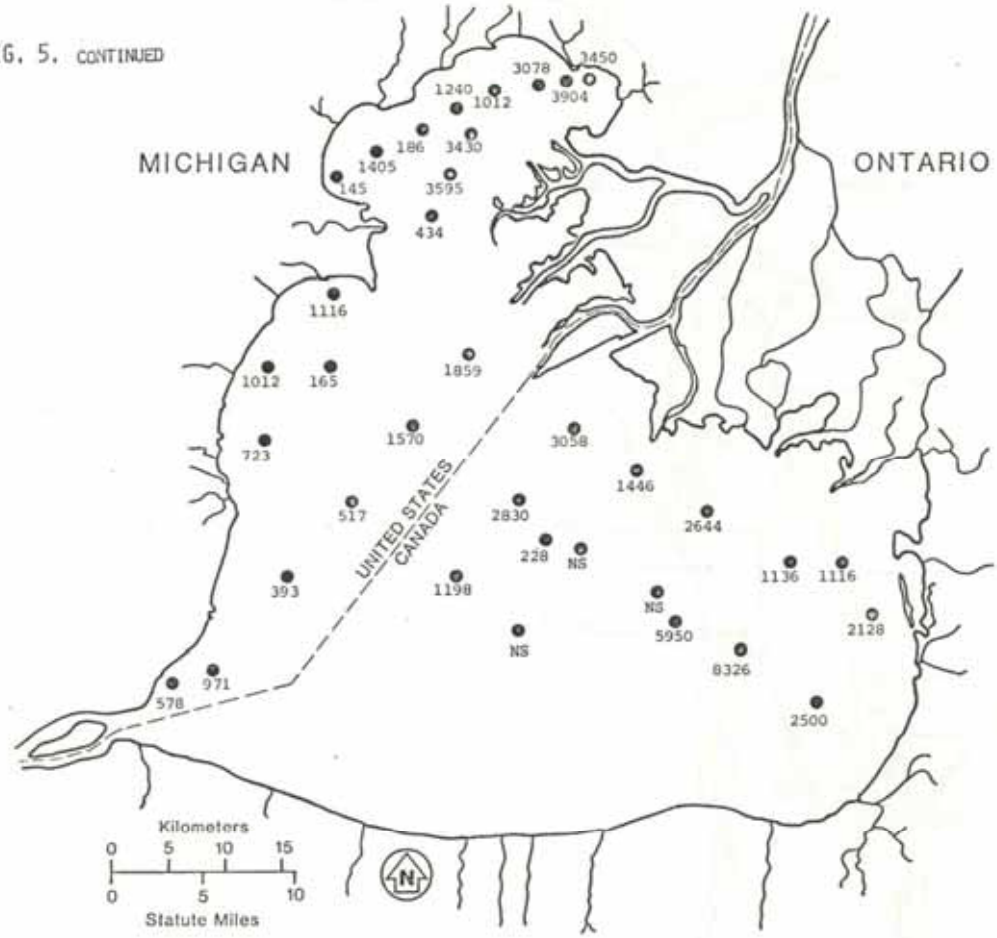


Figure 5. Distribution and density (mean number per square meter) of Oligochaeta in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 5. CONTINUED



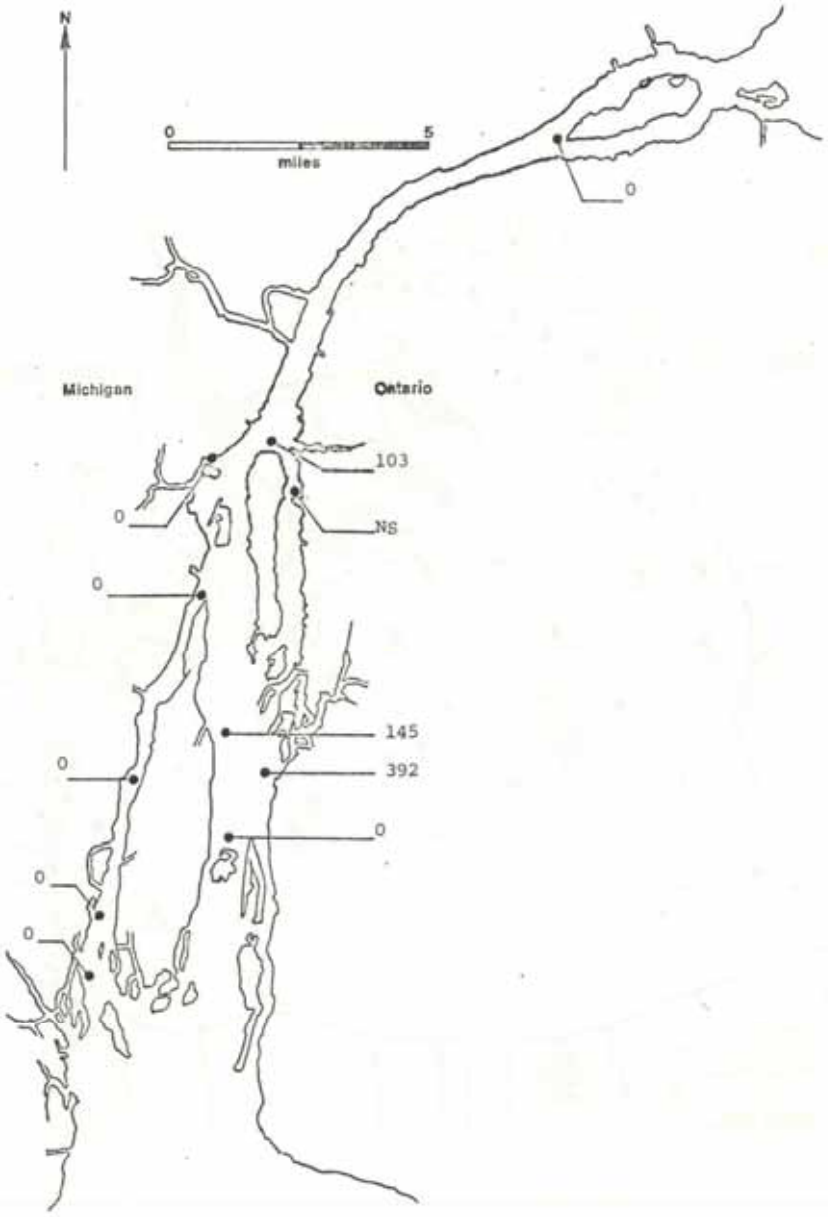
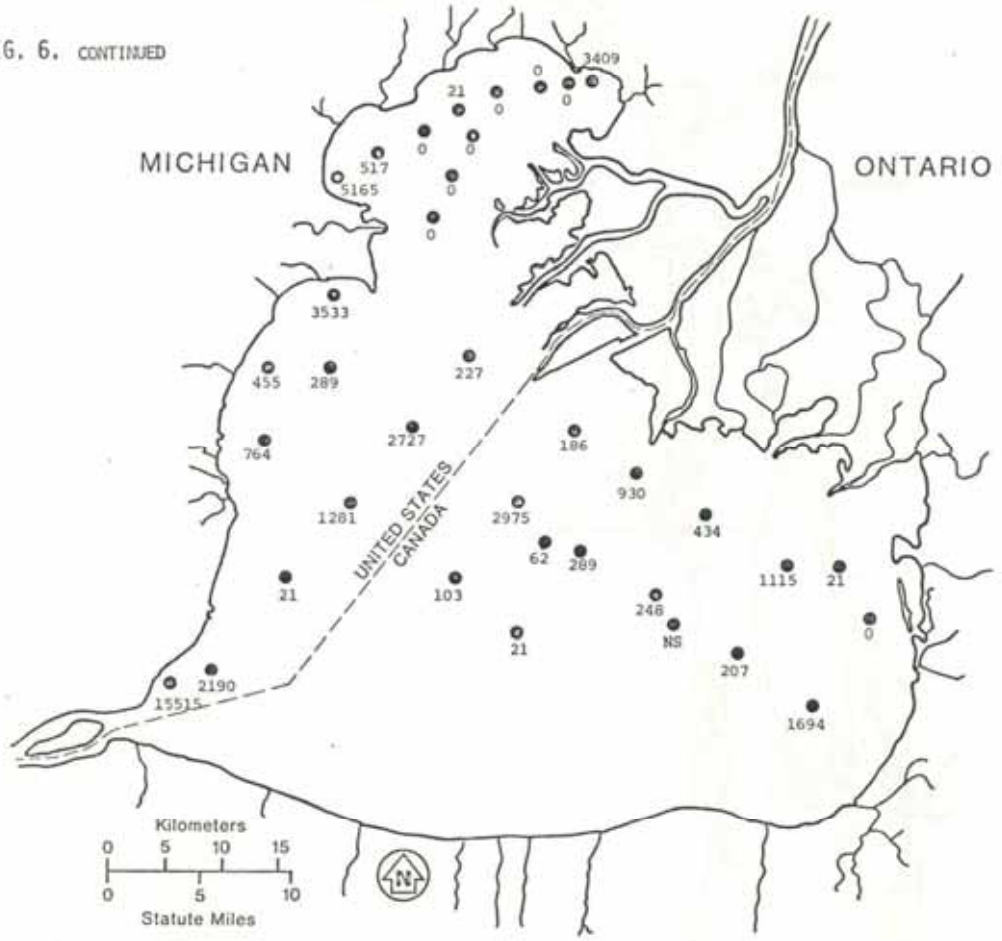


Figure 6. Distribution and density (mean number per square meter) of Polychaeta (Manayunkia speciosa) in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

FIG. 6. CONTINUED



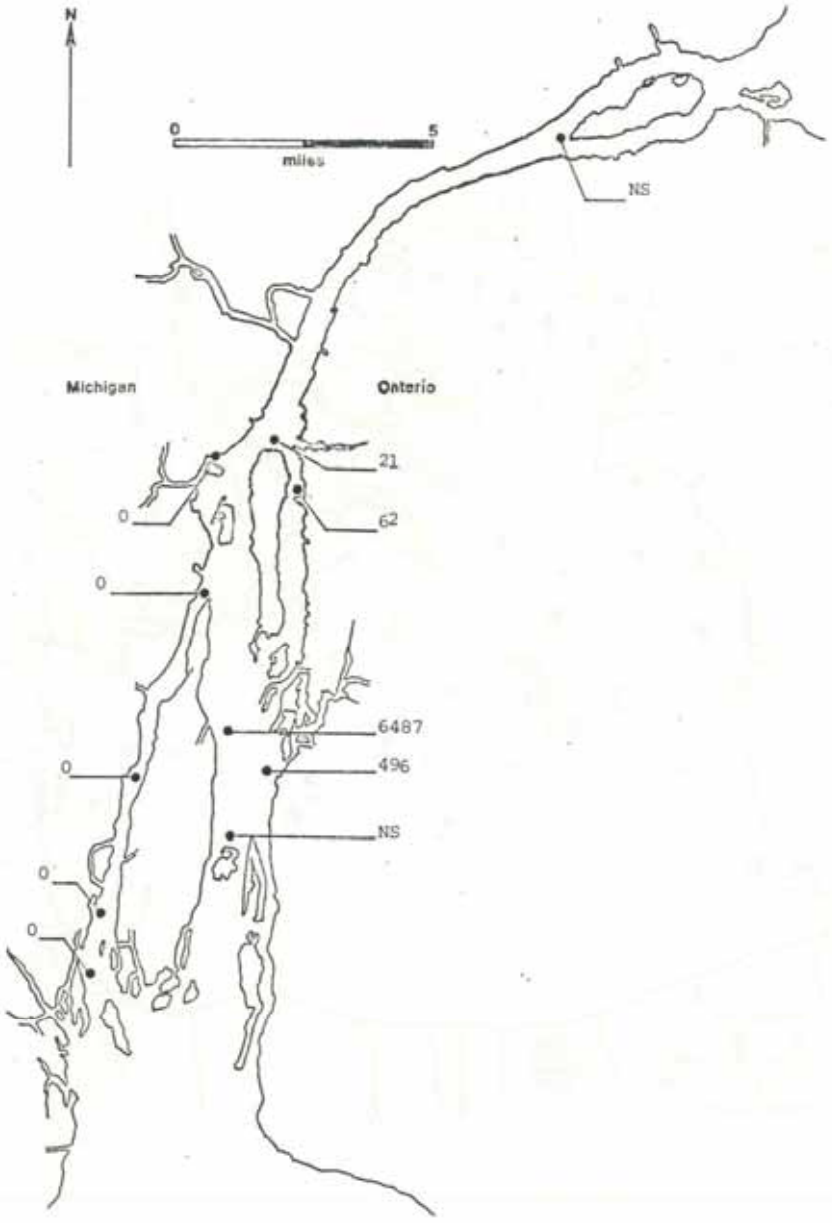
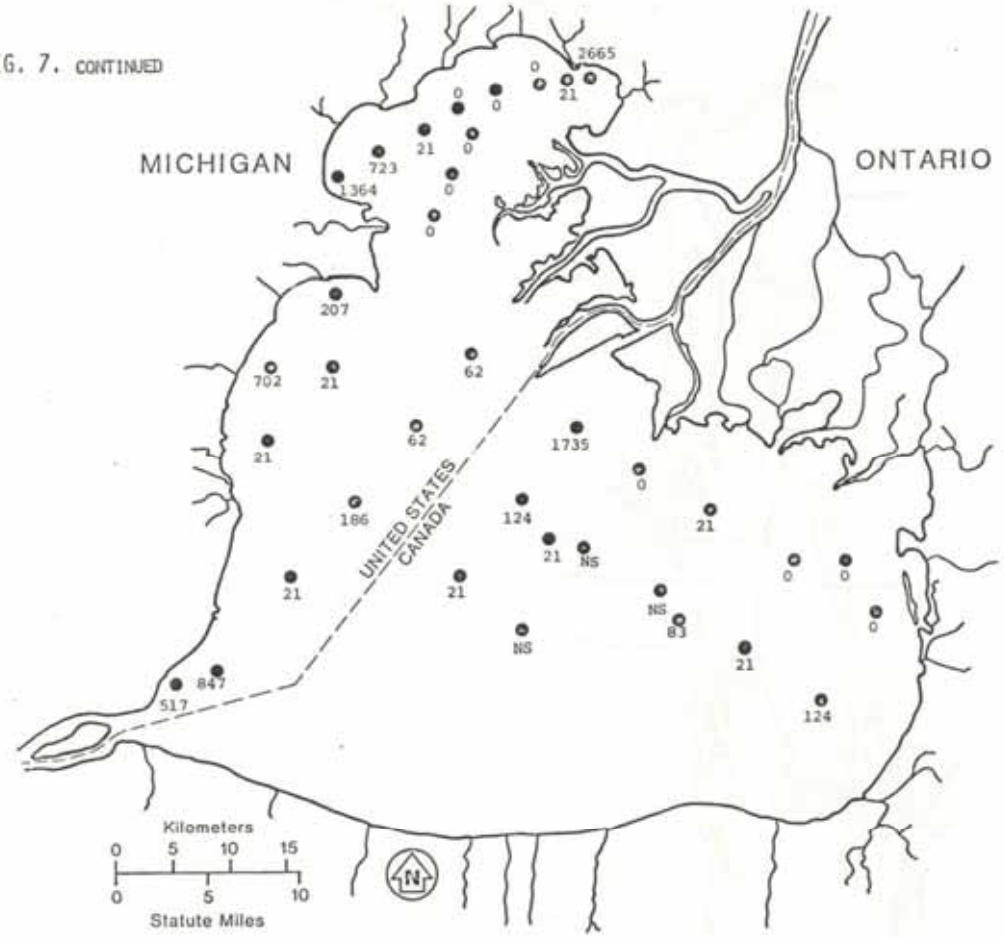


Figure 7. Distribution and density (mean number per square meter) of Polychaeta (Manayunkia speciosa) in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 7. CONTINUED



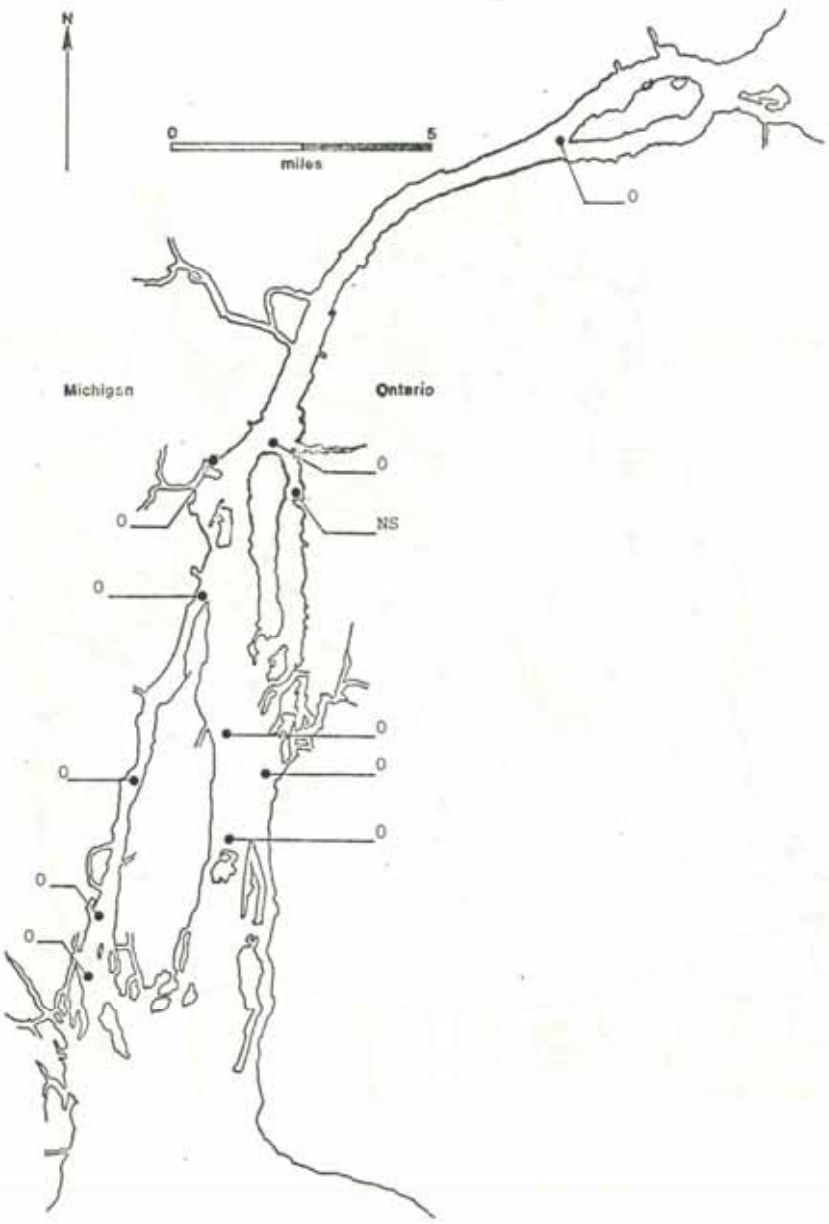
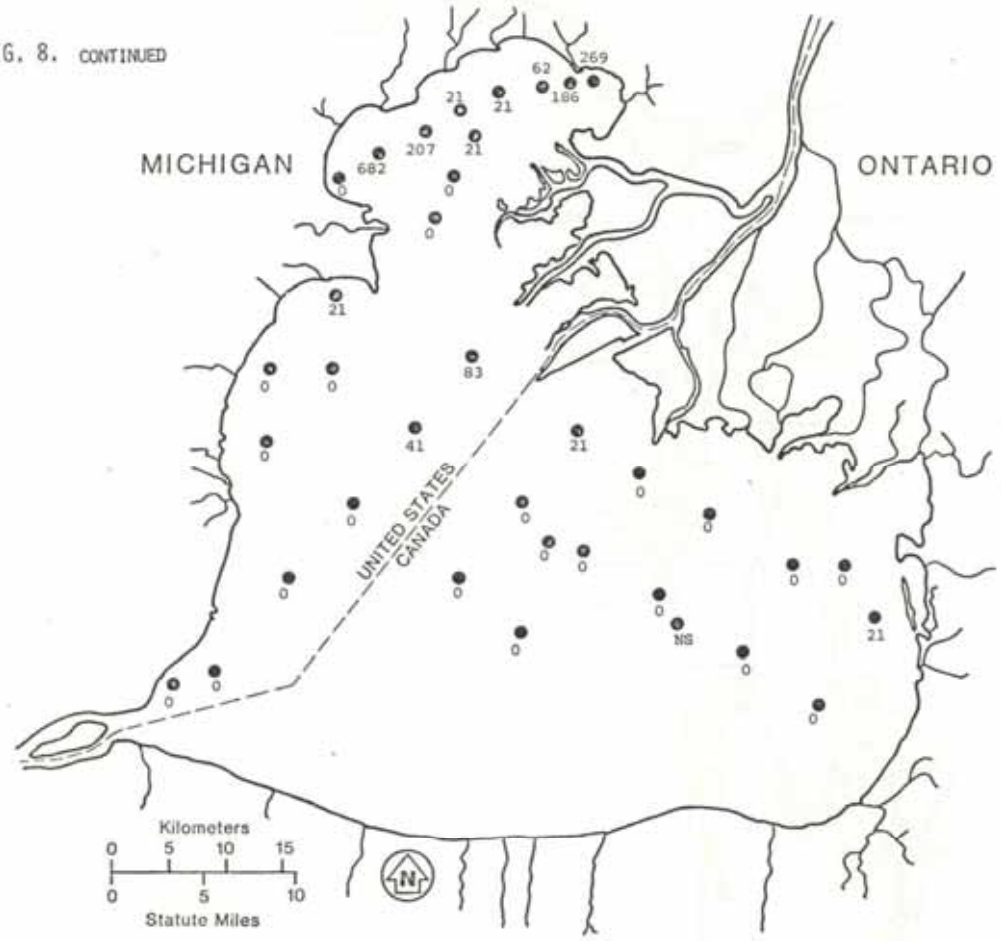


Figure 8. Distribution and density (mean number per square meter) of Hyalella azteca in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

FIG. 8. CONTINUED



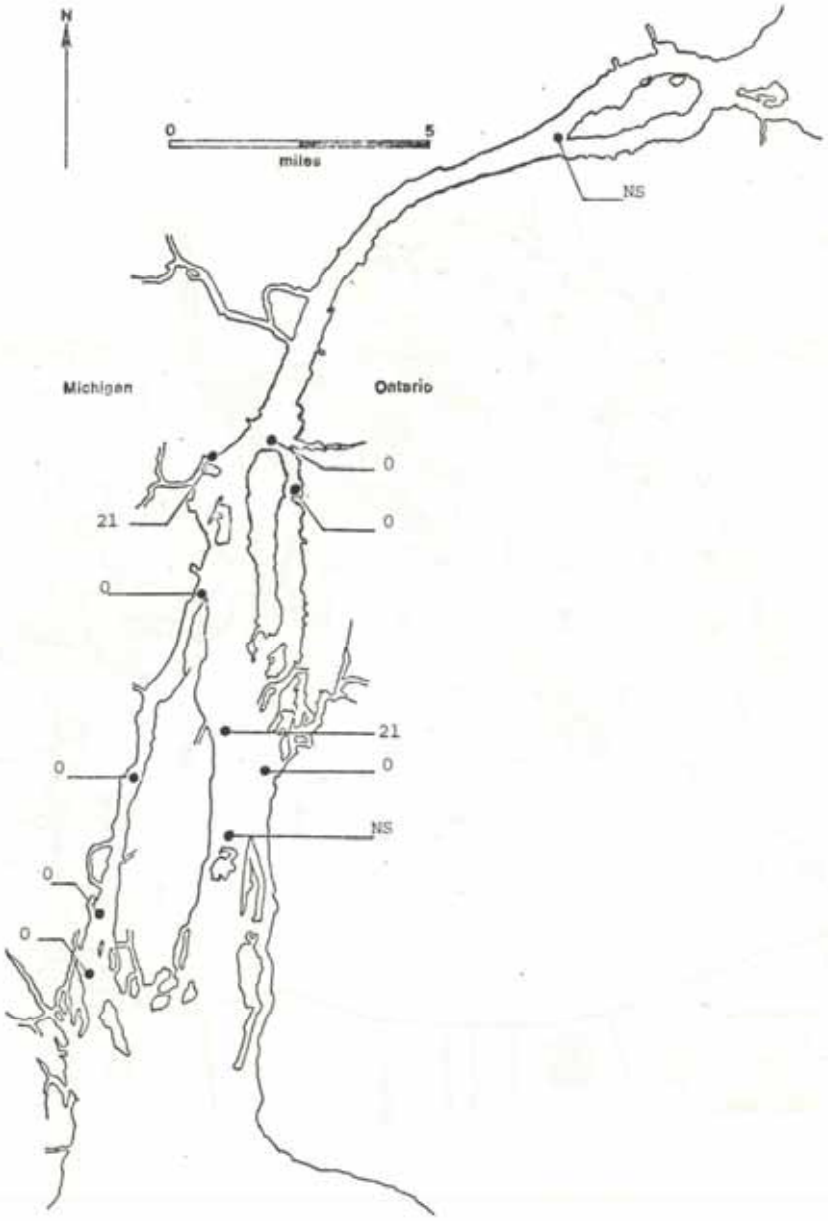
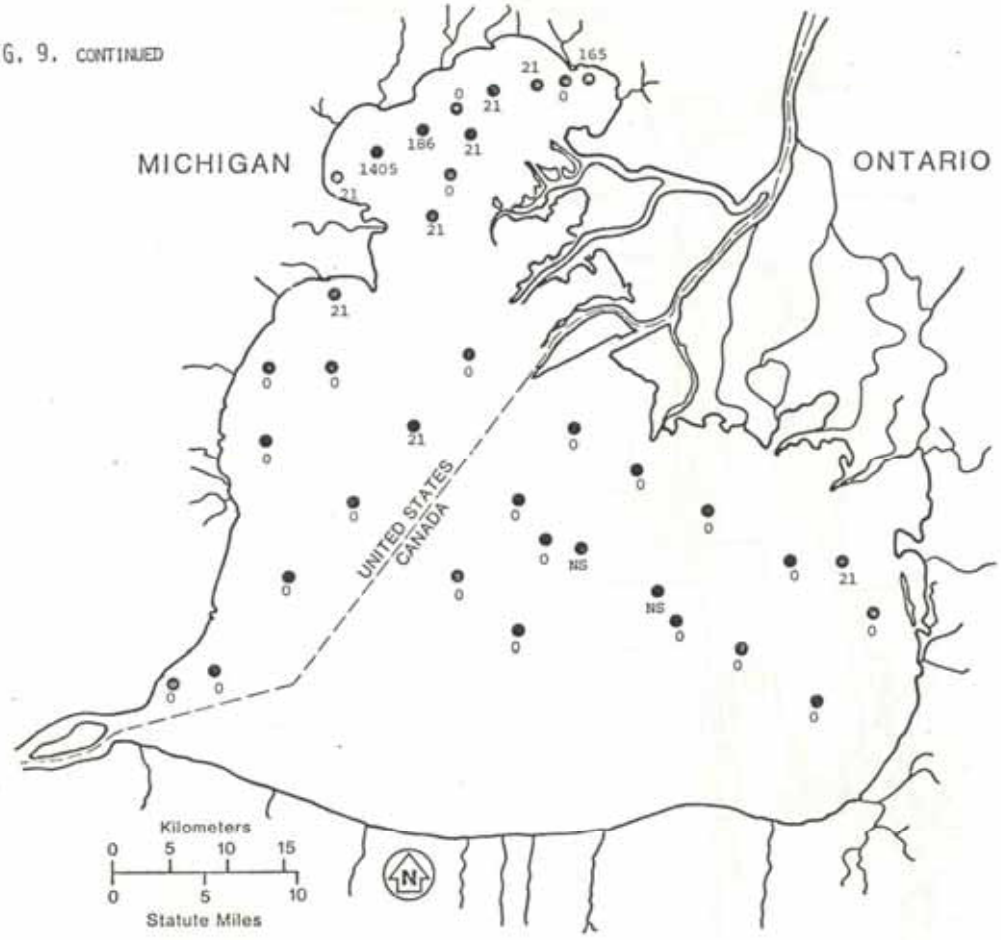


Figure 9. Distribution and density (mean number per square meter) of Hyalella azteca in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 9. CONTINUED



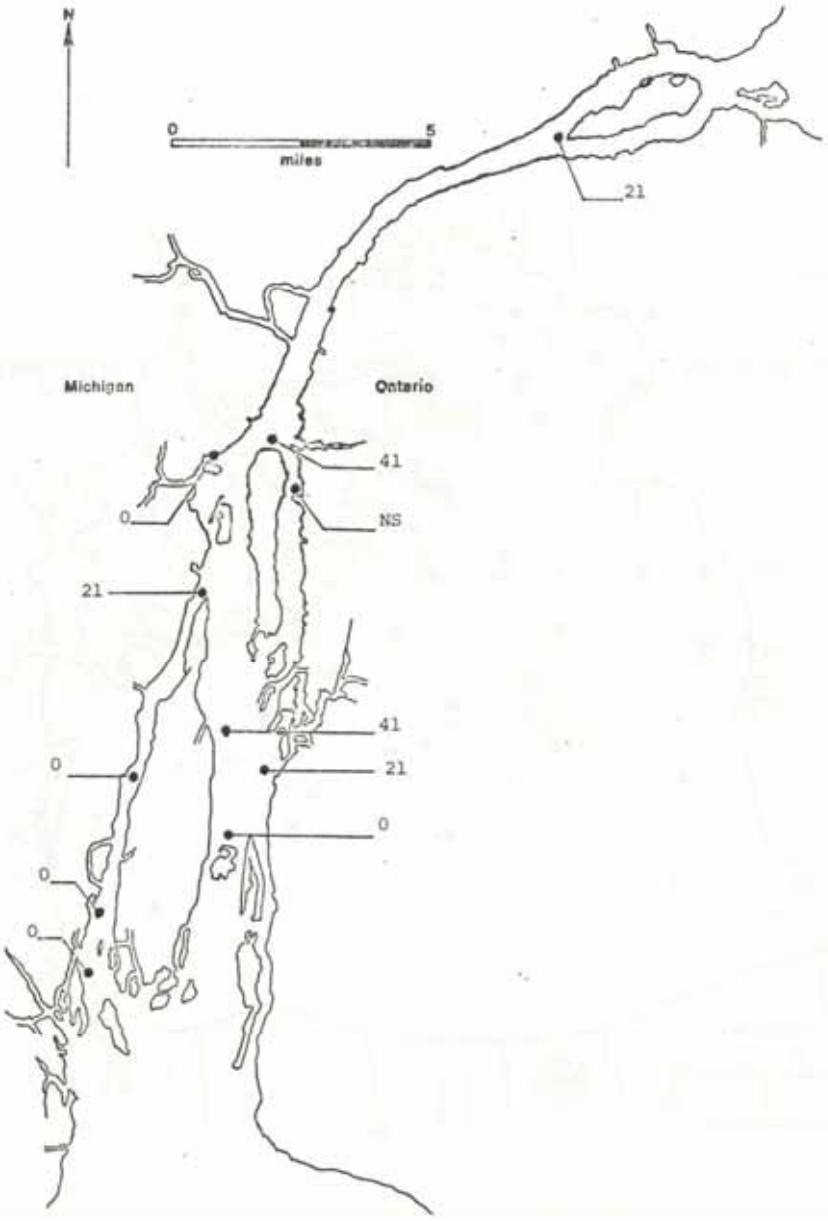
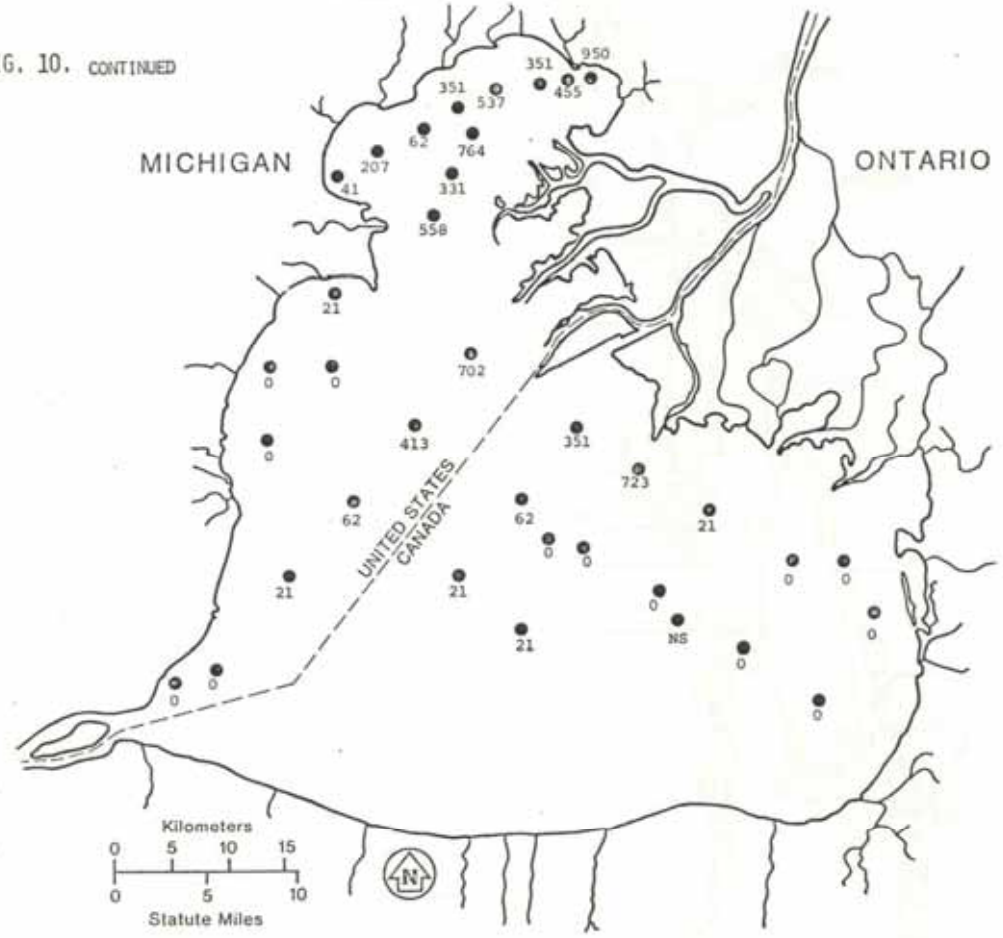


Figure 10. Distribution and density (mean number per square meter) of Gammarus in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

FIG. 10. CONTINUED



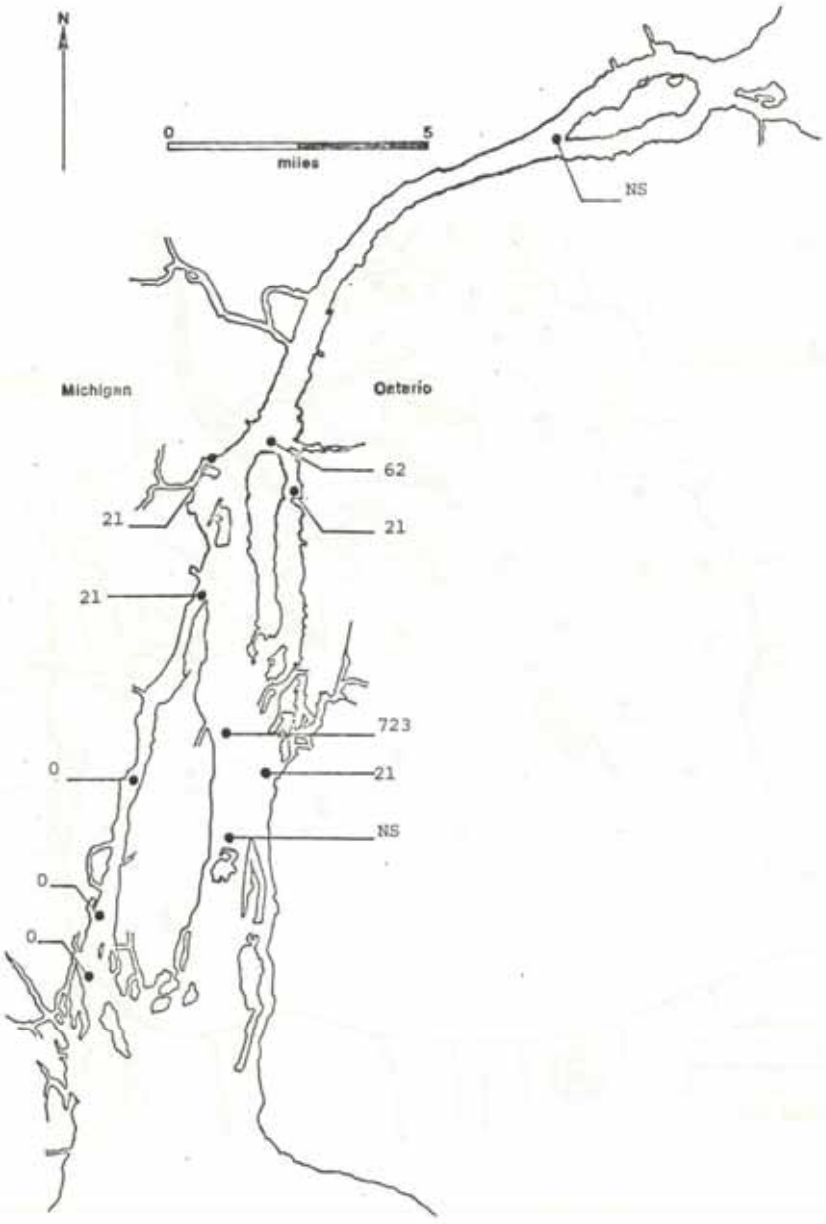
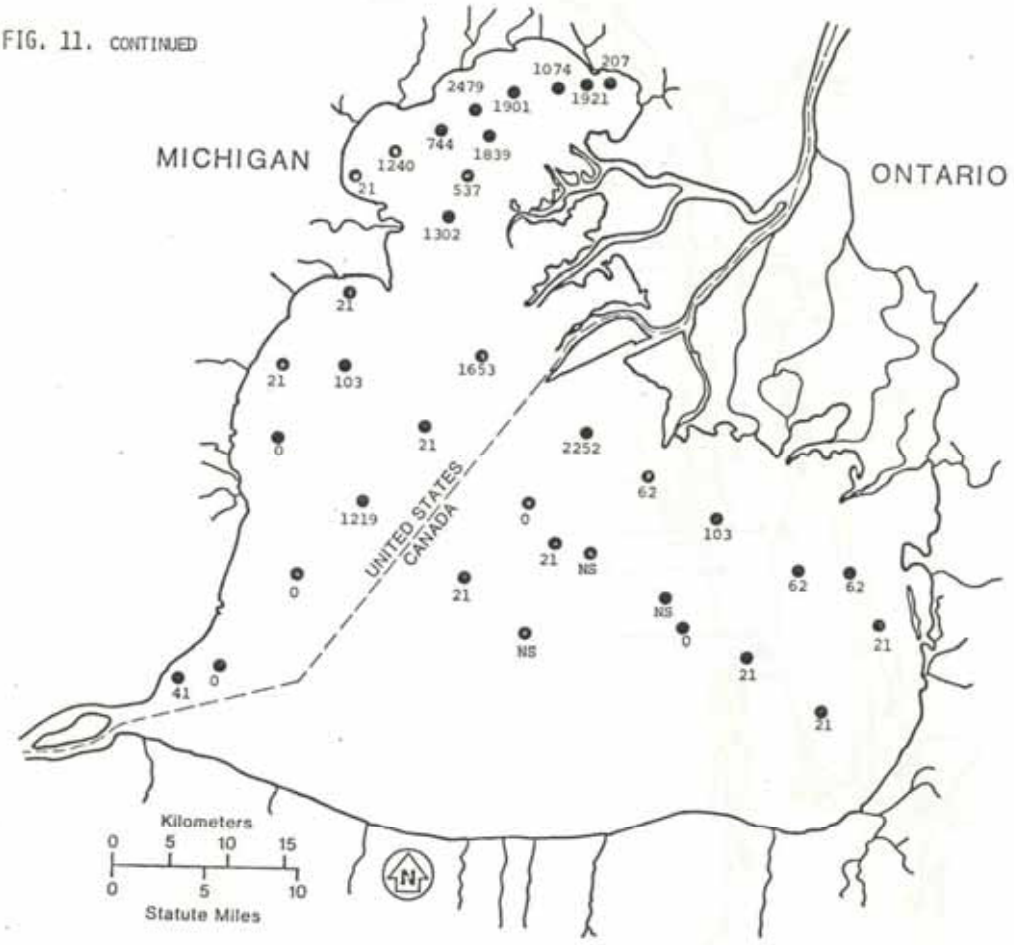


Figure 11. Distribution and density (mean number per square meter) of Gammarus in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 11. CONTINUED



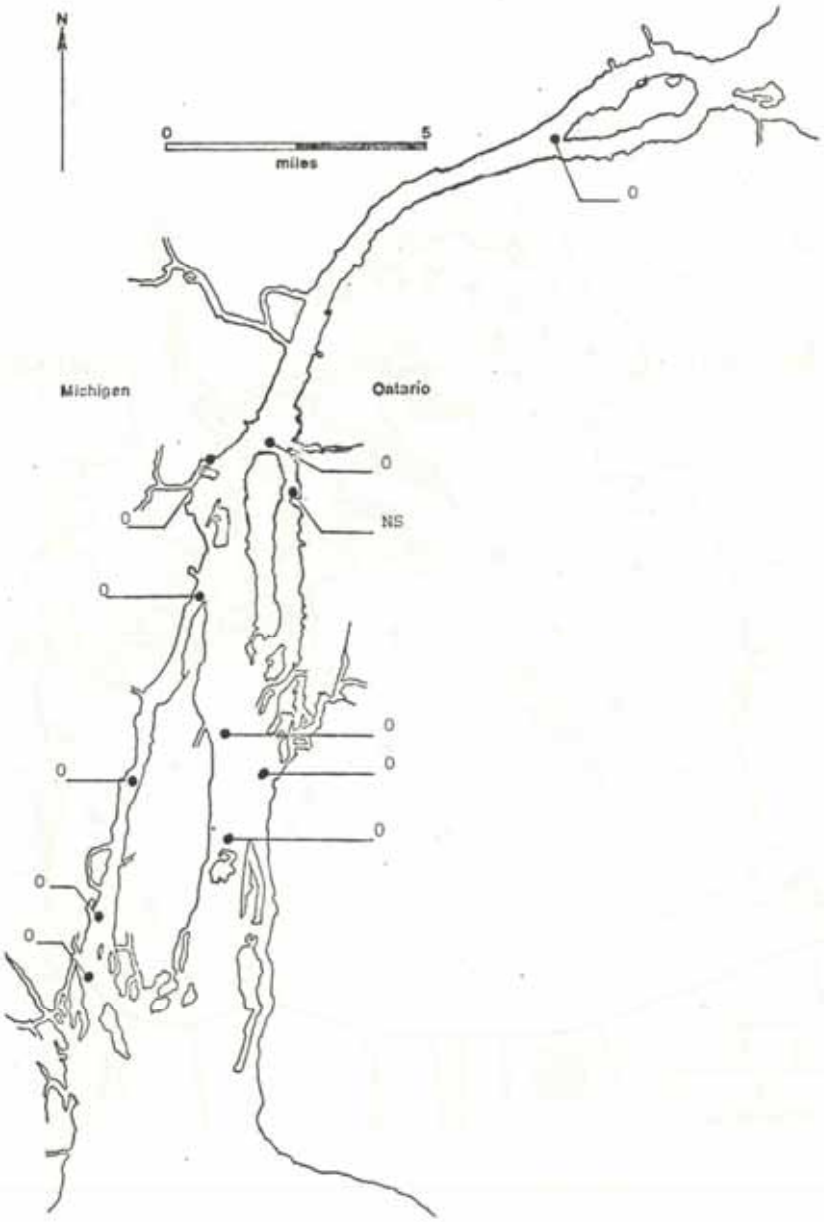
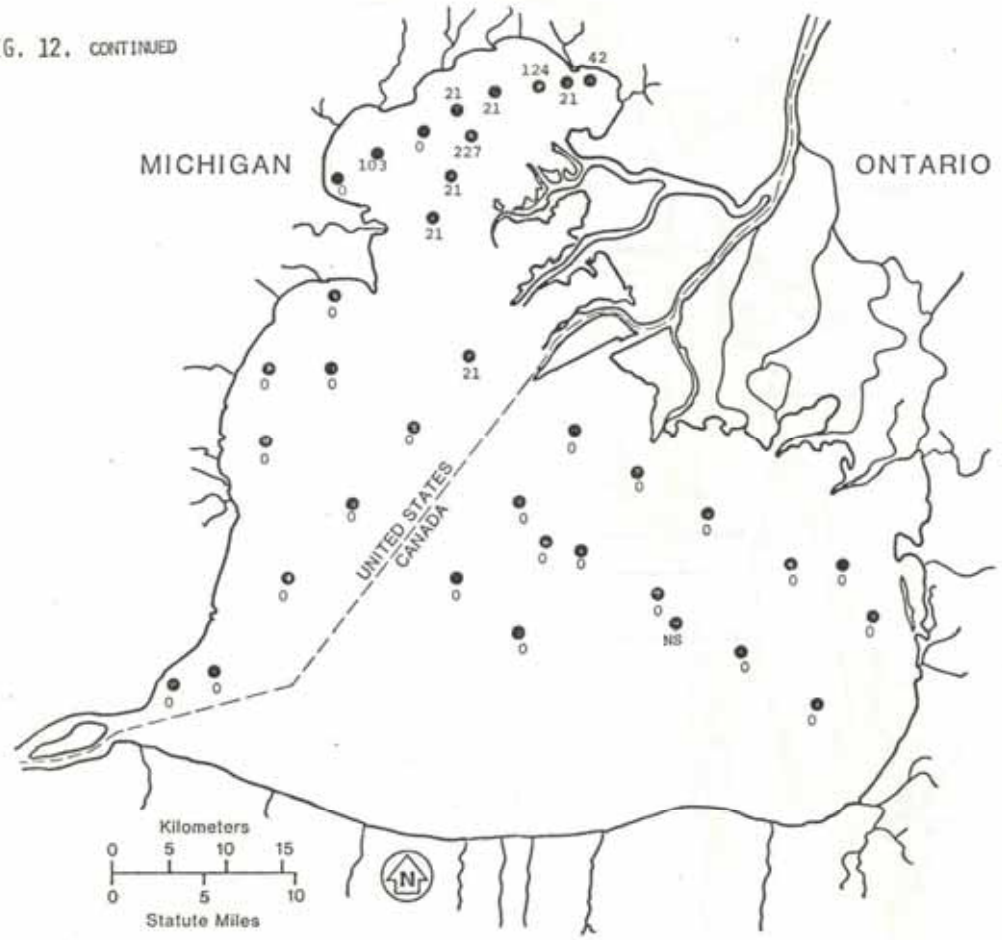


Figure 12. Distribution and density (mean number per square meter) of Asellus in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

FIG. 12. CONTINUED



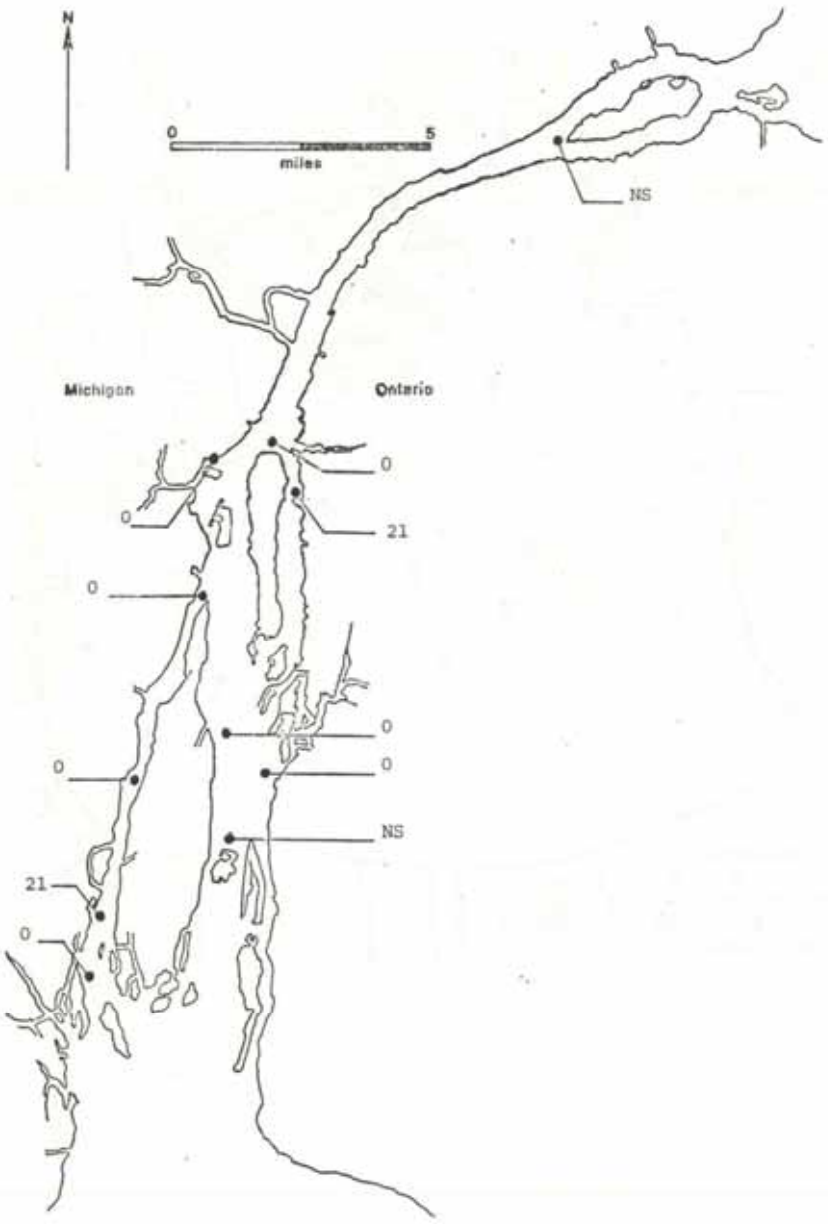
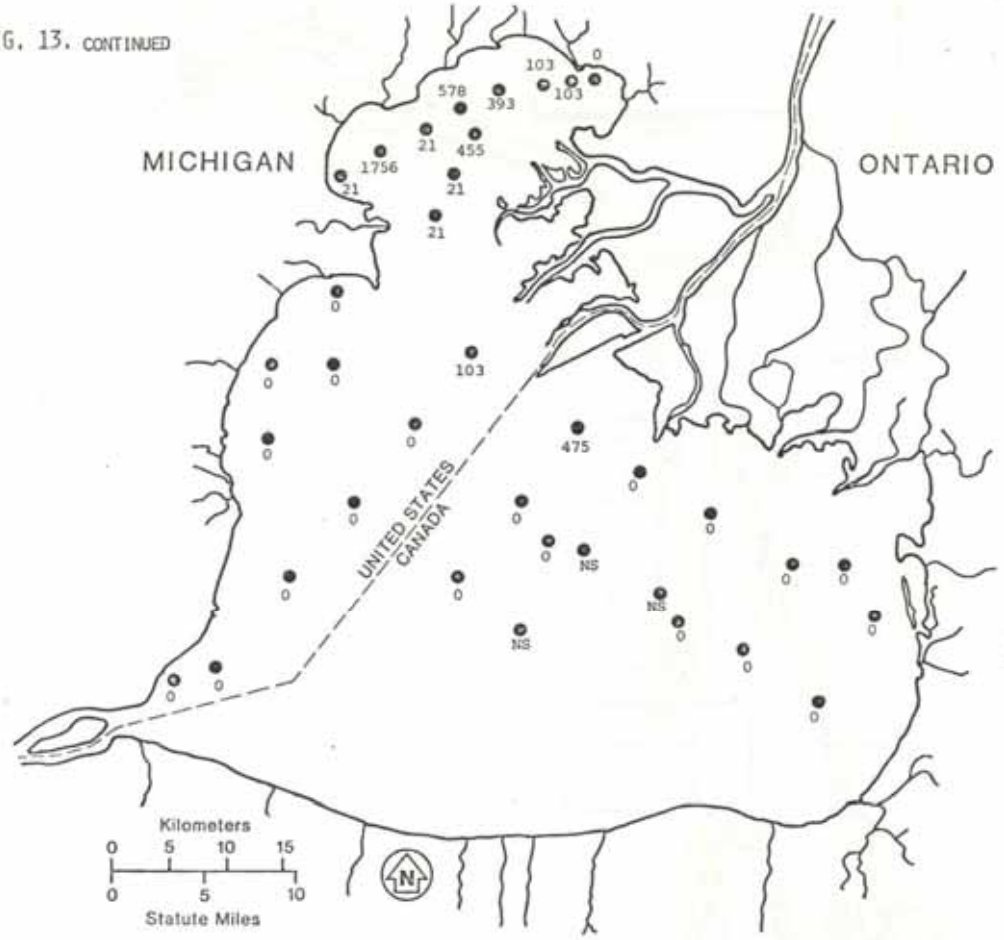


Figure 13. Distribution and density (mean number per square meter) of Asellus in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 13. CONTINUED



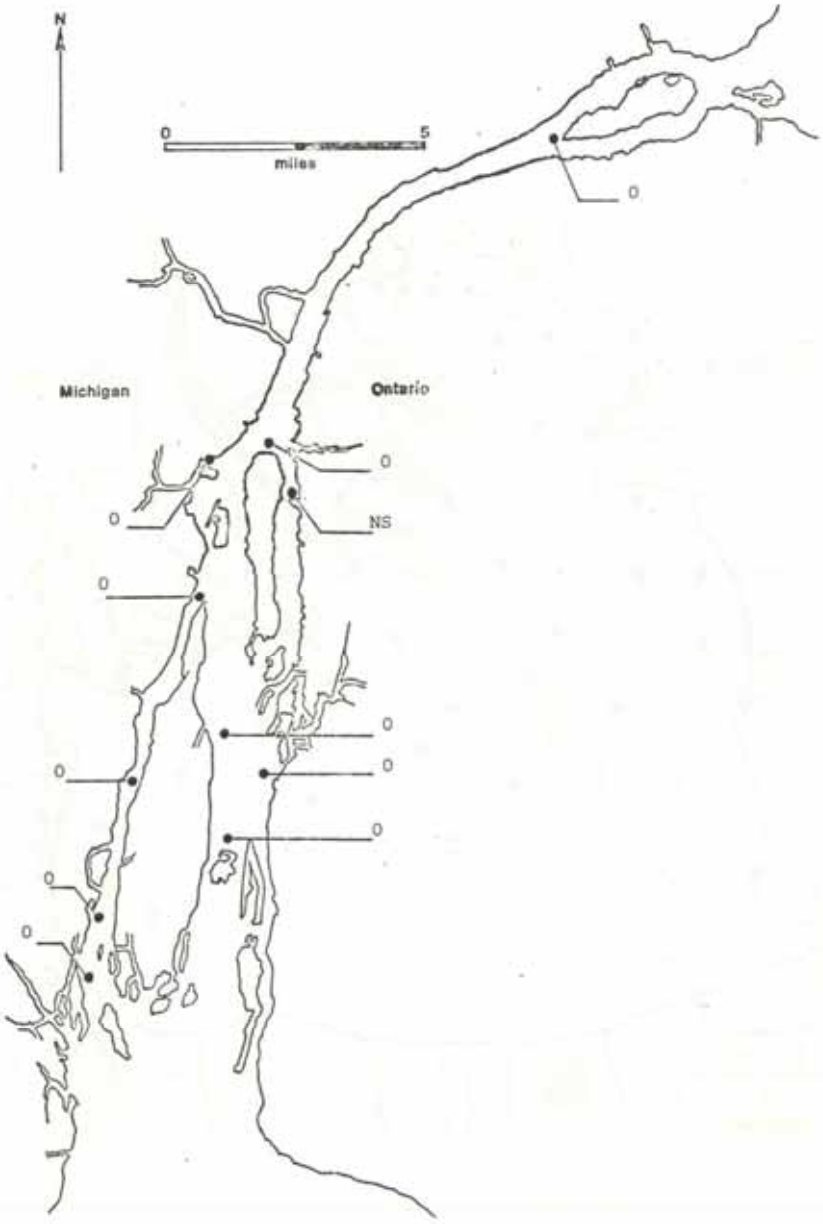
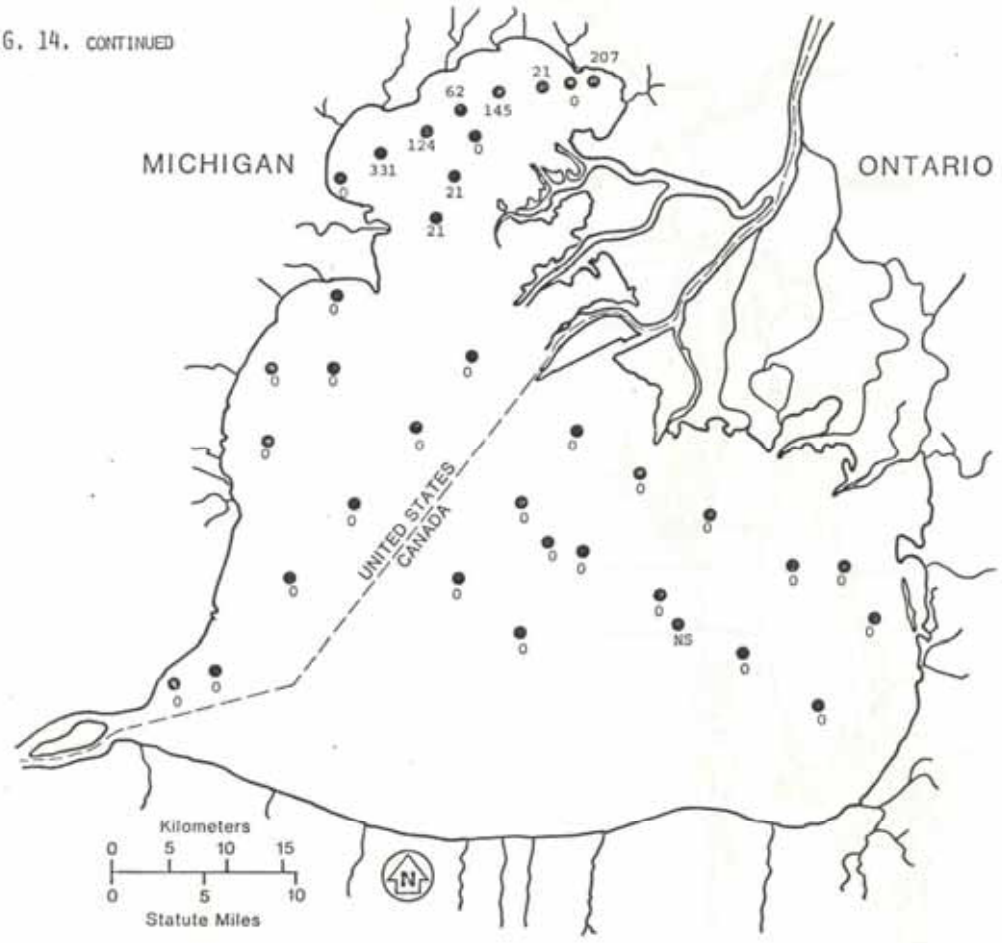


Figure 14. Distribution and density (mean number per square meter) of Lirceus in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

FIG. 14. CONTINUED



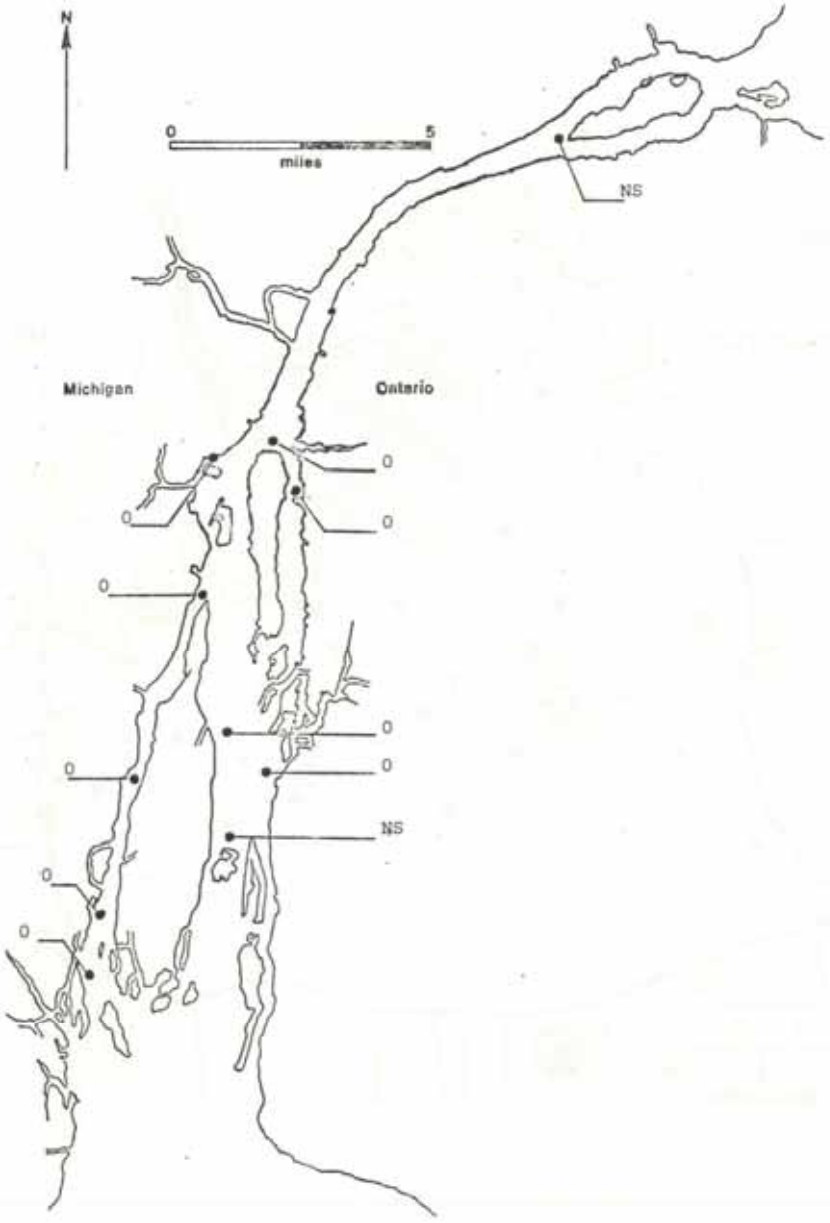
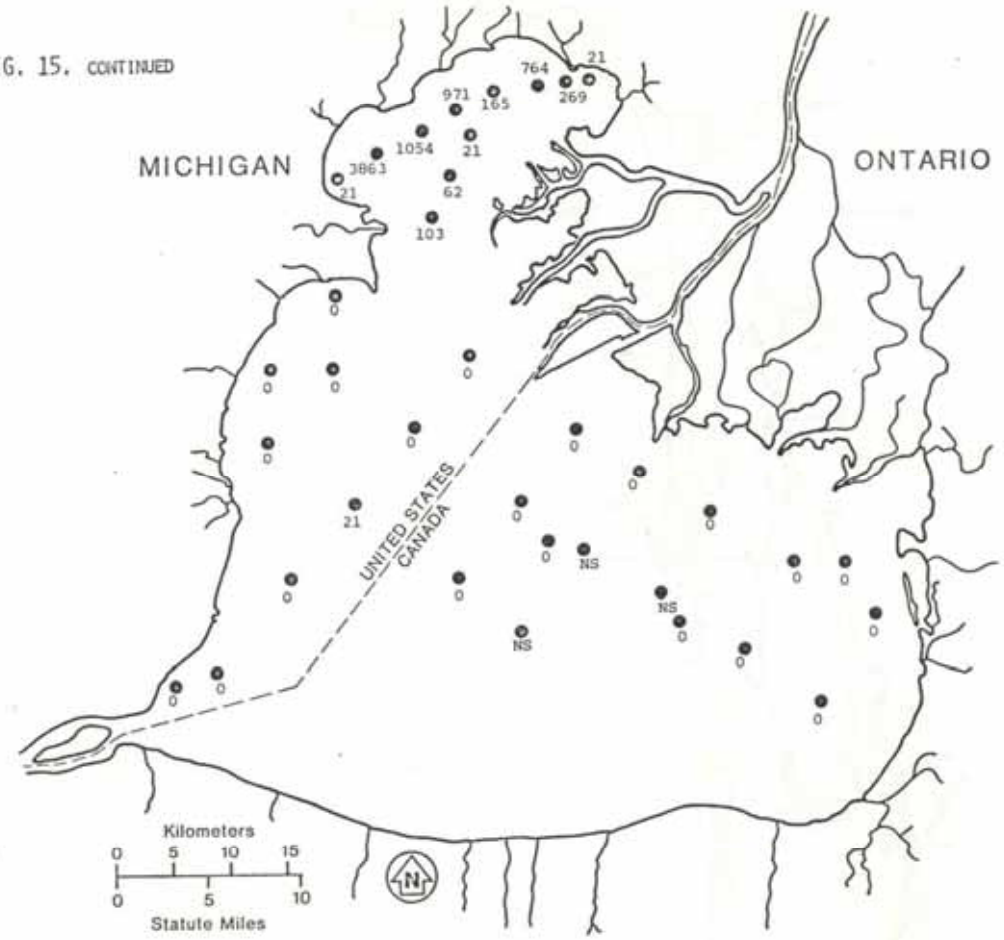


Figure 15. Distribution and density (mean number per square meter) of Lirceus in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 15. CONTINUED



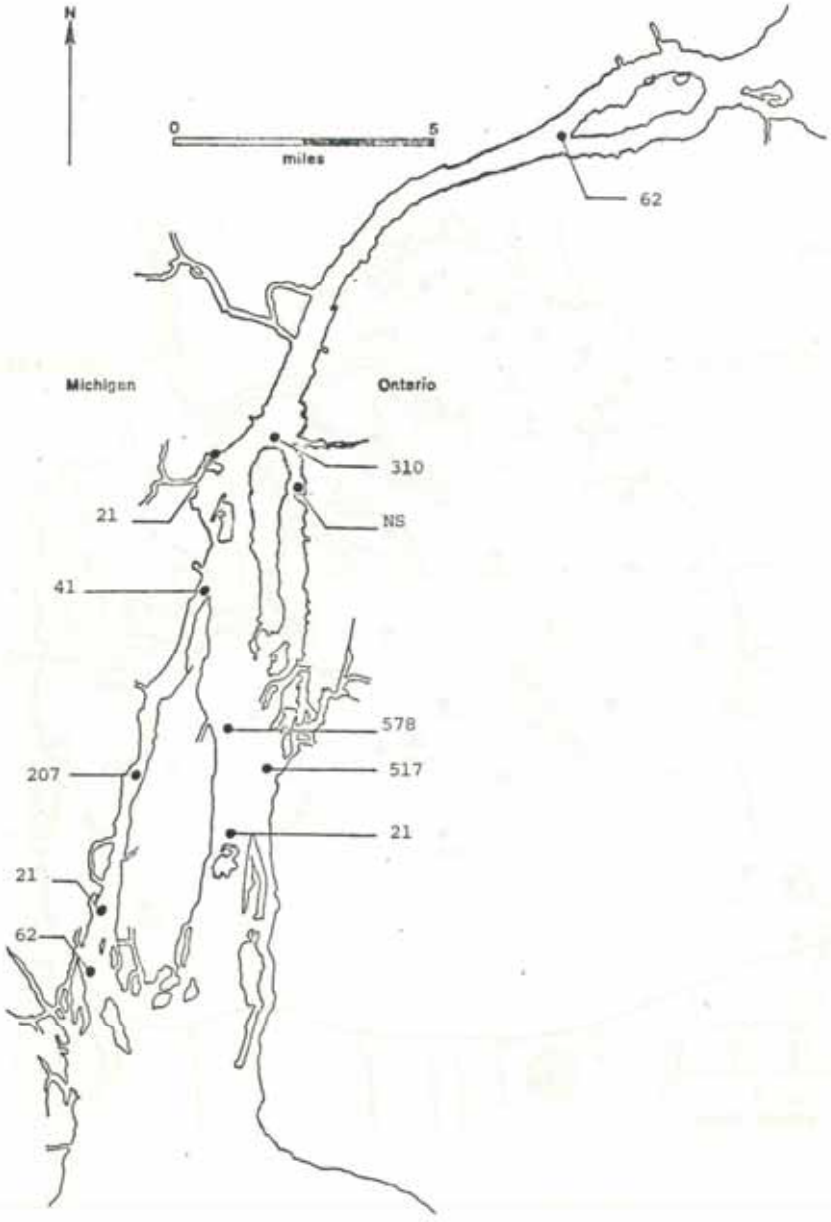
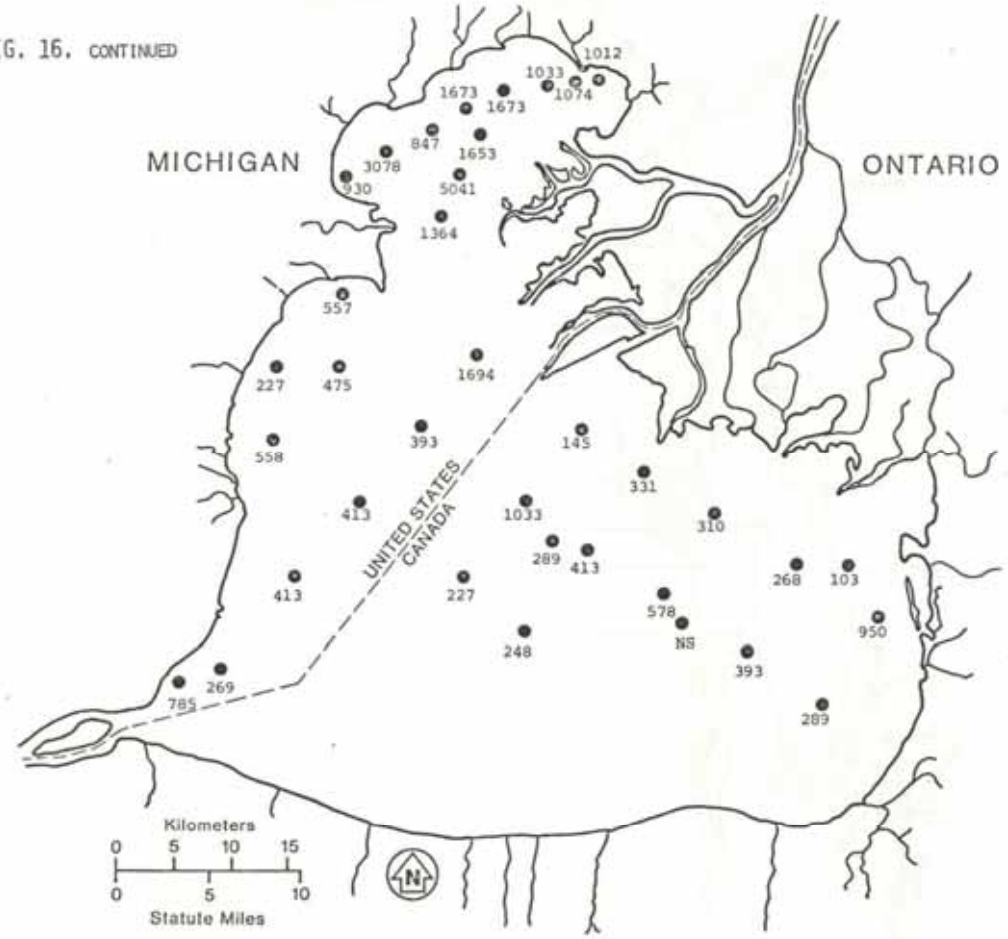


Figure 16. Distribution and density (mean number per square meter) of Chironomidae in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

FIG. 16. CONTINUED



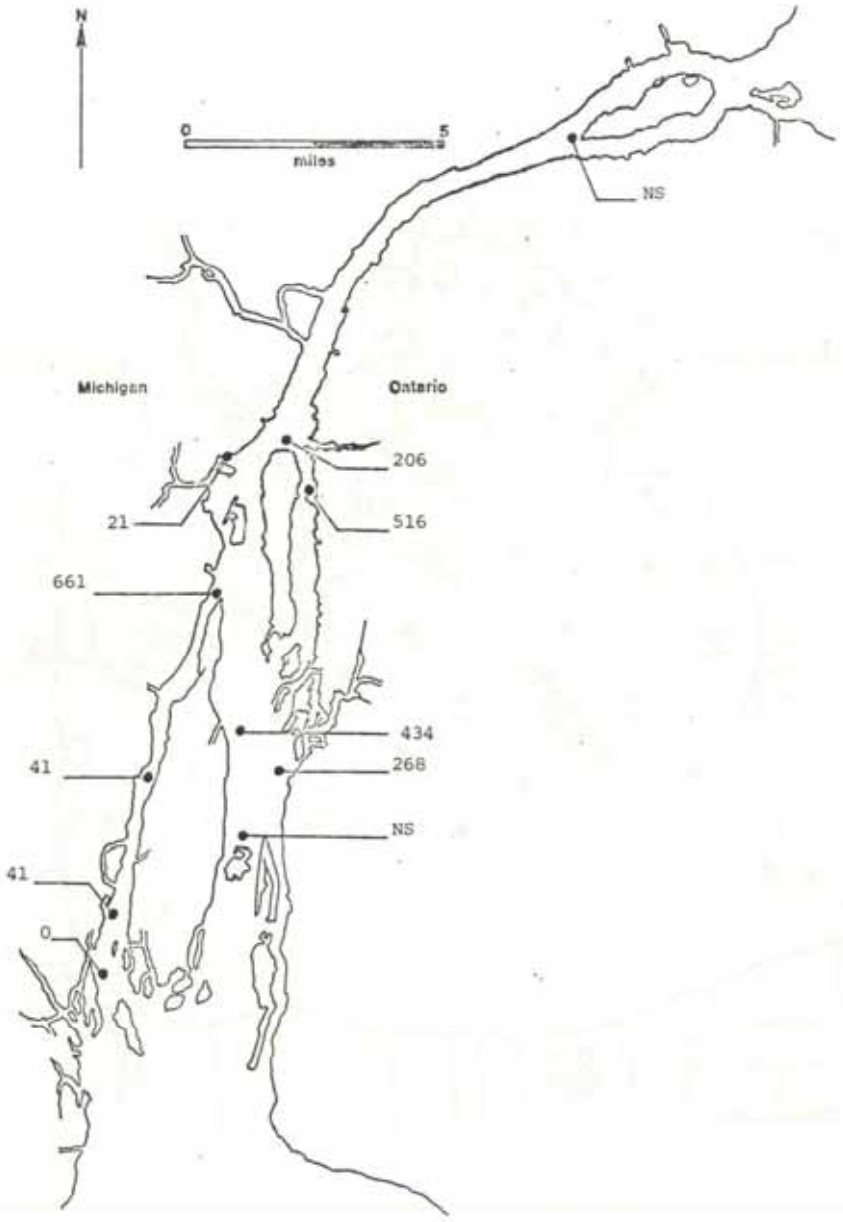
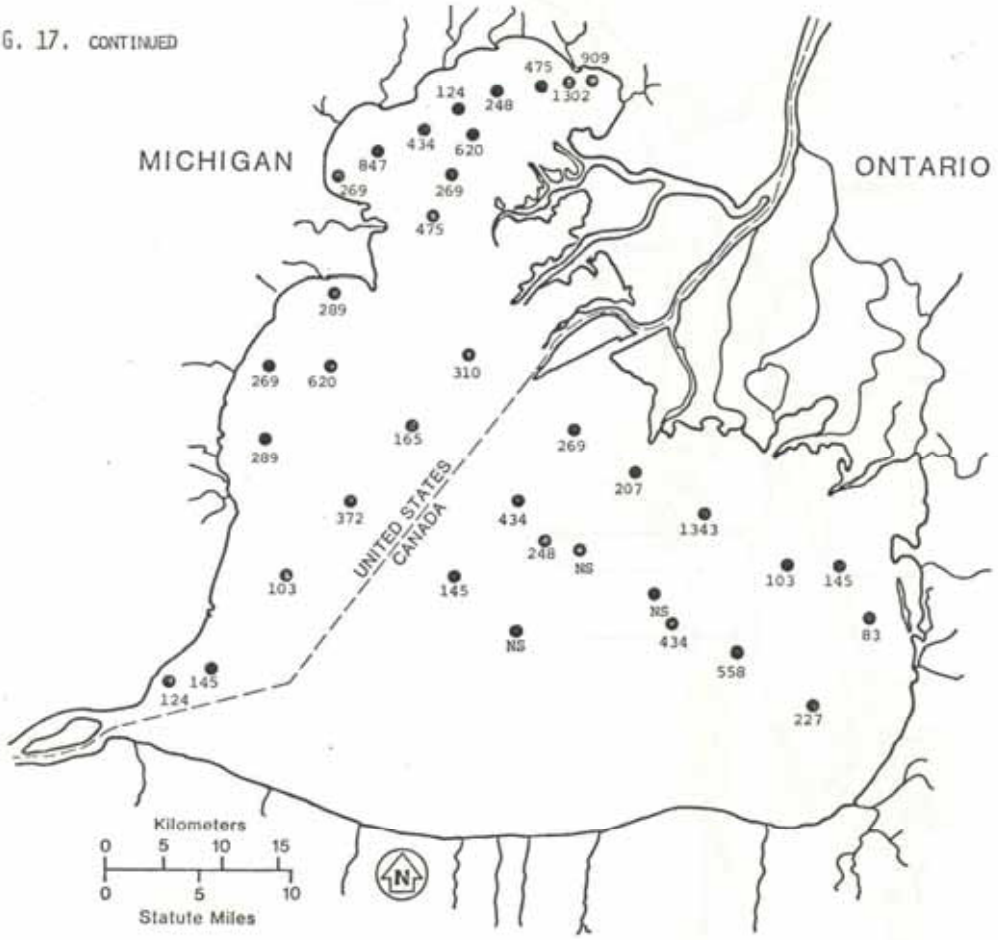


Figure 17. Distribution and density (mean number per square meter) of Chironomidae in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 17. CONTINUED



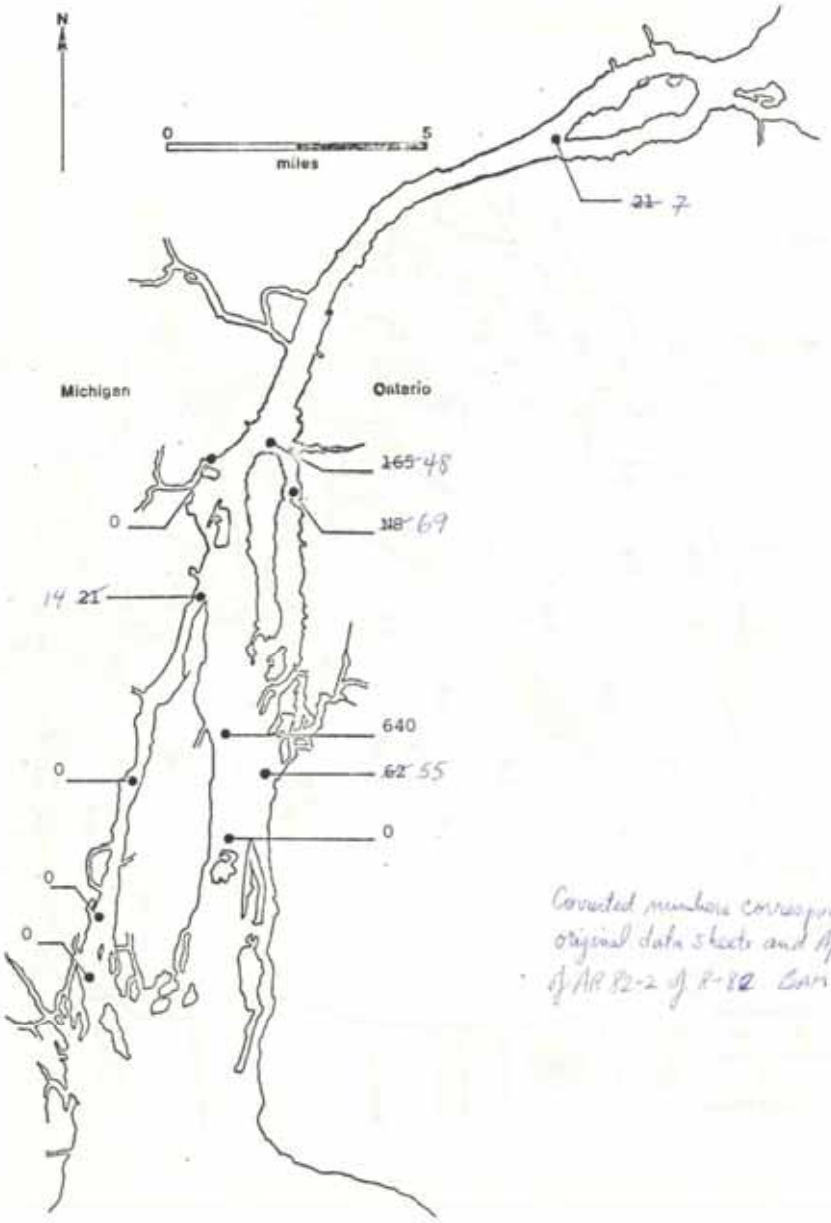
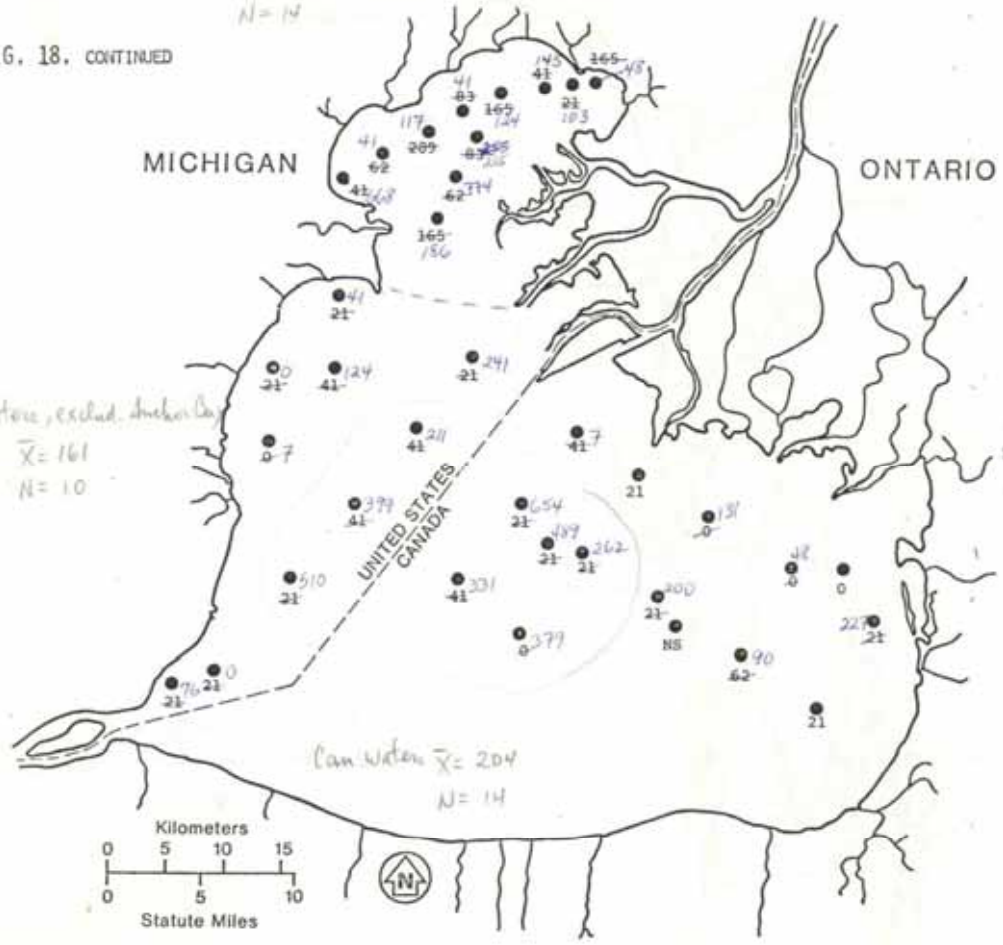


Figure 18. Distribution and density (mean number per square meter) of Ephemeroptera in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

Ephemeroptera, April 1977

FIG. 18. CONTINUED



Whole Lake average = 183 (incl Anchor Bay) 186 (excl Anchor Bay)
N = 38

Center of Lake avg = 404
N = 8

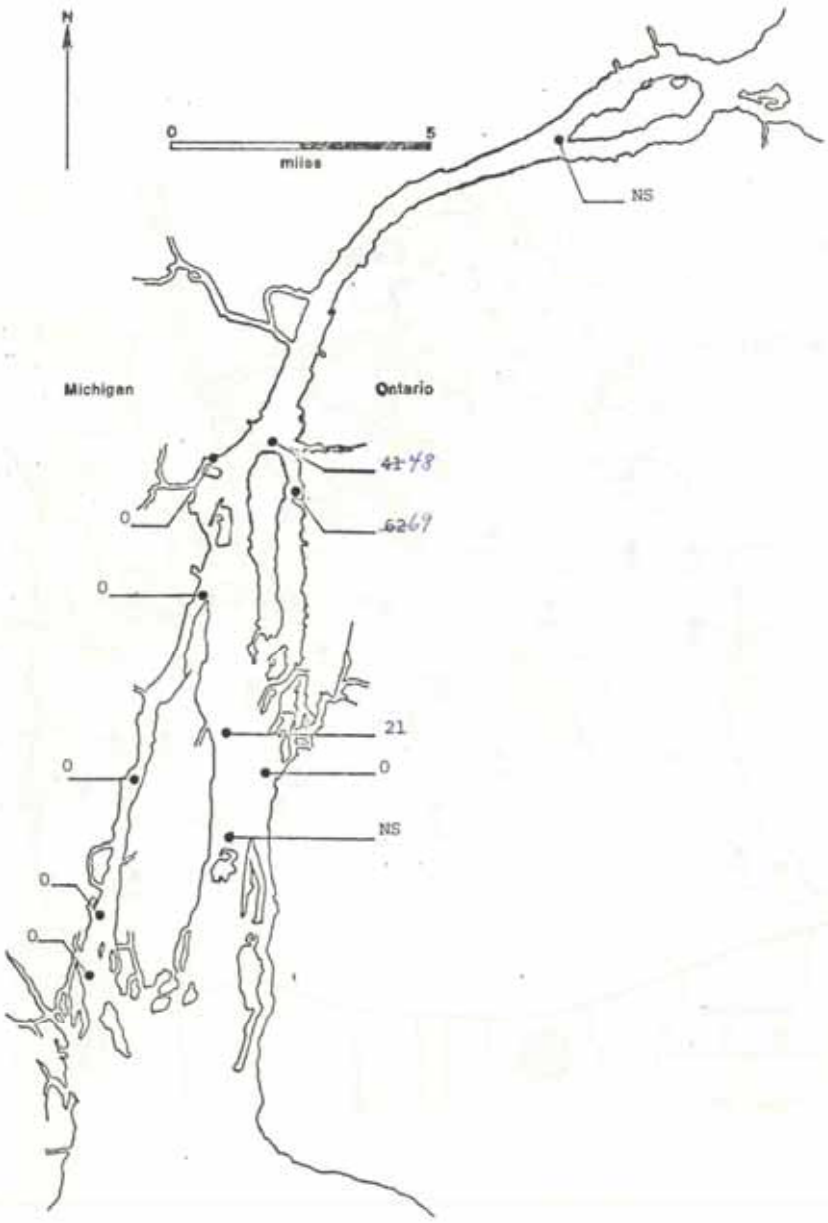
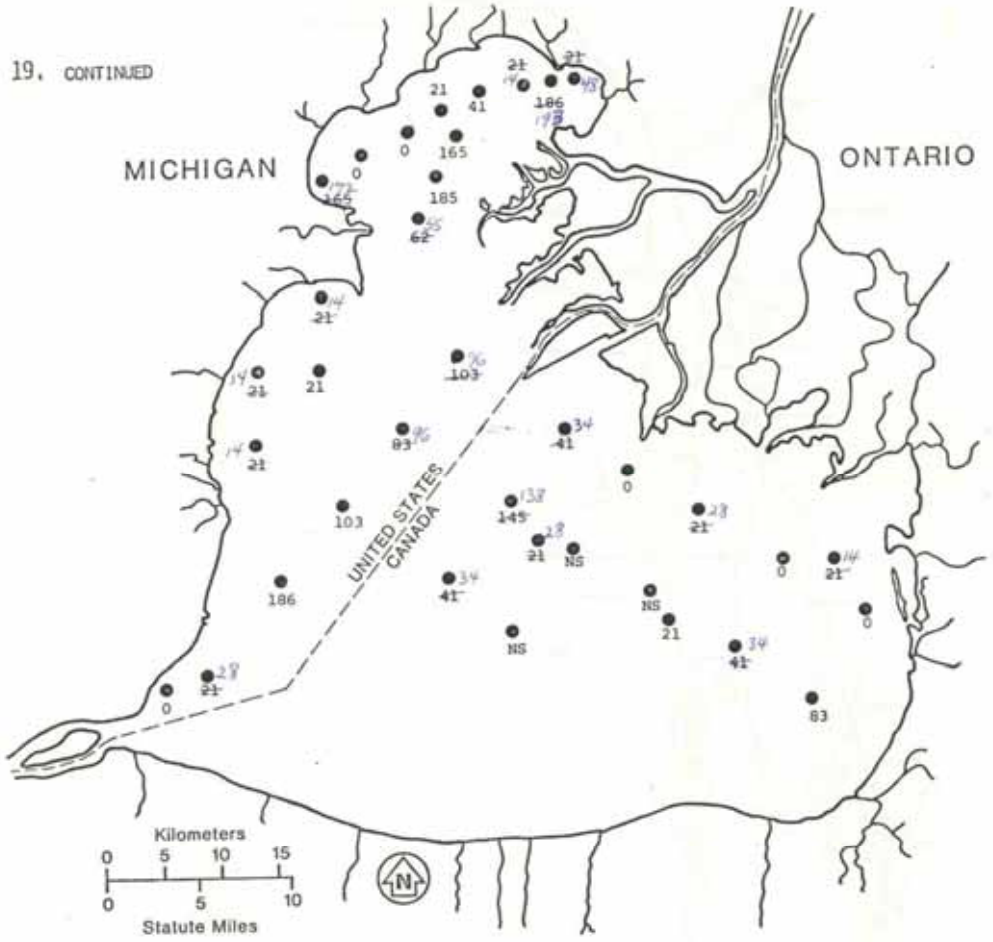


Figure 19. Distribution and density (mean number per square meter) of Ephemeroptera in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 19. CONTINUED



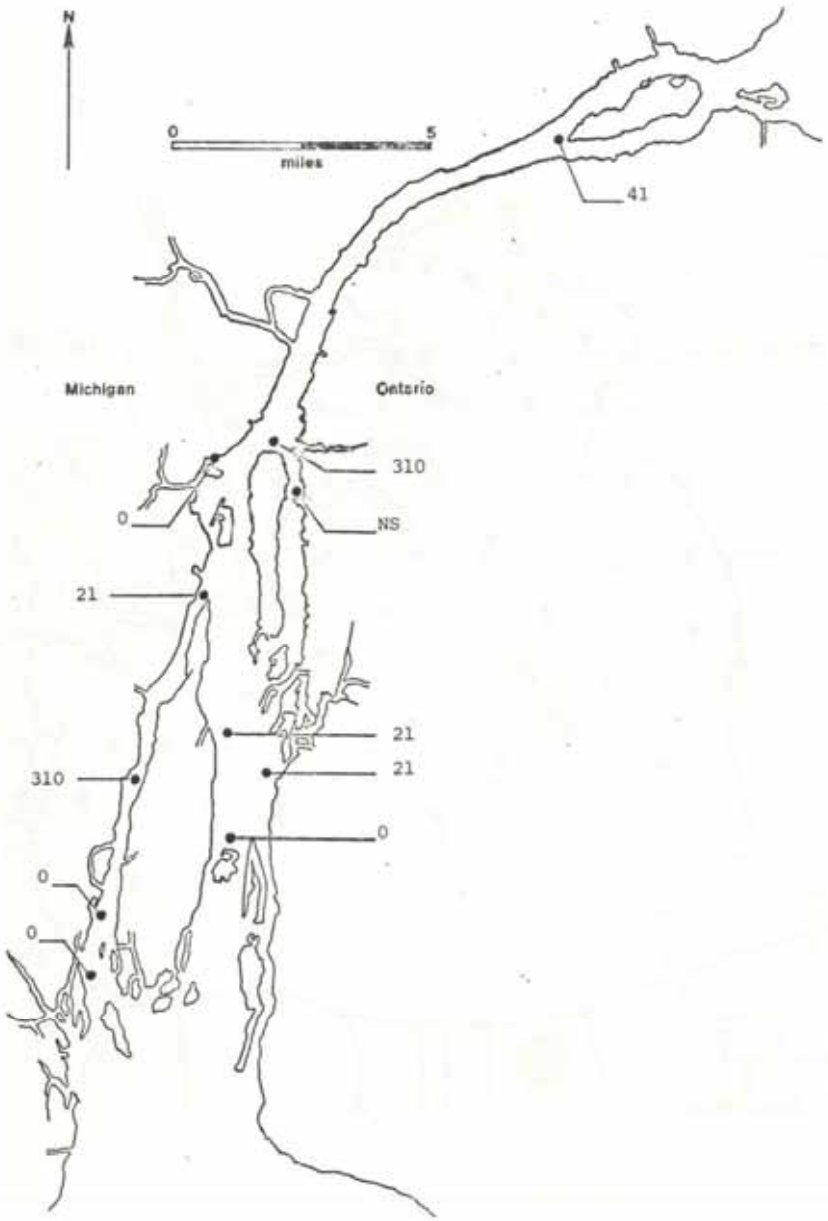
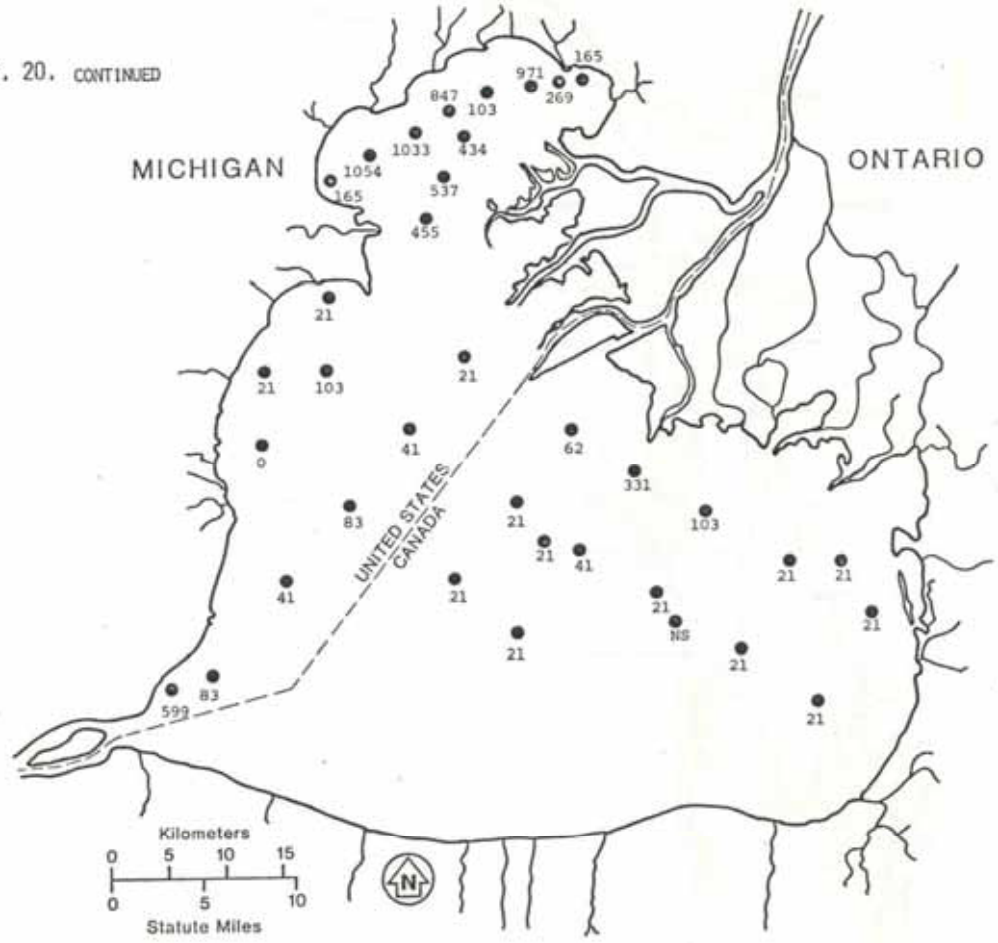


Figure 20. Distribution and density (mean number per square meter) of Gastropoda in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

FIG. 20. CONTINUED



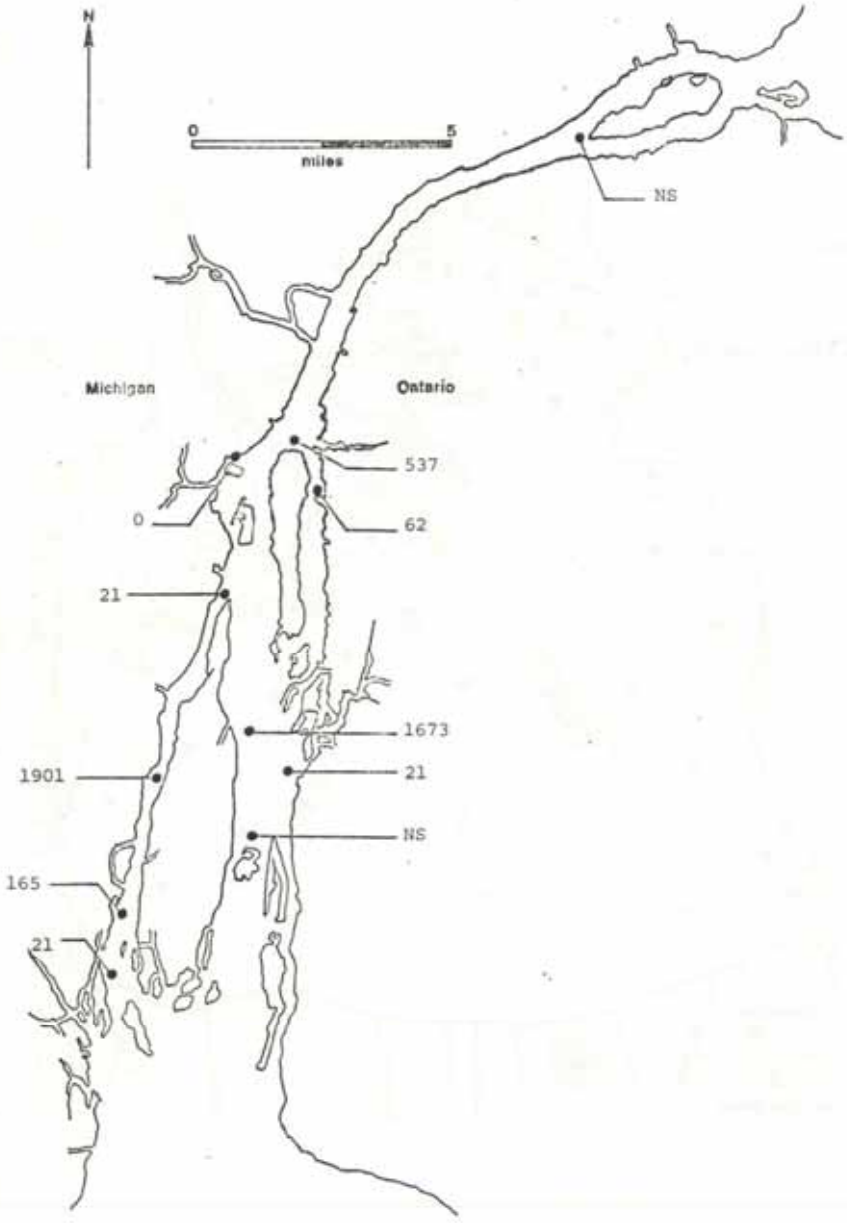
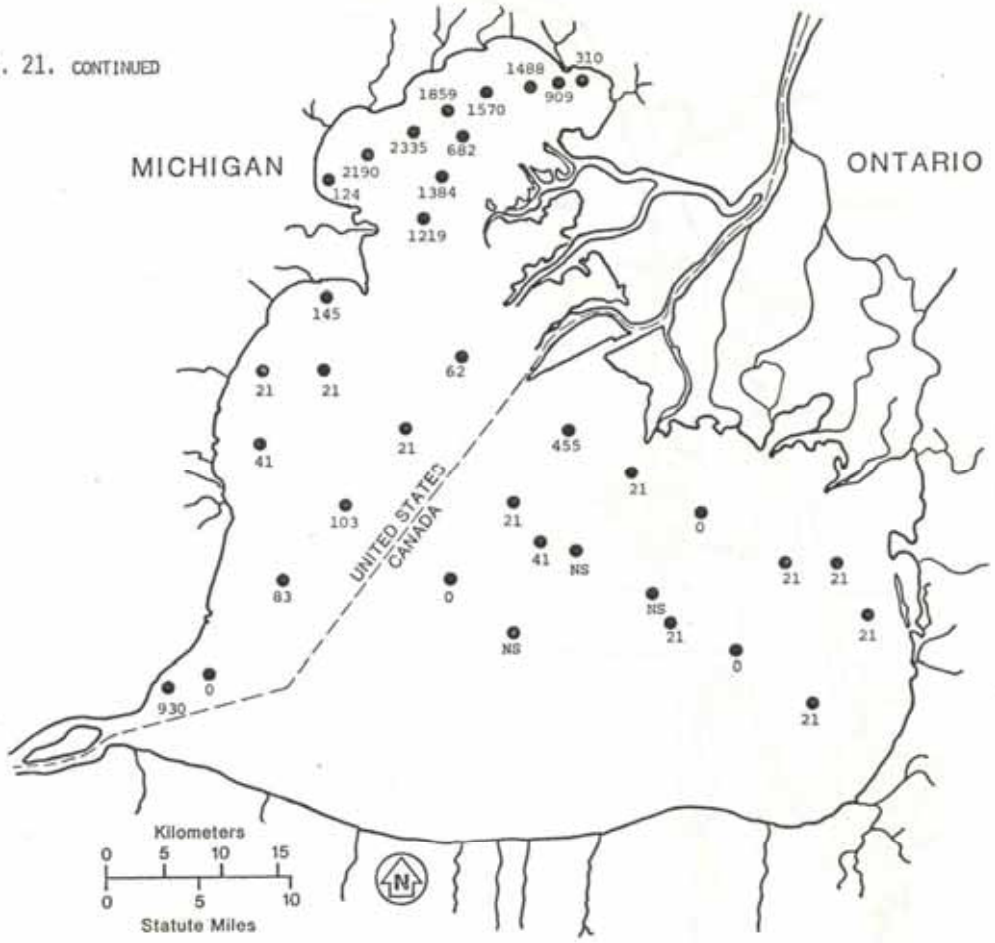


Figure 21. Distribution and density (mean number per square meter) of Gastropoda in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 21. CONTINUED



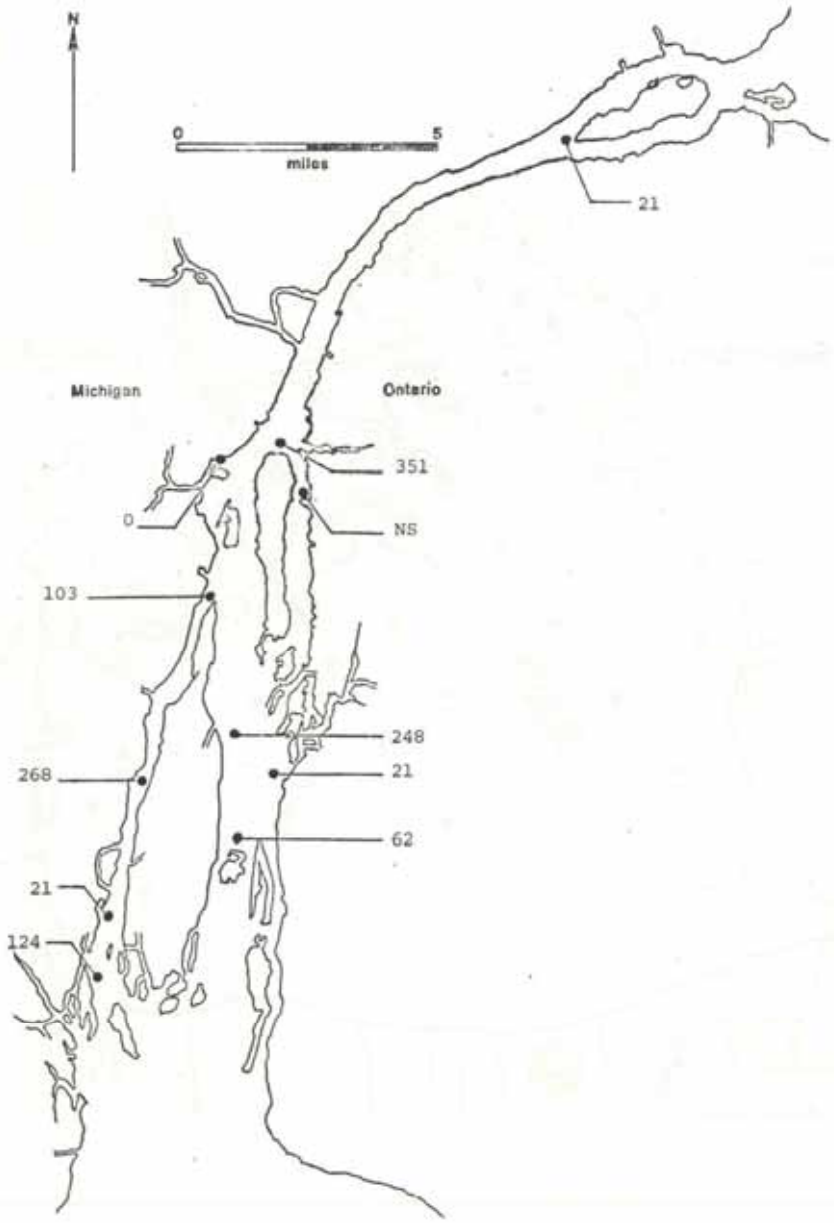
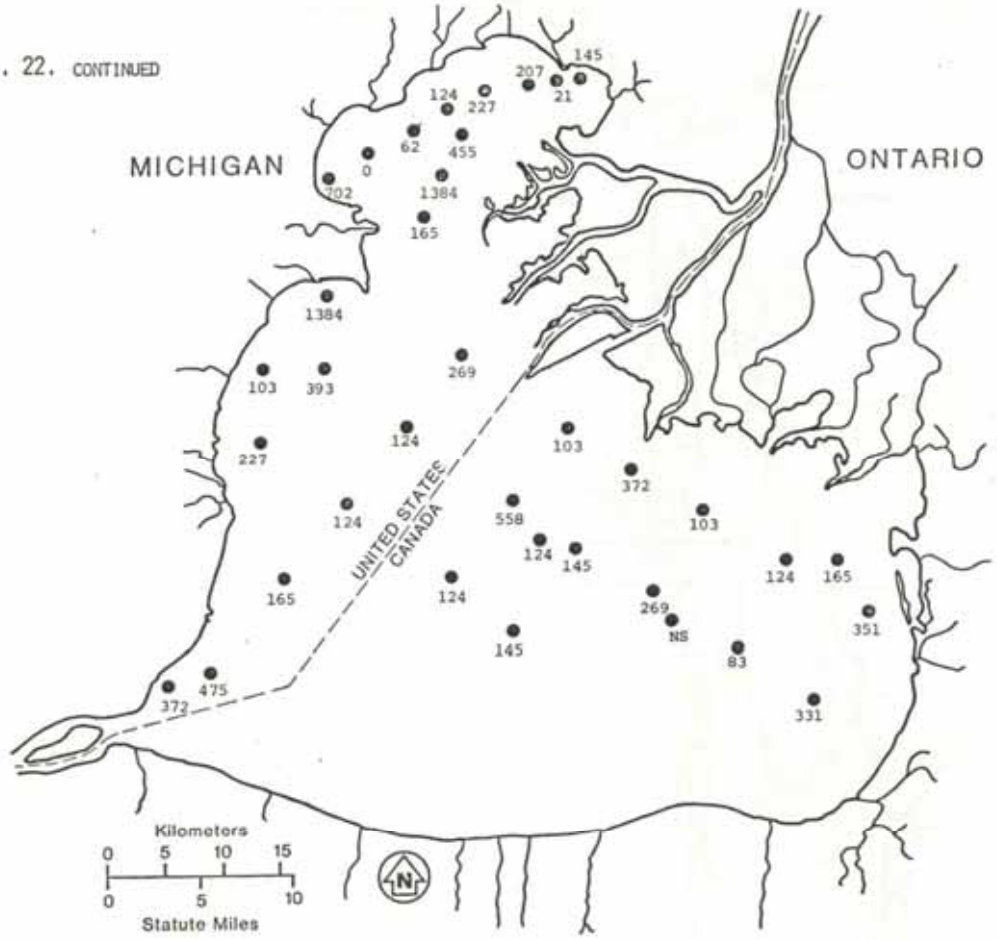


Figure 22. Distribution and density (mean number per square meter) of Pisidium in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

FIG. 22. CONTINUED



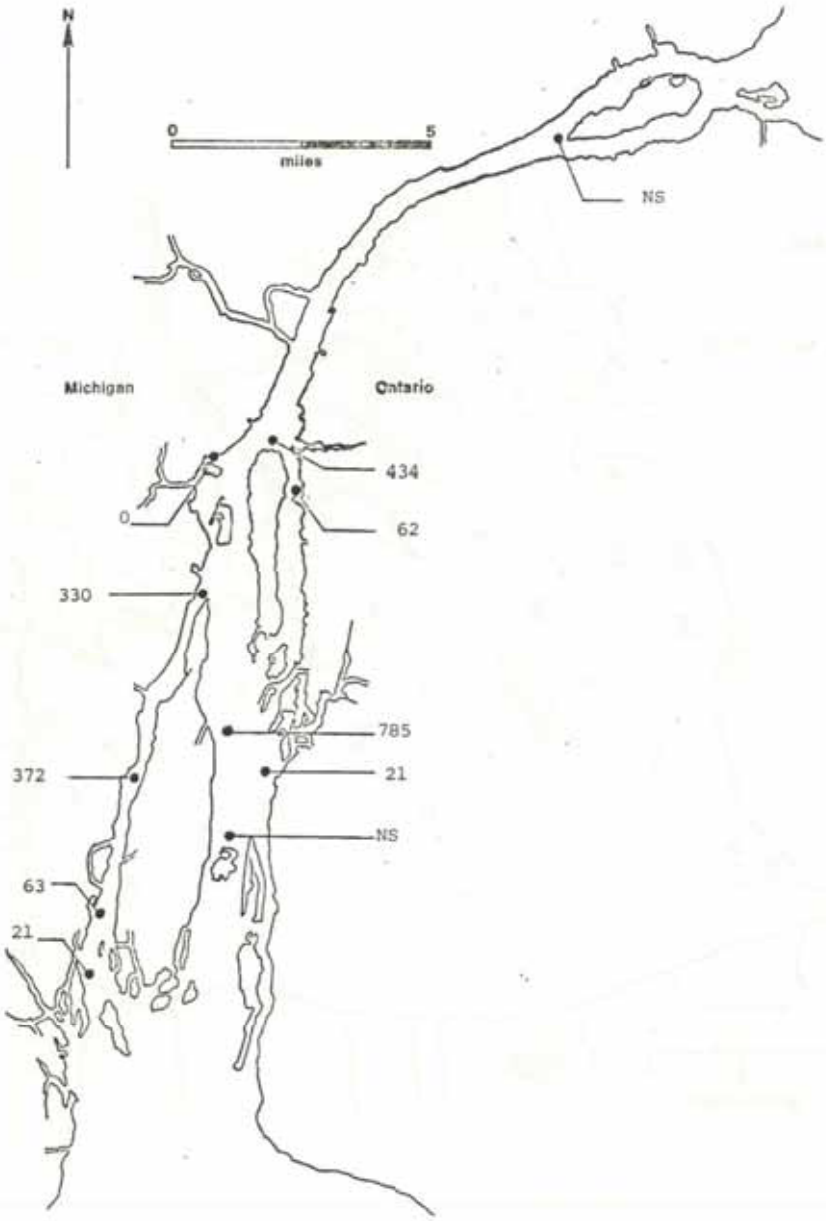
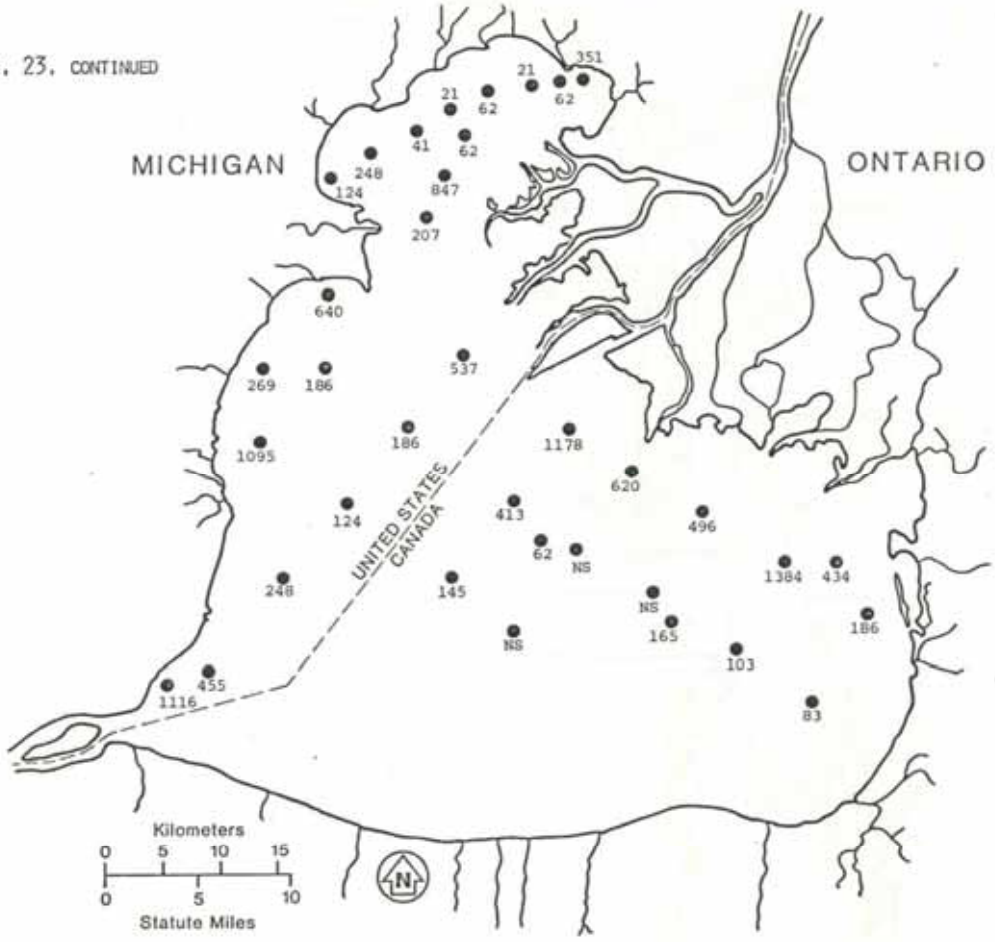


Figure 23. Distribution and density (mean number per square meter) of Pisidium in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 23. CONTINUED



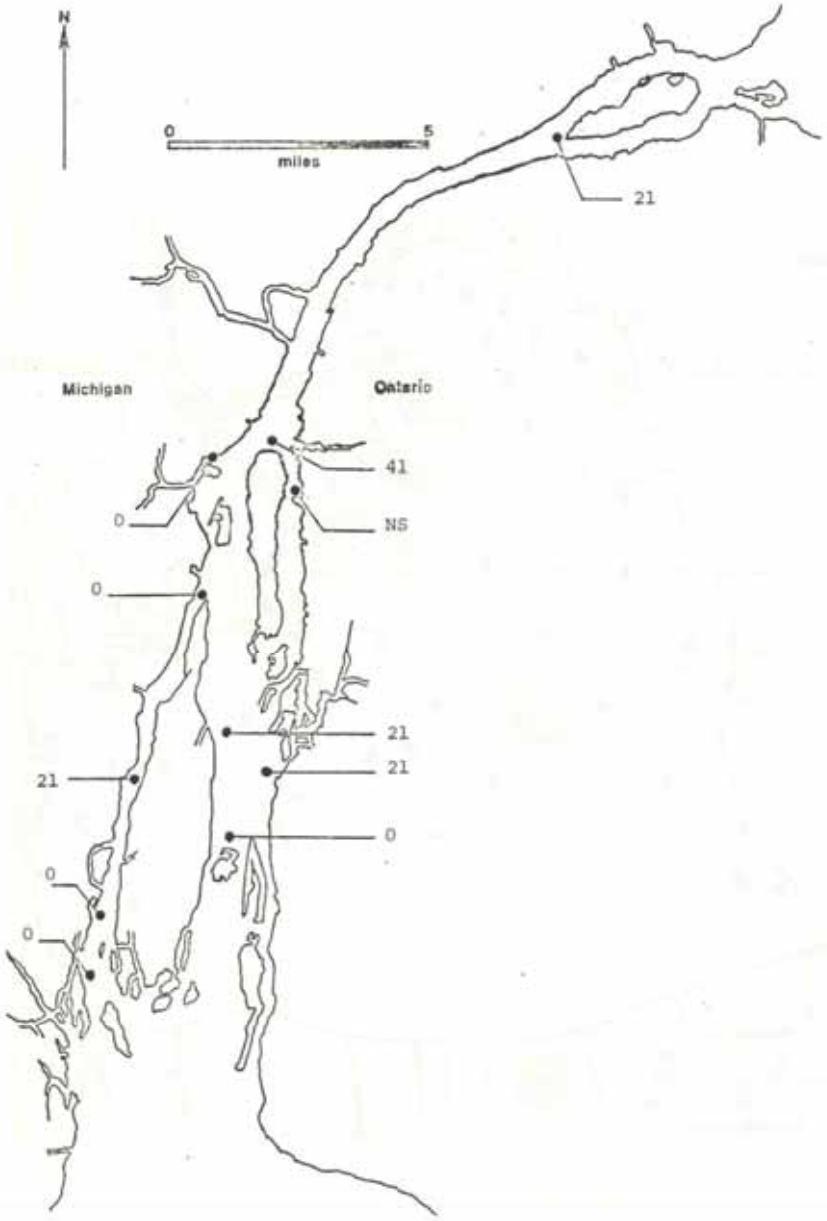
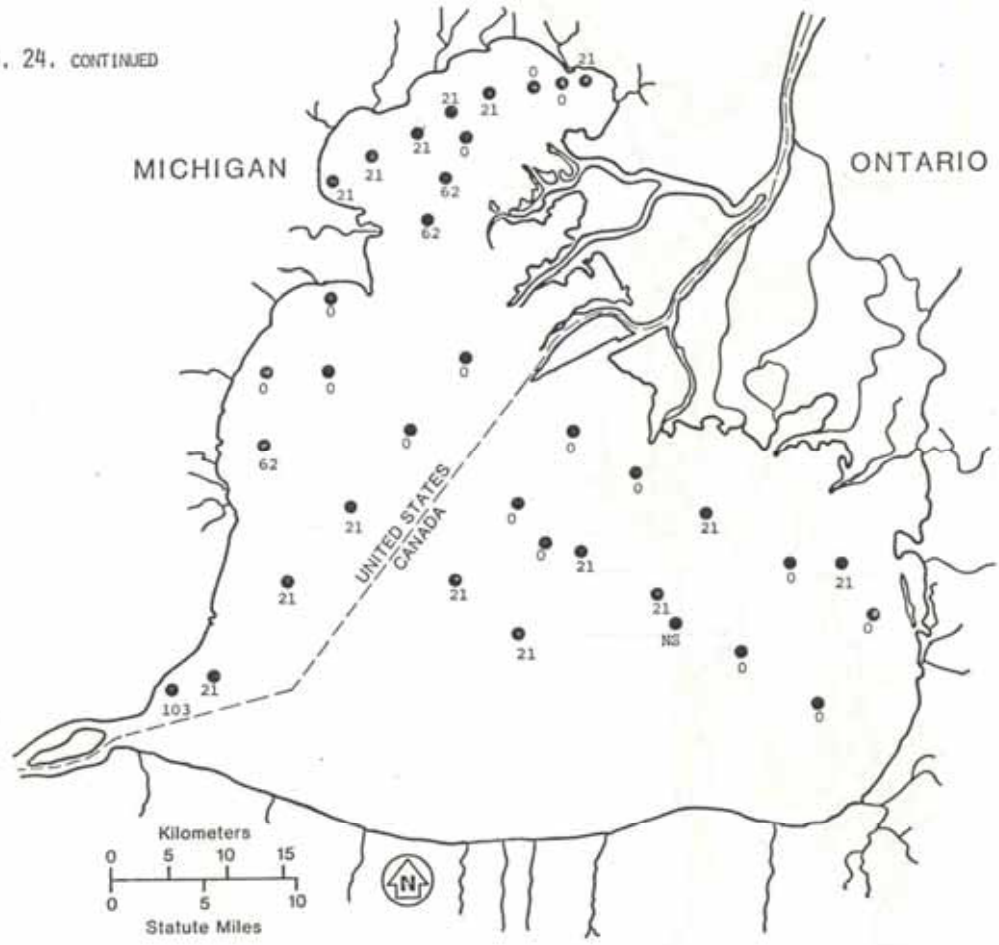


Figure 24. Distribution and density (mean number per square meter) of Sphaerium in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

FIG. 24. CONTINUED



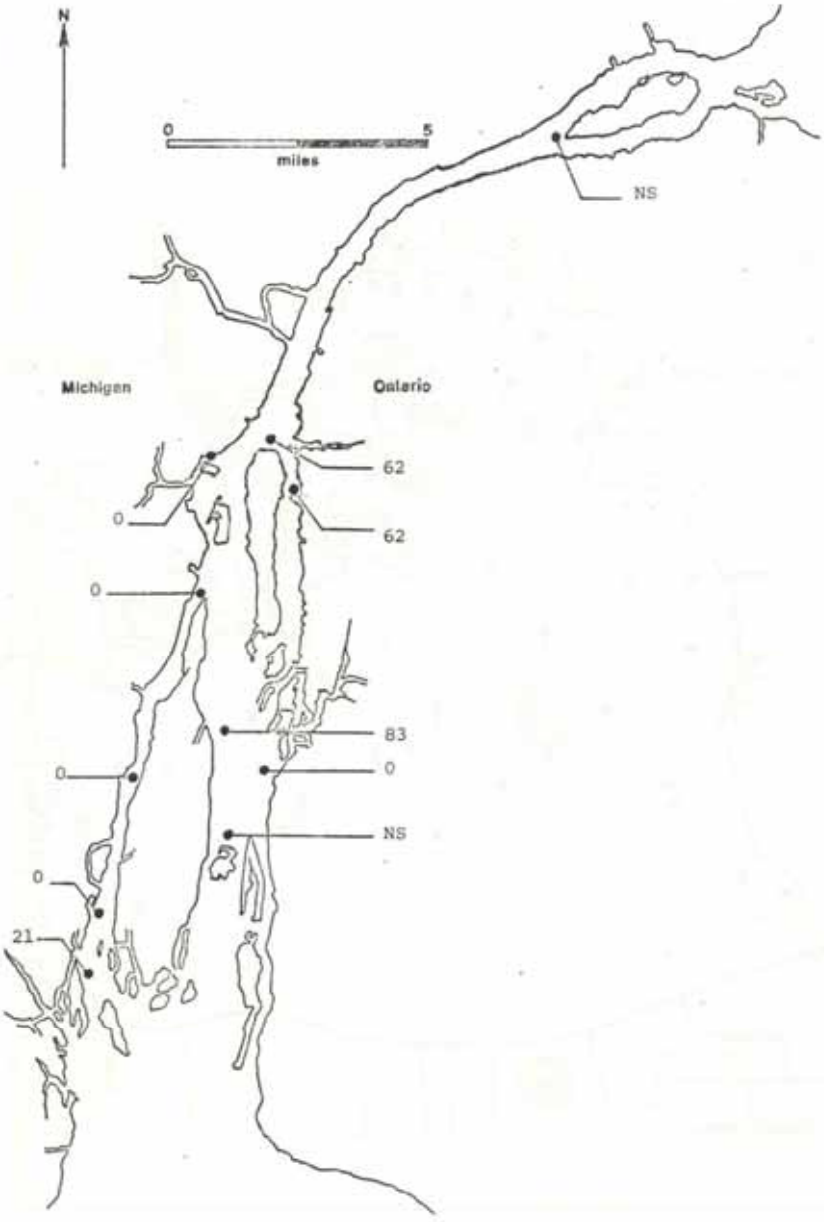
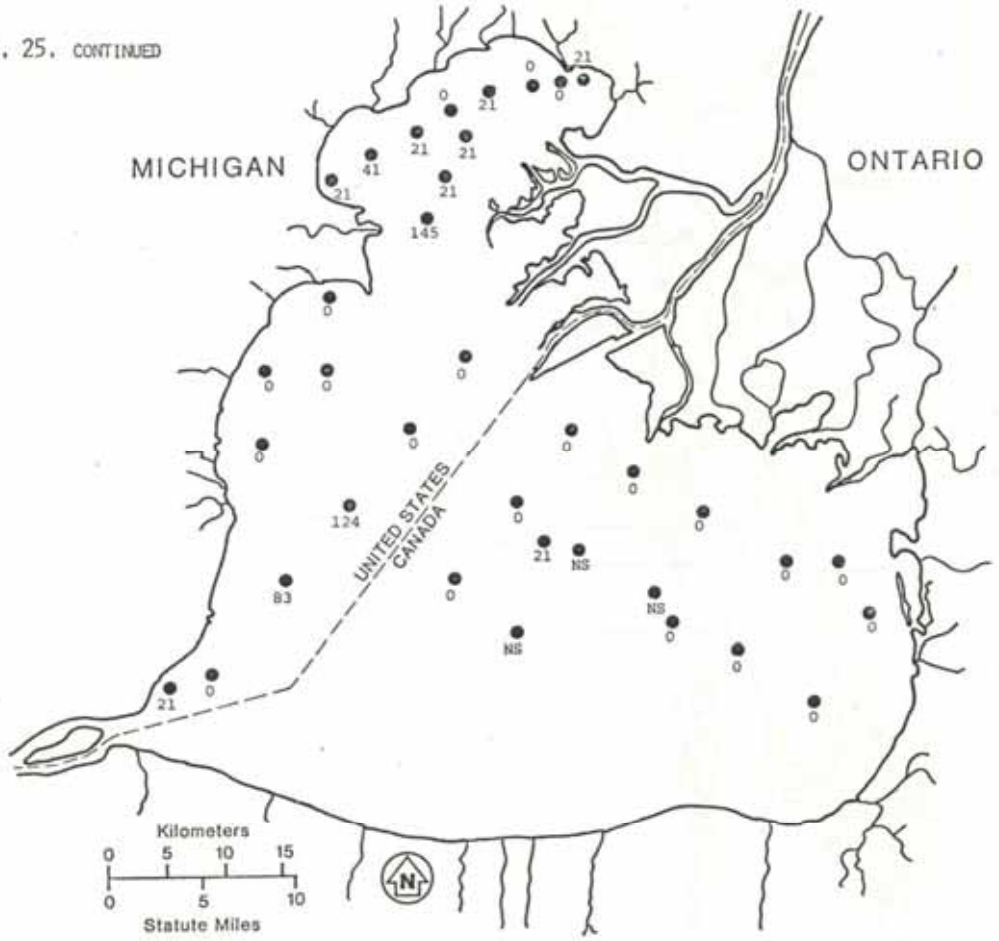


Figure 25. Distribution and density (mean number per square meter) of Sphaerium in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 25. CONTINUED



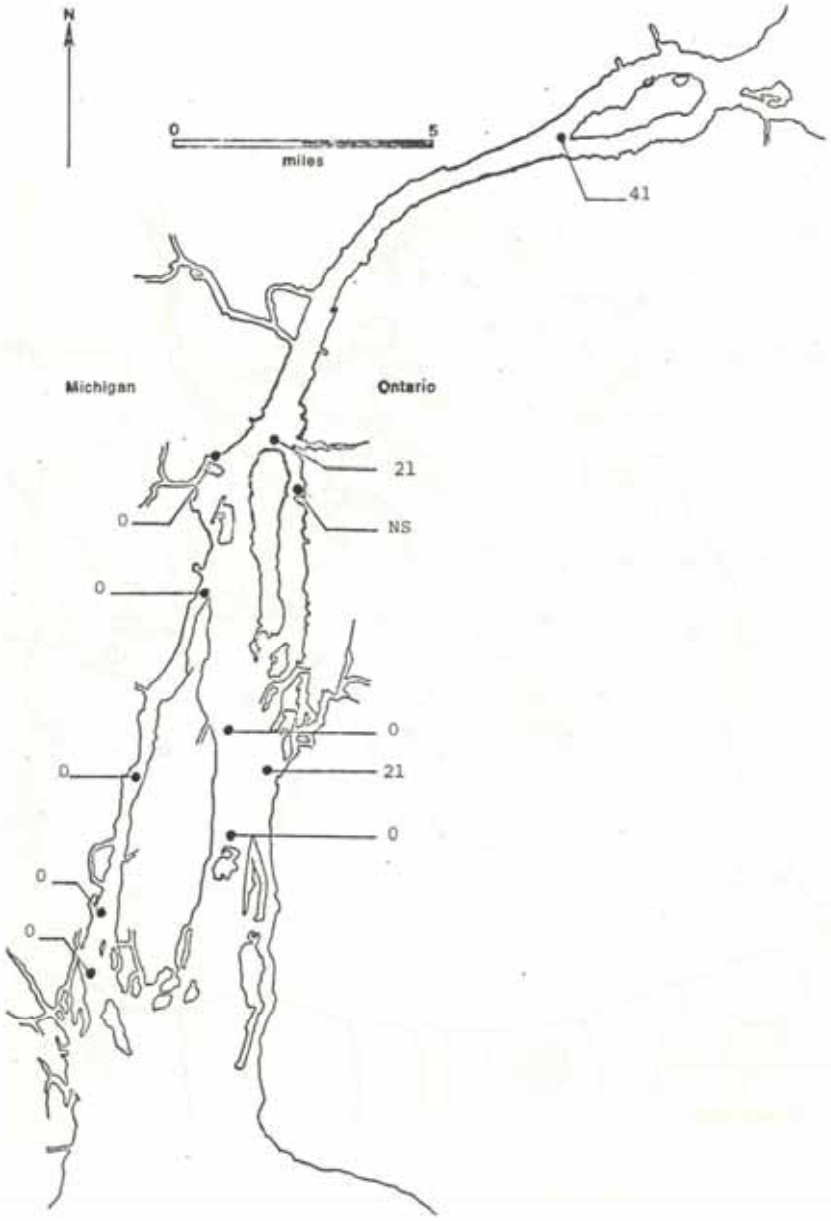
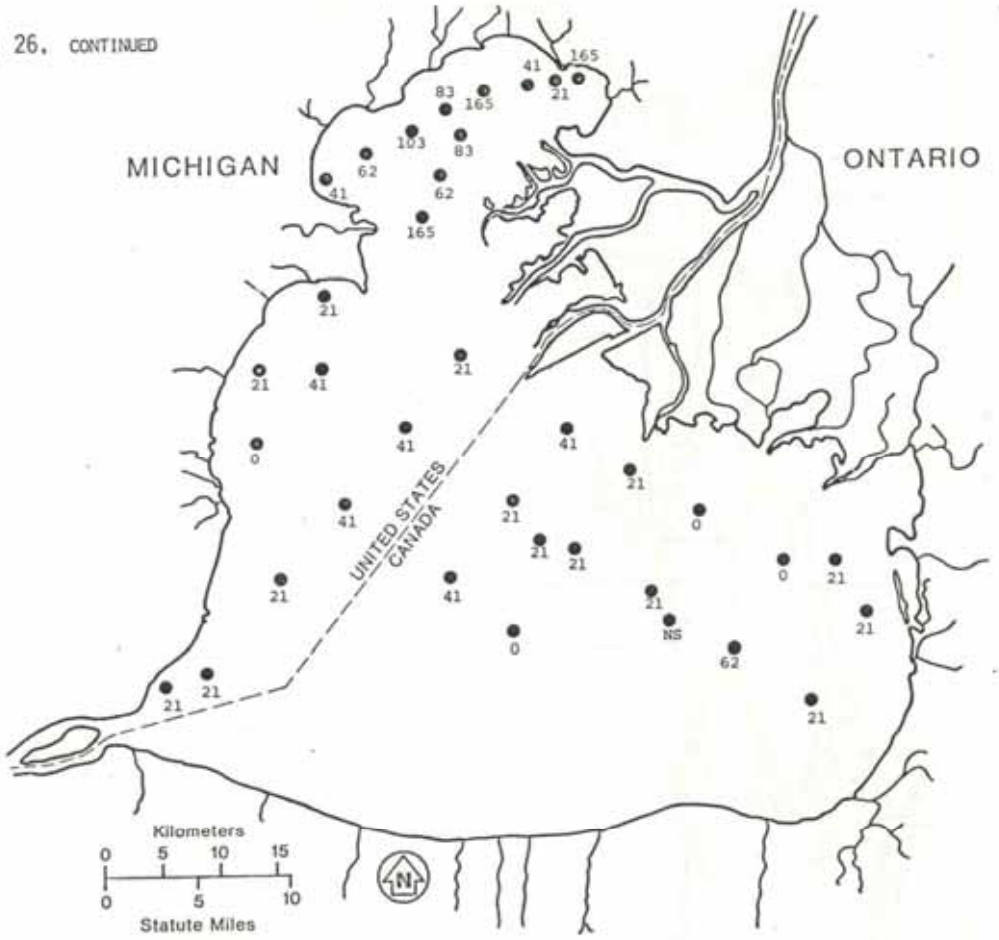


Figure 26. Distribution and density (mean number per square meter) of Trichoptera in the Detroit River and Lake St. Clair, including Anchor Bay, in April 1977. [NS = Not sampled]

FIG. 26. CONTINUED



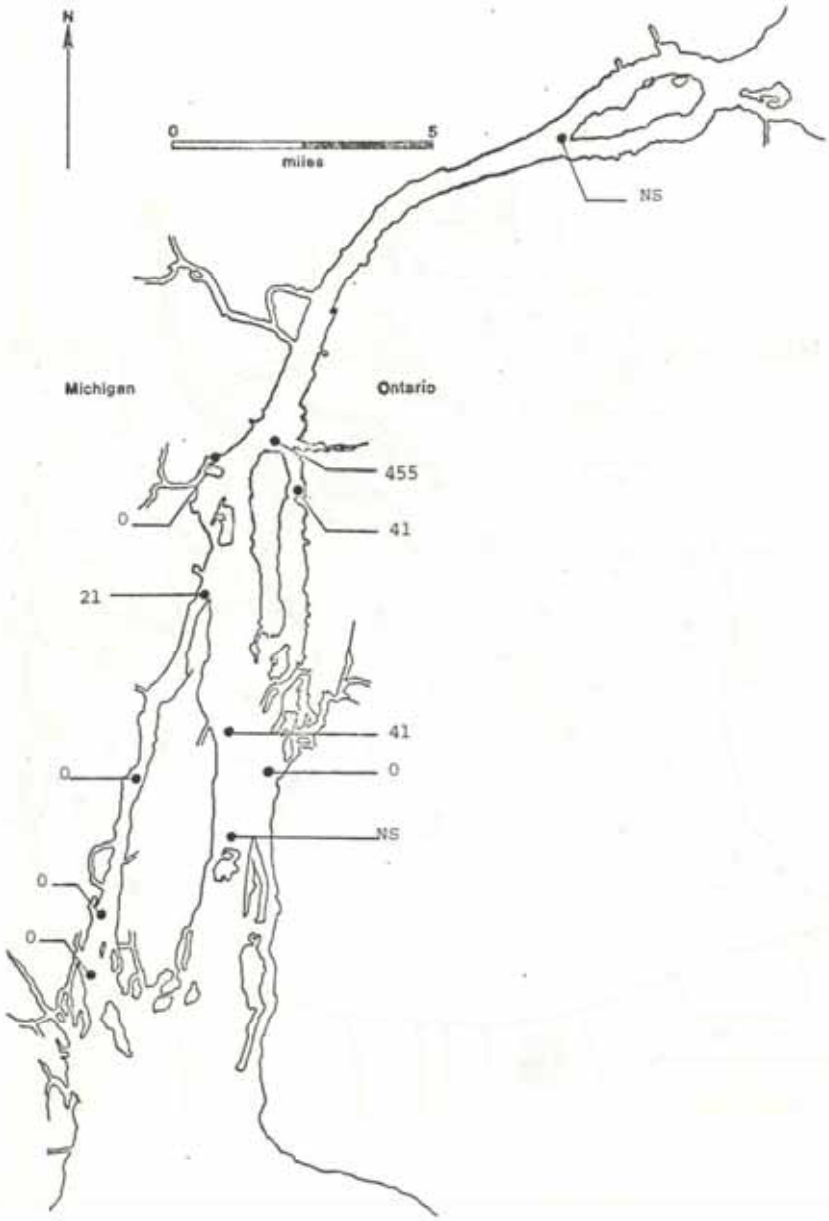
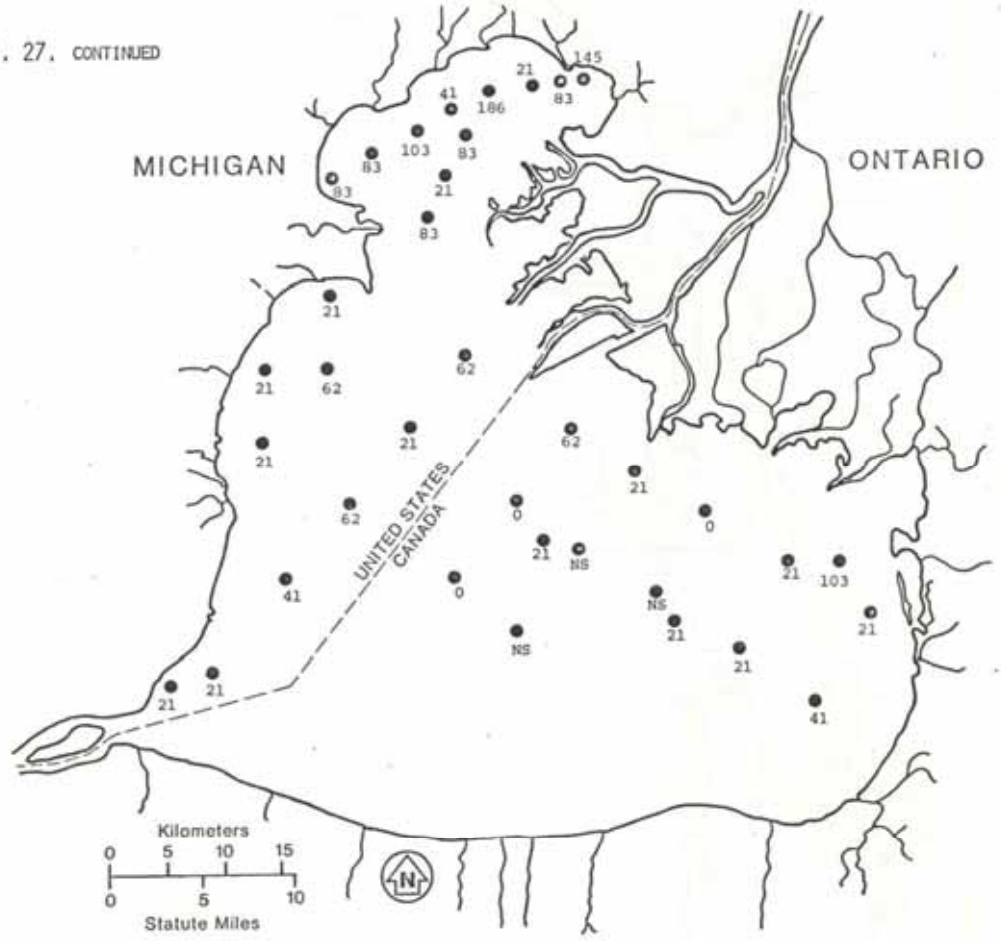


Figure 27. Distribution and density (mean number per square meter) of Trichoptera in the Detroit River and Lake St. Clair, including Anchor Bay, in July 1977. [NS = Not sampled]

FIG. 27. CONTINUED



Appendix 1. Station locations in Lake St. Clair and the Detroit River at which sampling for macrozoobenthos was conducted in 1977.

Station number	North latitude	West longitude
Anchor Bay		
100	42°35'36"	82°45'00"
101	42°39'48"	82°42'45"
102	42°40'00"	82°39'45"
103	42°37'00"	82°44'15"
104	42°38'26"	82°43'30"
105	42°39'55"	82°40'40"
106	42°40'05"	82°38'30"
107	42°39'15"	82°44'10"
108	42°38'45"	82°45'40"
110	42°37'50"	82°48'40"
119	42°38'18"	82°47'10"
Lake St. Clair proper		
200	42°23'10"	82°26'50"
201	42°25'00"	82°30'10"
202	42°26'40"	82°33'30"
203	42°28'25"	82°36'55"
204	42°30'12"	82°40'15"
205	42°31'55"	82°43'40"
206	42°20'42"	82°29'10"
207	42°22'26"	82°32'30"

Station	North latitude	West longitude
208	42°24'06"	82°35'52"
209	42°25'54"	82°39'10"
210	42°27'42"	82°42'35"
211	42°29'28"	82°46'00"
212	42°31'15"	82°49'20"
214	42°23'21"	82°41'30"
215	42°25'12"	82°44'55"
216	42°28'40"	82°51'40"
219	42°21'52"	82°52'55"
222	42°24'24"	82°50'40"
223	42°21'50"	82°54'45"
225	42°23'12"	82°35'00"
226	42°25'30"	82°27'30"
227	42°26'00"	82°41'15"
228	42°26'57"	82°48'22"
229	42°30'45"	82°51'37"
230	42°33'57"	82°48'45"
Detroit River		
301	42°14'30"	83°08'27"
302	42°12'05"	83°08'40"
303	42°09'00"	83°10'14"
304	42°06'55"	83°10'52"
305	42°05'38"	83°11'05"
311	42°08'10"	83°07'45"

Station	North latitude	West longitude
312	42°09'13"	83°07'05"
313	42°09'52"	83°07'35"
315	42°14'45"	83°07'05"
316	42°20'00"	83°00'23"
317	42°14'00"	83°06'25"

Appendix 2 -- Number of macrozoobenthos per grab and mean density per square meter at 49 stations in the Detroit River, Lake St. Clair, and Anchor Bay in April and July, 1977. Mean densities of each taxon were estimated by multiplying the average number in three grabs by 20.66.

(Only the following example page of Appendix 2 is reproduced as part of this report. All data are available upon request from the Great Lakes Fishery Laboratory).

Macrozoobenthos of the St. Clair-Detroit River Ecosystem

STATION 102

DATE	DEPTH(M.)	TAXON	--GRAB COUNTS--			MEAN NO./M2
7/21/77	2.0	CNIDARIA				
		HYDRA	0	0	2	14
		ALL CNIDARIA				14
		RHABDOCOELA	0	0	1	7
		NEMATODA	4	16	34	372
		HIRUDINEA				
		HIRUDINEA	0	4	0	
		GLOSSIPHONIIDAE				
		MELOBDELLA STAGNALIS	0	3	0	
		ALL HIRUDINEA				48
		OLIGOCHAETA				
		STYLARIA LACUSTRIS	0	3	3	
		OTHER	86	222	253	
		ALL OLIGOCHAETA				3905
		POLYCHAETA				
		MANAYUNKIA SPECIOSA	0	0	2	14
		ALL POLYCHAETA				14
		OSTRACODA	10	21	9	275
		AMPHIPODA				
		GAMMARUS	109	77	92	1914
		ALL AMPHIPODA				1914
		ISOPODA				
		ASELLUS	8	3	3	
		LIRCEUS	11	12	15	
		ALL ISOPODA				358
		DIPTERA				
		CHIRONOMIDAE	32	72	85	1302
		EPHEMEROPTERA				
		EPHEMEROPTERA				
		BRACHYCERCUS	0	9	0	
		EPHEMERIDAE				
		HEXAGENIA	7	8	4	
		ALL EPHEMEROPTERA				193
		TRICHOPTERA				
		MYSTACIDES	2	2	3	
		OECETIS	1	1	1	
		TRIAENODES	0	0	1	
		OTHER	0	0	1	
		ALL TRICHOPTERA				83
		GASTROPODA				
		AMNICOLA	6	13	14	
		GONIOBASIS LIVESCENS	3	1	1	
		GYRAULUS	9	1	1	
		LYMNAEA	2	2	0	
		PHYSA	32	19	29	
		ALL GASTROPODA				909
		PELECYPODA				
		PISIDIUM	2	3	3	55
		ALL PELECYPODA				55

,Example page of Appendix 2.

Appendix 3. Composition of the substrate at stations in Lake St. Clair and the Detroit River where sampling was conducted for macrozoobenthos in 1977.

Station number	Substrate composition
Anchor Bay	
100	Silt, mud, and clay
101	Sand, silt, mud, and clay
102	Sand and silt
103	Sand, silt, mud, and clay
104	Silt and clay
105	Sand, silt, mud, and clay
106	Sand and silt
107	Sand, silt, and mud
108	Sand, silt, mud, and clay
110	Sand, silt, and clay
119	Sand and silt
Lake St. Clair proper	
200	Sand, silt, mud, and clay
201	Sand, silt, and clay
202	Sand, silt, and clay
203	Sand and silt
204	Sand, clay, and silt
205	Sand, mud, and silt
206	Sand, silt, mud, and clay

Station number	Substrate composition
207	Gravel, clay, mud, and silt
208	Mud and clay
209	Mud and clay
210	Mud, silt, and clay
211	Mud, silt, and clay
212	Sand, silt, and clay
214	Mud and clay
215	Mud and clay
216	Sand
219	Sand and gravel
222	Mud and clay
223	Sand and silt
225	Mud and clay
226	Sand
227	Mud and clay
228	Mud and clay
229	Sand, silt, and gravel
230	Sand, silt, and mud
Detroit River	
301[a/]	Mud
302	Sand, silt, and mud
303	Sand and clay

Station number	Substrate composition
304	Gravel, sand, and mud
305	Sand, clay, and mud
306	Sand and clay
310	Sand and mud
311[a]	Mud
312	Sand and silt
313	Sand, mud, and silt
315	Mud, silt and gravel
316	Sand and gravel
317	Sand and mud

[a] Oil or foul odors, or both, were detected in the sediments at the time of sample collection.