APPENDIX IX

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SEA LAMPREY MANAGEMENT IN THE GREAT LAKES

by

William E. Daugherty and Harry H. Moore

U.S. Fish and Wildlife Service

Marquette, Michigan 49855

and

J. J. Tibbles, S. M. Dustin, and B. G. H. Johnson

Department of Fisheries and Oceans

Sault Ste. Marie, Ontario P6A 1P0

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SEA LAMPREY MANAGEMENT IN THE GREAT LAKES

William E. Daugherty and Harry H. Moore
U.S. Fish and Wildlife Service
Marquette, Michigan 49855

J. J. Tibbles, S. M. Dustin, and B. G. H. Johnson
Department of Fisheries and Oceans
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The activities in 1983 by the sea lamprey control units of Canada and the United States are summarized in this joint report. Sea lamprey management programs are in place on all the Great Lakes except Lake Erie, where effort is confined to monitoring spawning-phase sea lampreys in one stream. The sea lamprey management program consists of four activities: surveys, chemical treatments, assessment, and biological investigations. Surveys for presence or absence and distribution of larval lampreys are carried out by the use of electricity or chemicals, treatments of streams or other bodies of water require the controlled application of selective toxicants, and assessment of lamprey numbers is accomplished by means of weirs and traps and purchasing lampreys from fishermen. Biological studies are focused upon the distribution, movement, growth, and abundance of sea lampreys.

Activities of the sea lamprey management program conducted in the United States and Canada progressed well in 1983. No new populations of sea lampreys were detected by surveys. A total of 77 chemical treatments were completed (Table 1), including first treatments of the lower Nipigon River and Polly Creek. Assessment traps captured 43,151 sea lampreys from 38 tributaries of the Great Lakes. Biological data on these lampreys are presented in Table 2. Parasitic-phase lampreys are abundant in northern Lake Huron.

The following sections describe the management activities and biological investigations for each lake basin in 1983.

LAKE SUPERIOR

Surveys

Surveys were conducted on 98 tributaries and 2 lentic areas of Lake Superior in 1983 to assess larval sea lamprey populations. Pretreatment investigations were completed on 28 streams; 14 were later treated and the others are scheduled for treatment in the future. Reestablished populations are also present in another 24 south shore streams. The most significant reinfestations appear to be developing in the Firesteel River and upstream reaches of the Sucker River. Sea lampreys are reestablished in all north shore rivers treated in 1981 and 1982 except in the Little Gravel River.

Residual sea lamprey larvae were collected from 7 of 10 Canadian streams surveyed to assess the effectiveness of lampricide treatments conducted in 1982 and 1983. Although only a few residual sea lampreys were found in the Sable, Michipicoten, and Gravel rivers, collections from the other four streams suggest higher numbers present. Relatively high numbers of larvae survived treatment in the Goulais River. Residual lampreys found in the mouth of Cash Creek and in the estuary of the lower Nipigon River probably survived the TFM treatments due to dilution. In the Steel River, attenuation of the lampricide block because of low flow probably contributed to larval survival.

Residual sea lampreys were found in 18 streams along the south shore of Lake Superior. The populations in all but three streams appeared to be small and should require no remedial action. In the Betsy, Traverse, and Miners rivers, however, residual lampreys were more numerous, and these populations will be monitored regularly to ascertain if re-treatment dates should be moved ahead. Larvae in the Betsy (12 larvae, 46-113 mm long) were scattered throughout the system and probably resulted from significant water level fluctuations during the last treatment in September 1982. The majority of residuals (28, 34-114 mm) in the Traverse River were collected near the confluence of a high water channel that apparently was not exposed to lethal concentrations of lampricide during the July 1982 treatment. Most survivors of the 1982 treatment of the Miners River were confined to the delta area of the inlet to Miners Lake, where 8 larvae (66-112 mm) were recovered.

Granular Bayer 73 was used to survey lentic waters of Lake Superior. Batchawana Bay has been surveyed frequently in recent years and granular Bayer 73 treatments conducted where sea lamprey abundance appeared highest--in 1983, the assessment effort was increased to improve our knowledge of spatial distribution and abundance. Five separate sites in Goulais Bay (11,152 m^2, 120,000 sq. ft.) were sampled with granular Bayer 73, and 1,007 larval lampreys, including 129 sea lampreys (range, 31-156 mm long) were collected. The sample sites selected were along the dropoff area near the multiple mouths of the river. Because of the large area of Goulais Bay, an extensive effort would be required to provide an accurate assessment of the larval sea lamprey population. Surveys of lentic areas with Bayer 73 and backpack shockers yielded small numbers of sea lamprey larvae off the mouths of the Sucker, Silver, and Black rivers, and in inland lakes which are part of Harlow Creek, Miners River, and Beaver Lake systems.

Surveys continued in the St. Louis River to monitor changes in the larval population that first became established in 1979. Sampling in 1983, as in previous years, indicated a low density population extending downstream from a barrier dam at Fond du Lac to the bridge at Oliver (about 9 km, 5.6 miles). A total of 24 sea lamprey ammocetes (43 to 162 mm) were recovered from 28 sites sampled with granular Bayer 73. Only two of the larvae were longer than 80 mm.

Surveys were conducted to assess the effectiveness of the barrier dams on Stokely Creek and Gimlet Creek, a tributary of the Pancake River. Sea lamprey larvae above the dam on Stokely Creek were of the 1981 and earlier year classes, indicating the dam stopped upstream migrations of sea lampreys.

Treatments

During 1983, TFM was applied to 25 tributaries and granular Bayer 73 to areas of 2 inland lakes and 4 bays on Lake Superior (Table 3, Fig. 1). The treatment season was characterized by extreme water levels--excessive discharge in the spring and late fall and near drought during summer. Sea lamprey larvae were abundant in the Salmon-Trout (Marquette County), Brule, Big Garlic, and Batchawana rivers and Polly Creek; moderately abundant in the Lower Nipigon, Chippewa, Little Carp, Two Hearted, and Silver rivers and Stillwater and Harlow creeks; and scarce in the remainder of the streams treated.

Polly Creek and the lower Nipigon River were treated for the first time. Polly Creek is tributary to a lake in the Nipigon River system and a large number of all age classes of ammocetes were present. The Nipigon River, from the outlet of Helen Lake to Lake Superior, was treated in July with the cooperation of Ontario Hydro who gave a controlled flow for 76 hours. Lake seiche and strong winds caused chemical application problems, but it is felt that the treatment was successful in killing the majority of larval sea lampreys in the river.

Granular Bayer 73 was applied to the mouth of the upper Nipigon River in Helen Lake during the period of controlled flow. The low water levels and good visibility resulted in the most efficient treatment of this area. Large numbers of sea lamprey ammocetes were observed and collected.

A concentrated effort was made in 1983 to attack the known lentic populations of larval sea lampreys within Batchawana Bay. Because of a hot, sunny summer, treatment conditions were excellent--bottom temperatures were the highest recorded for years--and relatively effective treatments were realized in all areas. Six areas in close proximity to known sea lamprey-producing streams were treated with Bayer 73 granules. Larval sea lampreys were scarce off Harmony River and Stokely Creek, moderate off Sable and Batchawana rivers and Sand Point near the Batchawana River, and abundant off Chippewa River. Annual granular Bayer 73 treatments of the well-defined dropoff area off the Chippewa River, in conjunction with annual TFM treatments of the Chippewa River, are required to reduce this significant source of sea lamprey recruitment to Batchawana Bay.

Spawning-phase Sea Lampreys

Assessment traps were fished in nine tributaries of Lake Superior in 1983. The catch of adult sea lampreys was 1,464, compared with 1,325 in 1982 (Table 4, Fig. 1). The number of lampreys declined in the Tahquamenon, Betsy, and Pancake rivers and Stokely Creek in eastern Lake Superior. Catches of sea lampreys in all other streams increased with the exception of Miners River, which remained the same. The average length and weight of sea lampreys and the percentage of males decreased slightly in 1983 from those taken in 1982 (Table 4).

Parasitic Sea Lampreys

A total of 491 sea lampreys were collected (487 by commercial and 4 by sport fishermen) in Lake Superior through September 1983 (490 in U.S. and 1 in Canada), compared with 300 taken in 1982. Fishermen from statistical district MS-4 (Munising, Michigan, area) and the statistical district of Wisconsin collected the largest number of sea lampreys from U.S. waters of Lake Superior in 1983--289 and 158, respectively, compared with 84 and 161 in 1982. The increase in number of sea lampreys captured in the Munising area is probably attributed to the additional effort by a commercial gill net fisherman, as spring wounding rates on lake trout remained the same for 1982 and 1983, 7.6% and 7.7%, respectively. In September 1983, a commercial fisherman in Little Marais, Minnesota, area (M-2), recovered the first parasitic-phase sea lamprey for bounty from inside a lake trout which measured 82 cm (32 inches) long and weighed 6.3 kg (14 pounds).

Estimate of larval sea lamprey population in the Big Garlic River. A critical element in the Heimbuch/Youngs approach for determining the cost-benefit ratio for treating a stream infested with sea lamprey larvae is the ability to estimate the production of transformed lampreys within that stream. Since most streams are treated every 3 to 5 years, only a small percentage of the larvae reach the transformation stage and few of these are ever found. A more appropriate or realistic estimate to strive for may be the number of ammocetes in a population >120 mm, a length where transformation is likely to occur.

The decision to abandon the inclined-plane downstream trap in the Big Garlic River and chemically treat the stream presented an opportunity to estimate the population of larvae and the percentage >120 mm. Past attempts to estimate the total number of larvae in a stream generally centered on mark/release trials over an entire stream length, often many kilometers. Such efforts may result in low recovery of marked animals and inadequate precision in the estimate. A more reliable approach may be to separate the stream into several zones based on distribution of larvae and types of habitat, then within each zone intensively study (mark/release experiment) a short representative section, expand the resulting estimate over the entire zone, and sum the numbers from the zones for the total stream estimate.

During July 1983, larval habitat in the infested length of the river upstream of the trap was mapped for potential use by ammocetes. The habitat was measured in square meters and, in general, classified as having areas of high potential for colonization (backwaters, silt, silt/detritus, silt/sand interfaces with vegetation, etc.), less potential (shifting sand in main stream flow), and little or no potential (bedrock, boulders, rubble, and gravel).

After the habitat mapping, the river was surveyed with backpack shockers to determine the relative distribution and abundance of larvae. Larvae were found over 8,504 m (27,900 ft.) of stream length. The river was divided into four zones based on larval abundance and changes in physical characteristics of the stream. Zone A extended from the trap upstream 640 m (2,100 ft.) and was characterized by slow flows with substrates primarily of sand and silt. Larvae were most dense in this zone and much of the habitat had a high potential for colonization. Zone B was 1,646 m (5,400 ft.) and had habitat somewhat similar to that in A, but larvae were relatively less dense. Zone C (3,200 m, 10,500 ft.) shifted more to that of a riffle/pool environment with occasional rapids and falls; larvae were abundant in the available habitat. Zone D (3,018 m, 9,900 ft.) was similar to C in stream character, but larvae were far less abundant.

A 228.6- to 457.2-m (750- to 1,500-ft.) section of stream within each zone, typifying the zone in character and relative density of larvae, was chosen for intensive population study during lampricide application. To prevent immigration and emigration of larvae into the short sections, barriers of fine mesh hardware cloth were constructed at the upstream and downstream limits 48 hours before treatment. From 175 to 742 larvae within each section were marked with fluorescent dye, released near where they were captured, and allowed to acclimate during the 48-hour period.

Larvae were collected during the treatments with fyke and dip nets. The percentage of marked larvae recaptured ranged from 26 in Zone B to 51 in Zone A, with an overall recovery rate of 42% (Table 5). Poorer collecting conditions in Zones B and C accounted for the rates lower than in A and D. A total of 8,747 dead or dying unmarked larvae were collected in the study area. The Petersen formula was used to estimate the number of larvae in each study section. This estimate was then expanded on the basis of total habitat in the zone and the resulting numbers were summed to give the total population. The stream had 91,007 (95% confidence intervals, 73,106-113,595) sea lamprey larvae during the treatment in 1983. Of these, 33% were of the size where transformation may occur.

Assessment of populations of sea lampreys in Batchawana Bay. On the Canadian side of Lake Superior, development of a process was begun to evaluate recruitment of larvae and escapement of transforming lampreys in populations in Batchawana Bay. Data on larvae collected since the inception of the chemical control program were reevaluated for spatial distribution and length-frequency composition. Changes in larval distribution, density, and mean length were examined in relation to lampricide treatments of adjacent tributaries which are major sea lamprey producers (Stokely Creek and Harmony, Chippewa, Batchawana, and Sable rivers). The scheduling of future treatments of these streams will be manipulated so that monitoring of the lentic larval populations off their mouths can provide an evaluation of the effects of these strategies.

Big Garlic trap. Three transformed sea lampreys and 6,609 ammocetes were captured at the downstream trap in the Big Garlic River in 1983, compared with 28 and 3,272, respectively, in 1982. Large larvae (>120 mm) collected in the spring were allowed to transform in warmwater aquaria, and then transferred to the Hammond Bay Biological Station. Ammocetes that did not transform were used for special studies of the evaluation unit and other investigators. Small larvae (<120 mm) were held for use in bioassays conducted by personnel of the Marquette chemical control units, or for use by other cooperating investigators. The stream was chemically treated in October, and no live lampreys were taken after treatment. The facility will be operated for approximately 2 weeks in the spring of 1984 to further evaluate treatment effectiveness, and then placed on standby status.

Treatment effects upon nontarget organisms. Onsite testing of nontarget organisms was carried on during treatments of the Brule and Tahquamenon rivers Information from these studies is included in the Lake Michigan section of this report so that mortality can be compared by genera for all five streams studied (see Tables 8 and 9).

LAKE MICHIGAN

Surveys

Surveys to evaluate larval lamprey populations were conducted on 107 Lake Michigan tributaries in 1983.

Pretreatment work was completed on 20 Lake Michigan tributaries; 13 were later treated successfully and 7 (Jordan and Boyne rivers and Gibson, Duck, Hudson, Seiners, and Bursaw creeks) are scheduled for treatment in 1984. A moderate population was indicated in the Jordan River and smaller populations in the other streams scheduled for treatment in 1984. Treatment of Bursaw Creek is recommended because of a residual population remaining after an unsuccessful low water treatment in September 1983.

Reestablished populations were evident in 24 streams other than those examined for pretreatment purposes. The largest of these redeveloping populati appeared to be in the Muskegon, Fishdam, Sturgeon, and Peshtigo rivers. Young-o the-year larvae were found in 17 streams. However, monitoring for the 1983 year class, especially in the Lower Peninsula, was reduced because of work commitment in New York, and larvae are probably present in several more streams.

Residual sea lampreys were collected from 16 streams to evaluate chemical treatments and monitor reestablished populations. Residual numbers were small except in Bursaw Creek and in areas of three larger systems (Sturgeon, Whitefis and Cedar rivers), where most survivors could be attributed to treatment proble on small tributaries and backwater areas.

No sea lampreys were found during surveys of 10 historically negative stre In one untreated stream, Fischer Creek, a single ammocete (152 mm long) was fou

Surveys above dams on the St. Joseph, Grand, and Manistique rivers yielded no sea lampreys. The possibility that fishways incorporated in dams on the St. Joseph and Grand rivers might not be effective in blocking adult sea lampr and the past record of adults bypassing the barrier on the Manistique River prompted these surveys.

Lentic areas associated with seven streams were examined with granular Bayer and backpack shockers, and sea lamprey larvae were found in three instances. The only significant concentration appeared to be off the Manistique River where 42 ammocetes (37-132 mm long) were recovered.

For the past 5 years, observations have been made on a low-head barrier dam on Weston Creek, a tributary of the Manistique River. The barrier was created by inserting a gate 1.1 m (43 inches) high x 1 m (40 inches) wide in an existing structure. The water column created by the gate has ranged from an average of 79 to 102 cm (31 to 40 inches) over the 5 years. An electrical barrier was installed upstream to evaluate the effectiveness of this dam. Larval surveys also assessed the effectiveness of the barrier. No evidence has been found to indicate lampreys bypassed the dam. The combination of a 79-cm (31-inch) water column with a velocity about 2.7 m/s (8.8 ft./s) has prevented sea lampreys from bypassing the barrier while allowing passage of spawning rainbow trout.

Treatments

Chemical treatments were performed on 17 streams during the field season (Table 6, Fig. 2). Wide fluctuations in water levels encountered during the year complicated many treatments.

The Whitefish River treatment was very involved. The treatment began in June and the entire system was not completed until October due to variations in water levels and concern for the effects of TFM on walleye fry. Some mortality of burrowing mayflies and spawning brook trout occurred in Scotts Creek, a tributary. Perhaps the barrier dam on the West Branch of the Whitefish River will eliminate the need for future treatments of Scotts Creek.

Other factors resulted in treatment problems. A combination of agricultural fertilizers, pesticides, irrigation, and the application of TFM was the likely cause for a moderate fish mortality in the Pentwater River. A moderate fish kill occurred in the lower Pere Marquette River due to inadequate mixing of Bayer 73 below a booster feeder. Relatively high minimum lethal concentrations were required to treat two tributaries of the Grand River, Crockery and Sand creeks, and contributed to a moderate fish kill. A low stream discharge in the Carp Lake River permitted only treatment of the lowest 1.6 km (1 mile). Other treatments were marginally effective because of low water levels and sluggish flow.

The Ford River was treated in two sections--the headwaters and Ten Mile Creek in early spring and the main river in September--to allow undisturbed spawning of game fishes in the stream. Extensive effort was expended to apply TFM to backwater areas in the Ford River which were heavily infested with sea lamprey ammocetes.

Spawning-phase Sea Lampreys

A total of 12,158 sea lampreys were captured in assessment traps in six west shore and six east shore tributaries of Lake Michigan (Table 7, Fig. 2). On the west shore, the catch in the Peshtigo River (590) increased from that in 1982 (475), whereas the catch in the Menominee River (73) was about the same as in 1982 (62). The number of sea lampreys captured in the Manistique River (10,480) declined slightly (8%) from that in 1982 (11,417). No sea lampreys were captured for the fifth successive year in the Fox River, and only 18 were taken at the newly constructed barrier dam in the West Branch of the Whitefish River.

Catches of sea lampreys in six streams along the east shore of Lake Michigan decreased from the catches in 1982 (997 compared with 1,532). Most of the decline occurred in the Carp Lake, Jordan, and Boardman rivers, where catches decreased by 334, 123, and 84, respectively. Since the start of assessment trapping along the east shore in 1978, sea lampreys captured in the Carp Lake River have been significantly smaller than those captured at other sites in Lake Michigan and this trend continued in 1983. Sea lampreys from the Carp Lake River averaged 51 mm shorter and 55 g lighter than the average size of Lake Michigan lampreys; however, they average only 22 mm shorter and 31 g lighter than those sea lampreys captured in the Cheboygan river, a nearby stream in Lake Huron.

Parasitic Sea Lampreys

Lake Michigan fishermen captured 222 sea lampreys (commercial fisheries, 200; sport fisheries, 22) through October 1983, as compared with 188 in the same period in 1982. Fisheries from the Epoufette, Michigan, area (MM-3), and the Fairport, Michigan, area (MM-1), contributed the largest number of sea lampreys in 1983, 66 and 53, respectively, compared with 33 and 25, respectively, in 1982. Increases in northern Lake Michigan may indicate an influx of sea lampreys from large populations in Lake Huron.

The number of sea lampreys collected from the fisheries of Lake Michigan and fall wounding rates on lake trout indicate increases in lamprey populations in northern Lake Michigan and Green Bay. Northern Lake Michigan (excluding Green Bay) produced 103 sea lampreys in 1983, compared to 44 in 1982. Wounding rates in northern Lake Michigan for the same period increased from 2.1% to 3.4%. In Green Bay, similar increases were indicated by the number of sea lampreys collected, from 53 in 1982 to 88 in 1983, and wounding rates increased from 2.0% to 3.5%.

Special Studies

Population study in a lotic area. Point Patterson Creek is a relatively small, cool, trout stream, tributary to the north shore of Lake Michigan. The stream presented a unique opportunity for study because only a single year class of sea lampreys established between 1978 and 1983. The 1978 year class was first recovered in the fall of 1979 when six yearling sea lampreys were collected. The ammocete population was monitored by electrofishing through June 1983 for information on growth, relative abundance, transformation, and distribution.

Sea lamprey ammocetes of the 1978 spawning collected by electrofishing in Point Patterson Creek, 1979-83.

Month and year collected	Number of sea lampreys	Age	Length (mm) Range	Length (mm) Mean
Sept. 1979	6	I	32-44	40
July 1980	20	II	41-70	54
Aug. 1980	7	II	47-71	60
June 1981	2	III	72-82	77
Aug. 1981	11	III	74-106	84
Oct. 1981	50	III	72-110	88
May 1982	107	IV	76-134	104
June 1982	32	IV	87-129	107
Sept. 1982	51	IV	72-152	111
May 1983	43	V	96-160	119
June 1983	56	V	89-154	126
Total	385			

Ichthyomyzon larvae have never been collected in the stream; therefore, were used rather than marked sea lamprey larvae for the study. A total of 298 ammocetes about the same size as the sea lampreys in Point Patterson Creek were taken in September from a stream nearby. They were introduced at 10 sites within the infested portion of Point Patterson Creek, about 2.4 km (1.5 miles) of stream. Lampricide was applied to the stream in October, and a thorough collection effort yielded 497 sea lampreys and 81 Ichthyomyzon ammocetes. Thus, based on a recovery rate of 27.6%, the population of sea lamprey ammocetes numbered about 1,800.

Treatment effects upon nontarget organisms. Since 1980, the Control Units have intensified studies on the effects of TFM on nontarget organisms in response to public concerns. In 1983, an effort was made to establish a routine monitoring program on streams having a history of environmental complaints associated with previous treatments. Onsite testing of nontarget organisms was carried on in the Brule and Tahquamenon rivers (Lake Superior) and the Ford, Pere Marquette, and Whitefish rivers (Lake Michigan).

Before lampricide application, invertebrates and fish were caged in a portion of the stream that was to be treated and, as a control, in areas that would not be treated. Small fish (15.2 cm, <6 inches) were collected by electrofishing several days before treatment and caged in modified minnow traps. Invertebrates were dislodged from the substrate into a kick net and uninjured specimens were caged the day before treatment. Invertebrate cages (30.4 cm x 15.2 cm x 15.2 cm, 12 inches x 6 inches x 6 inches) were constructed of 6-mm

(1/4-inch) Plexiglas with Nitex nylon screening on two sides to allow water to flow through the cage. The cages were anchored to the stream bottom by attaching bricks. Because of the small size of some organisms, escapement was a problem in early trials, but was largely controlled by inserting balls of screening into the cages and by placing greater emphasis on sealing the cages.

The lampricide had little effect on most of the 22 species of fish included in the tests (Table 8). Mortality was high for fantail darters and the few longnose dace and blacknose dace tested in the Whitefish River. Treatment of this stream coincided with the spawning period for these species. Mortality of fish in control cages in all streams was insignificant.

The treatment of Scotts Creek, a tributary of the Whitefish River, was the final application of the 1983 field season. Sea lamprey larvae (50) and recently transformed individuals (2) were placed in the stream to determine if cold water (5°C, 41°F) would alter the effectiveness of TFM. All caged lampreys died during treatment.

Organisms of 31 invertebrate genera (Table 9) were tested. Mortality was high (92%) for Hexagenia in Scotts Creek due to an extremely long chemical bank. Mortality of this susceptible organism was much lower in the Brule River (19%), and Pere Marquette River where mortality for nymphs, <15 mm long, was 22% and for those >15 mm was 10% (20% were missing).

Mortality of Dolophilodes, a net-spinning caddisfly, and Glossosoma, a case-building caddisfly, was also significant where these organisms were tested. The differences in mortality of Campeloma snails in the Tahquamenon (40%) and Ford (15%) rivers probably reflect the addition of powdered Bayer to TFM in the treatment of the Tahquamenon River, whereas the Ford River was treated with TFM only. Mortality of invertebrates in control cages was usually insignificant.

LAKE HURON

Surveys

A total of 80 tributaries of Lake Huron were surveyed to assess larval sea lamprey populations.

Pretreatment surveys were completed in 32 streams; 9 were later treated and the remainder are scheduled for future treatment.

Posttreatment surveys were conducted in 10 streams. Residual sea lamprey larvae were recovered in the Little Pigeon River, Elliot and Albany creeks, and in the mouths of the Mississagi and Manitou rivers.

Reestablished populations of sea lampreys were detected in 17 streams. Moderate populations are indicated in the Pine (Mackinac County) and Carp rivers and small populations in the others. Young-of-the-year sea lampreys were found in nine streams, including the Ocqueoc River where spring floods allowed spawning-phase sea lampreys to negotiate the low-head barrier in the lower river. Survey of Martineau Creek revealed the first reinfestation of this stream since treatment in 1977.

Surveys upstream of the barrier dams on the Kaskawong and Sturgeon rivers were negative, confirming the effectiveness of the dams. Sea lampreys have become reestablished, however, below the dam in each river.

Sea lamprey ammocetes were found in two of four lentic areas surveyed with Bayer 73 granules. No larvae were collected off the mouths of either McKay or Nuns creeks and only one small ammocete (38 mm long) was collected in the 0.8 acre sampled in the Pine River (Mackinac County) delta. Surveys in St. Martin Bay, offshore of the Carp River, yielded 1,186 larvae (31-156 mm long) and 1 transforming sea lamprey. Individuals of the 1982 year class predominated in these collections, indicating rapid recruitment from the river.

Surveys were conducted in southeastern Michigan streams to identify significant sources of sea lamprey recruitment to southern Lake Huron. A total of 1,223 sea lamprey larvae (8-136 mm long) were collected from eight (Tawas, East Au Gres, Au Gres, Rifle, Pine (St. Clair County), Saginaw, and St. Clair rivers and Mill Creek) of 13 streams examined. The numbers and lengths of ammocetes (only 98 larvae >120 mm) indicate that these streams presently have a low potential for contributing significant numbers of parasitic-phase sea lampreys to Lake Huron.

Results of surveys conducted in 1983 and previous years in southern Georgian Bay suggest that sea lampreys are failing to reestablish in streams formerly known to produce them. Hog, Silver, and Telfer creeks and the Nottawasaga River, each entering southern Georgian Bay, were surveyed with negative results. Hog Creek has been treated once, Telfer Creek six times, Nottawasaga River four times (not the total system each time), and Silver Creek three times. During the last treatment of Silver Creek in September 1982 no larvae of the 1981 or 1982 year classes were collected. The recent decline in reestablishment of sea lampreys in tributaries of southern Georgian Bay is significant, and will continue to be monitored.

Sea lamprey problems continue to mount in the Saginaw River system, a major tributary to Lake Huron. Riprap constructed along the Dow Chemical Company dam on the Tittabawasse River, a Saginaw River tributary, may facilitate the migration of spawning-phase sea lampreys to the upper river. Prior to riprapping, spring floods or late closure of the fish ladder permitted spawning sea lampreys upstream from the dam in 1981, 1982, and 1983. Three year classes now inhabit the Chippewa River, a major tributary to the Tittabawasse River, and two year classes inhabit Bluff Creek, a minor tributary.

During surveys in the Saginaw River system in 1983, sea lampreys were found in two previously uninfested tributaries--the Cass River where 1 metamorphosed and 16 larval sea lampreys (72-169 mm long) were taken and the Shiawassee River where 1 metamorphosed individual was collected. Although populations appear small, the establishment of sea lamprey larvae in a river that was severely polluted reflects an improvement in water quality. Tributaries of the Saginaw River that will require treatment in 1984 are Bluff Creek, Chippewa and Cass rivers, and possibly the Shiawassee River.

Larval surveys were conducted in the St. Clair and Detroit rivers and Lake St. Clair in 1983. Sampling in the St. Clair River with Bayer 73 granules produced 42 sea lamprey ammocetes (32-125 mm long) from 10 of 29 stations; no larvae were collected from three stations surveyed with backpack shockers. One of six stations surveyed with granules in Lake St. Clair produced two sea lamprey larvae (74 and 106 mm). Although sea lampreys were not collected from five sites surveyed with Bayer 73 granules in the Detroit River, American brook lampreys were collected at three of the sites, indicating that a limited capacity for sea lamprey production may exist and further investigations are warranted.

Treatments

The lampricide TFM was applied to 14 streams of Lake Huron and the granulated formulation of Bayer 73 was applied to 4 areas of the St. Marys River and in Echo Lake in 1983 (Table 10, Fig. 3). Water levels in most streams were sufficient for lampricide application, except in McKay and Albany creeks where low water caused cancellation of the scheduled treatments. Sea lamprey ammocetes were numerous in the Au Sable, Mississagi, and Tawas rivers and Mulligan Creek and moderately abundant in Still and Rifle rivers.

Treatments of Elliot, Greene, Mulligan, and Schmidt creeks and the Pigeon River, a tributary of the Cheboygan River, were conducted during high stream discharges and at low lethal concentrations which resulted in negligible mortality of spawning white suckers.

Treatment of the Still River was conducted during late spring runoff and, consequently, it was not necessary to increase the discharge by manipulation of the dam at the outlet of Noganosh Lake. No problems were encountered during the treatment, and adequate levels of lampricide were maintained to the mouth. Sea lamprey ammocetes appeared to be absent above a small chute 11.7 km (7.3 miles) above the mouth, moderately abundant in the mid-section of the watershed, and scarce in the lower reaches. The Still River has sustained sporadic and marginal adult runs in recent years; however, a relatively high number of spawning adult lampreys was observed below the chute.

Treatment of the Mississagi River, a North Channel tributary and the most prolific sea lamprey producer on the Canadian side of Lake Huron, was facilitated by a controlled discharge provided by Ontario Hydro. Excellent lampricide coverage was obtained throughout three of the four channels in the vast mouth area, and substantial numbers of ammocetes were killed in the deltas. The effectiveness of the lampricide block on the most westerly channel was negated by strong winds and heavy seiche action, and posttreatment surveys indicated that some ammocetes survived in the lower 0.5 km (0.3 mile) of the channel. Some recruitment of metamorphosing specimens to the North Channel is expected.

An area directly off the mouth of the Echo River in Echo Lake was treated with Bayer 73 granules in 1983; large numbers of larval sea lampreys were observed. Periodic application of granules should provide an effective measure of control in this area.

Several large areas in the St. Marys River, from Whitefish Island to the mouth area of the Garden River, were again treated with Bayer 73 granules. Sea lamprey larvae were abundant in the area immediately below Whitefish Island and adjacent to the St. Marys Rapids. The number of sea lamprey larvae observed during treatments of this Whitefish Island area continues to fluctuate erratically and appears to be cyclic in nature--a year of high abundance succeeded by 2 or 3 years of declining numbers. Although treatment effectiveness undoubtedly plays a role in determining the numbers observed, a more influential aspect is spawning activity in the rapids area and subsequent downstream movement.

A large area extending along the shoreline of the St. Marys River, midway between Bellevue Park and the Sault Ste. Marie sewage treatment plant, identical to that treated in 1982, produced relatively large numbers of larval sea lampreys. However, numbers were considerably reduced from the 1982 treatment.

An area identical in size and location to that treated in 1980, 1981, and 1982 in the St. Marys River extending downstream from the mouth of the Garden River was again treated in 1983. Relatively large numbers of larval sea lampreys were observed, but a significant reduction in density has occurred since the original treatment in 1980.

A granular Bayer 73 application in the delta off the Root River produced moderate numbers of larval sea lampreys, comparable to that of the previous 5 years.

Spawning-phase Sea Lampreys

During the 1983 spawning season, 20,629 sea lampreys were captured in assessment traps in tributaries of Lake Huron (Table 11, Fig. 3), a decline from the number taken in 1982 (21,197). The Cheboygan River accounted for 71% of the total. No experiments were conducted in this stream in 1983, and future catches will be comparable on a year-to-year basis. The 1983 catch in the Thessalon River was the largest since trapping began in 1979. This increase supports the contention of commercial fishermen that sea lamprey populations are increasing in the North Channel and northern Lake Huron. The decrease in the catch from the Kaskawong River (446 in 1982 to 170 in 1983) is due to a decreased effort from 1982 when a mechanical weir was fished in conjunction with the trap. Beaver impoundments downstream of the barrier may have deterred the upstream movement of sea lampreys.

Traps fished in U.S. and Canadian waters of the St. Marys River captured 3,999 sea lampreys, 20% of the Lake Huron total. The total catch represented a 4% increase over the 1982 catch (3,848). Although this increase is slight, the proportion collected in U.S. and Canadian waters changed considerably. Traps were not fished in Canadian waters during 1982 because of the construction of a hydroelectric plant by Great Lakes Power Corporation, but only eight 8 lampreys (<1% of the total) were captured at the old powerhouse in 1981. The catch in U.S. waters of the St. Marys declined by 59% (3,848 in 1982 vs. 1,590 in 1983), whereas Canadian waters accounted for 2,409 sea lampreys (60% of the total) in 1983, by far the largest catch yet recorded there.

Parasitic Sea Lampreys

A total of 2,705 sea lampreys were collected (2,356 by commercial and 349 by sport fishermen) in Lake Huron (1,876 in U.S. and 829 in Canada), compared with 967 taken in 1982. Of the 829 sea lampreys submitted by Canadian commercial fisheries, 532 were from the North Channel and 297 from Lake Huron proper.

Commercial fishermen from statistical district MH-1 (DeTour-Rogers City, Michigan, area) contributed 1,302 sea lampreys in 1983, compared with 589 in 1982, indicating a continued high abundance of sea lampreys in northern Lake Huron. Also, the number of sea lampreys collected by commercial fishermen in statistical district MH-2 (Alpena, Michigan, area) increased from 82 in 1982 to 158 in 1983. Collections of sea lampreys in MH-4 (Tawas City-Bay Port, Michigan, area) remained the same in 1982 (68) and 1983 (67).

In recent years, sport fishermen in southern Lake Huron expressed concerns about increased wounds and scars on salmonids. Since 1982, sport fishermen from Port Austin and Harbor Beach, Michigan, and in 1983, fishermen from Grindstone City, Michigan, cooperated in the collection of parasitic-phase sea lampreys. A total of 349 sea lampreys were collected in 1983--305 from MH-4 (140 from Port Austin and 165 from Grindstone City, Michigan, area) and 44 from MH-5 (Harbor Beach, Michigan, area). Of the 150 lampreys from Port Austin and Harbor Beach, for which prey species were reported in 1983, 66% were attached to salmon and 34% were attached to lake trout; in 1982, 54% of 48 lampreys were attached to salmon and 46% to lake trout. The increased numbers of sea lampreys attached to salmon species indicate a shift in the predator-prey selection, or a decrease in the number of lake trout.

Special Studies

St. Marys River larval assessment. Evaluation of populations of larval sea lampreys in the St. Marys River continued in 1983. A total of 142 stations in U.S. and Canadian waters were surveyed with Bayer 73 granules, electroshockers, or a combination of both. Objectives were to define the abundance, lateral distribution, and length-frequency composition of ammocetes in the river. Other studies included examinations of larval and spawning habitats and preliminary investigations into food of larvae.

Surveys in the upper St. Marys River (upstream of the compensating gates), and upstream of any known sea lamprey-producing tributary, produced 32 sea lamprey larvae (41 to 141 mm long).

A total of 777 ammocetes (28-144 mm long) were taken from 26 of 32 areas examined in Lake Nicolet. Larvae were collected from the lake entrance to about 2 km (1.25 miles) north of Neebish Island (Fig. 4). Favorable larval habitat exists along the entire length of Sugar Island from a sand bench at the 1.8-2.4-m (6-8 ft.) contour to 4.6-6.1 m (15-20 ft.) where the bottom assumes the uniform silt-clay composition it retains to the shipping channel. Larvae were distributed laterally across this area from the shipping channel to 90 m (300 ft.) from Sugar Island. Habitat is less favorable west of the shipping channel where the bottom is relatively uniform and predominantly clay. The lateral distribution of larvae is not as extensive west of the channel.

Sea lamprey ammocetes were found for the first time in the West Neebish Channel. Twelve larvae (42-120 mm long) were collected from three of four areas examined upstream of the "rock cut", a narrow, bedrock-lined channel that separates Neebish Island and the U.S. mainland. No ammocetes were collected downstream of this area.

Sea lamprey ammocetes were first taken in the Middle Neebish Channel in 1978. Sampling since has centered near the "Hen and Chicken" island chain at the northeast corner of Neebish Island where ammocetes are collected regularly. Again in 1983, one area near the largest island yielded 48 sea lamprey larvae (41-128 mm long) and 1 transformed individual. Two areas down river were also examined, but did not yield ammocetes.

Sea lamprey larvae were found throughout Canadian waters of the Munuscong Channel. A total of 44 larvae (36-146 mm long), including two in early stages of transformation, were caught in seven positive surveys. No larvae were taken in two surveys in Munuscong Lake.

The section of the river north of Sugar Island to Lake George is heavily infested with larvae. Parts of this section of the river are treated annually on the Canadian side with Bayer 73 granules. U.S. waters in the channel were first examined in 1983, and 318 sea lamprey ammocetes were collected from 10 of 14 areas. The largest concentrations were in the upstream portion of the channel

Larvae were relatively scarce in Lake George and in East Neebish and St. Joseph Channels. Several larvae were taken in Lake George from the mouth to 2.5 km (1.5 miles) downstream, but none were captured in surveys throughout the remainder of the lake. A single larval sea lamprey was caught at the north end of St. Joseph Island, but judging from the direction of the flow in this area, it may have drifted from the Middle Neebish Channel.

Fall collections from the Whitefish Channel are used as an index to determine growth rates of sea lamprey ammocetes in the St. Marys River. Collections in 1983 indicated that age classes 0-III attained mean total lengths of 22 mm, 37 mm, 61 mm, and 85 mm by late October.

Mean total lengths (mm) of sea lamprey ammocetes collected from the Whitefish Channel in October, 1981-83.

Year collected	Age group 0	I	II	III
1981	25	45	66	94
1982	16	42	61	78
1983	22	37	61	85

Similar growth patterns have been observed in many cold, brook trout-type streams of the Upper Great Lakes where transformation likely does not begin until age VI or VII.

Substrate samples were taken throughout Canadian waters of the river to locate potential spawning gravel and evaluate larval habitat. From Gros Cap in the upper river to south of St. Joseph Island, 553 hauls were made with a ponar dredge. Good spawning gravel was found at various sites sampled from Point Louise in the upper river to below the confluence with the Garden River in the lower river (Fig. 4). Suitable larval habitat was found in most areas checked in the river, but the area sampled is too small to provide a quantitative evaluation of larval habitat. Coincidentally, 19 sea lamprey larvae were caught during the dredging operations.

Periphyton and phytoplankton samples were collected at seven sites in Canadian waters of the river during July to investigate food availability. Larval sea lampreys were collected at three of the sites to determine food utilization from gut analyses. Data from these collections have not been analyzed.

Population studies in a lotic area. Estimates of abundance of sea lamprey ammocetes in the St. Marys River are essential for overall assessment of the system. Population estimates were obtained for two areas near Whitefish Island.

Scuba divers constructed two square grids of four equal-sized plots in each. Grid 1 was near the southern breakwall bordering the Canadian locks. Grid 2 was about 61 m (200 ft.) south of grid 1 and just east of the channel through Whitefish Island. Cord was strung between stakes at the corners and center to delineate the grids on the stream bottom, and floats defined the corners and center of each grid on the surface.

Sea lamprey ammocetes were marked in four distinct groups and a different marked group was released on the bottom at the center of the inner quarter section of each plot. After an acclimation of 48 hours, Bayer 73 granules were applied at two rates. Grid 1 received 224.2 kg/ha (200 lbs/acre) and grid 2, 112.1 kg/ha (100 lbs/acre). Ammocetes were netted on the surface and collected by divers on the bottom.

The recovery of marked ammocetes was more than three times greater in grid 1 (35%) than in grid 2 (11%), and estimates of abundance were calculated for each grid because of the apparent influence of application rates. Two steps were involved in each estimate. First, the recovery rate of the four marked groups released into each grid was averaged and then the estimate for the grid was calculated based on the ratio of marked to unmarked larvae. The estimates were 201 larvae in grid 1 and 3,637 in grid 2. The higher density of larvae in grid 2 is likely due to its proximity to the mouth of the channel north of Whitefish Island.

<u>St. Marys River parasitic-phase assessment</u>. Monitoring the emigration of recently metamorphosed sea lampreys from the St. Marys River has been recognized as an important aspect in lamprey assessment. Although fyke netting was considered in the past, it was historically rejected as impractical on river systems such as the St. Marys. Nevertheless, an effort was undertaken in 1983 to determine if this method could be applied.

Sixteen riffle fyke nets with openings from 0.7 to 1.7 m^2 (8 to 18 sq. ft.) and mesh of 0.64 cm (0.25 inch) were operated from late October to early December. The nets were attached to navigational buoys or trap net anchors with 30.5 m (100 feet) lengths of nylon rope, and set at various depths from top to bottom over a maximum water depth of 9.8 m (32 ft.). The fyke nets were fished from 3.2 km (2 miles) downstream of Mission Point to 2 km (1.25 miles) downstream of Nine Mile Point in Lake Nicolet and at the entrance of the river into Lake George.

A total of seven transformed sea lampreys were taken in three of the fyke nets placed in the area about 3.2 km (2 miles) downstream of Mission Point. All were taken within 0.9 to 1.5 m (3 to 5 ft.) of the surface in water 7.6 m (25 ft.) deep, when water temperature ranged from 5.6 to 8.3°C (42 to 47°F), and during November 5-19. A recently transformed American brook lamprey was taken in one of the nets at the head of Lake George.

Four modified Susquehanna hoop-trap nets were also used to fish inshore areas. These nets were of 0.64-cm (0.25-inch) mesh with square hearts of 3.3 m^2 (36 sq. ft.) and 15.2- x 1.8-m (50- x 6-ft.) wings. Cods consisted of five 0.91-m (3-ft.) diameter hoops with throats at the second and fourth hoops. Hoop-trap nets were fished throughout the water column in depths of 1.5 m (5 ft. for 10 days in November at the following locations: 2.8 km (1.75 miles) downstr of Mission Point, Six Mile Point, and Nine Mile Point. No lampreys were taken i the hoop-trap nets.

The pilot netting operation conducted in the St. Marys River included more than 11,500 net hours of fishing and filtration of more than 10 million cubic meters of water (exclusive of the hoop-trap nets). Fyke nets are not precise scientific tools, but the capture of seven recently metamorphosed sea lampreys in light of a seemingly inefficient method is significant.

LAKE ERIE

No stream treatment program is in effect on Lake Erie, and no stream surveys were conducted in 1983.

Spawning-phase Sea Lampreys

Assessment traps fished for the fourth successive year in Cattaraugus Creek captured 1,671 sea lampreys, an increase of 75% from the number captured in 1982 (954). The mean length and weight of the spawning-run adults were about the same as those taken in 1981-82, but remained slightly smaller than the sea lampreys in 1980. The percentage of males increased from 50 in 1982 to 53 in 1983.

Parasitic Sea Lampreys

Commercial fishermen from the eastern basin of Lake Erie collected 31 parasitic-phase sea lampreys. The eastern basin is the deepest area of Lake Erie and contains a salmonid population for sea lampreys to feed on.

LAKE ONTARIO

Surveys

Larval surveys were conducted on 37 of 52 Lake Ontario tributaries. Streams designated as non-producers were not surveyed.

Pretreatment surveys were completed on the Rouge and Salmon rivers and Wilmot, Graham, Skinner, and Lindsey creeks and Cobourg Brook in preparation for 1983 treatments and on the Credit River and Duffin, Lynde, Oshawa, and Farwell creeks scheduled for treatment in 1984.

Treatment evaluation surveys were conducted on 13 tributaries treated in 1982. Shelter Valley Brook, a difficult stream to treat effectively, contained a significant number of residual sea lamprey larvae. Low numbers of residual sea lampreys were recovered in the Little Salmon River and Little Sandy, Grindstone, Bronte, and Grafton creeks; no residual sea lampreys were collected from Port Britain, Lakeport, Salem, Smithfield, Stony, Ninemile, and Sterling creeks.

Sea lamprey larvae were reestablished in 11 of the above 13 streams. Surveys were conducted too soon in the year to determine whether larvae reestablished in Stony Creek and the Little Salmon River after treatment in late fall of 1982.

Blind Sodus Creek (treated in 1976 and 1978) and Gage Creek (last treated in 1971) were surveyed in 1983; sea lamprey larvae did not become reestablished in these streams.

Surveys with granular Bayer 73 off the mouth of Mayhew Creek, a tributary of the Trent River, yielded 69 sea lamprey larvae. Spawning-phase sea lampreys have been observed in the Trent River upstream of the mouth of Mayhew Creek, and the larvae collected may be progeny of lampreys spawned in Mayhew Creek, the Trent River, or both.

Surveys of the Oneida Lake drainage were completed in preparation for treatment in 1984. Sea lampreys were found only in three north shore tributaries (Fish, Scriba, and Big Bay creeks). No native lampreys were found. Fish Creek yielded 1,599 larval (16-180 mm long) and 98 transforming sea lampreys in 56 of 217 stations. The numerous oxbows and side channels were not as extensively infested as anticipated; 253 ammocetes (29-149 mm) and and 36 transforming lampreys were collected in 11 of 32 oxbows. Lentic surveys off the mouth of Fish Creek produced four ammocetes (55-110 mm) and six metamorphosing lampreys in 5 of 12 stations. Big Bay Creek yielded 191 ammocetes (14-140 mm long) and 18 metamorphosed lampreys in 7 of 19 stations; no sea lampreys were found in four stations examined offshore. Only four ammocetes (54-63 mm long) were recovered from one of four stations examined in Scriba Creek and only one metamorphosed lamprey was collected from one of two stations examined offshore. None of the south shore tributaries examined contained sea lampreys probably due to the prevalence of municipal, industrial, and agricultural pollutants.

Treatments

Chemical treatments were completed on 10 Lake Ontario streams during the field season (Table 12, Fig. 5).

Treatments of Bowmanville and Mayhew creeks and Cobourg Brook were conducted at optimum discharges, and a high mortality of ammocetes was achieved throughout the watersheds. Historically, the estuary of Bowmanville Creek has been thermally stratified which decreases the effectiveness of treatment; however, the higher discharge in 1983 resulted in an effective treatment.

Treatment of Graham Creek was complicated by low discharge and required numerous lampricide applications to maintain adequate TFM levels. The estuary was thermally stratified and an effective kill of ammocetes was not attained in that area. Surveys indicated that sea lamprey larvae were moderately abundant in this area. Mortality of nontarget fish was sporadic throughout the watershed; a few common white suckers, creek chubs, and longnose dace were killed.

The lampricide application to the main Salmon River was facilitated by a controlled discharge provided by Niagara Mohawk Power Corporation and initiated from a point immediately below the Salmon River Fish Hatchery water intake. Satisfactory concentrations of lampricide were achieved throughout the large estuary. Sea lamprey larvae were scarce in the main stem; only 194 specimens (26-151 mm long) were collected.

Tributaries of the Salmon River (Orwell, Beaverdam, and Trout brooks) were treated at high discharges before the main stream. The higher discharges enhanced treatment and the lampricide was carried to large, inaccessible beaver ponds where significant escapement of larvae had occurred during the 1981 treatment. Sea lamprey ammocetes were moderately abundant in the tributaries and a significant number of residuals were collected.

The lampricide treatments of Skinner and Lindsey creeks were aided by good flows, and lethal concentrations of lampricide were attained to the stream mouths. The treatments were difficult because of rapid flow times, continual need to boost lampricide and cover tributaries, and the supplementary application requirements. Larval sea lampreys, including those of transformation size, were abundant in both streams, as were adult spawning-phase sea lampreys. Except for a short stretch of Big Deerlick Creek, a tributary of Skinner Creek, where about 1,000 mature bullheads were killed, nontarget fish mortality was negligible on both treatments.

Transforming sea lampreys were collected from South Sandy and Wilmot creeks and Rouge River during treatments in October. The largest number collected was in Rouge River, and justified scheduling the treatment 1 year in advance.

Spawning-phase Sea Lampreys

Traps fished in four tributaries of the north shore produced 5,898 spawning-phase sea lampreys in 1983 (Table 13, Fig. 5), more than a four-fold increase over the number captured in 1982 (1,414). In contrast, traps fished in five south shore streams captured 1,331 sea lampreys, compared with 1,364 in 1982. A partial explanation for the increase in lampreys on the north shore is the doubling of the trapping effort on the Humber River. The second trap contributed 2,513 sea lampreys to the total.

Little change in biological characteristics was observed from those sampled in 1982. Males composed a majority (60%) of the lampreys examined, a characteristic of the population prevalent since the first year of sampling in 1978.

Parasitic Sea Lampreys

No parasitic-phase sea lampreys were collected from the Lake Ontario commercial fisheries, but regulatory constraints direct the fishery away from preferred lamprey hosts.

Special Studies

Marking transforming sea lampreys in New York State. In the fall of 1982, a total of 1,588 sea lampreys from Fish and Big Bay creeks (tributaries to Oneida Lake, New York) were injected with a colored dye and released back into the creeks to determine whether these lampreys would find their way into Lake Ontario. Inspection of 99 parasitic sea lampreys taken from New York waters of Lake Ontario during the ELSO Derby in the spring of 1983 failed to indicate the presence of such a dye mark.

The study was continued in August 1983 when an additional 1,528 transforming sea lampreys were captured in Big Bay and Fish creeks, marked with dye injection and released into the same waters. Predatory-phase sea lampreys collected from the Lake Ontario fisheries in 1984 and spawning-phase sea lampreys captured in 1985 will be examined for marks to identify any which originated in the Oneida Lake system.

Treatment effects upon nontarget organisms. A study on the effects of TFM upon the invertebrates of Fish Creek (Oneida Lake) was begun in the fall of 1983. The initial treatment of Fish Creek is scheduled for 1984. This untreated system can provide valuable information on the effects of TFM upon nontarget invertebrates. All past field studies were conducted on previously treated systems. Samples were collected in September 1983 to gather base line data. Sampling will continue before and after TFM applications during the summer and again in the fall 1984 to determine effects of TFM on invertebrate communities.

Table 1. Summary of chemical treatments in streams, lakes, and bay areas of the Great Lakes in 1983.

Lake	Number of treatments	Discharge at mouth		TFM		Bayer 73			
						Powder		Granules	
				Act. Ingr.		Act. Ingr.		Total used[a]	
		m^3/s	f^3/s	kg	lbs	kg	lbs	kg	lbs
Superior	31	166.4	5,888	17,336	38,162	199	439	5,438	11,963
Michigan	17	72.7	2,565	19,024	41,866	65	143	-	-
Huron	19	154.6	5,463	20,725	45,672	77	169	2,183	4,802
Ontario	10	50.6	1,788	6,109	13,440	15	33	-	-
TOTAL	77	444.3	15,704	63,194	139,140	356	784	7,621	16,765

[a]Sand granules coated with Bayer 73 at 5% by weight active ingredient.

Table 2. Number and biological characteristics of adult sea lampreys captured in assessment traps in 38 tributaries of the Great Lakes in 1983.

Lake	Number of streams	Total captured	Number sampled	Percent males	Mean length (mm)		Mean weight (g)	
					Males	Females	Males	Females
Superior	9	1,464	1,283	30	416	407	162	157
Michigan	12	12,158	4,501	40	476	478	218	232
Huron	7	20,629	4,180	49	465	471	220	234
Erie	1	1,671	1,544	53	498	492	275	278
Ontario	9	7,229	3,220	60	463	459	221	230

[Number in parentheses corresponds to location of stream, lake, or bay in Figure 1.]

Stream, lake, or bay	Date	Discharge at mouth m^3/s	Discharge at mouth f^3/s	TFM Act. kg	TFM Ingr. lbs	Bayer 73 Powder Act. kg	Bayer 73 Powder Ingr. lbs	Bayer 73 Granules Total used[a] kg	Bayer 73 Granules Total used[a] lbs	Stream treated km	Stream treated miles	Area treated ha	Area treated acres
CANADA													
Little Carp R. (15)	June 7	0.7	25	71	156	-	-	-	-	9.4	6	-	-
Stillwater Cr. (5)	June 12	0.3	10	49	108	-	-	-	-	4.5	3	-	-
Polly Cr. (7)	June 15	0.2	8	48	106	-	-	-	-	2.8	2	-	-
Cash Cr. (8)	June 18	1.2	42	376	827	-	-	8	18	22.6	14	-	-
Lower Nipigon R.[b] (6)	July 10	67.4	2,382	6,188	13,614	99	218	-	-	5.0	3	-	-
Steel R. (12)	Aug. 16	3.4	120	316	695	5	11	-	-	10.1	6	-	-
Kaministikwia R. (2)	Aug. 19	28.8	1,017	3,057	6,725	53	117	9	20	58.1	36	-	-
Black Sturgeon R. (4)	Aug. 24	7.3	258	1,108	2,438	17	37	6	13	16.2	10	-	-
Chippewa R. (14)	Sept. 13	2.8	100	200	440	3	7	-	-	2.9	2	-	-
Batchawana R. (13)	Sept. 28	14.4	508	983	2,163	-	-	-	-	13.0	8	-	-
Helen Lake (9)	July 8	-	-	-	-	-	-	808	1,778	-	-	3.3	8
Batchawana Bay (13)													
Chippewa R.	July 20	-	-	-	-	-	-	908	1,998	-	-	3.7	9
Sable R.	July 22	-	-	-	-	-	-	294	647	-	-	1.2	3
Batchawana R.	July 25	-	-	-	-	-	-	907	1,995	-	-	3.7	9
Sand Point	July 26	-	-	-	-	-	-	272	598	-	-	1.1	3
Stokely Cr.	July 29	-	-	-	-	-	-	363	798	-	-	1.5	4
Harmony R.	Aug. 2	-	-	-	-	-	-	272	598	-	-	1.1	3
Polly Lake[b] (7)	Aug. 17	-	-	-	-	-	-	227	500	-	-	0.9	2
Mackenzie Bay (3)	Aug. 22	-	-	-	-	-	-	454	999	-	-	1.9	5
Cypress Bay (10)	Aug. 24	-	-	-	-	-	-	364	800	-	-	1.4	4
Mountain Bay (11)	Aug. 24	-	-	-	-	-	-	546	1,201	-	-	2.2	5
Total		126.5	4,470	12,396	27,272	177	390	5,438	11,963	144.6	90	22.0	55

(continued)

Table 3. Continued.

Stream, lake, or bay	Date	Discharge at mouth		TFM		Bayer 73				Stream treated		Area treated	
				Act. Ingr.		Powder Act. Ingr.		Granules Total used[a]					
		m3/s	f3/s	kg	lbs	kg	lbs	kg	lbs	km	miles	ha	acres
UNITED STATES													
Salmon Trout R. (26)	May 19	2.1	75	220	484	-	-	-	-	11.3	7	-	-
Iron R. (25)	June 29	4.0	140	329	726	-	-	-	-	3.2	2	-	-
Tahquamenon R. (17)	July 7	9.3	330	1,327	2,926	22	49	-	-	29.0	18	-	-
Galloway Cr. (16)	July 12	0.1	3	20	44	-	-	-	-	3.2	2	-	-
Little Two Hearted R. (18)	Aug. 5	1.0	37	100	220	-	-	-	-	14.5	9	-	-
Big Two Hearted R. (19)	Aug. 6	3.7	130	798	1,760	-	-	-	-	72.6	45	-	-
Laughing Whitefish R. (22)	Aug. 18	0.1	4	60	132	-	-	-	-	1.6	1	-	-
Furnace Cr. (21)	Aug. 21	0.2	8	20	44	-	-	-	-	1.6	1	-	-
Arrowhead R. (1)	Sept. 2	2.1	75	90	198	-	-	-	-	1.6	1	-	-
Brule R. (29)	Sept. 3	4.2	150	868	1,914	-	-	-	-	88.7	55	-	-
Big Garlic R. (24)	Oct. 7	0.8	30	100	220	-	-	-	-	9.7	6	-	-
Silver R. (28)	Oct. 18	5.2	185	469	1,034	-	-	-	-	4.8	3	-	-
Slate R. (27)	Oct. 18	1.6	56	60	132	-	-	-	-	1.6	1	-	-
Sucker R. (20)	Oct. 18	5.1	180	379	836	-	-	-	-	22.6	14	-	-
Harlow Cr. (23)	Nov. 2	0.4	15	100	220	-	-	-	-	6.5	4	-	-
Total		39.9	1,418	4,940	10,890	22	49	-	-	272.5	169	-	-
GRAND TOTAL		166.4	5,888	17,336	38,162	199	439	5,438	11,963	417.1	259	22.0	55

[a]Sand granules coated with Bayer 73 at 5% by weight active ingredient.

[b]Initial treatment.

Table 4. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Superior, 1983. [Letter in parentheses corresponds to location of stream in Figure 1.]

Stream	Number captured	Number sampled	Percent males	Mean length (mm)		Mean weight (g)	
				Males	Females	Males	Females
CANADA							
Pancake R. (A)	29	28	25	434	426	176	175
Stokely Cr. (B)	5	5	60	485	425	253	188
Total or average	34	33	30	449	426	199	176
UNITED STATES							
Tahquamenon R. (C)	182	182	50	430	431	174	180
Betsy R. (D)	58	56	21	394	395	135	150
Sucker R. (E)	183	32	38	408	388	154	147
Miners R. (F)	1	1	0	-	362	-	101
Rock R. (G)	608	581	28	412	407	154	153
Big Garlic R. (H)	361	361	23	407	402	160	154
Iron R. (I)	37	37	27	423	397	181	150
Total or average	1,430	1,250	30	415	407	161	156
GRAND TOTAL OR AVERAGE	1,464	1,283	30	416	407	162	157

Table 5. Variables used to determine the population estimate (95% confidence intervals in parentheses) of sea lamprey larvae and the percentage of larvae >120 mm in the Big Garlic River in 1983.

[Population estimate is calculated for each study area by the Petersen formula (number marked x number examined for marks divided by the number of marked recaptured), and then is expanded to an estimate for each zone based on the ratio of amount of habitable substrates in each study area to that in each zone. The total estimate for the stream is the sum of estimates for each zone.]

Zone	Zone length (ft.)	Study area in zone (ft.)	Marked larvae: Number released	Marked larvae: Recaptured Number	Marked larvae: Recaptured Percentage	Number unmarked collected	Study area: Area[a] (sq.ft.)	Study area: Population estimate	Total in zone: Area[a] (sq.ft.)	Total in zone: Population estimate[b]	Total in zone: Percentage[b] >120 mm
A	2,100	1,500	742	380	51	5,936	37,800	12,332	45,000	14,673 (13,270-16,193)	43
B	5,400	900	211	54	26	1,110	15,500	4,548	103,200	30,310 (23,220-39,537)	47
C	10,500	750	265	74	28	1,309	16,200	4,953	116,400	35,585 (28,342-44,702)	21
D	9,900	900	175	72	41	392	7,800	1,128	72,600	10,439 (8,274-13,163)	20
Total	27,900	4,050	1,393	580	42	8,747	77,300	22,961	337,200	91,007 (73,106-113,595)	33

[a]Refers to total area of substrate types in which larvae may be found.

[b]The percentage of larvae >120 mm was calculated as a separate estimate similar to that of the estimate of all larvae (i.e., number >120 mm marked x number >120 mm examined for marks divided by the number of marked >120 mm recaptured, and then expanded by total habitable substrates), but for simplicity, is represented as percentage of the total estimate.

Table 6. Details on the application of lampricides to streams of Lake Michigan, 1983.

[Number in parentheses corresponds to location of stream in Figure 2.]

Stream	Date	Discharge at mouth		TFM		Bayer 73 powder		Stream treated	
		m^3/s	f^3/s	Act. kg	Ingr. lbs	Act. kg	Ingr. lbs	km	miles
ord R. (2)									
Upper R.	May 7	5.7	200	738	1,628	-	-	16.1	10
Ten Mile Cr.	May 10	4.1	145	1,068	2,354	-	-	40.3	25
Lower R.	Sept. 30	5.7	200	2,784	6,072	-	-	161.3	100
orton Cr. (10)	May 10	0.6	20	120	264	-	-	1.6	1
arent Cr. (5)	May 20	0.5	17	60	132	-	-	3.2	2
ock R. (8)	May 22	0.5	18	70	154	-	-	3.2	2
ark R. (1)	June 3	2.1	75	359	792	-	-	4.8	3
hitefish R. (4)									
Haymeadow Cr.	June 4	2.0	70	150	330	-	-	8.1	5
Pole Cr.	June 6	1.6	56	110	242	-	-	8.1	5
Bills Cr.	June 7	1.0	35	50	110	-	-	6.5	4
Whitefish R. (main stream)	June 18	7.1	250	2,475	5,456	-	-	61.3	38
Haymeadow Cr. (re-treatment)	Oct. 25	0.8	30	130	286	-	-	8.1	5
Dexter Cr.	Oct. 26	0.6	20	120	264	-	-	11.3	7
Scotts Cr.	Oct. 27	0.3	12	210	462	-	-	4.8	3
ortage Cr. (3)	June 5	1.3	45	150	330	-	-	16.1	10
urns Ditch (17)	June 5	1.8	65	479	1,056	-	-	33.9	21
alien R. (16)	June 19	1.2	44	589	1,298	-	-	22.6	14
entwater R. (13)	June 29	1.7	60	399	880	-	-	30.6	19
hite R. (14)	July 8	11.0	390	3,114	6,864	19	41	121.0	75

(continued)

Table 6. Continued.

Stream	Date	Discharge at mouth		TFM		Bayer 73 powder		Stream treated	
		m^3/s	f^3/s	Act. kg	Ingr. lbs	Act. kg	Ingr. lbs	km	mile
Pere Marquette R. (12)	July 24	15.6	550	3,792	8,360	38	84	248.4	154
Betsie R. (11)	Aug. 8	4.8	170	1,158	2,552	8	18	14.5	9
Bursaw Cr. (6)	Sept. 14	0.1	2	30	66	-	-	3.2	2
Point Patterson Cr. (7)	Sept. 16	0.1	2	20	44	-	-	1.6	1
Carp Lake R. (9)	Oct. 1	0.1	4	30	66	-	-	1.6	1
Grand R. (15)									
Sand Cr.	Oct. 28	0.5	19	230	506	-	-	3.2	2
Crockery Cr.	Oct. 31	1.9	66	589	1,298	-	-	38.7	24
TOTALS		72.7	2,565	19,024	41,866	65	143	874.1	542

Table 7. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Michigan, 1983.

[Letter in parentheses corresponds to location of stream in Figure 2.]

Stream	Number captured	Number sampled	Percent males	Mean length (mm) Males	Mean length (mm) Females	Mean weight (g) Males	Mean weight (g) Females
WEST SHORE							
Fox R. (A)	0	0	-	-	-	-	-
Peshtigo R. (B)	590	590	44	480	481	235	247
Menominee R. (C)	73	73	41	449	461	188	215
W. Br. Whitefish R. (D)	18	17	47	471	440	232	210
Manistique R. (E)	10,480	2,835	39	484	483	218	233
Weston Cr. (F)	0	0	-		-	-	-
EAST SHORE							
Carp Lake R. (G)	241	241	39	424	427	165	171
Jordan R.							
Deer Cr. (H)	6	6	38	480	442	251	206
Boardman R. (I)	88	88	40	455	455	216	221
Betsie R. (J)	235	225	41	453	460	217	230
Muskegon R. (K)	86	86	43	474	485	223	255
St. Josephs R. (L)	341	340	39	474	486	227	245
ND TOTAL OR AVERAGE	12,158	4,501	40	476	478	218	232

Table 8. Percentage of fish dead or missing of those caged during treatments of five streams with lampricides in 1983.

	Lake Superior						Lake Michigan								
	Brule River			Tahquamenon R.			Ford River			Pere Marquette R.			Whitefish River		
		Percentage			Percentage			Percentage			Percentage			Percentage	
Species of fish	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost
Sea lamprey[a]															
Larvae													50	100	0
Metamorphosed larvae													2	100	0
Brook trout	5	0	0												
Chinook salmon										4	50	0			
Coho salmon										2	0	0			
Rainbow trout	8	0	12							21	0	25	1	0	0
Blacknose dace				1	0	0							3	67	0
Bluntnose minnow							1	0	0						
Common shiner							15	0	0						
Longnose dace				6	0	0	4	25	0				2	50	0
Northern redbelly dace													2	0	0
Northern hog sucker							1	0	0						

(continued)

Table 8. Continued.

Species of fish	Lake Superior						Lake Michigan								
	Brule River			Tahquamenon R.			Ford River			Pere Marquette R.			Whitefish River		
		Percentage			Percentage			Percentage			Percentage			Percentage	
	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost
White sucker													1	0	0
Burbot				2	0	0							7	0	0
Brook stickleback													1	0	0
Rock bass				8	25	0	3	0	0						
Smallmouth bass							8	0	0						
Blackside darter				10	0	0	10	0	0						
Fantail darter							16	0	25				6	83	0
Johnny darter				10	0	25	10	0	0						
Logperch				7	0	0	3	0	0						
Mottled sculpin	1	0	0	10	0	10				5	0	0	19	0	0
Slimy sculpin										5	0	0			

[a]Sea lampreys were caged in Scott Creek, a tributary of the Whitefish River.

with lampricides in 1983.

Taxon	Lake Superior						Lake Michigan								
	Brule River			Tahquamenon R.			Ford River			Pere Marquette R.			Whitefish River		
		Percentage			Percentage			Percentage			Percentage			Percentage	
	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost
Plecoptera															
Perlidae															
Acroneuria	7	0	0	7	0	0							3	0	0
Paragnetina				4	0	0							5	0	0
Phasganophora													2	0	0
Pteronarcidae															
Pteronarcys	3	0	0												
Ephemeroptera															
Ephemerellidae															
Ephemerella	2	0	0							7	0	0	10	0	20
Heptageniidae															
Epeorus													21	0	14
Stenonema				1	0	0	23	0	0						
Ephemeridae															
Hexagenia (≤15 mm)										25	8	20			
Hexagenia (>15 mm)										27	22	0			
Hexagenia	27	19	0										50[a]	92[a]	0[a]
Potamanthidae															
Potamanthus							20	0	5						
Siphlonuridae															
Isonychia							20	5	10	12	8	0			

(continued)

Table 9. Continued.

Taxon	Lake Superior						Lake Michigan								
	Brule River			Tahquamenon R.			Ford River			Pere Marquette R.			Whitefish River		
	No.	Percentage Dead	Percentage Lost	No.	Percentage Dead	Percentage Lost	No.	Percentage Dead	Percentage Lost	No.	Percentage Dead	Percentage Lost	No.	Percentage Dead	Percentage Lost
Ephemeroptera (continued)															
Tricorythidae															
<u>Tricorythodes</u>										17	0	0			
Baetidae															
<u>Baetis</u>	15	33	7	7	14	14	3	0	0	1	0	0			
<u>Centroptilum</u>							2	0	0						
<u>Pseudocloeon</u>				5	20	20	16	0	0						
Leptophlebiidae															
<u>Paraleptophlebia</u>							3	0	0						
Trichoptera															
Philopotamidae															
<u>Dolophilodes</u>	10	100	0										21	19	81
Polycentropodidae															
<u>Phylocentropus</u>													17[a]	29[a]	0[a]
Hydropsychidae															
<u>Cheumatopsyche</u>				4	0	0	4	0	0						
<u>Hydropsyche</u>							1	0	0	15	0	0			
<u>Macronema</u>							1	0	0						
<u>Symphitopsyche</u>	10	0	0	17	4	0	3	0	0				11	0	67
Rhyacophilidae															
<u>Rhyacophila</u>	2	0	0										7	0	30

(continued)

	Lake Superior						Lake Michigan								
	Brule River			Tahquamenon R.			Ford River			Pere Marquette R.			Whitefish River		
		Percentage			Percentage			Percentage			Percentage			Percentage	
Taxon	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost
Trichoptera (continued)															
Glossosomatidae															
Glossosoma				2	0	0				19	42	10	20	45	5
Glossosoma (small)	10	20	80												
Glossosoma (large)	20	85	15												
Brachycentridae															
Brachycentrus	11	18	9							10	0	0			
Limnephilidae															
Pycnopsyche													10	0	0
Coleoptera															
Elmidae (larvae)							6	0	33						
Optioservus (adult)							15	0	0						
Stenelmis (adult)							5	0	0						
Diptera															
Athericidae															
Atherix	13	0	0							6	0	33			
Gastropoda															
Campeloma				10	40	0	20	15	0						

[a]Organisms were caged in Scott Creek, a tributary of the Whitefish River.

Table 10. Details on the application of lampricides to streams, lakes, or bays of Lake Huron, 1983.

[Number in parentheses corresponds to location of stream, lake, or bay in Figure 3.]

Stream, lake, or bay	Date	Discharge at mouth		TFM		Bayer 73 Powder		Bayer 73 Granules Total used[a]		Stream treated		Area treated	
		m^3/s	f^3/s	Act. kg	Ingr. lbs	Act. kg	Ingr. lbs	kg	lbs	km	miles	ha	acres
CANADA													
Still R. (6)	June 3	5.9	207	156	343	-	-	-	-	19.7	12	-	-
Echo R. (3)	June 28	1.0	35	77	170	-	-	-	-	2.8	2	-	-
Lauzon Cr. (5)	July 28	0.6	23	25	55	-	-	-	-	0.8	1	-	-
Mississagi R. (4)	July 27	59.5	2,102	3,912	8,606	57	125	2	4	39.5	24	-	-
Echo Lake (3)	June 29	-	-	-	-	-	-	273	600	-	-	1.1	3
St. Marys R. (2)													
Garden R.	July 12	-	-	-	-	-	-	364	800	-	-	1.5	4
Station H	July 20	-	-	-	-	-	-	749	1,650	-	-	3.0	7
Whitefish Island	July 22	-	-	-	-	-	-	681	1,498	-	-	2.7	7
Root R.	July 25	-	-	-	-	-	-	114	250	-	-	0.5	1
Total		67.0	2,367	4,170	9,174	57	125	2,183	4,802	62.8	39	8.8	22

(continued)

Table 18. Continued.

Stream, lake, or bay	Date	Discharge at mouth m^3/s	Discharge at mouth f^3/s	TFM Act. Ingr. kg	TFM Act. Ingr. lbs	Bayer 73 Powder Act. Ingr. kg	Bayer 73 Powder Act. Ingr. lbs	Bayer 73 Granules Total used[a] kg	Bayer 73 Granules Total used[a] lbs	Stream treated km	Stream treated miles	Area treated ha	Area treated acres
UNITED STATES													
Elliot Cr. (8)	May 6	0.8	28	60	132	-	-	-	-	3.2	2	-	-
Cheboygan R. (7)													
Little Pigeon R.	May 11	1.2	42	299	660	-	-	-	-	4.8	3	-	-
Cheboygan R. (lower)	Oct. 3	20.0	707	3,672	8,096	2	5	-	-	1.6	1	-	-
Green Cr. (9)	May 21	0.5	18	50	110	-	-	-	-	3.2	2	-	-
Mulligan Cr. (10)	May 23	0.7	26	60	132	-	-	-	-	4.8	3	-	-
Schmidt Cr. (11)	May 25	1.0	35	100	220	-	-	-	-	1.6	1	-	-
Tawas R. (15)	Aug. 19	1.1	38	269	594	-	-	-	-	9.7	6	-	-
Au Sable R. (13)	Aug. 23	37.9	1,340	7,624	16,808	-	-	-	-	22.6	14	-	-
Rifle R. (14)	Sept. 6	22.7	800	3,892	8,580	18	39	-	-	177.4	110	-	-
Flowers Cr. (1)	Sept. 15	0.0	1	10	22	-	-	-	-	1.6	1	-	-
Swan R. (12)	Oct. 17	1.7	61	519	1,144	-	-	-	-	4.8	3	-	-
Total		87.6	3,096	16,555	36,498	20	44	-	-	235.3	146	-	-
GRAND TOTAL		154.6	5,463	20,725	45,672	77	169	2,183	4,802	298.1	185	8.8	22

[a]Sand granules coated with Bayer 73 at 5% by weight active ingredient.

Table 11. Number and biological characteristics of adult sea lampreys captured in assessment traps fished in tributaries of Lake Huron, 1983. [Letter in parentheses corresponds to location of stream in Figure 3.]

Stream	Number captured	Number sampled	Percent males	Mean length (mm)		Mean weight (g)	
				Males	Females	Males	Females
CANADA							
St. Marys R. (A)	2,409	1,663	56	465	475	223	240
Echo R. (B)	0	-	-	-	-	-	-
Kaskawong R. (C)	170	170	35	439	455	187	211
Thessalon R. (D)	734	662	48	475	483	230	251
Total or average	3,313	2,495	53	466	475	223	241
UNITED STATES							
St. Marys R. (A)	1,590	682	44	486	484	239	249
Trout R. (E)	4	0	-	-	-	-	-
Ocqueoc R. (F)	1,010	0	-	-	-	-	-
Cheboygan R. (G)	14,712	1,003	41	445	451	196	204
Total or average	17,316	1,685	42	463	466	214	225
GRAND TOTAL OR AVERAGE	20,629	4,180	49	465	471	220	234

Table 12. Details on the application of lampricides to streams of Lake Ontario, 1983.

[Number in parentheses corresponds to location of stream in Figure 5.]

Stream	Date	Discharge at mouth		TFM		Bayer 73				Stream treated	
						Powder		Granules			
				Act.	Ingr.	Act.	Ingr.	Total used[a]			
		m^3/s	f^3/s	kg	lbs	kg	lbs	kg	lbs	km	miles
CANADA											
Bowmanville Cr. (2)	May 7	2.8	100	921	2,026	7	15	-	-	11.6	7
Cobourg Br. (5)	June 8	1.3	46	466	1,025	-	-	-	-	11.2	7
Mayhew Cr. (6)	June 10	0.2	7	59	130	-	-	-	-	3.2	2
Graham Cr. (4)	June 12	0.3	11	219	482	-	-	-	-	16.4	10
Wilmot Cr. (3)	Oct. 20	0.7	24	487	1,071	-	-	-	-	22.0	14
Rouge R. (1)	Oct. 25	1.5	53	751	1,652	-	-	-	-	29.9	19
Total		6.8	241	2,903	6,386	7	15	-	-	94.3	59
UNITED STATES											
Skinner Cr. (8)	May 11	1.9	68	414	910	-	-	-	-	12.6	8
Salmon R. (10)	May 16	27.5	972	1,176	2,588	8	18	-	-	27.6	17
Orwell Br.	May 7	2.0	71	189	416	-	-	-	-	4.2	3
Beaverdam Br.	May 9	2.2	78	180	396	-	-	-	-	5.4	4
Trout Br.	May 13	1.8	64	189	416	-	-	-	-	16.7	10
Lindsey Cr. (9)	May 14	0.8	29	152	334	-	-	-	-	14.5	9
South Sandy Cr. (7)	Oct. 16	7.6	265	906	1,994	-	-	-	-	11.9	7
Total		43.8	1,547	3,206	7,054	8	18	-	-	92.9	58
GRAND TOTAL		50.6	1,788	6,109	13,440	15	33	-	-	187.2	117

[a]Sand granules coated with Bayer 73 at 5% by weight active ingredient.

Table 13. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Ontario, 1983.

[Letter in parentheses corresponds to location of stream in Figure 5.]

Stream	Number captured	Number sampled	Percent males	Mean length (mm)		Mean weight (g)	
				Males	Females	Males	Females
CANADA							
Humber R. (A)	4,626	1,670	59	457	452	212	224
Duffin Cr. (B)	606	428	62	450	450	214	226
Bowmanville Cr. (C)	100	100	60	470	482	216	240
Wilmot Cr. (D)	566	542	61	465	460	235	239
Total or average	5,898	2,740	60	458	455	217	227
UNITED STATES							
Grindstone Cr. (E)	678	2	50	455	447	192	274
Little Salmon R. (F)	7	6	67	472	495	250	308
Catfish Cr. (G)	11	10	50	512	481	274	243
Sterling Valley Cr. (H)	461	461	63	487	483	243	247
Sterling Cr. (I)	174	1	100	447	-	195	-
Total or average	1,331	480	63	487	483	243	248
GRAND TOTAL OR AVERAGE	7,229	3,220	60	463	459	221	230

CAPTIONS FOR FIGURES

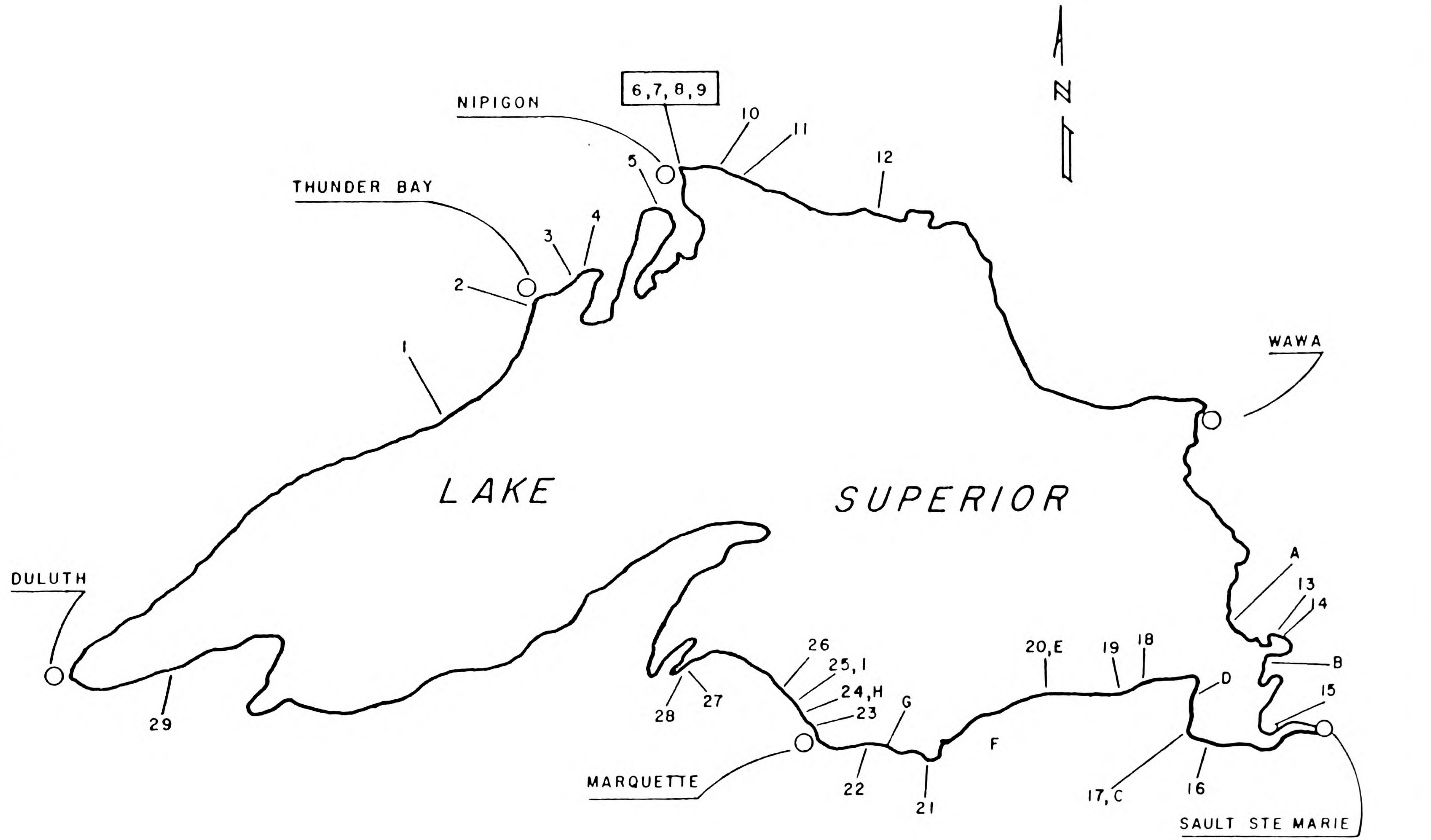
Figure 1. Location of streams, lakes, or bays of Lake Superior treated with lampricides (numerals; see Table 3 for names of streams or areas), and of streams where assessment traps were fished (letters; see Table 4 for names of streams) in 1983.

Figure 2. Location of streams tributary to Lake Michigan treated with lampricides (numerals: see Table 6 for names of streams), and of streams where assessment traps were fished (letters; see Table 7 for names of streams) in 1983.

Figure 3. Location of streams, lakes, or bays of Lake Huron treated with lampricides (numbers; see Table 10 for names of streams or areas), and of streams where assessment traps were fished (letters; see Table 11 for names of streams) in 1983.

Figure 4. Location of sites surveyed with Bayer 73 granules or electroshockers for larval sea lampreys in the St. Marys River in 1983.

Figure 5. Location of streams tributary to Lake Ontario treated with lampricides (numerals; see Table 12 for names of streams), and of streams where assessment traps were fished (letters; see Table 13 for names of streams) in 1983.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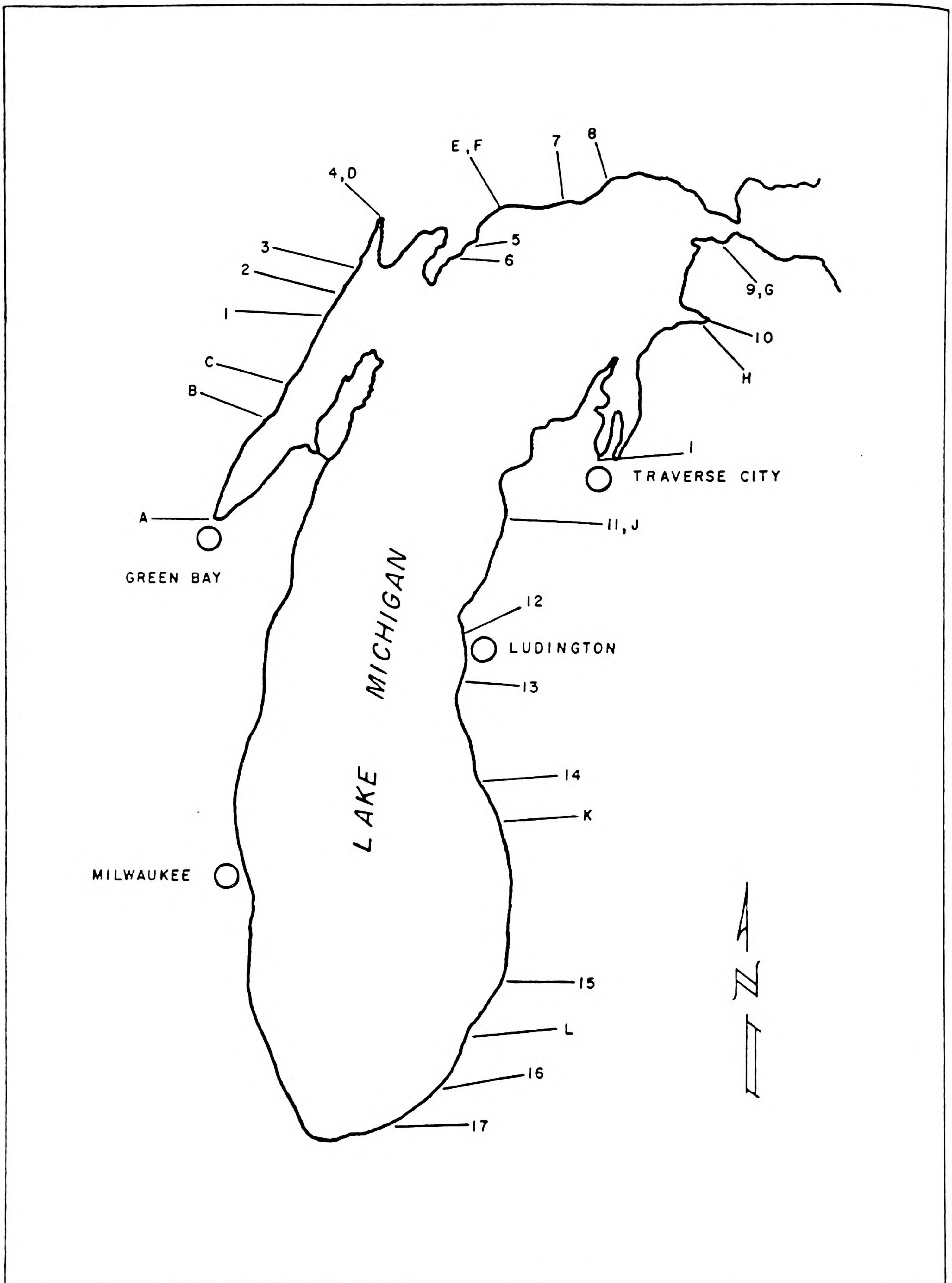
SAULT STE MARIE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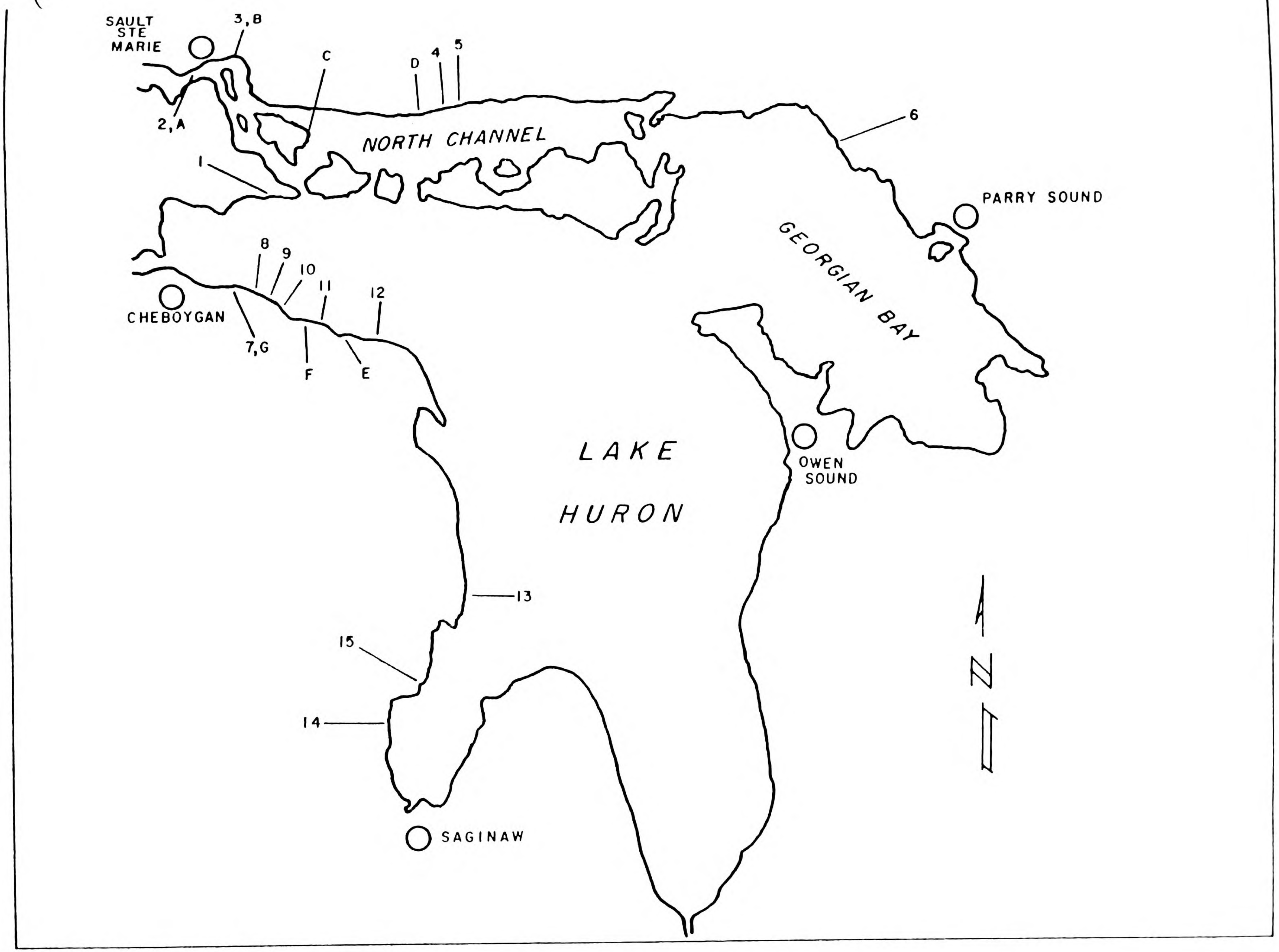
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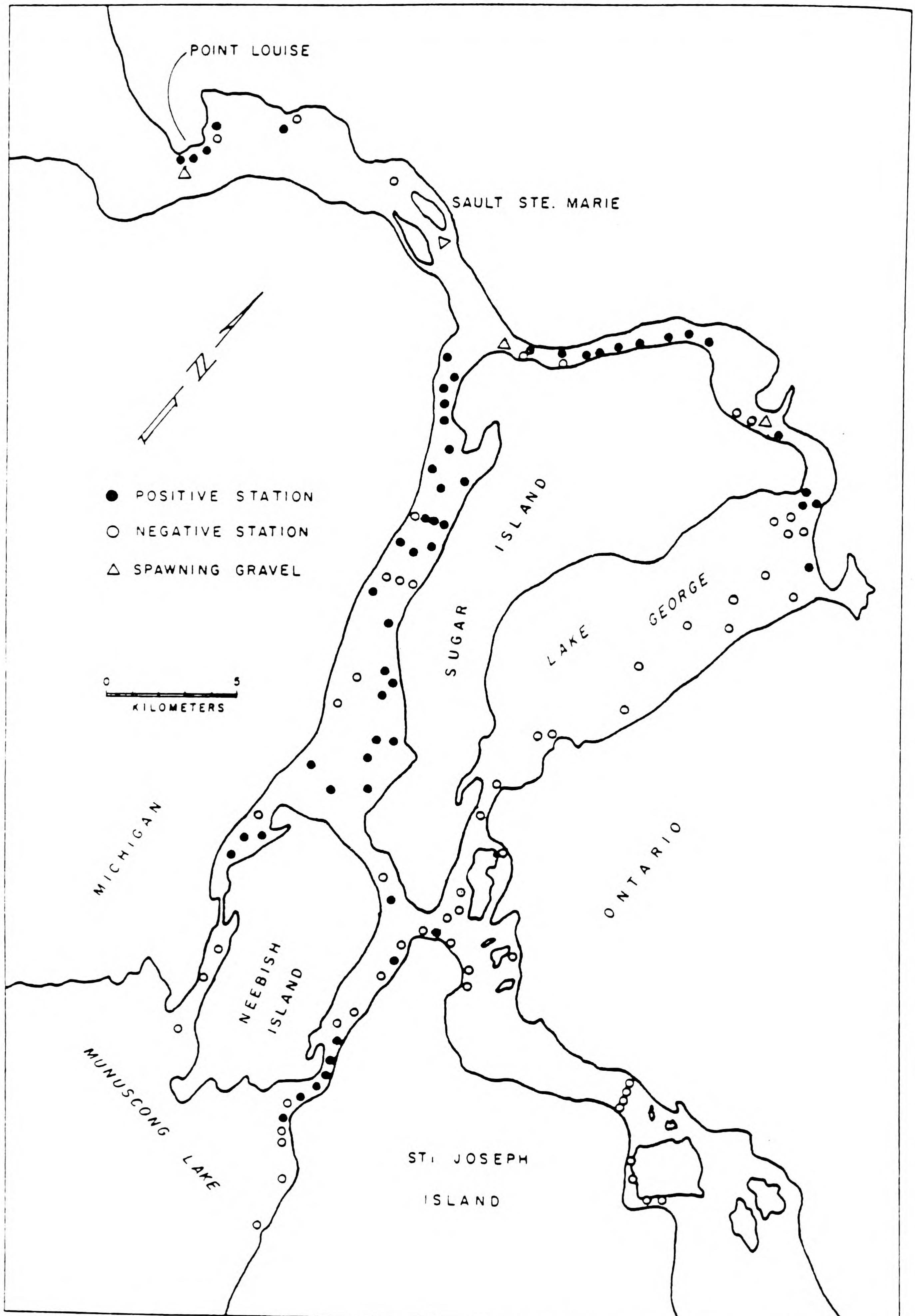
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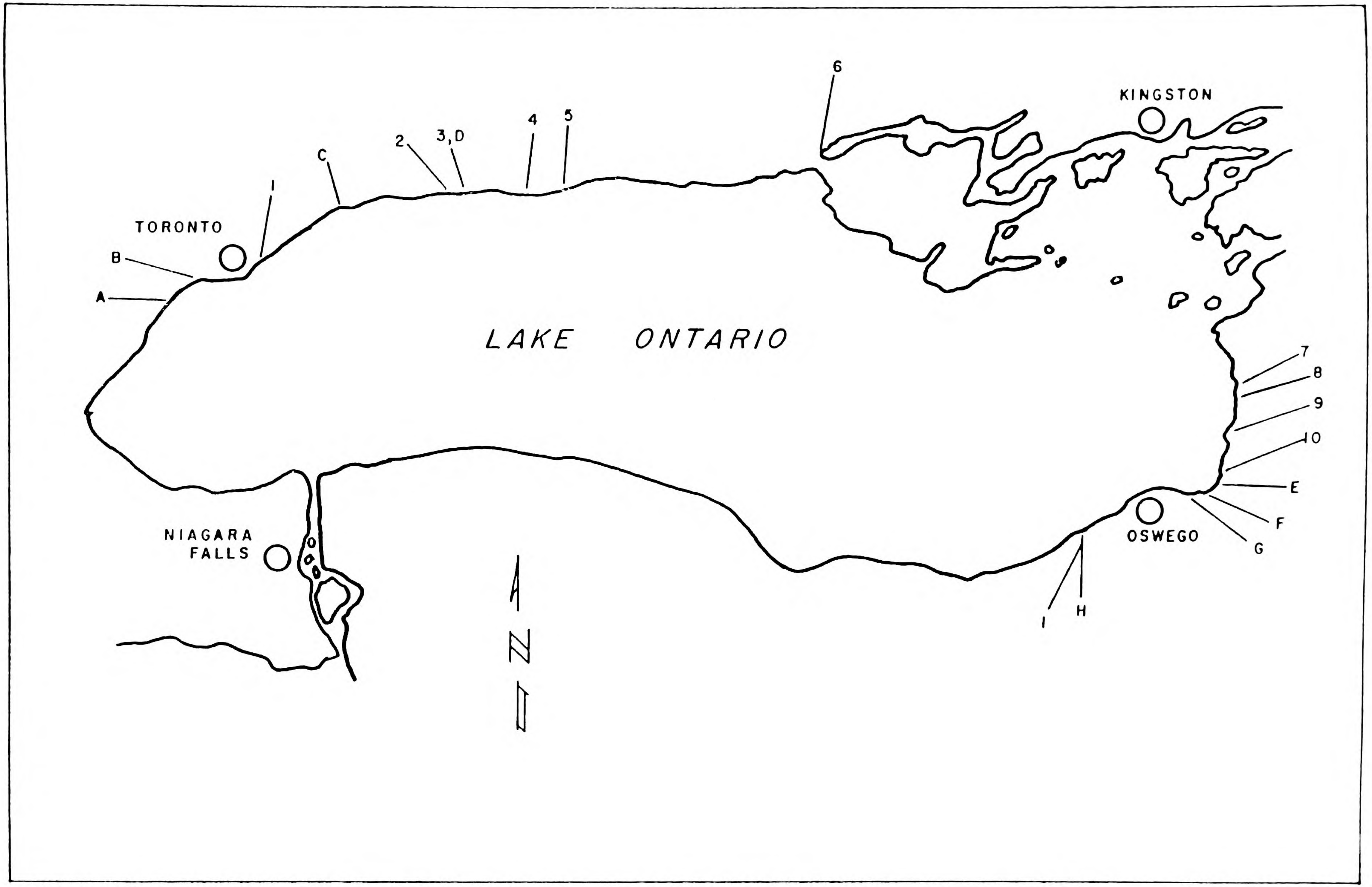
MICHIGAN
ONTARIO
NEEBISH ISLAND
MUNUSCONG LAKE
ST. JOSEPH ISLAND


KINGSTON
TORONTO
LAKE ONTARIO
NIAGARA FALLS
OSWEGO
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C
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Table 3. Details on the application of lampricides to streams, lakes, or bays of Lake Superior, 1983.

[Number in parentheses corresponds to location of stream, lake, or bay in Figure 1.]

Stream, lake, or bay	Date	Discharge at mouth m^3/s	Discharge at mouth f^3/s	TFM Act. kg	TFM Ingr. lbs	Bayer 73 Powder Act. kg	Bayer 73 Powder Ingr. lbs	Bayer 73 Granules Total used[a] kg	Bayer 73 Granules Total used[a] lbs	Stream treated km	Stream treated miles
CANADA											
Little Carp R. (15)	June 7	0.7	25	71	156	-	-	-	-	9.4	6
Stillwater Cr. (5)	June 12	0.3	10	49	108	-	-	-	-	4.5	3
Polly Cr. (7)	June 15	0.2	8	48	106	-	-	-	-	2.8	2
Cash Cr. (8)	June 18	1.2	42	376	827	-	-	8	18	22.6	14
Lower Nipigon R.[b] (6)	July 10	67.4	2,382	6,188	13,614	99	218	-	-	5.0	3
Steel R. (12)	Aug. 16	3.4	120	316	695	5	11	-	-	10.1	6
Kaministikwia R. (2)	Aug. 19	28.8	1,017	3,057	6,725	53	117	9	20	58.1	36
Black Sturgeon R. (4)	Aug. 24	7.3	258	1,108	2,438	17	37	6	13	16.2	10
Chippewa R. (14)	Sept. 13	2.8	100	200	440	3	7	-	-	2.9	2
Batchawana R. (13)	Sept. 28	14.4	508	983	2,163	-	-	-	-	13.0	8
Helen Lake (9)	July 8	-	-	-	-	-	-	808	1,778	-	-
Batchawana Bay (13)											
Chippewa R.	July 20	-	-	-	-	-	-	908	1,998	-	-
Sable R.	July 22	-	-	-	-	-	-	294	647	-	-
Batchawana R.	July 25	-	-	-	-	-	-	907	1,995	-	-
Sand Point	July 26	-	-	-	-	-	-	272	598	-	-
Stokely Cr.	July 29	-	-	-	-	-	-	363	798	-	-
Harmony R.	Aug. 2	-	-	-	-	-	-	272	598	-	-
Polly Lake[b] (7)	Aug. 17	-	-	-	-	-	-	227	500	-	-
Mackenzie Bay (3)	Aug. 22	-	-	-	-	-	-	454	999	-	-
Cypress Bay (10)	Aug. 24	-	-	-	-	-	-	364	800	-	-
Mountain Bay (11)	Aug. 24	-	-	-	-	-	-	546	1,201	-	-
Total		126.5	4,[illegible]	[illegible]	27,272	177	390	5,438	11,963	144.6	90

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Table 3. Continued.

Stream, lake, or bay	Date	Discharge at mouth		TFM		Bayer 73				Stream treated		Ar tre
						Powder		Granules				
				Act.	Ingr.	Act.	Ingr.	Total used[a]				
		m^3/s	f^3/s	kg	lbs	kg	lbs	kg	lbs	km	miles	ha
UNITED STATES												
Salmon Trout R. (26)	May 19	2.1	75	220	484	-	-	-	-	11.3	7	-
Iron R. (25)	June 29	4.0	140	329	726	-	-	-	-	3.2	2	-
Tahquamenon R. (17)	July 7	9.3	330	1,327	2,926	22	49	-	-	29.0	18	-
Galloway Cr. (16)	July 12	0.1	3	20	44	-	-	-	-	3.2	2	-
Little Two Hearted R. (18)	Aug. 5	1.0	37	100	220	-	-	-	-	14.5	9	-
Big Two Hearted R. (19)	Aug. 6	3.7	130	798	1,760	-	-	-	-	72.6	45	-
Laughing Whitefish R. (22)	Aug. 18	0.1	4	60	132	-	-	-	-	1.6	1	-
Furnace Cr. (21)	Aug. 21	0.2	8	20	44	-	-	-	-	1.6	1	-
Arrowhead R. (1)	Sept. 2	2.1	75	90	198	-	-	-	-	1.6	1	-
Brule R. (29)	Sept. 3	4.2	150	868	1,914	-	-	-	-	88.7	55	-
Big Garlic R. (24)	Oct. 7	0.8	30	100	220	-	-	-	-	9.7	6	-
Silver R. (28)	Oct. 18	5.2	185	469	1,034	-	-	-	-	4.8	3	-
Slate R. (27)	Oct. 18	1.6	56	60	132	-	-	-	-	1.6	1	-
Sucker R. (20)	Oct. 18	5.1	180	379	836	-	-	-	-	22.6	14	-
Harlow Cr. (23)	Nov. 2	0.4	15	100	220	-	-	-	-	6.5	4	-
Total		39.9	1,418	4,940	10,890	22	49	-	-	272.5	169	-
GRAND TOTAL		166.4	5,888	17,336	38,162	199	439	5,438	11,963	417.1	259	22.0

[a]Sand granules coated with Bayer 73 at 5% by weight active ingredient.

[b]Initial treatment.

Table 5. Variables used to determine the population estimate (95% confidence intervals in parentheses) of sea l larvae and the percentage of larvae >120 mm in the Big Garlic River in 1983.

[Population estimate is calculated for each study area by the Petersen formula (number marked x number examin for marks divided by the number of marked recaptured), and then is expanded to an estimate for each zone bas on the ratio of amount of habitable substrates in each study area to that in each zone. The total estimate the stream is the sum of estimates for each zone.]

			Marked larvae				Study area			Total in zone	
			Number	Recaptured							
Zone	Zone length (ft.)	Study area in zone (ft.)	released	Number	Percentage	Number unmarked collected	Area[a] (sq.ft.)	Population estimate	Area[a] (sq.ft.)	Population estimate[b]	Perc >12
A	2,100	1,500	742	380	51	5,936	37,800	12,332	45,000	14,673 (13,270-16,193)	
B	5,400	900	211	54	26	1,110	15,500	4,548	103,200	30,310 (23,220-39,537)	
C	10,500	750	265	74	28	1,309	16,200	4,953	116,400	35,585 (28,342-44,702)	
D	9,900	900	175	72	41	392	7,800	1,128	72,600	10,439 (8,274-13,163)	
Total	27,900	4,050	1,393	580	42	8,747	77,300	22,961	337,200	91,007 (73,106-113,595)	

[a]Refers to total area of substrate types in which larvae may be found.

[b]The percentage of larvae >120 mm was calculated as a separate estimate similar to that of the estimate of all l (i.e., number >120 mm marked x number >120 mm examined for marks divided by the number of marked >120 mm recapt then expanded by total habitable substrates), but for simplicity, is represented as percentage of the total est

Table 9. Percentage of invertebrates dead or missing of those caged during treatments of five streams with lampricides in 1983.

	Lake Superior						Lake Michigan								
	Brule River			Tahquamenon R.			Ford River			Pere Marquette R.			Whitefish Rive		
		Percentage			Percentage			Percentage			Percentage			Percentag	
Taxon	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Los
Plecoptera															
Perlidae															
<u>Acroneuria</u>	7	0	0	7	0	0							3	0	0
<u>Paragnetina</u>				4	0	0							5	0	0
<u>Phasganophora</u>													2	0	0
Pteronarcidae															
<u>Pteronarcys</u>	3	0	0												
Ephemeroptera															
Ephemerellidae															
<u>Ephemerella</u>	2	0	0							7	0	0	10	0	20
Heptageniidae															
<u>Epeorus</u>													21	0	14
<u>Stenonema</u>				1	0	0	23	0	0						
Ephemeridae															
<u>Hexagenia</u> (≤15 mm)										25	8	20			
<u>Hexagenia</u> (>15 mm)										27	22	0			
<u>Hexagenia</u>	27	19	0										50[a]	92[a]	0[a]
Potamanthidae															
<u>Potamanthus</u>							20	0	5						
Siphlonuridae															
<u>Isonychia</u>							20	5	10	12	8	0			

(continued)

Table 9. Continued.

Taxon	Lake Superior						Lake Michigan								
	Brule River			Tahquamenon R.			Ford River			Pere Marquette R.			Whitefish River		
		Percentage			Percentage			Percentage			Percentage			Percentage	
	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost
Ephemeroptera (continued)															
Tricorythidae															
Tricorythodes										17	0	0			
Baetidae															
Baetis	15	33	7	7	14	14	3	0	0	1	0	0			
Centroptilum							2	0	0						
Pseudocloeon				5	20	20	16	0	0						
Leptophlebiidae															
Paraleptophlebia							3	0	0						
Trichoptera															
Philopotamidae															
Dolophilodes	10	100	0										21	19	[illegible]
Polycentropodidae															
Phylocentropus													17[a]	29[a]	[illegible]
Hydropsychidae															
Cheumatopsyche				4	0	0	4	0	0						
Hydropsyche							1	0	0	15	0	0			
Macronema							1	0	0						
Symphitopsyche	10	0	0	17	4	0	3	0	0				11	0	[illegible]
Rhyacophilidae															
Rhyacophila	2	0	0										7	0	[illegible]

(continued)

Table 9. Continued.

	Lake Superior						Lake Michigan								
	Brule River			Tahquamenon R.			Ford River			Pere Marcuette R.			Whitefish River		
		Percentage			Percentage			Percentage			Percentage			Percentage	
Taxon	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost
Trichoptera (continued)															
Glossosomatidae															
Glossosoma				2	0	0				19	42	10	20	45	5
Glossosoma (small)	10	20	80												
Glossosoma (large)	20	85	15												
Brachycentridae															
Brachycentrus	11	18	9							10	0	0			
Limnephilidae															
Pycnopsyche													10	0	0
Coleoptera															
Elmidae (larvae)							6	0	33						
Optioservus (adult)							15	0	0						
Stenelmis (adult)							5	0	0						
Diptera															
Athericidae															
Atherix	13	0	0							6	0	33			
Gastropoda															
Campeloma				10	40	0	20	15	0						

[a]Organisms were caged in Scott Creek, a tributary of the Whitefish River.

Table 12. Details on the application of lampricides to streams of Lake Ontario, 1983.

[Number in parentheses corresponds to location of stream in Figure 5.]

Stream	Date	Discharge at mouth		TFM		Bayer 73				Stream treated	
						Powder		Granules			
				Act.	Ingr.	Act.	Ingr.	Total	used[a]		
		m^3/s	f^3/s	kg	lbs	kg	lbs	kg	lbs	km	miles
CANADA											
Bowmanville Cr. (2)	May 7	2.8	100	921	2,026	7	15	-	-	11.6	7
Cobourg Br. (5)	June 8	1.3	46	466	1,025	-	-	-	-	11.2	7
Mayhew Cr. (6)	June 10	0.2	7	59	130	-	-	-	-	3.2	2
Graham Cr. (4)	June 12	0.3	11	219	482	-	-	-	-	16.4	10
Wilmot Cr. (3)	Oct. 20	0.7	24	487	1,071	-	-	-	-	22.0	14
Rouge R. (1)	Oct. 25	1.5	53	751	1,652	-	-	-	-	29.9	19
Total		6.8	241	2,903	6,386	7	15	-	-	94.3	59
UNITED STATES											
Skinner Cr. (8)	May 11	1.9	68	414	910	-	-	-	-	12.6	8
Salmon R. (10)	May 16	27.5	972	1,176	2,588	8	18	-	-	27.6	17
Orwell Br.	May 7	2.0	71	189	416	-	-	-	-	4.2	3
Beaverdam Br.	May 9	2.2	78	180	396	-	-	-	-	5.4	4
Trout Br.	May 13	1.8	64	189	416	-	-	-	-	16.7	10
Lindsey Cr. (9)	May 14	0.8	29	152	334	-	-	-	-	14.5	9
South Sandy Cr. (7)	Oct. 16	7.6	265	906	1,994	-	-	-	-	11.9	7
Total		43.8	1,547	3,206	7,054	8	18	-	-	92.9	58
GRAND TOTAL		50.6	1,788	6,109	13,440	15	33	-	-	187.2	117

[a]Sand granules coated with Bayer 73 at 5% by weight active ingredient.