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SEA LAMPREY MANAGEMENT IN THE GREAT LAKES 1993

ANNUAL REPORT

TO

GREAT LAKES FISHERY COMMISSION

by

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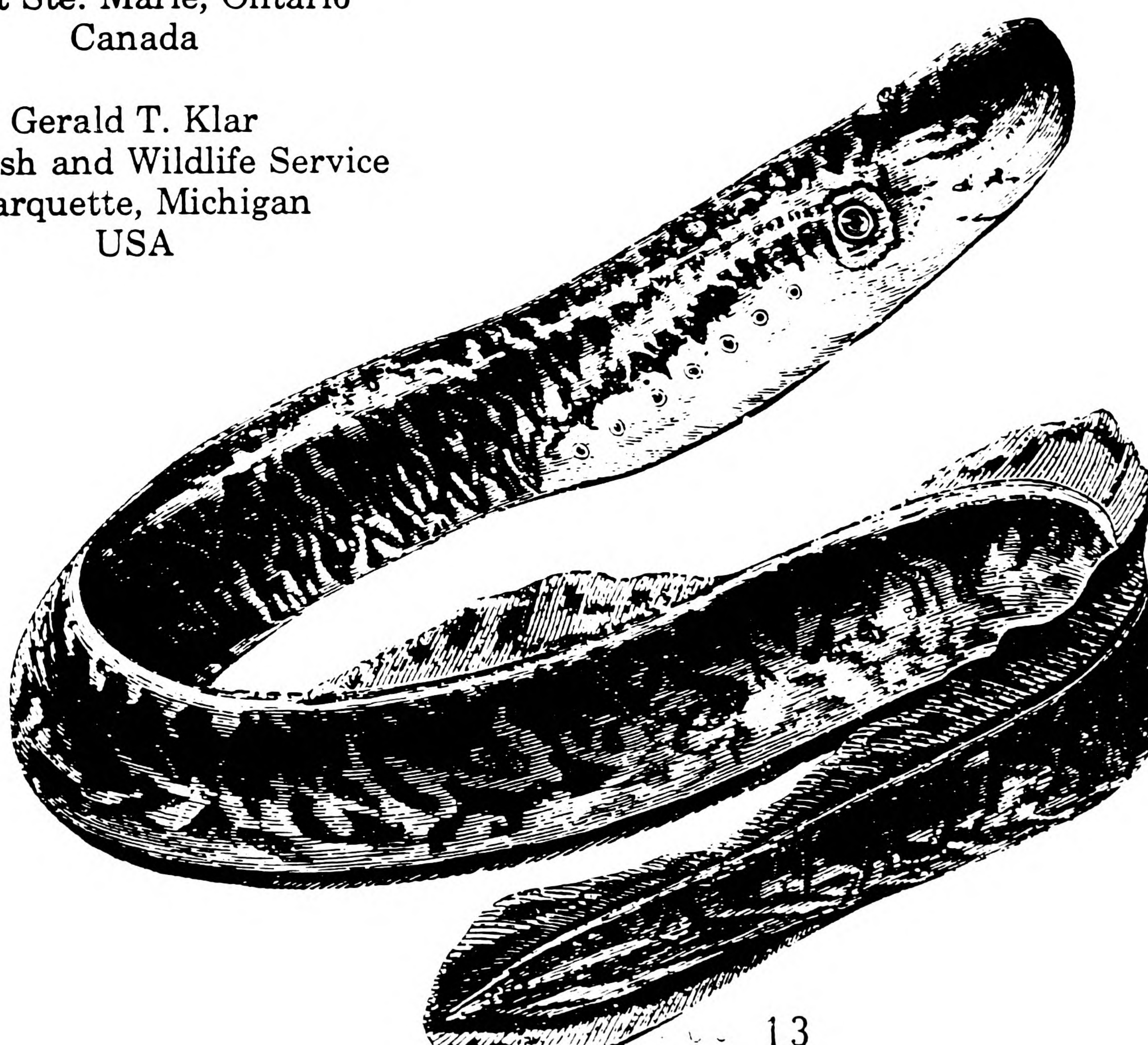

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This report summarizes sea lamprey management activities of the Department of Fisheries and Oceans Canada and the United States Fish and Wildlife Service. Larval assessment crews surveyed 408 Great Lakes tributaries, inland lakes and lentic areas to assess TFM treatment or barrier effectiveness and to plan future TFM treatments. TFM treatments were conducted on 49 tributaries, with three streams deferred to 1994 (Table 1). Spawning-phase assessment traps were fished in 54 tributaries and captured 80,357 sea lamprey (Table 2). Our data suggests that sea lamprey objectives are being met on Lake Erie and Ontario and populations of lamprey may be declining in Lake Superior. However, unmanaged populations in the St. Marys River are resulting in significant increases in lamprey abundance to unacceptably high populations in Lake Huron and are compromising lake trout rehabilitation efforts. In addition, lamprey production from the St. Marys River is causing increased populations in northern Lake Michigan.

Canadian and US agents completed the first year of larval and habitat mapping as part of the St. Marys River control strategy. Results suggest that lamprey density is low but the population has a spatially discrete distribution. Mark and recapture at spawning assessment traps indicate record abundance in the St. Marys River. Development of an effective St. Marys River control strategy continued this year with development of enhanced spawner trapping plans and contracting of a St. Marys flow model.

The sterile male release technique was successfully implemented in 26 Lake Superior tributaries. Nest evaluation studies indicate that 0% of eggs are viable from sterile male:female matings. However, sterile males were not observed at expected ratios in nesting areas. Nest and spawner observation studies will be completed in 1994 to address questions related to SMRT effectiveness.

US and Canadian barrier coordinators were appointed in 1993. The Barrier Task Force developed an implementation strategy and criteria for stream selection. In addition, the Canadian Agent completed construction of a new concept velocity barrier. Evaluation of the structure will be completed in 1994.

The US agent completed a long-term evaluation on lampricide effects on Hexagenia populations. Results indicate that TFM treatments can have significant impacts on mayflys, especially older year classes. Negative impacts can be minimized by scheduling treatments after adult emergence and in even year increments (≥ 4 years).

Table 1. Summary of lampricide treatments in streams of the Great Lakes in 1993. [Lampricides used are in kg of active ingredient.]

Lake	Number of Streams	Discharge m^3*s^{-1}	TFM[1] kg	Bayer 73 kg	Distance km
Superior	11	30.9	3,047	-	189.3
Michigan	8	31.0	8,233	-	384.0
Huron	20	122.3	18,312	33.4	772.2
Ontario	10	28.7	4,281	3.3	159.9
Total	49	212.9	33,873	36.7	1,505.4

[1]includes 658.3 TFM bars (132.7 kg) applied in 17 streams.

Table 2. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of the Great Lakes in 1993.

Lake	Number of Streams	Total captured	Number sampled	Percent males	Mean Length (mm)		Mean Weight (g)	
					Males	Females	Males	Females
Superior	15	5,374	2,174	44	448	441	199	206
Michigan	13	20,853	20,700	45	467	468	239	252
Huron	11	53,004	4,896	55	455	459	207	223
Erie	6	552	262	74	489	487	306	299
Ontario	9	574	24	92	461	462	261	199
Total	54	80,357	28,056	47	463	476	231	247

INTRODUCTION

The Great Lakes Fishery Commission (GLFC) has developed Lake Committees through its Fish Community Objectives as part of the Strategic Plan for Great Lakes fishery management (SGLFMP). Each Lake Committee has established objectives for acceptable levels of mortality that will enable the establishment and maintenance of self-sustaining stocks of lake trout and other salmonids. In some cases, the Lake Committees have established specific objectives for sea lamprey populations in the Fish Community Objectives or the lake trout rehabilitation plans. The current Sea Lamprey Management program is a critical component in the management of fishery mortality.

The GLFC is working with the Lake Committees through their Lake Technical Committees to refine the current objective statements and to develop common targets for each of the lakes. These targets will consider the costs and benefits of sea lamprey control to define the management program "that supports the fish community objectives and that is ecologically and economically sound and socially acceptable" (GLFC 1992). Targets for each lake will define the abundance of lamprey that can be tolerated and the economically viable level of control required to reach this suppression objective. Koonce et al. (1993), Greig et al. (1991), and Greig et. al. (1992) document the methods that are being used to establish economic injury level targets.

This report documents the activities of the sea lamprey management program and GLFC Task Force areas during 1993. As well, we will relate recent trends in sea lamprey abundance to fish community objectives and the GLFC vision (GLFC 1992b).

GLFC Vision

The GLFC (1992) identified milestones in relation to the "Integrated Management of Sea Lamprey Vision Statement" that included:

Development and use of alternative control techniques to reduce reliance on lampricides to 50% of current levels.

Since the inception of the TFM management program, the Canadian and US agents have worked to increase their efficiency in using TFM. The combination of improved analytical and application techniques, barriers and assessment techniques have resulted in significant reductions in TFM use relative to volume of water treated (Figure 1). These decreases have occurred despite the addition of lakes with higher TFM requirements (e.g., Michigan and Ontario) because of the higher alkalinity tributaries of these lakes.

NEW FIELD OFFICE

A field office of the Sea Lamprey Control Program was established at Amherst, New York, that is jointly staffed by the U.S. Fish and Wildlife Service and Department of Fisheries and Oceans Canada, and is co-located with the Services Lower Great Lakes Fishery Resources Office.

Index of TFM use in the Great Lakes

TFM use per unit of flow treated

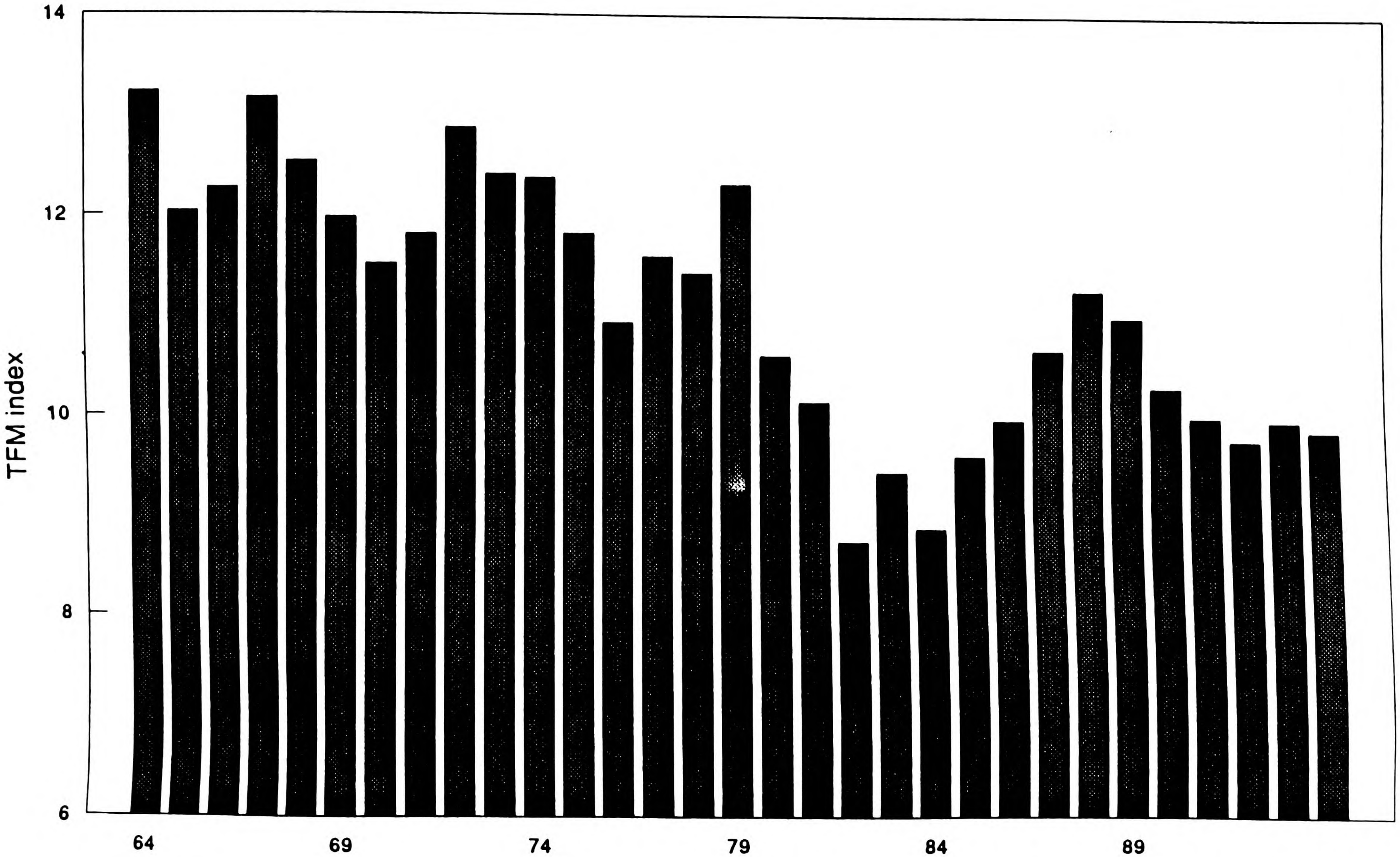

Figure 1. Index of TFM use relative to volume of water treated in Great Lake tributaries by Canadian and US Agents from 1964-93.

LAKE SUPERIOR

TRIBUTARY INFORMATION

- 1,566 (833 Canadian, 733 United States) tributaries to Lake Superior.

- 136 (47 Canadian, 89 United States) tributaries have historical records of production of sea lamprey larvae

- 81 (31 Canadian, 50 United States) tributaries have been treated with lampricides at least once during 1984-93

- Of these, 54 (21 Canadian, 33 United States) tributaries are treated on a regular (3-5 year) cycle.

SEA LAMPREY AND FISH COMMUNITY OBJECTIVES

The Lake Superior Committee (LSC) established the following specific objectives for sea lamprey populations in their Fish Community Objectives (Busiahn 1990).

Achieve a 50% reduction in parasitic-phase sea lamprey abundance by 2000, and a 90% reduction in parasitic-phase sea lamprey abundance by 2010.

The Lake Superior Committee established these documents to reflect the need for enhanced control on Lake Superior based on estimates of the damage caused by the parasitic-phase population in the mid-1980's. They recognized the need for further evaluation of the costs of suppressing lamprey to these levels.

This sea lamprey objective was developed to support the objective for the lake trout and salmonine community.

Achieve a sustained annual yield of 4 million pounds of lake trout from naturally reproducing stocks, and an unspecified yield of other salmonid predators, while maintaining a predator/prey balance which allows normal growth of lake trout.

These naturally reproducing stocks of lake trout can only be maintained with a total annual mortality rate less than 45% (Lake Superior Lake Trout Technical Committee 1986; Lake Superior Technical Committee 1994). The Lake Superior Committee will reach the objective for total mortality through a combination of regulation of fishery exploitation and control of sea lamprey abundance.

The USFWS maintains an extensive spawner trapping network along the south shore of Lake Superior. The US agent annually estimates populations east and west of the Keweenaw Peninsula (Figure 2). Populations west of Keweenaw have declined significantly from 1989 while populations west of the Keweenaw have remained stable or increased slightly during the same period. The program would achieve the fish community objective for Lake Superior (50% decline by 2000) if this rate of decline can be maintained. However, population estimates are within [illegible] trends may represent the bottom in cyclical abundance in Lake

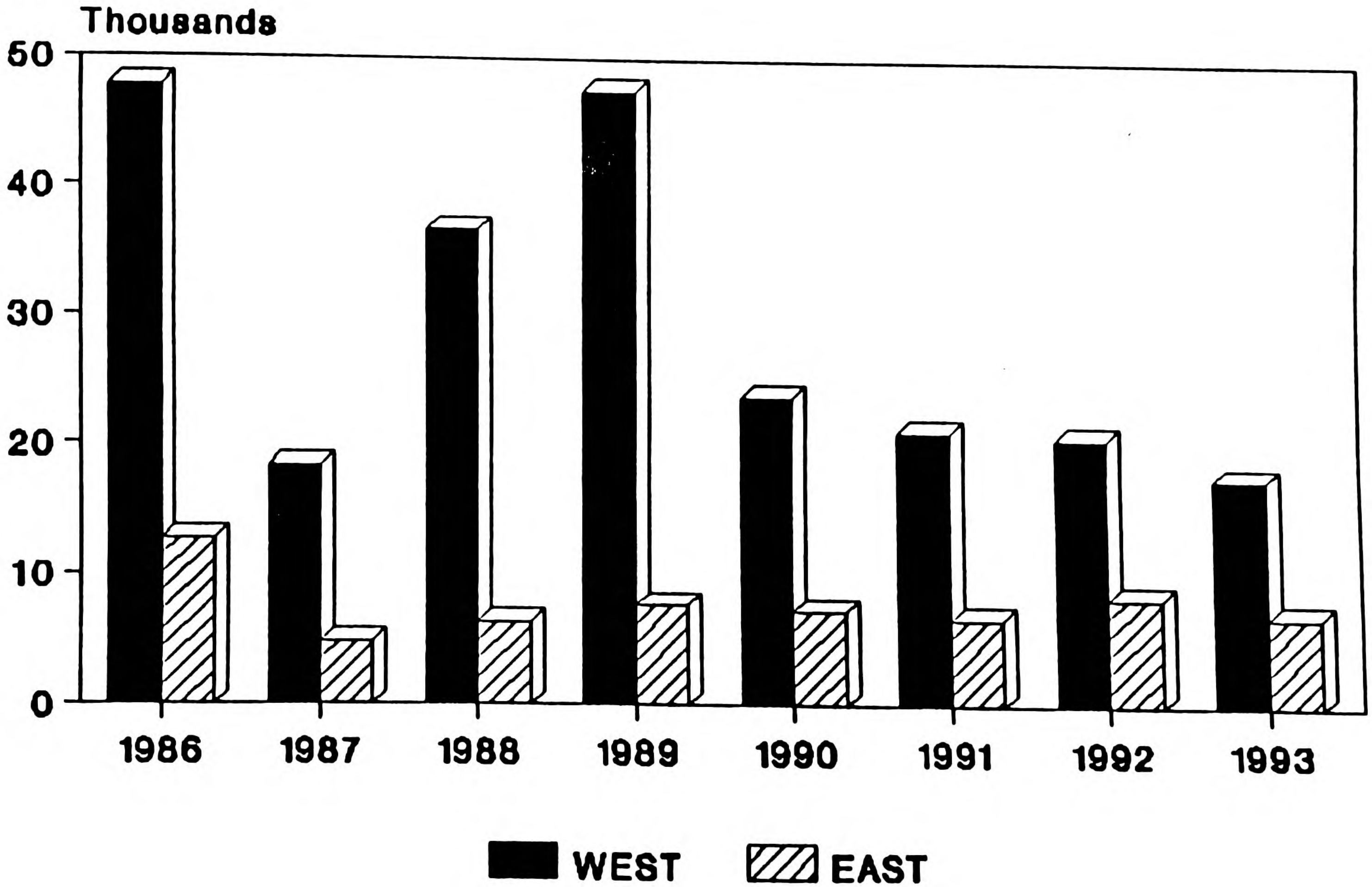

Figure 2 . Estimated number of spawning sea lampreys in U.S. waters (west and east of Keweenaw Peninsula) of Lake Superior.

LARVAL ASSESSMENT

United States

Surveys were conducted to prepare for lampricide treatments, assess the success of past treatments, monitor reestablished populations of larval sea lampreys, and search for new infestations of larvae in 72 Lake Superior tributaries. Surveys to schedule lampricide applications were conducted in 33 streams. Of the surveyed streams, 1 was successfully treated, 9 were scheduled for treatment in 1994, and the remaining 23 were deferred. Sea lamprey larvae that remained from past treatments were found in 15 streams, but comprised less than 5% of the total number of larvae collected in all streams. Larvae had reestablished in 42 of the streams that were surveyed. Estuarine surveys were conducted in 17 streams, and offshore surveys were conducted near 4 streams. Original surveys to search for new infestations were conducted in 10 streams and no larvae were found.

Surveys to assess recruitment of the 1993 year class were conducted in 50 streams and young-of-the-year larvae were recovered in 29. Sea lamprey larvae have not been detected for 5 or more years in 8 streams that have been examined annually. Nine streams were surveyed on Isle Royale and no larvae were found.

The populations of larval sea lampreys were estimated in 6 tributaries of Lake Superior through a random transects habitat-based technique in 1993. (Table 3) These studies estimated the area and type of habitat for larvae and the number of larvae and transformers inhabiting each river. The tributaries examined were the Black (tributary to the Nemadji River), Misery, Sturgeon, Potato, Au Train and Ontonagon rivers.

Area of habitat in streams was estimated with 1.5 m wide transects across the river at equally spaced intervals throughout the stream. The initial transect was randomly selected near the stream mouth. The percentage and composition of substrate (sand, silt, gravel, clay, etc.) along a transect were recorded. From these measurements, the substrate was placed into one of three broad habitat categories based on potential for habitation by lamprey larvae: Type I habitat was considered optimal, Type II was acceptable though not preferred, and Type III was uninhabitable.

Larval lampreys were captured with backpack and deepwater electrofishing gear. Lamprey densities at each transect were determined by a depletion method of sampling. Delineated areas of type I and II habitat in each transect were sampled one or more times with electrofishing gear. The diminishing number of lampreys captured in each sample site in successive passes with the gear was used to estimate lamprey density. All lampreys captured in each depletion were identified, counted, measured for total length, and removed from the stream. The total area of the stream, the percentage of each habitat type, and the mean lamprey density in each habitat type were used to calculate the total number of larvae (excluding young-of-the-year larvae, $\leq$20 mm) in each river. Length frequency data allowed estimation of age class populations. Number of larvae $\geq$120 mm (minimum length for transformation) also was estimated. The number of transformers was calculated as the percentage of those lampreys $\geq$120 mm that would be expected to transform in each stream. This percentage was based upon previous collections of larvae during fall lampricide treatments for each river. The estimated number of larval lampreys ranged from 1,944 in the Sturgeon River (lower river only) to 99,736 in the Misery River (Table 3).

A 2 year (1992-93) examination of the sea lamprey larvae population in the Ontonagon River was completed in 1993. The Ontonagon River is in the western upper peninsula of Michigan. The objectives of the examination included estimation of the larval population each year (excluding young of the year in 1992 and yearlings in 1993) and estimation of the number of larvae that remained after the lampricide treatment in 1992.

The population of larvae prior to the lampricide treatment in 1992 was 794,736 and the population that survived was estimated at 7,704 in 1993. Of these, about 367 were ≥120 mm (potential transformers) and 26 were transformers. Additional larvae may have survived the treatment but died over winter or transformed and left the river. Prior to the treatment larvae inhabited 73 miles of river, and in 1993 larvae were detected only in the uppermost 21 miles of the East Branch.

Canada

The Sea Lamprey Control Centre annually conducts larval sea lamprey surveys in Lake Superior tributaries. Survey objectives include establishing range distribution, TFM treatment evaluation, determining the first year class to reestablish as well as estimating population abundance and size class distribution in streams to schedule treatments in the following year. The standard techniques used in larval assessment include electrofishing (shallow streams) and Bayer 73 surveys (deep water). Surveys were conducted on 32 Lake Superior tributaries and four lentic areas in preparation for chemical treatment in 1993 and 1994.

<u>Distribution surveys</u>:

Distribution surveys were completed on the Goulais River in preparation for treatment in 1993 and on eleven streams tentatively scheduled for treatment in 1994 (Batchawana, Carp, Prairie, Little Pic, Gravel, Cypress, Black Sturgeon, Wolf, Cloud and Pigeon rivers and the Neebing-McIntyre Floodway). No significant change was observed in larval distribution within these streams.

<u>Treatment Evaluation and Larval Reestablishment:</u>

Treatment evaluation surveys were completed on the three tributaries treated in 1992 (Jackfish, Nipigon and Kaministiquia rivers). Moderate numbers of residual larvae were collected from the Nipigon and Kaministiquia, about half of which are of the 1992 year class. These results indicate either, i) late spawning due to below average temperatures in 1992, or ii) less than expected mortality during the treatment. No larval lampreys were collected from the Jackfish River surveys.

Reestablishment surveys were completed on seven streams last treated in 1991 or earlier. Both the 1991 and 1992 year classes of larvae were found in Cash Creek and Pearl River. No larval sea lampreys were found in surveys of East Davignon, West Davignon, Cranberry and Sawmill creeks or the Harmony River.

able 3. **The estimated amount of habitat (m²) for sea lamprey larvae, density (larvae/m²), total number of year classes in the population, total larvae and transformers in the population, number ≥120 mm, and number of transformers for 6 tributaries of Lake Superior, 1993. (The 95% confidence intervals for total numbers, number ≥120 mm, and transformers are listed in parenthesis below each respective estimated value.)**

River	Method of Estimation	Area of Habitat Types[1]			Density of Larvae[2]		Year[3] Classes	Total Larvae[4] and transformers	Number[5] ≥120 mm	Number of[6] transformers
		I	II	III	I	II				
ntonagon[7]	Random transects[8]	340,830	1,995,012	1,072,456	.02	.00	-	7,704 (24-15,535)	367 (1-1,005)	26 (0-70)
lack	Random transects	19,261	83,463	4,280	.15	.00	3	3,103 (1,388-5,038)	408 (5-1,081)	29 (0-76)
Misery	Random transects	82,366	162,236	4,992	.92	.15	4	99,736 (49,624-149,847)	1,056 (6-2,740)	116 (1-301)
Sturgeon[9]	Random transects	258,038	421,009	0	.01	.00	3	1,944 (3-4,157)	0	0
Potato	Random transects	16,213	124,843	21,078	.78	.25	3	43,661 (2,534-87,129)	332 (1-990)	27 (0-79)
Au Train	Random transects	88,032	243,781	6,772	.03	.00	2	2,799 (238-5,828)	284 (2-633)	26 (0-57)

[1]Type I habitat is considered optimal for sea lampreys, type II is acceptable though not preferred, and type III is uninhabitable.
[2]The density of larvae in type III habitat is 0 for all streams.
[3]The number of year classes of larvae in the stream generally is a result of the number of years since the last treatment. Young-of-the-year larvae (≤20 mm) are not included as a year class. Some residuals also are present in all populations, but these also are not included in the year classes because exact measurement of age of each residual is impractical.
[4]The estimated number of larvae does not include young-of-the-year.
[5]The number ≥120 mm was estimated separate from the value for total larvae and is based on the actual number ≥120 mm taken in the various sampling procedures.
[6]The number of transformers was estimated as either the number taken in the sampling procedures, or the percentage of those larvae ≥120 mm that were undergoing transformation that were collected during treatments of 1993 or previous years. The percentage is different for each stream and ranges from 6.5% for the Ontonagon River to 11% for the Misery River.
[7]Post-treatment estimate.
[8]The random transect method is a measurement of the amounts of habitat on randomly selected 5-foot wide transects across the river at predetermined intervals, and the amounts are expanded to include the unmeasured area.
[9]Estimate is for lower Sturgeon River from Lake Superior upstream to the junction with Otter Lake outlet only. The majority of sea lampreys produced in the river are found upstream of the surveyed area.

Barrier evaluation:

a) Low-head barriers

Barrier dams on Stokely, Sheppard and Gimlet creeks and on Carp, Wolf and Neebing rivers were all effective at blocking the 1992 spawning run. Remedial work done on the Carp River dam in 1990 and 1991 appears to have been effective at blocking spawning runs since 1991. However, due to the presence of a large 1990 year class, a lampricide treatment is scheduled for the Carp River in 1994.

b) Velocity barrier

Assessment of the experimental velocity barrier, built on the McIntyre River in August 1993, began with the establishment of larval lamprey index sites above and below the structure. Both index sites have a mix of spawning and larval habitat.

The sea lamprey ammocoete population was estimated for each index site by the Petersen mark-and-recapture method. Larval sea lamprey electrofished from the McIntyre and Wolf rivers were marked by tail clip and released upstream [n=325] downstream [n=255] of the proposed site. Two days later the study sites were surveyed using the standard methodology for index surveys with backpack electrofishers. The larval habitat in each study area was electrofished at a rate of approximately 1 minute /m^2.

A total of 144 sea lamprey larvae were collected at the upstream index site, of which 19 were marked. This yielded an estimate of 2,138 larvae with an average density of 1.13/m^2 in suitable larval habitat. At the index station downstream of the barrier we collected 142 sea lamprey and 20 marked sea lamprey, giving an estimate of 952 and average density of 1.06/m^2.

Survey efficiency was comparable in both index sites. CUE for all larval lampreys combined [unmarked, marked and native] was 158 and 154 larvae/h of timed electrofishing. For unmarked sea lamprey only, CUE was even closer at 98.4 and 97.4 larvae/h.

Our results indicate that the larval sea lamprey population above and below the experimental barrier were similar at the time of its construction. These index sites will be monitored annually for the duration of the barrier study.

Lentic Surveys:

Larval populations were surveyed in Batchawana and Mountain bays and in Lake Helen (Nipigon River) in 1993. Although some questions remain about the transformation rates from these large and essentially uncontrolled populations, we suspect these populations are significant contributors to parasitic stocks in Lake Superior.

In 1993, we estimated the larval population in Mountain Bay. Marked sea lamprey larvae (n=636) were released into three randomly selected 1800 m^2 plots. One hundred and twenty marked and 3,601 unmarked sea lamprey larvae were collected following treatment of the plots with the granular formulation of Bayer 73. The average density within the study plots was 3.53/m^2. Larval sea lamprey populations were estimated at 353,000 by extrapolating this to the 10 ha of Mountain Bay thought to have moderate to high densities.

Twenty-eight percent of the lamprey collected from the three study areas were of transformable size (i.e., ≥ 120 mm). However, only one was obviously metamorphosing (119 mm). We suspect these results do not accurately indicate the rate of metamorphosing lamprey because of the selectivity of this technique for non-metamorphosing lamprey.

LAMPRICIDE MANAGEMENT

United States

Lampricide treatments were completed on 6 streams (Table 4, Figure 3) with a combined discharge of 4.9 $m^3 \cdot s^{-1}$. All treatments were successful in removing sea lamprey populations. Lampricide concentrations were maintained at desired levels during all treatments. Non-target mortality was insignificant on all treatments, with no non-target mortality reported on the Black, Falls, Furnace, or Misery rivers. Sea lamprey larvae were abundant in the Big Garlic and Misery rivers and less abundant in the others. The Silver and Falls rivers and Furnace Creek are treated annually to prevent lentic populations from developing off their mouths.

Stream discharges during most treatments were not optimal but did not prohibit successful treatment. A 15-hour block of TFM was used to compensate for low stream discharge during the Black River treatment. Stream discharge was low on the Misery and Big Garlic rivers at the start of the treatment, however, rainfall during these treatments increased the discharge.

Trace amounts of TFM were observed in the L'Anse (Baraga County, Michigan) municipal water system after the treatment of the Falls River. The contaminant was observed to be in the raw water supply for less than 24 hours. This same problem occurred when the Falls River was treated in 1992. Plans to eliminate this contamination are being studied.

Table 4. Details on the application of lampricide to streams of Lake Superior, 1993.
(Lampricides used are in kg of active ingredient.)
[Number in parentheses corresponds to location of stream in Fig. 3]

Stream	Date	Discharge $m^3 * s^{-1}$	TFM[1] kg	Bayer 73 kg	Dista[nce] km
UNITED STATES					
Big Garlic R. (2)	July 9	0.4	74	-	9.7
Nemadji R. (Black R.) (6)	Aug. 6	0.5	200	-	11.3
Furnace Cr. (1)	Aug. 17	0.3	38	-	1.6
Falls R. (4)	Sept. 10	1.7	126	-	1.6
Silver R. (3)	Sept. 11	1.0	93	-	8.0
Misery R. (5)	Sept. 13	1.0	248	-	20.9
Total		4.9	779	-	53.1
CANADA					
Little Carp R. (11)	June 28	0.4	34	-	3.5
Big Carp R. (10)	June 28	0.6	53	-	5.1
Pancake R. (8)	July 28	2.1	115	-	8.6
Goulais R. (9)	Aug. 4	19.2	1,807	-	110.4
Pays Plat R. (7)	Aug. 19	3.7	259	-	8.6
Total		26.0	2,268	-	136.2
GRAND TOTAL		30.9	3,047	-	189.3

[1]Includes a total of 199.5 TFM bars (39.9 kg) applied in 7 streams.

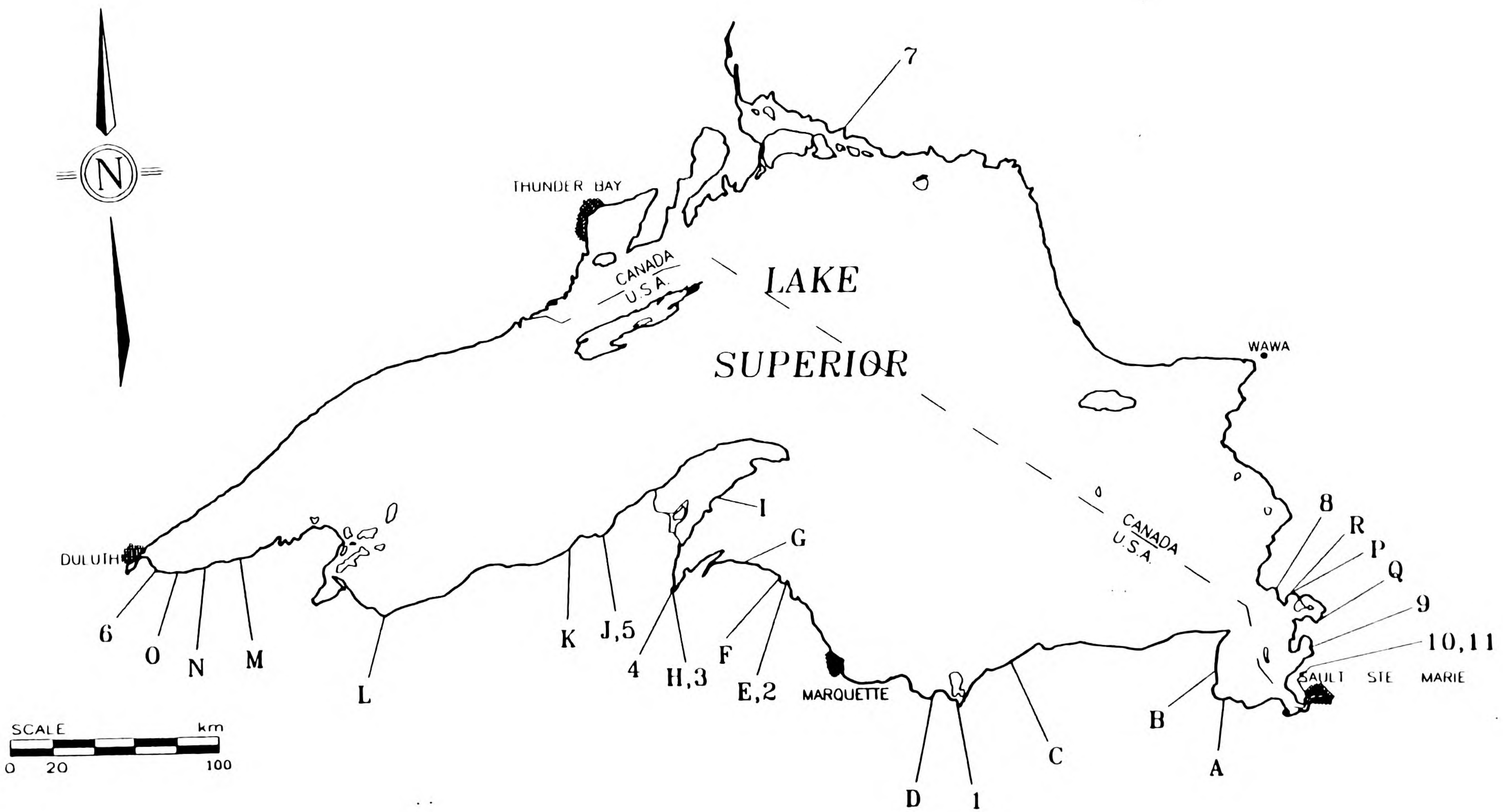

Figure 3: Location of Lake Superior tributaries treated with lampricides (numerals; see Table 4 for names of streams), and of streams where assessment traps were operated (letters; see Table 5 for names of streams) in 1993.

Canada

Successful treatments were completed on the Big and Little Carp, Goulais, Pancake, and Pays P rivers (Table 4, Figure 3), with a combined discharge of 26.0 $m^3 * s^{-1}$. Sustained high flows throughout t season forced postponement of the Black Sturgeon River treatment.

Treatment of the Pays Plat River, originally scheduled for treatment in 1992, was deferred that ye because of concerns expressed by residents of the Pays Plat First Nation. An opportunity to discu treatment techniques and management strategies with band members early in 1993 resulted reinstatement of the Pays Plat River onto the 1993 schedule.

Larval numbers were subjectively ranked as scarce in Big and Little Carp rivers but abundant the remaining streams treated. Non-target mortality was low in all treatments.

SPAWNING-PHASE ASSESSMENT

United States

Assessment traps placed in 15 tributaries of Lake Superior captured 5,374 spawning-phase se lampreys (Table 5, Figure 3). Spawning runs were monitored through cooperative agreements in eigh streams with the Great Lakes Indian Fish and Wildlife Commission (Amnicon, Middle, Bad, Firestee Misery, Traverse, Silver, and Huron rivers), and in the Brule River with the Wisconsin Department o Natural Resources.

The total number of spawning-phase sea lampreys was estimated in U.S. waters of Lake Superior for the eighth consecutive year (Table 6). The estimate is based on a relation of average stream discharge (x) and the estimated number of adult lamprey that enter tributaries (y). The estimated number of lampreys that enter tributaries is determined from mark/recapture studies and predictive linear regressions relating past year trap catch to mark/recapture estimates. The relation between discharge and population estimates was calculated separately for streams east and west of the Keweenaw Peninsula. In western waters, an estimated 17,491 lampreys were present ($y=231.58x$; $r=0.38$; $P<0.50$), while 6,838 lampreys were estimated ($y=95.76x$; $r=0.71$; $P<0.20$) east of the Keweenaw Peninsula. The total estimate of 24,329 sea lampreys was calculated using a combined flow of 171.73 cms (96.31 cms west and 75.42 cms east). This is less than the Lake Superior 5-year average (1988-1992) of 36,986 (27,545-55,032

Table 5. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Superior, 1993.
[Letter in parentheses corresponds to location of stream in Figure 3.]

Stream	Number captured	Number sampled	Percent Males	Mean Length (mm) Males	Mean Length (mm) Females	Mean Weight (g) Males	Mean Weight (g) Females
UNITED STATES							
Tahquamenon River (A)	244	26	73	457	431	224	199
Betsy River (B)	27	2	100	437	-	183	-
Miners River (C)	60	10	40	415	445	144	158
Rock River (D)	1,015	962	41	455	459	164	179
Big Garlic River (E)	28	4	50	440	472	132	187
Iron River (F)	5	0	-	-	-	-	-
Huron River (G)	55	6	33	395	353	168	261
Silver River (H)	0	0	-	-	-	-	-
Traverse River (I)	4	0	-	-	-	-	-
Misery River (J)	3,619	1,065	46	445	426	230	236
Firesteel River (K)	59	6	50	442	474	206	243
Bad River (L)	84	2	50	382	368	115	126
Brule River (M)	133	86	45	417	422	174	188
Middle River (N)	35	3	100	424	-	180	-
Amnicon River (O)	6	2	0	-	345	-	134
Total or Average	5,374	2,174	44	448	441	199	206
CANADA							
Stokely Creek (P)	5	0	-	-	-	-	-
Carp River (Q)	95	0	-	-	-	-	-
Pancake (R)	13	0	54	-	-	-	-
Total or Averages	113	0	54	-	-	-	-
GRAND TOTAL OR AVERAGE	5,487	2,174	44	448	441	199	206

Table 6. Mean discharge for U.S. streams located east and west of Keweenaw Ba Superior from May 6-June 30, 1986-1990, ranked as primary and secondary produce lampreys, and the estimated number of spawning phase sea lampreys in 1993.

[Population estimates were calculated from results of stratified multiple mark/ studies or predictive regressions relating past years trap catch to mark/recapture in 12 of 15 streams with traps. A simple linear regression estimates populations streams by the relation of mean stream discharge to the number of lampreys enterin tributaries.]

PRIMARY STREAMS

STREAM	DISCHARGE CMS	POPULATION ESTIMATE MARK/RECAP.	POPULATION ESTIMATE REGRESSION
WEST			
Nemadji River	13.87	-	3,212
Amnicon River	6.80	1,216	1,575
Middle River	1.42	184	329
Brule River	5.52	646	1,278
Red Cliff River	0.03	-	7
Bad River	12.37	2,428	2,865
Ontonagon River	29.18	-	6,758
East Sleeping River	0.74	-	171
Firesteel River	1.90	256	440
Misery River	1.39	8,859	322
Subtotal (West)	73.22	13,589	16,957
(w/traps)	29.40	13,589	6,809
(w/o traps)	43.82	-	10,148
EAST			
Traverse River	0.59	-	56
Sturgeon River	17.18	-	1,645
Falls River	1.73	-	166
Silver River	1.95	-	187
Slate River	0.54	-	52
Ravine River	0.59	-	56
Huron River	3.08	254	295
Salmon Trout River	1.58	-	151
Iron River	2.80	-	268
Big Garlic River	0.42	183	40
Little Garlic River	0.31	-	30
Harlow Creek	0.57	-	55
Chocolay River	2.91	-	279
Rock River	0.93	1,861	89
Au Train River	3.03	-	290
Furnace Creek	0.17	-	16
Miners River	1.08	189	103
Sucker River	2.12	-	203
Two Hearted River	6.14	-	588
Little Two Hearted River	0.96	-	92
Betsy River	2.09	103	200
Tahquamenon River	18.65	1,707	1,786
Waiska River	1.53	-	147
Subtotal (East)	70.95	4,297	6,794
(w/traps)	31.59	4,297	3,024
(w/o traps)	39.36	-	3,770
PRIMARY LAKE TOTAL	144.17	17,886	23,751

SECONDARY STREAMS

STREAM	DISCHARGE CMS
WEST	
Washington Creek	0.82
Arrowhead River	9.82
Poplar River	1.27
Gooseberry River	0.08
Split Rock River	0.28
Sand River	0.31
Black River	2.75
Cranberry River	1.70
Potato River	1.02
Elm River	0.59
Salmon Trout River	1.25
Fish Creek	2.21
Poplar River	0.99
Subtotal (West)	23.09
EAST	
Big Gratiot River	0.34
Eliza Creek	0.03
Dead River	1.42
Sand River	0.45
Five Mile Creek	0.06
Beaver Lake Outlet	0.48
Sable Creek	0.28
Galloway Creek	0.11
Pendills Creek	0.59
Laughing Whitefish River	0.71
Subtotal (East)	4.47
SECONDARY LAKE TOTAL	27.56

TOTAL SOUTH SHORE DISCHARGE: [illegible]

TOTAL SO. SHORE POPULATION ESTIMATE: [illegible]

Canada

Trap Operations:

Stokely Creek and Carp River were trapped (with low-head barriers including permanent traps) as part of the regular assessment network (Figure 3). In addition, the Pancake River was fished in conjunction with a sterile male release study. We did not collect biological information because lamprey collected were used for instream mark-recapture studies. The stratified population estimate was unreliable for Stokely Creek because of small sample size. The Carp River yielded an estimated run of 129, and an efficiency of 74% based on catch to estimate (59% based on recovered to marked.

To obtain a run estimate for the Pancake River, we fished fyke nets in the estuary and at a site 5 km upstream. The nets in the estuary consisted of two 1 m x 2 m fyke nets (one fishing upstream and the other down) and hardware cloth leads, placed to fish nearly one-half the stream's width. This site was located within 50 m of the mouth of the river and 0.5 km below the sterile male release site at the Highway 17 bridge. The second net array, consisting of a single downstream-facing fyke net with lead, was located approximately halfway up that portion of the Pancake utilized by sea lamprey. It fished one-half the stream's width.

At the estuary all captures were made in the net monitoring upstream movement. Two normal males and three females were collected. At the upstream site, seven sterile males were netted, V-notched, and returned to the stream. Five normal males and three females were also caught, V-notched, and released at the same site. We did not recapture any lamprey and were unable to estimate the spawning run population.

PARASITIC-PHASE ASSESSMENT

United States

A total of 11 parasitic-phase sea lampreys were collected from Lake Superior commercial fishermen in 1993 (Table 7). The largest number of sea lampreys was collected from fishermen in management unit WI-8 (Bayfield, Wisconsin area). Most lampreys were attached to fish collected by fishermen using gill nets (91%) and 64% were attached to lake trout.

Sport fishermen captured 33 parasitic-phase sea lampreys in 1993 (Table 8). Of the total, 30 were from the charterboat fishery and 3 were from noncharter fishermen. Fishermen from management unit MI-2 (Black River Harbor to Ontonagon, Michigan area) contributed the largest number of lampreys (16). All reported lampreys were attached to lake trout (Table 9).

The low number of parasitic-phase sea lampreys reported by commercial and noncharter fishermen is due in part to a change in collection effort. Due to change in priority, agency personnel were unable to dedicate effort equal to previous years for the collection of lampreys.

Table 7. Number[1] of parasitic-phase sea lampreys collected in commercial fisheries in U.S. waters of the Upper Great Lakes in 1993.

Lake Superior		Lake Michigan		Lake Huron	
Unit	Number	Unit	Number	Unit	Number
MN-1	-	MM-1	24	MH-1	616
MN-2	-	MM-2	10	MH-2	61
MN-3	-	MM-3	1	MH-3	-
WI-1	-	MM-4	-	MH-4	17
WI-2	6	MM-5	2	MH-5	-
MI-1	-	MM-6	-	MH-6	-
MI-2	-	MM-7	-		
MI-3	-	MM-8	-		
MI-4	-	WM-1	-		
MI-5	-	WM-2	5		
MI-6	-	WM-3	5		
MI-7	-	WM-4	-		
MI-8	5	WM-5	-		
		WM-6	-		
		Ill	-		
		Ind.	-		
Total	11		47		694

[1]A zero (0) indicates sampling effort with negative results and a dash (-) indicates no effort.

Table 8. Number[1] of parasitic-phase sea lampreys collected in sport fisheries in U.S. waters of the Upper Great Lakes in 1993[2].

Lake Superior			Lake Michigan			Lake Huron		
Unit	Charter	Noncharter	Unit	Charter	Noncharter	Unit	Charter	Noncharter
MN-1	-	-	MM-1	0	0	MH-1	53	14
MN-2	-	-	MM-2	-	-	MH-2	63	43
MN-3	0	0	MM-3	2	0	MH-3	113	57
WI-1	-	-	MM-4	6	0	MH-4	4	1
WI-2	0	2	MM-5	11	0	MH-5	54	-
MI-1	5	0	MM-6	48	2	MH-6	1	-
MI-2	16	0	MM-7	37	0			
MI-3	0	0	MM-8	75	0			
MI-4	0	0	WM-1	-	-			
MI-5	7	1	WM-2	1	1			
MI-6	2	0	WM-3	5	1			
MI-7	0	0	WM-4	13	1			
MI-8	0	0	WM-5	22	5			
			WM-6	20	1			
			Ill.	4	0			
			Ind.	-	-			
Total	30	3		244	11		288	215

[1]The Michigan and Wisconsin Departments of Natural Resources provided data on the occurrence of parasitic-phase sea lampreys in charterboat catches.
[2]A zero (0) indicates sampling effort with negative results and a dash (-) indicates no effort.

Table 9. Incidence of sea lampreys and numbers of lake trout and chinook salmon[1] taken by operators in the Michigan and Wisconsin charterboat fishery, 1993.[2]

[Incidence of sea lampreys is the number of lampreys attached per 100 fish; includes lampreys that were brought in the boat and those that were observed but dropped off the fish.]

Lake and District[3]	Incidence on lake trout: Sea lampreys per 100 trout	Incidence on lake trout: Number of trout	Incidence on chinook salmon: Sea lampreys per 100 salmon	Incidence on chinook salmon: Number of salmon
UNITED STATES				
Superior				
MI-1	0.6	879	0.0	0
MI-2	0.9	1,854	0.0	23
MI-3	0.0	77	0.0	2
MI-4	0.0	349	0.0	12
MI-5	0.5	1,360	0.0	17
MI-6	0.3	751	0.0	0
MI-7	0.0	124	0.0	0
MI-8	0.0	0	0.0	0
All Units	0.6	5,422	0.0	57
Michigan				
MM-3	0.2	1,070	0.0	96
MM-4	0.6	997	0.0	77
MM-5	0.2	6,107	0.0	1,101
MM-6	0.9	4,185	0.2	4,934
MM-7	0.7	4,754	0.1	2,705
MM-8	0.7	9,872	0.1	2,315
WM-2	0.0	41	0.1	1,663
WM-3	0.2	506	0.1	3,384
WM-4	0.2	4,619	0.0	4,973
WM-5	0.2	5,254	0.0	5,241
WM-6	0.3	5,655	0.0	893
Ill.	0.3	1,174	0.2	464
All Units	0.5	44,234	0.1	27,846
Huron				
MH-1	0.0	38	8.3	639
MH-2	3.5	85	9.6	625
MH-3	3.0	394	10.0	955
MH-4	0.0	178	3.8	104
MH-5	2.0	1,223	5.0	579
MH-6	0.0	6	0.3	320
All Units	2.0	1,924	7.5	3,222

[1]Lake trout and chinook salmon are the primary target species of the charter fishery of the Upper Great Lakes.
[2]The Michigan and Wisconsin Departments of Natural Resources provided data on the occurrence of parasitic phase sea lampreys in charterboat catches.
[3]Data were not obtained from units WI-1, WI-2, MM-1, MM-2, WM-1 and Indiana.

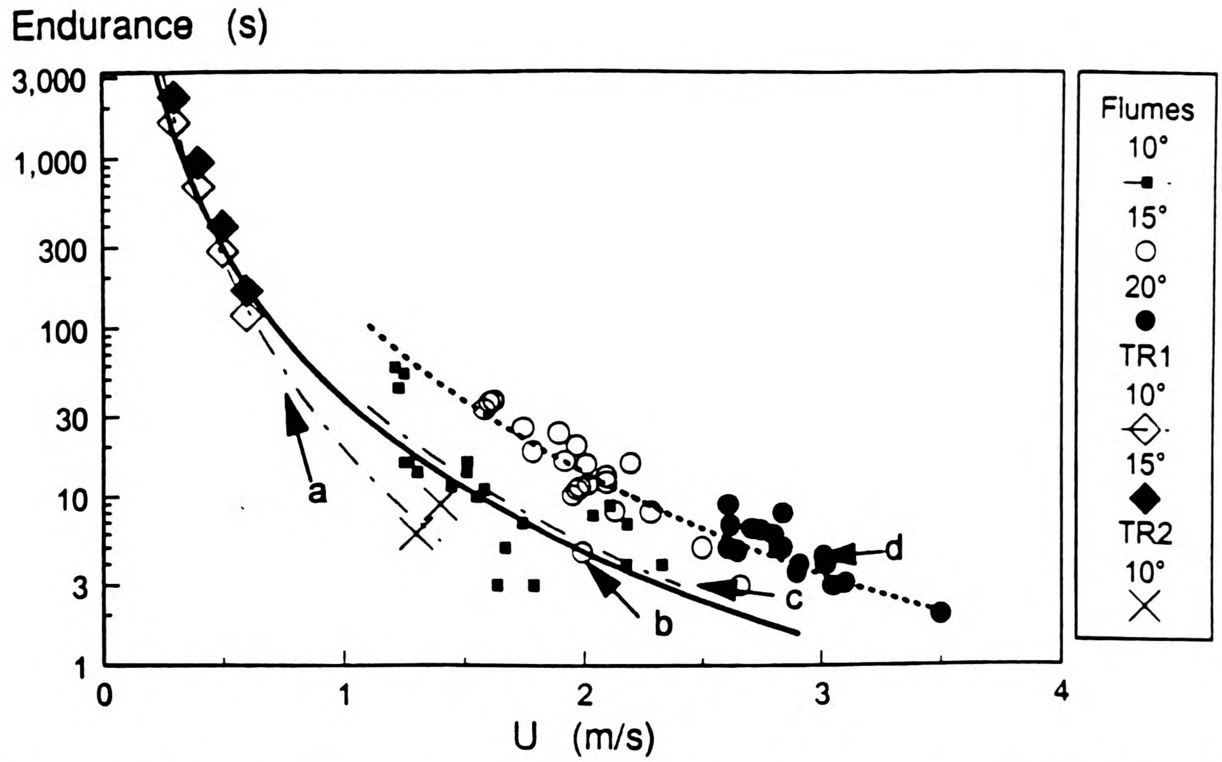

Figure 6 Swimming speed - endurance relationships for 45 cm long sea lampreys. Tunnel respirometer data is from Beamish (TR1) at 10° (curve a) and 15° and from Bergstedt (TR2) at 10°. Regressions for burst swimming in the flume at 10° (curve c) and at 15° and 20° (curve d) are shown along with the 10° curve (b) for prolonged and burst swimming from Figures 4 and 5.

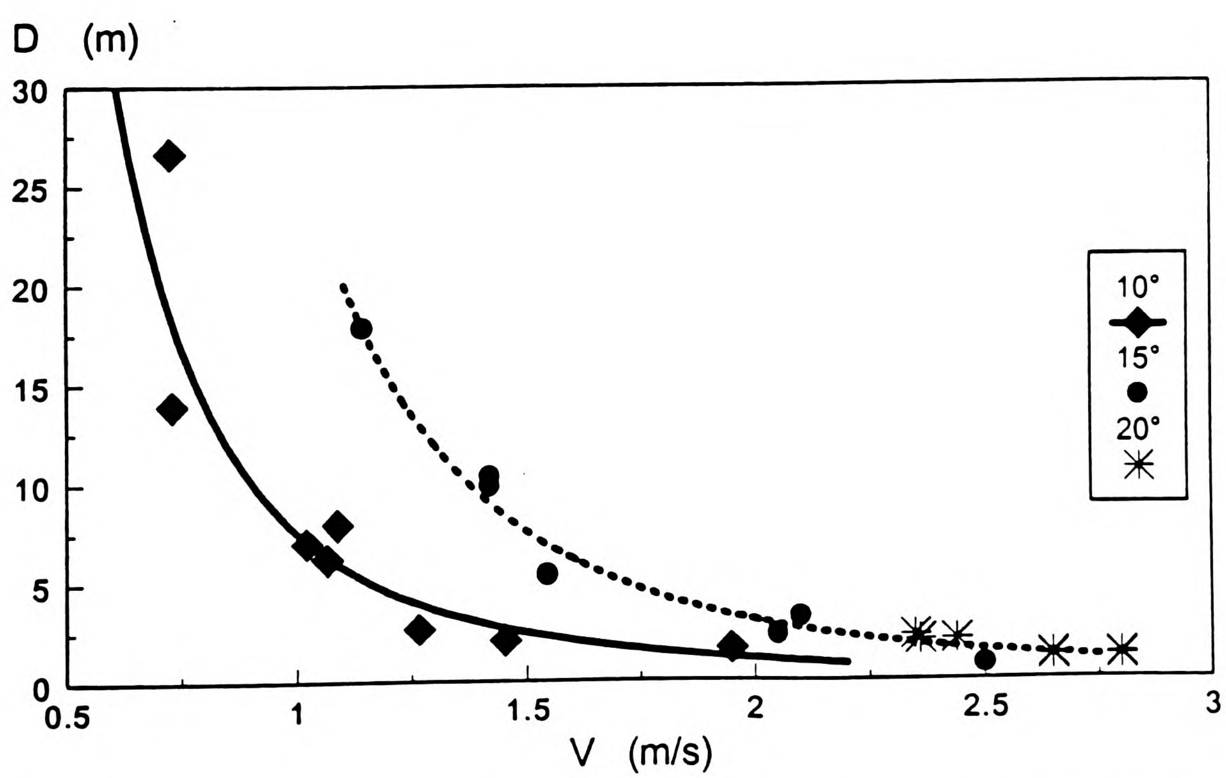

Figure 7 Median swimming distances of sea lampreys at different water velocities and temperatures in our 1991 and 1992 tests.

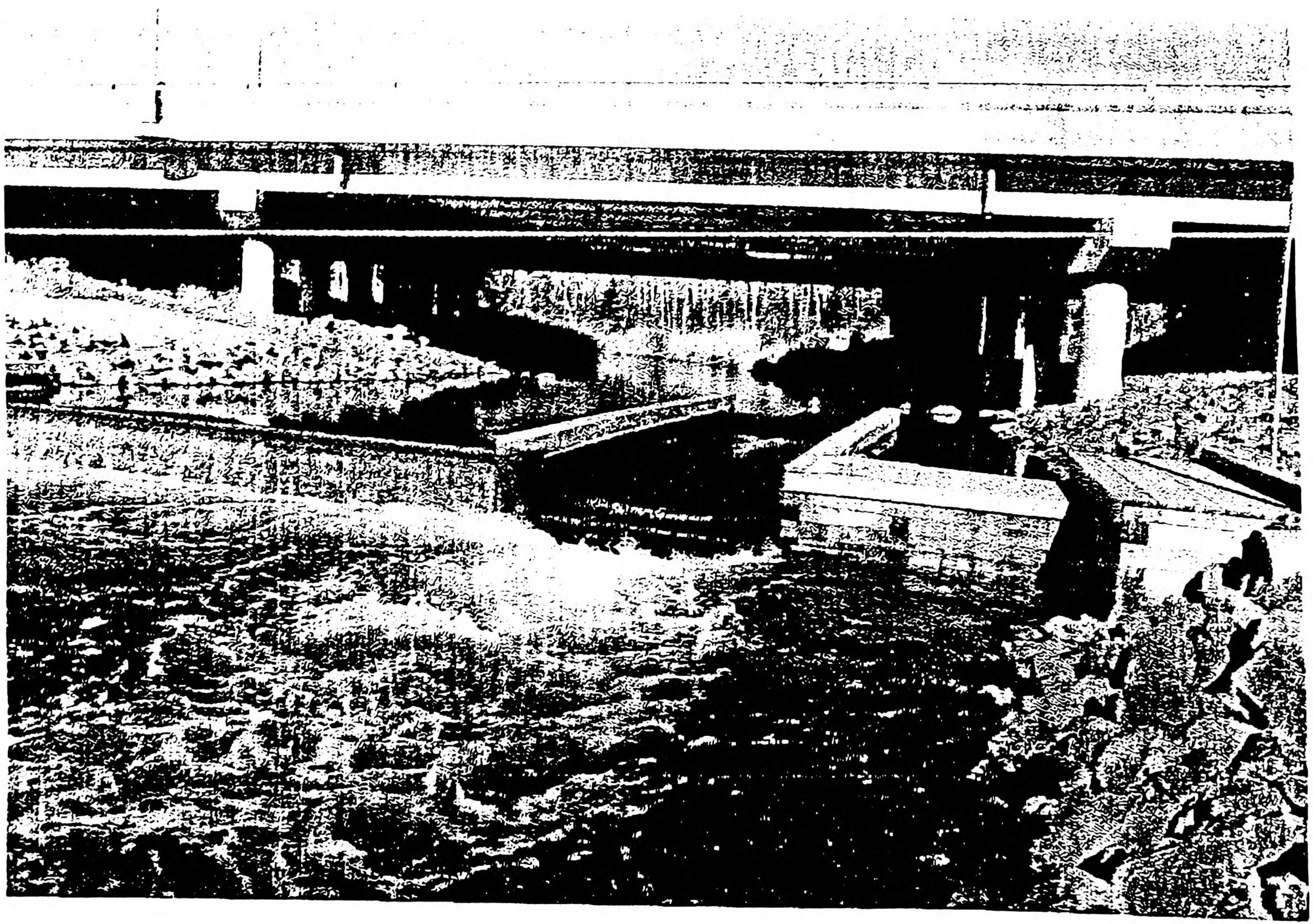

Figure 8. McIntyre River velocity barrier constructed in 1993

BARRIER DAMS

Canada

No conventional low-head barriers were constructed on Lake Superior tributaries. Required maintenance was conducted on three existing barriers.

Development of an Experimental Velocity Barrier to Control Sea Lamprey:

Background:

Barriers that exploit the physical differences between sea lampreys and other migratory species show significant potential for use in lamprey control. One of several physical differences that can be exploited is swimming endurance (Figure 4). Anguilliform swimming is hydromechanically less efficient than the sub-carangiform swimming mode used by other Great Lakes migratory fish. All of the marine teleosts in tests of prolonged swimming endurance were able to swim for longer periods at higher speeds than could sea lampreys (Beamish 1974; 1978). Differences exist in endurance between sea lampreys, steelhead, walleyes and suckers (Figure 5). It should be noted that there is a lack of burst swimming information in the literature on the latter two species.

The concept of using a velocity barrier technique as a control tool grew out of the challenges and problems related to passing diverse fish species at existing barrier dams and electric barriers. It has also grown out of the search by the Control Program for lamprey barriers that will function at minimal hydraulic heads. Lower head barriers have greater flexibility in site choices and can bring increased potential for lampricide reductions on many treated streams.

Hanson et al. (1980), considered velocity barriers to be infeasible when they observed a maximum sprint velocity of lampreys to be 4 m/s. The idea was not developed, because it was considered that a velocity greater than maximum swimming speed would be necessary because of the attachment advantage of sea lampreys.

Eliminating the attachment advantage permits the use of lower water velocities in velocity barriers. A velocity barrier becomes simply a planned combination of water velocity flowing over a distance such that it blocks sea lamprey passage. The longer the velocity chute, the lower the velocity required to stop lampreys. Conversely, the faster the water, the shorter the barrier required. This permits a certain flexibility in design and planning. The length and velocity of a barrier can be selected according to fish passage, budget and site criteria.

Accurate swimming performance data over the appropriate ranges of velocities and temperatures is indispensable in planning velocity barriers. Draft results from open flume swim tests for lampreys in 1991 and 1992 can be seen in Figures 4 to 7. The relation to previous work carried out on lampreys is also included in Figures 4, 5 and 6. Regressions were found for sea lamprey's swimming endurance and for distances attained in the various tests carried at water velocities between 0.7 and 2.8 m/s and over temperatures ranging from 9° to 21°. Endurance was found to vary inversely as the cube of swimming velocity at 10°. We observed the endurance curve

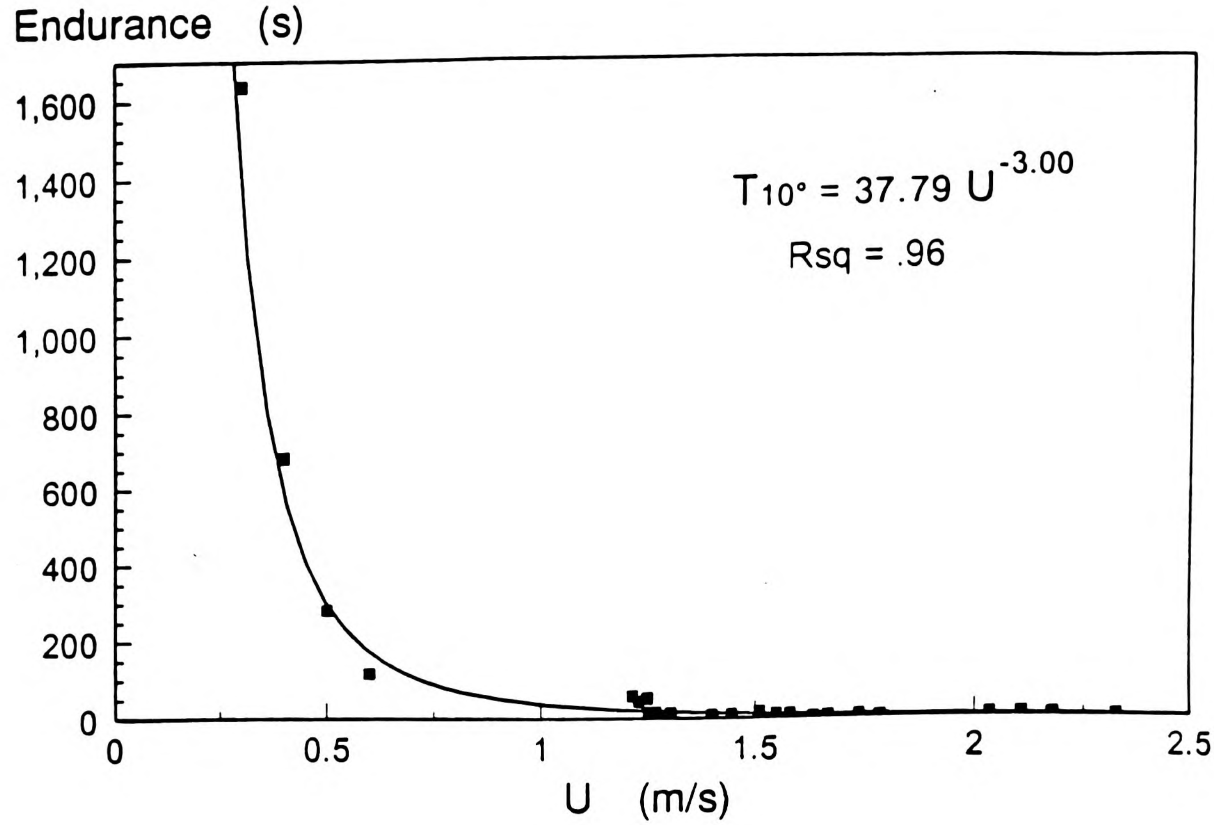

Figure 4 Relationship between endurance and swimming speed for 45 cm sea lampreys at 10° (Data from Beamish, Bergstedt and McAuley andYoung).

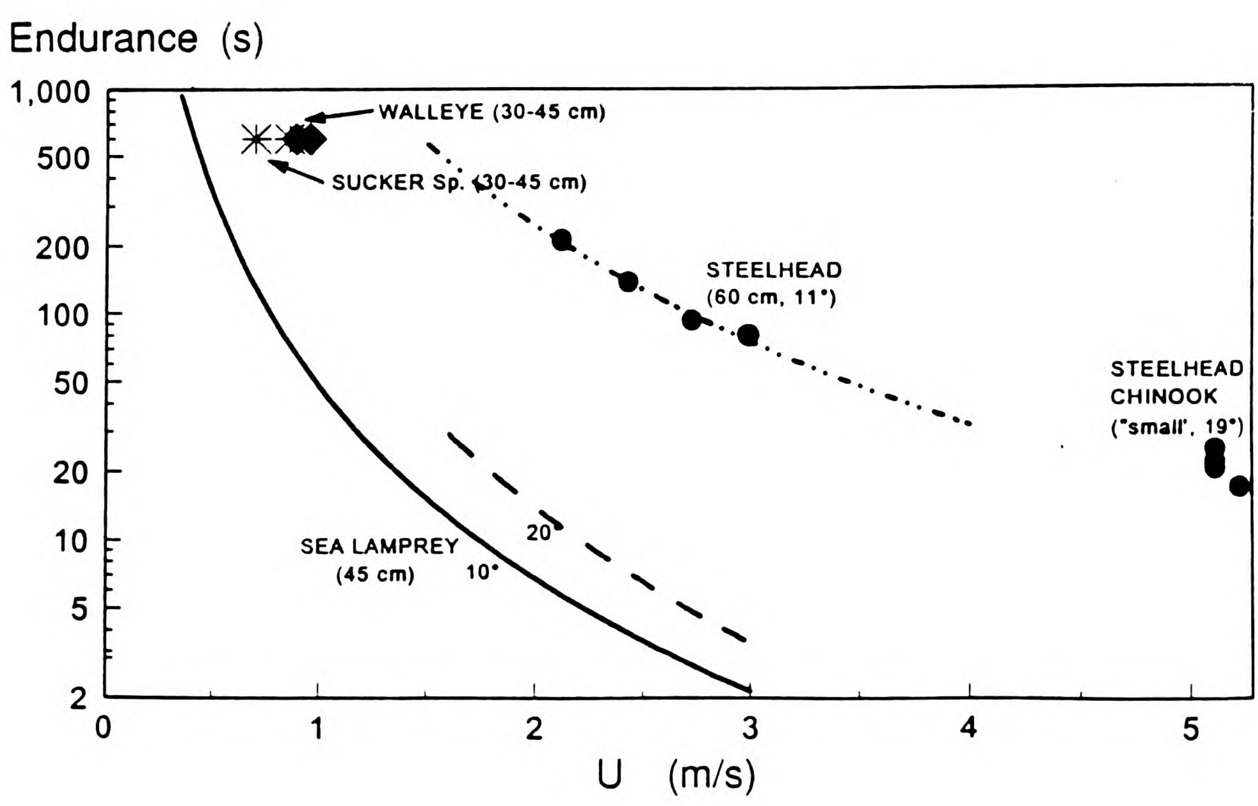

Figure 5 Endurance differences between up-migrant sea lampreys, several salmonid species and walleye and suckers (Data from Beamish, McAuley andYoung, Jones et al., Paulik et al., and Weaver). The 10°curve for lamprey is the same seen in Figure 4.

shifts to a new continuous upper level (Figure 6) for tests of 15° through 20°. We speculate that drag reduction results from a swimming mode adjustment to lower amplitude body waves. In considering the swimming performance of fish to be passed, it is important to use data from adult migratory animals at the range of water velocities considered. A search of the literature shows that this information is somewhat rare for upper prolonged and burst swimming for migratory species of concern in the Great Lakes basin.

Measured swim distances (Figure 7) include valuable information on lamprey swimming strategy. This data can be used to confirm any projections of distance achieved made from endurance data (which assume rates of travel).

Materials preventing attachment of sea lampreys were also tested. A suitable "non-attach" material was chosen from the six tested for use in the first instream velocity barrier. Hydraulic modelling of the velocity chute and overflow crest sections was carried out at the University of Manitoba hydraulics lab to confirm and improve design hydraulics.

McIntyre River:

An experimental velocity barrier (with lamprey trap) was built in 1993 on the McIntyre River in Thunder Bay on Lake Superior (Figure 8). The barrier has an 8.5 m long by 2.4 m wide velocity chute covered with a plastic grid material that prevents lamprey from attaching. The chute slopes at 2% with an average water velocity of 1.95 m/s at the stream's mean discharge. Total cost of the structure was $66,176. The first lamprey spawning run to the barrier will be in the spring of 1994. An evaluation of the barrier's success at fish passage and lamprey stoppage will be conducted in 1994.

For the future, there are a number of creative hydraulic structures including velocity barrier design variations, fishways and traps that exploit both swimming and behavioral differences which could be designed and tested.

LAKE MICHIGAN

TRIBUTARY INFORMATION

- 511 tributaries to Lake Michigan
- 121 tributaries have records of production of sea lamprey larvae.
- 70 tributaries have been treated with lampricide at least once during 1984-93.
- Of these, 36 tributaries are treated on a regular (3-5 year) cycle.

SEA LAMPREY AND FISH COMMUNITY OBJECTIVES

The Lake Michigan Committee (LMC) is currently revising the draft Fish Community Objectives developed in 1990. The draft does not have an explicit objective for sea lamprey. The

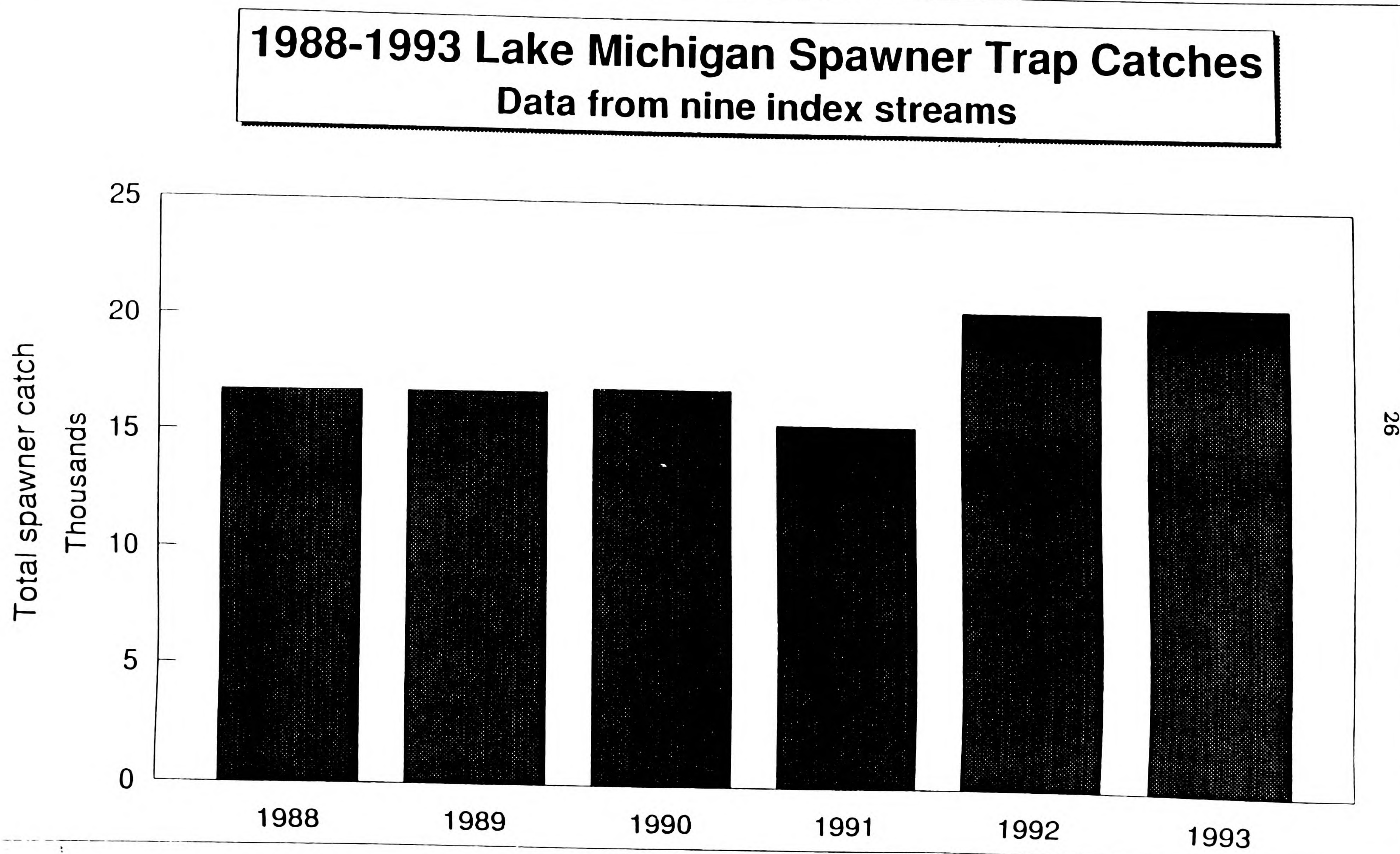

Figure 9. Relative abundance index of Lake Michigan spawner catches derived from

Lake Michigan Committee recommends the general strategy of "reducing residual lamprey populations further" with an integrated program of new technologies in addition to lampricide control. Current drafts being considered by the Lake Michigan Committee maintain a general objective that sea lamprey must be "suppressed to tolerable levels" to "restore and maintain the biological integrity of the fish community so that production of desirable fish is sustainable and ecologically efficient".

The original and current drafts of the Fish Community Objectives have explicit expectations for the establishment of self-sustaining lake trout populations capable of sustaining yields comparable to those experienced in the sustained historic fishery. To achieve and maintain a suitable spawning population a target total annual mortality of less than 40% must be met (Lake Michigan Lake Trout Technical Committee 1985). Control of sea lamprey populations and fishery exploitation will be necessary to meet this mortality objective. The lake-wide management plan specifies four areas (refuges, primary, secondary, and deferred rehabilitation zones), in order to focus rehabilitation actions to the areas where the chances of success are best. The LMC recommends priority be given to reducing mortality caused by sea lamprey located in primary rehabitat zones and refuges in the mid-northern region, the mid-lake reef zone, and an off-shore reef area in the southwest portion of the lake.

The US agent has annually operated an assessment network for spawning-phase sea lampreys on nine streams in Lake Michigan (Figure 9). We hypothesize that increased production of sea lampreys from the St. Marys River are contributing to increased lamprey populations in northern Lake Michigan. Catch has increased in 1992-93 when compared to 1988-91 and lampreys are more abundant in northern areas of the lake compared to southern areas.

LARVAL ASSESSMENT

Surveys were conducted to prepare for lampricide treatments, assess the success of past treatments, monitor reestablished populations of larval sea lampreys, and search for new infestations of larvae in 89 Lake Michigan tributaries. Surveys to schedule lampricide applications were conducted in 38 streams. Of these, 7 were successfully treated, 9 were scheduled for treatment in 1994, and the remaining 22 were deferred. Sea lamprey larvae that remained from past treatments were found in 19 streams, but comprised less than 5% of the total number of larvae collected in all streams. Larvae had reestablished in 43 of the streams that were surveyed. Estuarine surveys were conducted in 6 streams, and offshore surveys were conducted near 2.

Surveys to assess recruitment of the 1993 year class were conducted in 87 streams and young-of-the-year larvae were recovered in 40. Sea lamprey larvae have not been detected for 5 or more years in 21 streams that have been examined annually.

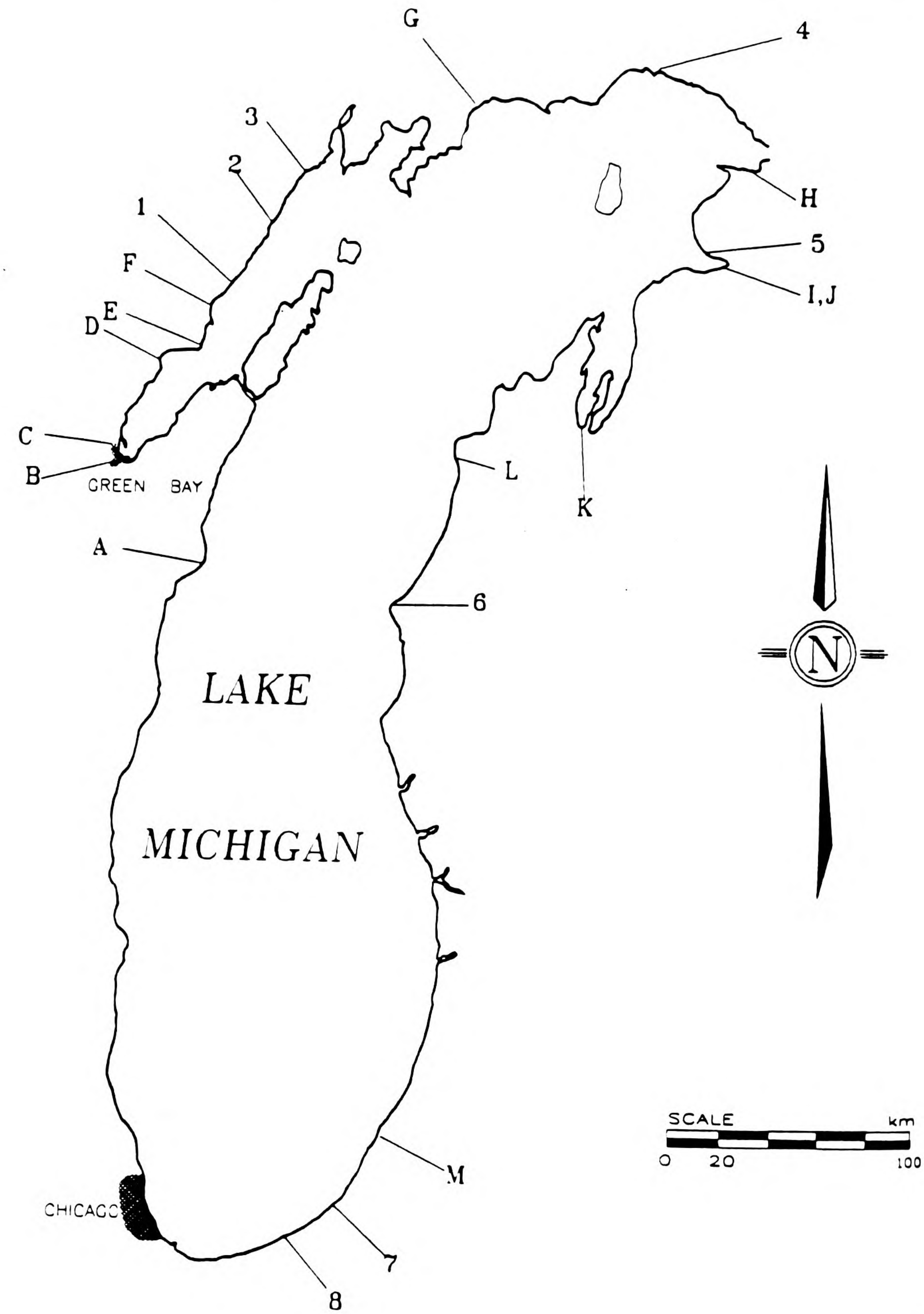

Figure 10: Location of Lake Michigan tributaries treated with lampricide (numerals; see Table 10 for names of streams), and of streams where assessment traps were fished (letters; see Table 11 for names of streams) in 1993.

LAMPRICIDE MANAGEMENT

Lampricide treatments using TFM were completed on 8 streams (Table 10, Figure 10) with a combined discharge of 31 $m^3 \cdot s^{-1}$. Sea lamprey larvae were abundant in the Ford River and less abundant in the other streams. Treatment of Porter Creek was postponed due to high discharge. No significant non-target mortality occurred during treatments.

Rain and the resulting fluctuations in discharge were common, however, minimum lethal concentrations (MLC) of TFM were maintained throughout most treatments. Some segments of the Ford River and the last stream mile of the Cedar River received less than the defined MLC of lampricide. Surveys later indicated no larvae had survived in either river.

Table 10. Details on the application of lampricide to streams of Lake Michigan, 1993.
(Lampricides used are in kg of active ingredient.)
[Number in parentheses corresponds to location of stream in Fig. 10.]

Stream	Date	Discharge $m^3 \cdot s^{-1}$	TFM[1] kg	Bayer 73 kg	Distance km
Ford R. (3)	April 30	15.6	4,141	0	187.2
Galien R. (7)	June 13	7.7	1,826	0	48.0
Burns D. (8)	June 29	1.7	359	0	32.0
Gurney Cr. (6)	Sept. 9	0.2	44	0	1.6
Horton Cr. (5)	Sept. 16	0.6	127	0	1.6
Black R. (4)					
Middle Branch	Sept. 25	2.0	282	0	30.4
Cedar R. (2)	Sept. 25	3.1	1,442	0	81.6
Bailey Cr. (1)	Sept. 29	0.1	12	0	1.6
Total		31.0	8,233	0	384

[1]Includes a total of 145 TFM bars (30 kg) applied in 2 streams.

SPAWNING-PHASE ASSESSMENT

A total of 20,853 sea lampreys were captured in assessment traps placed in 7 west shore and 6 east shore tributaries of Lake Michigan in 1993 (Table 11). This is higher than the 5-year (1988-1992) average of 17,442 (15,824-20,590). Duck Creek was monitored through a cooperative agreement with the Oneida Tribes of Wisconsin. The Manistique River catch (18,497) was only 78 less than the record catch of 1992 (18,575). The estimated number of spawning-phase sea lampreys in this system in 1993 was 25,267.

Table 11. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Michigan, 1993.
[Letter in parentheses corresponds to location of stream in Fig. 10.]

Stream	Number captured	Number sampled	Percent Males	Mean Length (mm) Males	Mean Length (mm) Females	Mean Weight (g) Males	Mean Weight (g) Females
East Twin River (A)	61	61	38	393	426	272	264
Fox River (B)	0	0	-	-	-	-	-
Duck Creek (C)	0	0	-	-	-	-	-
Oconto River (D)	7	7	29	406	391	243	235
Peshtigo River (E)	418	415	50	484	487	270	296
Menominee River (F)	28	28	57	485	479	269	275
Manistique River (G)	18,497	18,493	45	-	-	-	-
Carp Lake River (H)	423	414	41	433	443	190	208
Jordan River (I)	3	0	-	-	-	-	-
Deer Creek (J)	106	105	49	465	495	241	295
Boardman River (K)	115	113	49	470	468	235	244
Betsie River (L)	1,085	954	47	475	470	241	251
St. Joseph River (M)	110	110	33	485	491	221	244
Total or average	20,853	20,700	45	467	468	239	252

PARASITIC-PHASE ASSESSMENT

Lake Michigan commercial fishermen captured 47 parasitic-phase sea lampreys in 1993 (Table 7). The largest number of sea lampreys was collected from fishermen in the Michigan management unit MM-1 (Menominee-Gladstone-Fairport, Michigan area). Most lampreys were attached to fish captured by gill net (82%) and primarily were attached to whitefish (64%).

A total of 255 parasitic-phase sea lampreys were collected from the Lake Michigan sport fishery (244 charter, 11 noncharter) (Table 8). The management unit that contributed the largest number was MM-8 (Saugatuck-South Haven, Michigan area). Lampreys primarily were attached to lake trout (84%) (Table 9).

The decline in the number of parasitic-phase sea lampreys reported by commercial and noncharter fishermen is due in part to a change in collection effort. Due to change in priority, agency personnel were unable to dedicate effort equal to previous years for the collection of lampreys.

LAKE HURON

TRIBUTARY INFORMATION

- 1,761 (1,334 Canadian, 427 United States) tributaries to Lake Huron
- 116 (54 Canadian, 62 United States) tributaries have records of production of sea lamprey larvae

- 66 (33 Canadian, 33 United States) tributaries have been treated with lampricide at least once during 1984 - 1993

- Of these, 49 (27 Canadian, 22 United States) tributaries are treated on a regular (3-5 year) cycle

SEA LAMPREY AND FISH COMMUNITY OBJECTIVES

The Lake Huron Committee (1993) established a specific objective for sea lamprey abundance as part of its Fish Community Objectives:

Reduce sea lamprey abundance to allow the achievement of other fish community objectives; obtain a 75% reduction in parasitic sea lamprey by the year 2000 and a 90% reduction by the year 2010 from present levels.

Progress toward this objective will be monitored by the abundance of spawning lamprey in four index streams in Northern Lake Huron, the Thessalon, St. Marys, Cheboygan, and Ocqueoc rivers (Lake Huron Technical Committee 1991).

This sea lamprey objective supports the objectives for the other species groups in the fish community. For example, the Salmonine community objective to:

Establish a diverse salmonine community which can sustain an annual harvest of 5.3 million pounds, with lake trout the dominant species and anadromous species also having a prominent place.

Total annual mortality should not exceed 45% to develop and maintain a self sustaining lake trout population capable of supporting 3-4 million pounds of this overall yield objective. (Lake Huron Technical Committee 1991). The plan calls for management of exploitation and lamprey to reach this objective. The lake-wide management plan identifies refuges and special rehabilitation zones in which rehabilitation is most likely to succeed. These priority zone are distributed around the lake, including the northern section and the North Channel. These areas should be priority areas for the suppression of lamprey and control of fishery exploitation.

The Canadian and US agents annually trap three index traps since 1985 to monitor abundance of sea lamprey in northern Lake Huron. During this period, lamprey abundance has doubled (Figure 11). Our observations of significantly greater numbers in Lake Huron are substantiated by similar patterns of parasitic sea lamprey abundance and fish wounding. We suggest that without substantive action to manage the uncontrolled population of larvae in the St. Marys River that we will fail to make progress in achieving sea lamprey objectives or lake trout rehabilitation in Lake Huron.

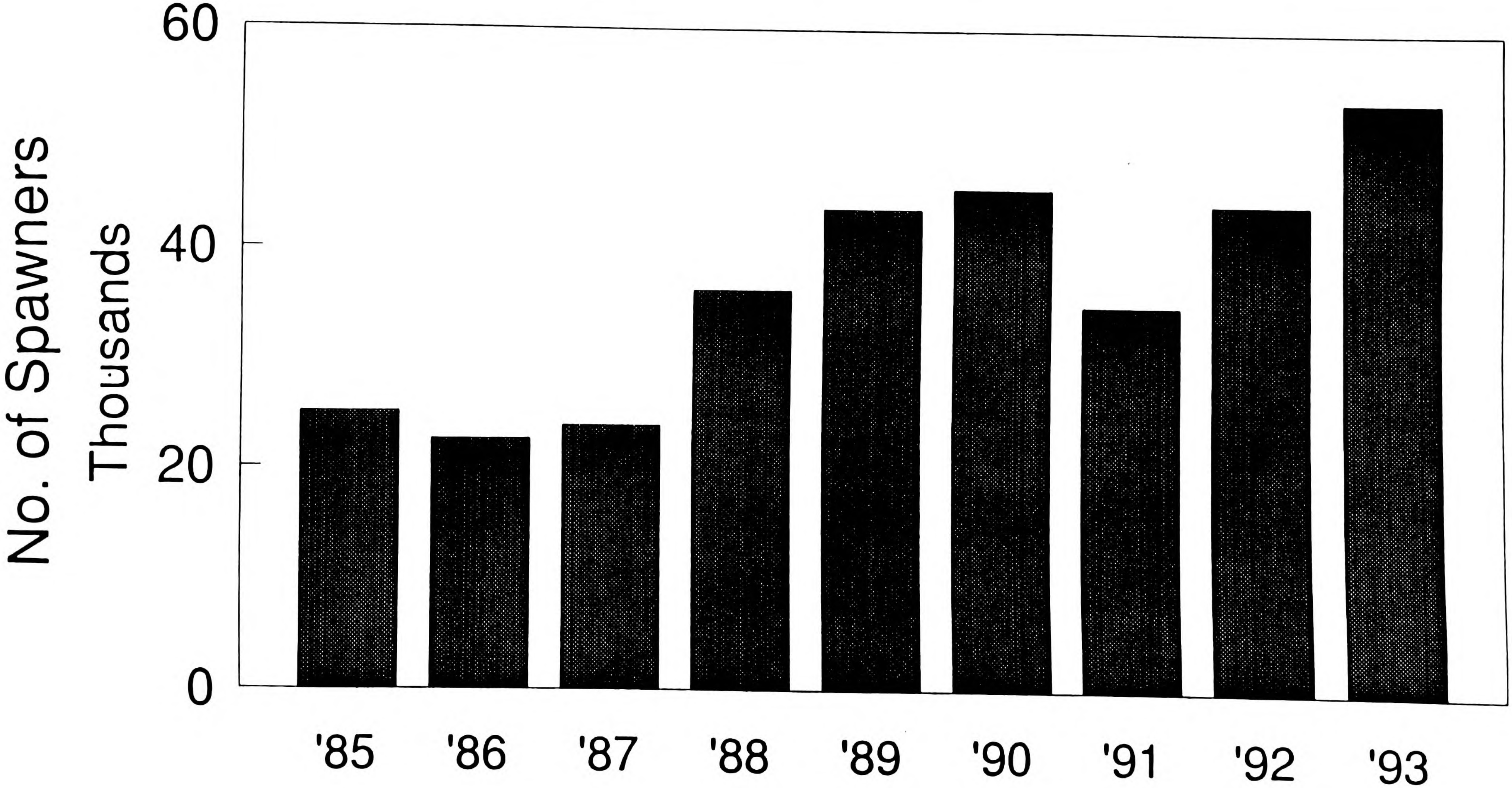

Figure 11. Index of spawner abundance

LARVAL ASSESSMENT

United States

Surveys were conducted to prepare for lampricide treatments, assess the success of past treatments, monitor reestablished populations of larval sea lampreys, and search for new infestations of larvae in 59 Lake Huron tributaries. Surveys to schedule lampricide applications were conducted in 25 streams. Of these, 5 were successfully treated, 8 were scheduled for treatment in 1994, and the remaining 12 were deferred. Sea lamprey larvae that remained from past treatments were found in 10 streams, but comprised less than 5% of the total number of larvae collected in all streams. Larvae had reestablished in 27 of the streams that were surveyed. Estuarine surveys were conducted in one stream, and offshore surveys were conducted near another stream. Original surveys to search for new infestations were conducted in 17 streams and no larvae were found.

Surveys to assess recruitment of the 1993 year class were conducted in 41 streams and young-of-the-year larvae were recovered in 24. Sea lamprey larvae have not been detected for 5 or more years in 6 streams that have been examined annually.

Canada

The Sea Lamprey Control Centre annually conducts larval sea lamprey surveys in Lake Huron tributaries. Survey objectives include establishing range distribution, TFM treatment evaluation, determining the first year class to reestablish as well as estimating population abundance and size class distribution in streams to schedule treatments in the following year. The standard techniques used in larval assessment include electrofishing (shallow streams) and Bayer 73 surveys (deep water).

<u>Distribution surveys:</u>

Distribution surveys were completed on the Nottawasaga River prior to the 1993 treatment and on ten streams tentatively scheduled for treatment in 1994 (Garden, Echo, Spanish, Wanapitei, and Manitou rivers and Watson, Sand, Livingstone, Silver and Blue Jay creeks). With the exception of the Echo and Manitou rivers, no significant change in distribution was observed in streams scheduled for treatment in 1994 or the Nottawasaga River.

Remedial work on the barrier dam in the Upper Echo River in 1991 has considerably reduced its larval distribution. Surveys in Solar Lake and its upstream tributaries (located about 17 km above the dam) found only a small number of large larvae that had escaped the last treatment (1990). No indication that parasitic lamprey completed their life cycle in Solar Lake was found, despite our observation of heavily wounded pike in 1992. However, larvae have extended their distribution in Bar Creek, a tributary to the Lower Echo River, to the historical maximum.

The Ontario Ministry of Natural Resources modified a low falls located about 1 km from the mouth of the Manitou River, in 1983, to enhance passage for jumping fish and improve lamprey blocking potential. Sea lamprey are now able to surpass these falls and larval distribution has increased by about 5 km.

Treatment Evaluation and Larval Reestablishment:

Treatment evaluation surveys were done on four of the five Lake Huron tributaries treated in 1992. A moderate number of residual sea lamprey larvae was found in the Root River and none in the lower Thessalon River and Gordon and Browns creeks. The Root River and Gordon Creek were also found to have reestablished with the 1992 year class of larvae following treatment.

Reestablishment surveys were completed on nine other streams last treated prior to 1992. Surveys were positive for the Chikanishing River and negative for Pretty and Sydenham rivers, as well as Two Tree, H-65, Kaboni, Squirrel, Silver and Bothwell's creeks.

Barrier Evaluation:

Barrier evaluation surveys were conducted at five barriers in 1993. Low-head barrier dams on the Echo, Koshkawong, Still and Sturgeon rivers were effective at blocking the 1992 run of adult lampreys. Spawning does occur downstream of the dams on all four rivers.

Low numbers of the 1991 and 1992 year class of larval sea lamprey were found in the Thessalon River above Rock Lake. Spawning lamprey continue to pass McCreight's Dam at the outlet of Ottertail Lake. We believe this dam effectively blocked spawning lamprey from 1957 until the early 1980's. Attempts to restore its barrier capability by repositioning stop logs have failed. An additional 40 km of stream will likely require treatment again in 1996.

Quantitative Assessment

i) *Nottawasaga River*

In June 1993, the sea lamprey ammocoete population of the main stem of the Nottawasaga River (Figure 12) was estimated by the Petersen mark-and-recapture method. Although larvae had been reestablished in the Nottawasaga River for at least seven years, surveys indicated that densities in the main stem were very low. However, even at low densities our data suggested that the larval population and its contribution to parasitic stocks in Southern Georgian Bay could be substantive, given the large amount of suitable larval habitat in the almost 90 km of main stem infested. An apparent upsurge in parasitic activity and spawner numbers provided additional evidence of an uncontrolled source of transformers in this part of Lake Huron as well.

We conducted a mark-and-recapture study in conjunction with the TFM treatment to evaluate the decision to treat this large and expensive river. Additionally we would be able to index this abundance to assessment catches and provide a measure of treatment efficiency.

The main river above the Mad River was divided into five reaches (Table 12, Figure 12). Three of the reaches were upstream of the confluence with the Pine River and two were below. Within each reach a study area 500 m in length was selected that was representative of the reach. The reaches and study areas were designated from upstream down as A, B, C, D and E. For each

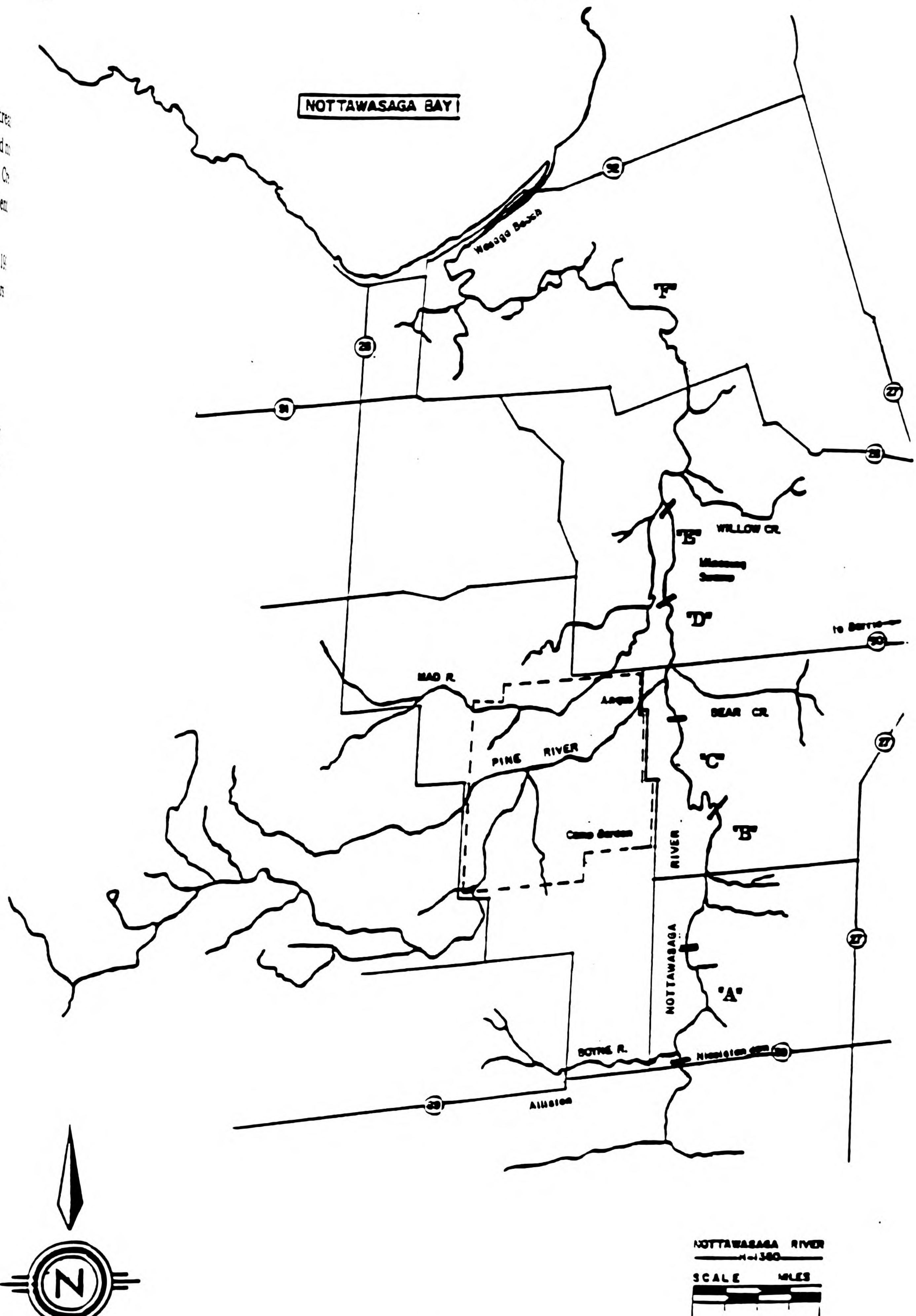

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Figure 12 Locations of mark and recapture study plots in N...

of the five study areas, we measured average width and depth, and classified habitat as Type I (preferred), Type II (suitable) or Type III (unsuitable) (Table 12). For the analysis, we lumped Types I & II habitat because workers did not consistently distinguish among these classifications. Habitat for the entire reach was determined by extrapolation from the study area data.

A modified Petersen estimate was made of the larval sea lamprey population in each study area. Sea lamprey larvae were electrofished from the Pine River, anesthetized, marked with a tail clip, and measured to length. Larvae were released into the study area at the rate of about $0.05/m^2$. We did not enclose the study areas with nets and assumed an equilibrium between immigration and emigration from the study area. We collected animals during the lampricide treatment with dip and fyke nets. The population of each study area was estimated and average densities determined (Table 12). As expected sea lamprey larval densities were very low, ranging from a high of $0.15/m^2$ in Type I & II habitat at Site C, to a low of $0.005/m^2$ at Site E. Average density for all five study sites was 0.08 larvae/m^2. The population of each reach of the main Nottawasaga was calculated by applying estimated densities within the 500 m study areas to the total amount of habitat in each reach (Table 12). The density at the lowermost study site, i.e., Site F was used to estimate a population for that part of the river downstream of the Mad River.

Summing the reach estimates produced a total estimate of 79,784 larvae for the main stem of the Nottawasaga River. The size of the sea lamprey larvae in the main river was, on average, very large with 141 of the 309 collected (46%) being ≥ 120 mm in length. This is probably due in part to very high mortality of young larvae that are unable to adapt to the relatively unstable substrate in the main river and that much of the spawning occurs in tributary streams.

We estimated 36,000 sea lamprey larvae were of transformable size in the Nottawasaga River, although the potential transformation rate from this untreated population is unknown. In a comparable situation on the Rouge River in 1983, 31% of larvae ≥ 120 mm were undergoing transformation. At a similar rate, the Nottawasaga would have produced over 11,000 transformed larvae in 1994 had it not been treated.

Table 12. Nottawasaga River population estimate from mark and recapture experiments in June 1993.

[Population estimates for stream derived by expanding densities within study plots to entire stream reach.]

	A	B	C	D	E	F	Total
Area type 1&2 combined (m^2)	7042	8834	8419	14965	9804		49064
%>=120 mm-	78.1	85.2	34.3	79.3	100		45.6
Avg dens all hab (#'s/m^2)	0.1	0.0	0.1	0.1	0.0		0.1
Avg dens type 1&2 (#s/m^2)	0.1	0.0	0.2	0.1	0.0		0.1
Population estimate (reach)	8259	8740	44429	10441	844	7071	79784

ii) Other population estimates

Randomly selected sites on six stream tributaries to Lake Huron were electroshocked with AbP-2 fishers using depletion methodology to estimate larval sea lamprey densities. Areas and percentage larval habitat were calculated from transect measurements. Total larval populations were calculated for each stream based on average density and habitat distribution by section (Table 13).

On Manitoulin Island, population estimates were conducted on the Manitou River and Timber Bay and Blue Jay creeks. Due to extremely high water, only habitat estimates on the Mindemoya River were conducted. On the north shore of the North Channel, the Garden River was surveyed from High Falls to the confluence of Driving Creek and five areas of the Spanish River were surveyed using the deep water shocking unit.

Table 13. Population and habitat estimates of Lake Huron tributaries surveyed using depletion sampling

Stream	Distance km	Width m	Area ha	% Larval Habitat	Density $\#/m^2$	Population (95%)
Timber Bay Cr.	3.1	8.8	2.4	64	1.4	36,860 (8768-46683)
Blue Jay Cr.	8.7	9.5	8.3	52	0.2	7,644 (1889-16891)
Manitou R.	0.9	16.2	1.8	15	0.06	160 (0-514)
Mindemoya R.	4.8	12.1	5.8	95	-	-
Garden R.	66.9	17.0	112.5	37	1.4	584,836 (409597-796322)
Spanish R.	15.0	126.0	238.0	79	0.01	94,339 (8069-86970)

LAMPRICIDE MANAGEMENT

United States

Lampricide treatments were completed on 12 streams (Table 14, Figure 13) with a combined discharge of 47 $m^3 * s^{-1}$. Sea lamprey larvae were abundant in the East Au Gres and Rifle rivers and relatively less abundant in the remainder of the streams. The Pigeon and Rifle rivers were treated with a combination of TFM and Bayer 73 wettable powder and the other rivers with TFM only.

Rain caused discharge fluctuations during treatments but lampricide concentrations lethal to lampreys were maintained in most streams. Estuary areas of Martineau and Prentiss creeks, the lower mainstream of the Rifle River, the Pigeon River upstream from Red Bridge, and several sites on the Pine and Carp rivers indicated sublethal TFM concentrations. Rain-induced

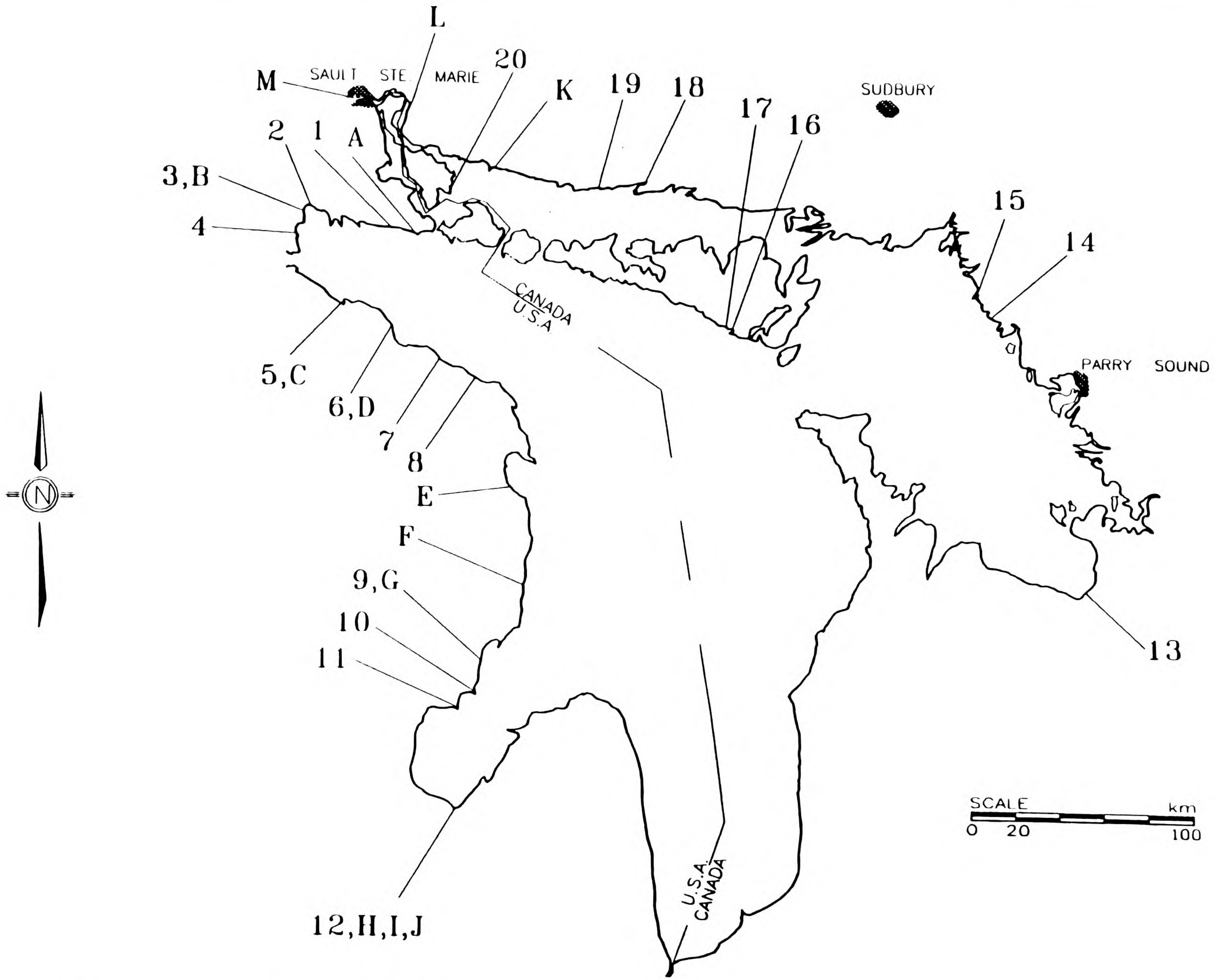


Figure 13: Location of Lake Huron tributaries treated with lampricide (numerals; see Table 15 for names of streams) and of streams where assessment

high water levels were a positive factor during treatment of the Big Salt River because the river is untreatable at low discharges.

Private landowners affected success of treatments in two rivers. The upper portion of Hope Creek (Au Gres River) was not treated because the landowner denied the agency access to the area. Excellent cooperation was obtained from the Sage Lake Association in the upper Au Gres River regarding operation of the private dams and no related water problems occurred. A premature water release overrode part of the lampricide bolt in the middle of the Pigeon River during treatment. A boost application restored the integrity of the bank and lethal concentrations were maintained for the remainder of the treatment.

Non-target species mortality during most treatments was not significant, but some nongame fish were killed in three rivers. During the Big Salt River treatment several hundred stonecats, a small number of mud puppies, and several of 13 other nongame fish species died. Over two hundred fish including sucker species, stonecats, and various minnow species died during treatment of the Au Gres River because of a decrease in pH levels. An estimated 1,300 trout-perch were killed in the lower 6 mile section of the Pine River. Data is not available on tolerance of trout-perch to TFM to estimate the percentage of the total population that may have been affected.

Table 14. Details on the application of lampricide to streams of Lake Huron, 1993.
(Lampricides used are in kg of active ingredient.)
[Number in parentheses corresponds to location of stream in Fig. 13.]

Stream	Date	Discharge $m^3 * s^{-1}$	TFM[1] kg	Bayer 73 kg	Distance km
UNITED STATES					
Saginaw R.					
Big Salt R. (12)	May 10	4.3	1,951	0	38.4
Augres R. (10)	May 20	2.1	825	0	65.6
East Augres R. (9)	May 26	2.8	538	0	17.6
Carp R. (4)	May 31	13.3	2,052	0	92.8
Pine R. (2)	June 11	6.5	1,450	0	112.0
Trout R. (8)	June 12	0.7	291	0	6.4
Rifle R. (11)	July 10	10.0	3,690	7.6	195.2
Schmidt Cr. (7)	Aug. 27	0.1	25	0	3.2
Ocqueoc R.					
Lower Ocqueoc (6)	Aug. 28	3.4	861	0	6.4
Cheboygan R.					
Pigeon R. (5)	Aug. 30	3.6	1,070	12.5	48.0
Prentiss Cr. (1)	Oct. 6	0.1	37	0	4.8
Martineau Cr. (3)	Oct. 6	0.1	13	0	3.2
Total		47.0	12,803	20.1	593.6
CANADA					
Naiscoot R. (14)	June 2	9.8	259	0	10.5
Mindemoya R. (17)	June 3	2.0	324	0	3.7
Timber Bay Cr. (16)	June 4	0.6	82	0	1.7
Nottawasaga R. (13)	June 13	11.2	2,974	13.3	142.3
Magnetawan R. (15)	July 8	32.0	1,329	0	6.5
Lauzon Cr. (19)	July 11	1.1	30	0	0.8
Koshkawong R. (20)	July 13	0.5	40	0	1.6
Serpent R. (18)	July 20	18.1	471	0	11.5
Total		75.3	5,509	13.3	178.6
GRAND TOTAL		122.3	18,312	33.4	772.2

[1] Includes a total of 312.8 TFM bars (62.6 kg) applied in 7 streams.

Canada

All eight streams scheduled for treatment in 1993 were treated successfully. Treatment details and stream locations are shown in Table 14 and Figure 13 respectively. Treatments on the Koshkawong, Magnetawan, and Nottawasaga rivers and Lauzon and Timber Bay creeks were conducted at discharges marginally above historical treatment average. Discharges on the Serpent and Naiscoot rivers were substantially above historical treatment average. However, the extremely low minimum lethal concentration of lampricide required to provide satisfactory ammocoete mortality on these rivers allowed treatment without significant cost overrun.

Observations of larval sea lamprey during treatments indicated no significant variation from historical abundance records. All treatments had minimal impact on non-target organisms.

The entire Nottawasaga River system, a large southern Georgian Bay tributary, had not required treatment since 1968, but the Pine River, one of its major tributaries, was re-infested in the late 1980's and was treated in 1991. Subsequent surveys indicated recolonization of the main branch. Therefore, the Pine River and the main branch were both treated in 1993. Although greatest larval densities were observed in the Pine River, the main branch supported sufficient larvae to suggest that regular treatments of the entire system will be required.

SPAWNING-PHASE ASSESSMENT

United States

During the 1993 spawning season, 53,004 sea lampreys were captured in assessment traps placed in 11 tributaries of Lake Huron (Table 15, Figure 13). The Tittabawassee, Cass, and Chippewa rivers were new trap sites in 1993. The total Lake Huron trap catch minus the catch from these 3 new systems (51,894) is substantially higher than the five year (1988-1992) average of 32,694 (24,863-42,097).

Spawning runs were monitored through cooperative agreements in two rivers. The Carp River was operated by the Chippewa/Ottawa Treaty Fishery Management Authority and the Tittabawassee River was managed by Dow Chemical U.S.A.

A record catch of 38,831 in the Cheboygan River exceeded the 1992 record of 35,047. An estimated 55,043 sea lampreys comprised the spawning run in the Cheboygan River in 1993. Population estimates also were conducted in the Carp (7,759), Devils (430), and Tittabawassee (10,111) rivers.

Canada

Three streams were trapped in 1993, the St. Marys, Echo and Thessalon rivers, yielding 16,219 spawning-phase adults. At the Echo River we used a permanent trap at a low-head sea lamprey barrier, while portable traps were used at St. Marys and Thessalon rivers. The Echo River experienced its largest catch since construction of the low-head sheet piling barrier prior to the 1987 trapping season (Table 15). Remedial work on this barrier, done in conjunction with removal of the rock crib barrier immediately upstream, may have contributed to the large catch. Although the catch of 142 adults in the main stem of the Thessalon River was very low, Bridgeland Creek (a major tributary) yielded 5,181 spawners, the largest count since the re-introduction of trapping to the river in 1979. The combined catch also proved to be a record for the same period. Sex ratio data was also recorded for each site (Table 16). The Echo mark/recapture study was limited to only the lower release sites, as previous results have suggested it to be representative of the entire run (Table 16). In addition, we planned for stratified mark/recapture estimates at Thessalon River and Bridgeland Creek (Table 16). However, the Thessalon River estimate was unreliable due to a lack of recaptures.

Table 15. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Huron, 1993.
[Letter in parentheses corresponds to location of streams in Fig. 13.]

Stream	Number captured	Number sampled	Percent Males	Mean Length (mm) Males	Mean Length (mm) Females	Mean Weight (g) Males	Mean Weight (g) Females
UNITED STATES							
Albany Creek (A)	134	133	38	417	426	177	184
Carp River (B)	1,041	384	48	475	479	231	244
Cheboygan River (C)	38,831	0	-	-	-	-	-
Ocqueoc River (D)	8,032	0	-	-	-	-	-
Devils River (E)	119	29	14	458	494	200	256
Au Sable River (F)	530	527	46	457	464	197	217
East Au Gres River (G)	354	354	44	462	472	210	231
Cass River (H)	331	327	47	458	465	203	221
Tittabawassee River (I)	574	78	40	455	465	201	218
Chippewa River (J)	205	211	53	426	-	212	-
St. Marys River (M)	2,853	2,853	62	% males determined by external characteristics			
Total or Average	53,004	4,896	55	455	459	207	223
CANADA							
St. Marys River (M)	7,679	0	54	% males determined by			
Echo River (L)	3,217	0	49	external characteristics			
Thessalon River (K)	5,323	0	59	"			
Lake Total or Averages	16,219						
GRAND TOTAL	69,223	4,896	55	455	459	207	223

Table 16. Stratified mark-recapture estimates and trap efficiencies.

	ESTIMATE	TRAP EFFICIENCY	
		Catch/Estimate	Marked/Recovered
St. Marys River (Can. & US)	45,620	23.2%	21.5%
Echo River	7,159	44.9%	24.3%
Thessalon River			
Main	-	-	8.3%
Bridgeland	17,502	29.6%	25.7%

PARASITIC-PHASE ASSESSMENT

United States

A total of 694 parasitic-phase sea lampreys were collected by commercial fishermen in U.S. waters of Lake Huron (Table 7). Fishermen from management unit MH-1 (Detour-Rogers City, Michigan area) contributed the most (616).

Sport fishermen on the U.S. side of Lake Huron captured 503 parasitic-phase sea lamprey (215 noncharter, 288 charter) (Table 8). Fishermen from management district MH-3 (Harrisville-Oscoda, Michigan area) contributed the largest number of sea lampreys (170). Lampreys primarily were attached to chinook salmon (87%) (Table 9).

The low number of parasitic-phase sea lampreys reported by commercial and sport fishermen in some areas of the lake is due in part to a change in collection effort. Due to change in priority, agency personnel were unable to dedicate effort equal to previous years for the collection of lampreys. However, new sites were established and monitored by personnel from the Hammond Bay Biological Station in conjunction with a coded wire tag study. These sites account for 133 of the parasitic-phase sea lampreys captured in the noncharter sport fishery and 104 from the commercial fishery.

Canada

a) Commercial Fisheries

Commercial fishery submissions totalled 1,403 during 1993. To date, 968 lamprey were captured in the North Channel and 435 in the Main Basin. These observations represent a decline of 52% over 1992 submissions.

b) Sport Fisheries

No derbies were monitored for marking data this year. The annual King Salmon Derby in Sault Ste. Marie, MI, was cancelled for 1993. A weekend-long event sponsored by a local angling club, was held in its place. Both this and the Can-Am Salmon Tournament of Sault Ste. Marie, ON, were used as sources of live juvenile sea lamprey for a coded-wire tagging study in northern Lake Huron by the Hammond Bay Biological Station.

BARRIER PROGRAM

Canada

No new lamprey barriers were constructed on Lake Huron tributaries in 1993. Required maintenance was carried out at three existing barriers.

LAKE ERIE

TRIBUTARY INFORMATION

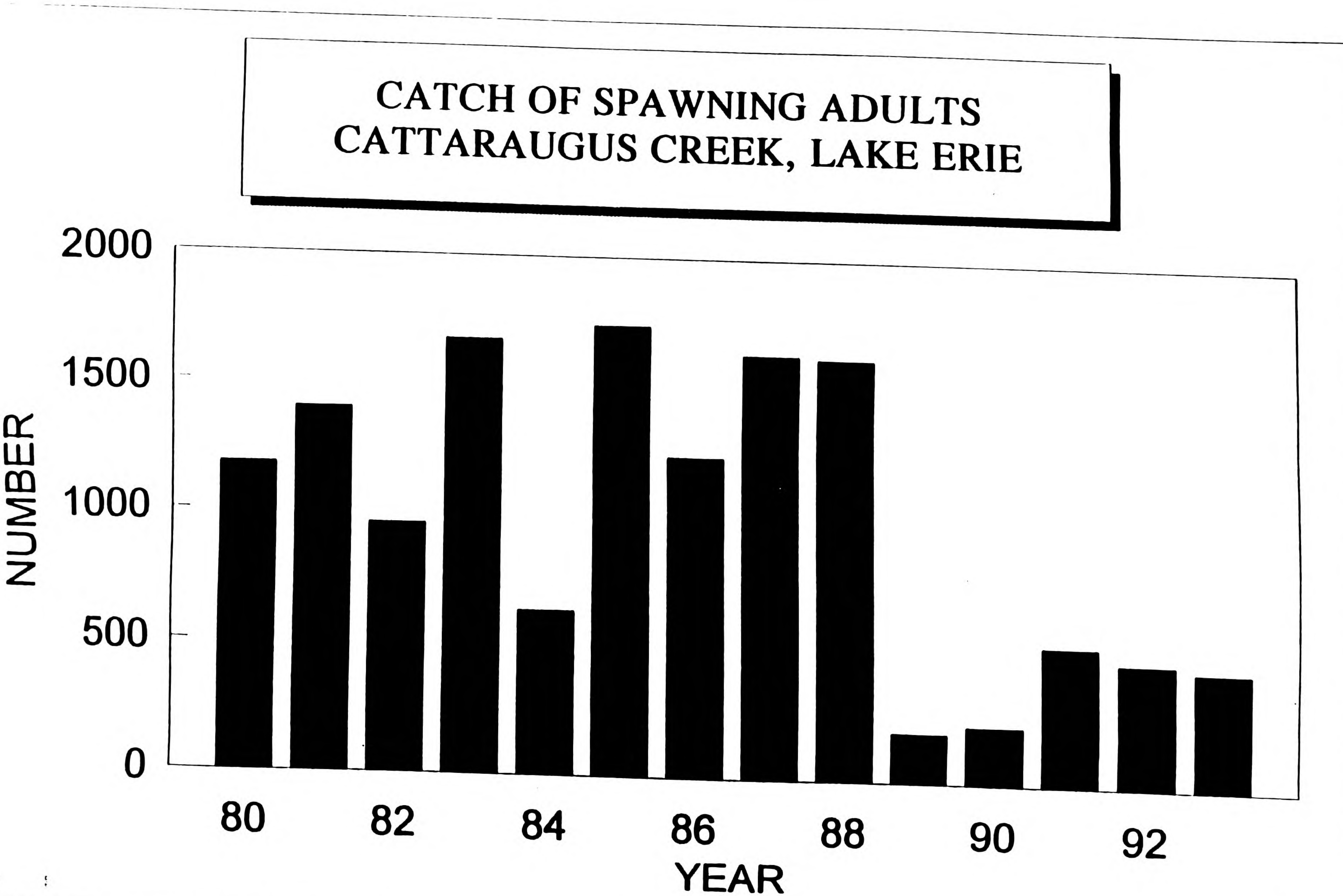
- 842 (525 Canadian, 317 United States) tributaries to Lake Erie.
- 20 (12 Canadian, 8 United States) tributaries have records of production of sea lamprey larvae.
- 18 (10 Canadian, 8 United States) tributaries have been treated with lampricide at least once during (1986-93).
- 7 (3 Canadian, 4 United States) tributaries are treated on a regular (3-5 year) cycle.

SEA LAMPREY AND FISH COMMUNITY OBJECTIVES

The Lake Erie Committee (LEC) is currently developing Fish Community Goals and Objectives for the lake. The LEC is considering the previous management plans and will define objectives for the eastern basin salmonid community. The current draft in development recognizes the need for continuing control but does not set specific objectives for sea lamprey (Lake Erie Committee 1993).

A specific management plan for sea lamprey in Lake Erie was developed prior to the implementation stream treatments in 1986 (Lake Erie Lake Trout Task Group 1985a). The plan defined an "experimental program" of control to reduce sea lamprey populations to levels where; 1) wounding on lake trout would be less than 5%; 2) portable assessment trap catches of lamprey would be less than 10% of pre-treatment levels; and, 3) nest densities would be less than 2 nests per kilometre of spawning habitat. By 1989 the first two of these objectives had been met in the eastern basin of Lake Erie. Based on the success of the experimental control program, in 1992 the Great Lakes Fishery Commission (1992) declared the control program on Lake Erie to be an ongoing program like the stream treatment programs in the other lakes.

The sea lamprey management plan was developed in support of the lake trout management plan (Lake Erie Lake Trout Task Group, 1985b). The plan for the rehabilitation of self-sustaining stocks of lake trout in the eastern basin of Lake Erie prescribed a maximum annual mortality rate of less than 40% be achieved to permit the establishment and maintenance of suitable stock of [illegible] Mortality would be controlled through management of fishery exploitation and [illegible] a lamprey.


CATCH OF SPAWNING ADULTS
CATTARAUGUS CREEK, LAKE ERIE
2000
1500
1000
500
0
NUMBER
80
82
84
86
88
90
92
YEAR

The US agent has consistently trapped spawning-phase lamprey in Cattaraugus Creek since 1980. Current catches in this index stream are significantly less than catches observed prior to TFM management in 1986, but greater than 10% of pretreatment catches (Figure 14). However, lake trout wounding remains less than 5%. The Canadian and US agents apparently are achieving sea lamprey objectives in Lake Erie.

LARVAL ASSESSMENT

United States

Surveys were conducted to prepare for lampricide treatments, assess the success of past treatments, monitor reestablished populations of larval sea lampreys, and search for new infestations of larvae in 16 Lake Erie tributaries. Surveys to schedule lampricide applications were conducted in five streams. Of these, 1 was scheduled for treatment in 1994, 1 was scheduled for treatment in 1995, and the remaining 3 were deferred. Sea lamprey larvae that remained from past treatments were found in one stream, but comprised less than 5% of the total number of larvae collected in the stream. Larvae had reestablished in four of the streams that were surveyed. Estuarine surveys were conducted in one stream. Original surveys to search for new infestations were conducted in eight streams and no larvae were found.

Surveys to assess recruitment of the 1993 year class were conducted in 8 streams and young-of-the-year larvae were recovered in 2. Sea lamprey larvae have not been detected for 5 or more years in 4 streams that have been examined annually.

Canada

The Sea Lamprey Control Centre annually conducts larval sea lamprey surveys in Lake Erie tributaries. Survey objectives include establishing range distribution, TFM treatment evaluation, determining the first year class to reestablish as well as estimating population abundance and size class distribution in streams scheduled for treatment in the following year. The standard techniques used in larval assessment include electrofishing (shallow streams) and Bayer 73 surveys (deep water).

Treatment evaluation:

Treatment evaluation surveys were completed on Big Creek, last treated in 1992. Surveys found a low number of residual larvae. In addition, the 1992 year class of larvae reestablished in moderate abundance following the treatment. At the present time, Big Creek is the only Lake Erie tributary of the ten that have been treated at least once that continues to repopulate with a sizable larval sea lamprey population.

Larval reestablishment:

No sea lamprey larvae were found in either Young's or Big Otter creeks in the 1993 surveys despite low abundance of the 1991 year class collected in 1992 surveys of each stream. Although survey conditions were not ideal this year it is unlikely that either stream supports a significant larval population.

Blue Springs Creek, a small tributary to the Grand River system, was surveyed following reported sightings of spawning lamprey. A large population of American brook lamprey was found but no sea lamprey.

Barrier evaluation:

Barrier dams on Little Otter (tributary to Big Otter), Clear, Forestville and Normandale creeks all appear to have been effective at blocking the 1992 spawning run.

SPAWNING-PHASE ASSESSMENT

United States

A total of 552 sea lampreys were captured in assessment traps placed in 6 tributaries of Lake Erie in 1993 (Table 17). This is less than the five year (1988-1992) average of 729 (235-1,903). Mark/recapture studies were conducted in two rivers. The population in Cattaraugus Creek was estimated at 754 and in the Grand River at 318.

Table 17. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Erie, 1993.
[Letter in parentheses corresponds to location of stream in Fig. 15.)

Stream	Number captured	Number sampled	Percent Males	Mean Length (mm) Males	Mean Length (mm) Females	Mean Weight (g) Males	Mean Weight (g) Females
UNITED STATES							
Cattaraugus Creek (A)	452	239	74	487	485	310	303
Crooked Creek (B)	1	0	-	-	-	-	-
Raccoon Creek (C)	2	0	-	-	-	-	-
Conneaut Creek (D)	1	0	-	-	-	-	-
Grand River (E)	90	21	71	504	514	252	257
Chagrin River (F)	6	2	100	535	-	322	-
Total or average	552	262	74	489	487	306	299
CANADA							
Big Otter Cr. (G)	2	0	-	-	-	-	-
Young's Cr. (H)	56	0	-	-	-	-	-
Total or average	58	-	-	-	-	-	-
GRAND TOTAL OR AVERAGES	610	262	74	489	487	306	299

Canada

Spawning-phase lamprey were trapped at Little Otter Creek (a major tributary of Big Otter Creek and Young's Creek, in 1993. (Table 17, Figure 15). Although the remedial work carried out on the barrier and permanent trap at Little Otter Creek improved operations and servicing, the catch of both sea lamprey and other fish species was not significantly affected. We remain concerned over trap effectiveness at this site. Young's Creek trapped satisfactorily, but we collected few marked lamprey in the mark/recapture study. We speculated that high lake levels may have created a seiche action at the release site that confounded the ability of the marked specimens to orientate properly as stream flows declined.

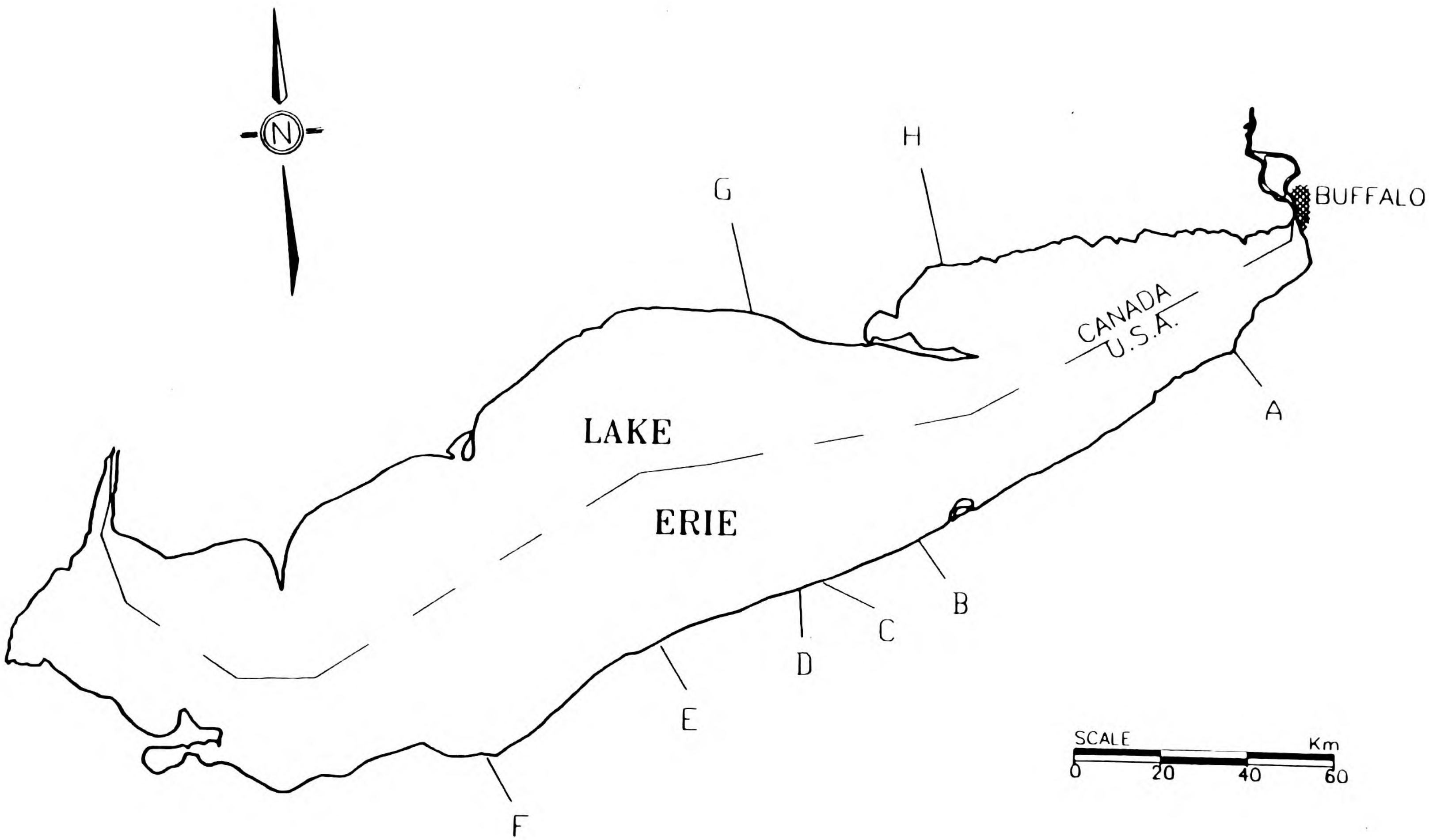


Figure 15: Location of Lake Erie tributaries where spawning-phase assessment traps were operated (letters; see Table 18 for names of streams) in 1993.

BARRIER PROGRAM

Canada

No new barriers were constructed on Lake Erie tributaries. Maintenance was carried out as required on the four existing low-head barriers in place, Big Otter (Little Otter Creek), Clear, Forestville and Normandale creeks.

Consultation help on lamprey passage and trapping at denil fishways was provided for the fishpass installation project at the Dunnville dam on the Grand River.

The remedial works plan for the Quance dam in Big Creek was reviewed for effects on sea lamprey spawning passage.

Barrier coordinators are currently gathering information on Lake Erie sea lamprey streams to develop a basin-wide barrier construction plan.

LAKE ONTARIO

TRIBUTARY INFORMATION

- 659 (405 Canadian, 254 United States) tributaries to Lake Ontario.
- 56 (28 Canadian, 28 United States) tributaries have records of production of sea lamprey larvae. (All Oswego River tributaries counted as one tributary.)
- 38 (19 Canadian, 19 United States) tributaries have been treated with lampricide at least once during 1984-93
- Of these, (17 Canadian, 17 United States) tributaries are treated on a regular (3-5 year) cycle.

SEA LAMPREY AND FISH COMMUNITY OBJECTIVES

The Lake Ontario Committee (LOC 1988) in the Lake Ontario fish community objectives supported continuing sea lamprey control and defined a specific objective for lamprey in terms of morality to lake trout:

Limit the size of the sea lamprey population to a level that will not cause mortality in excess of 90,000 lake trout annually.

This specific objective was developed to support the productive salmonine community including a lake trout population that shows significant reproduction in the near term.

[illegible]ttee has revised its Lake Ontario Lake Trout Rehabilitation Plan

(Schneider et al. 1991) from the original plan developed in 1983 (Schneider et al. 1983). The goal of the plan is to rehabilitate a self-sustaining population of lake trout as defined in the Fish Community Objectives. The plan includes the fundamental premise that continued control of sea lamprey induced mortality is necessary for lake trout rehabilitation. The plan includes a specific objective for sea lamprey of:

> *Controlling sea lamprey so that fresh wounding rates (A1) of lake trout larger than 432 mm (17 in) is less than 2 marks/100 fish.*

This specific objective is meant to maintain the annual survival rate at 60% or greater in order to maintain a target adult spawning stock of 0.5 to 1.0 million adults of multiple year classes. Along with sea lamprey mortality, angler and commercial exploitation shall also be controlled so that annual harvest does not exceed 120,000 fish in the near-term.

The Canadian and US agents have annually fished nine index streams for spawning-phase sea lampreys in Lake Ontario since 1987. During that period, spawning catches have remained relatively stable, between four and seven thousand annually (Figure 16). Lake wide wounding rates average approximately 2 marks/100 fish, with annual survival between 50-70% (Schneider et al. 1994). As well, lake trout deaths from sea lamprey were approximately 30,000. Thus, the control program is apparently achieving the current sea lamprey objectives for Lake Ontario.

LARVAL ASSESSMENT

United States

The U.S. Agent has the responsibility to monitor sea lamprey larvae in all tributaries of Lake Ontario that have not been treated with lampricide. Surveys were conducted to monitor populations of larval sea lampreys and search for new infestations of larvae in nine Lake Ontario tributaries. Estuarine surveys were conducted in one stream, and offshore surveys were conducted in another. Original surveys to search for new infestations were conducted in six streams and no larvae were found.

Surveys to assess recruitment of the 1993 year class were conducted in three streams and young-of-the-year larvae were recovered in one. Sea lamprey larvae have not been detected for 5 or more years in one stream that has been examined annually.

Canada

The Sea Lamprey Control Centre annually conducts larval sea lamprey surveys in Lake Ontario tributaries. Survey objectives include establishing range distribution, evaluating TFM treatments, determining the first year class to reestablish as well as estimating population abundance and size class distribution in streams to schedule treatments in the following year. The standard techniques used in larval assessment include electrofishing (shallow streams) and Bayer 73 surveys (deep water). In 1993, we completed surveys on 78 Lake Ontario tributaries.

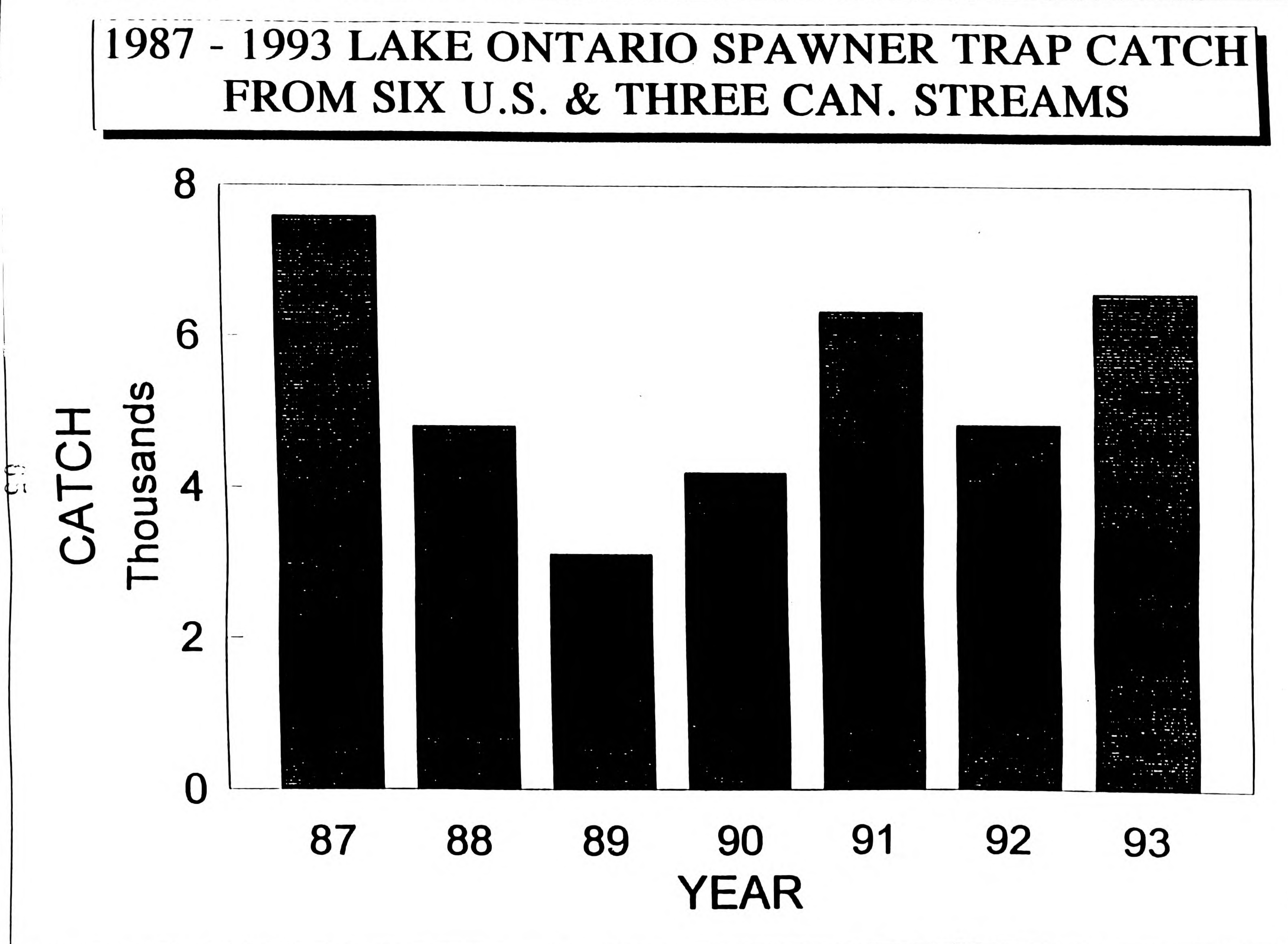


Figure 16. Index of spawner abundance in Lake Ontario from trap catches from nine Lake Ontario tributaries, 1987-93.

Distribution surveys:

We surveyed larval populations on 7 of the 11 streams tentatively scheduled for treatment in 1994: Salem, Covert, Grindstone, Sterling, and Red creeks and Salmon (Ontario), and Little Salmon rivers (New York). The distribution in Salmon River has expanded due to the successive failure of dams at Shannonville and Lonsdale, Ontario to completely block spawning run sea lamprey. The distribution in the Little Salmon River has also expanded due to the recent failure of the dam at Mexico, New York, to completely block spawning adults. In addition, the distribution of larvae in Grindstone Creek has expanded back to the maximum historical limits. Larval distribution in Covert Creek, a new producer found in 1993, is limited to the lower 1.3 km of stream.

Treatment evaluation:

Treatment evaluation surveys were conducted on 8 of the 10 streams treated in 1993. We found moderate numbers of residuals in Lindsey Creek, low numbers in Oshawa and Skinner creeks and none in Wilmot, Duffins, South Sandy, Catfish and Salmon creeks. All eight streams have reestablished with the 1993 year class of larvae. No evaluation surveys were done on Fish and Big Bay creeks, both of which were treated late in the year.

Surveys done on the Black River in the fall of 1993 suggest that the number of larvae surviving the last (1991) treatment were higher than previously thought. Thirty-nine of 62 larvae collected in September were ≥ 120 mm in length and eight of them were undergoing transformation to the parasitic stage. All of the large larvae were collected using back pack electrofishers which are not normally used on the Black River. The Black River has been tentatively scheduled for treatment in 1994 pending the results of a population estimate to be made this spring using a deep water electrofisher.

Barrier evaluation:

Unexpectedly high water levels occurred in Lake Ontario in the spring of 1993. These high water levels resulted from heavy precipitation and ice damming in the St. Lawrence River. As a result, the drop at two of the low-head barrier dams was reduced to the extent that spawning sea lampreys surpassed them. Observed sea lamprey spawning upstream of the dam on Shelter Valley Creek and larvae of the 1993 year class were found above the Graham Creek dam in September. Low-head dams on Duffins, Bowmanville, Port Britain, Grafton and Colborne creeks remained effective at blocking the 1993 spawning run.

Population surveys:

We surveyed 34 streams on the Canadian shore of Lake Ontario with potential sea lamprey habitat, but with no previous record of lamprey production. Survey crews discovered a small, multi-year class population in Covert Creek, but all other streams were negative.

Quantitative Assessment

Population and habitat estimates were conducted on seven Lake Ontario streams in 1993 (Table 18). Randomly selected sites were electroshocked with AbP-2 fishers using depletion methodology to estimate larval sea lamprey densities. Areas and percentage larval habitat were calculated for each stream based on average density and habitat distribution by section.

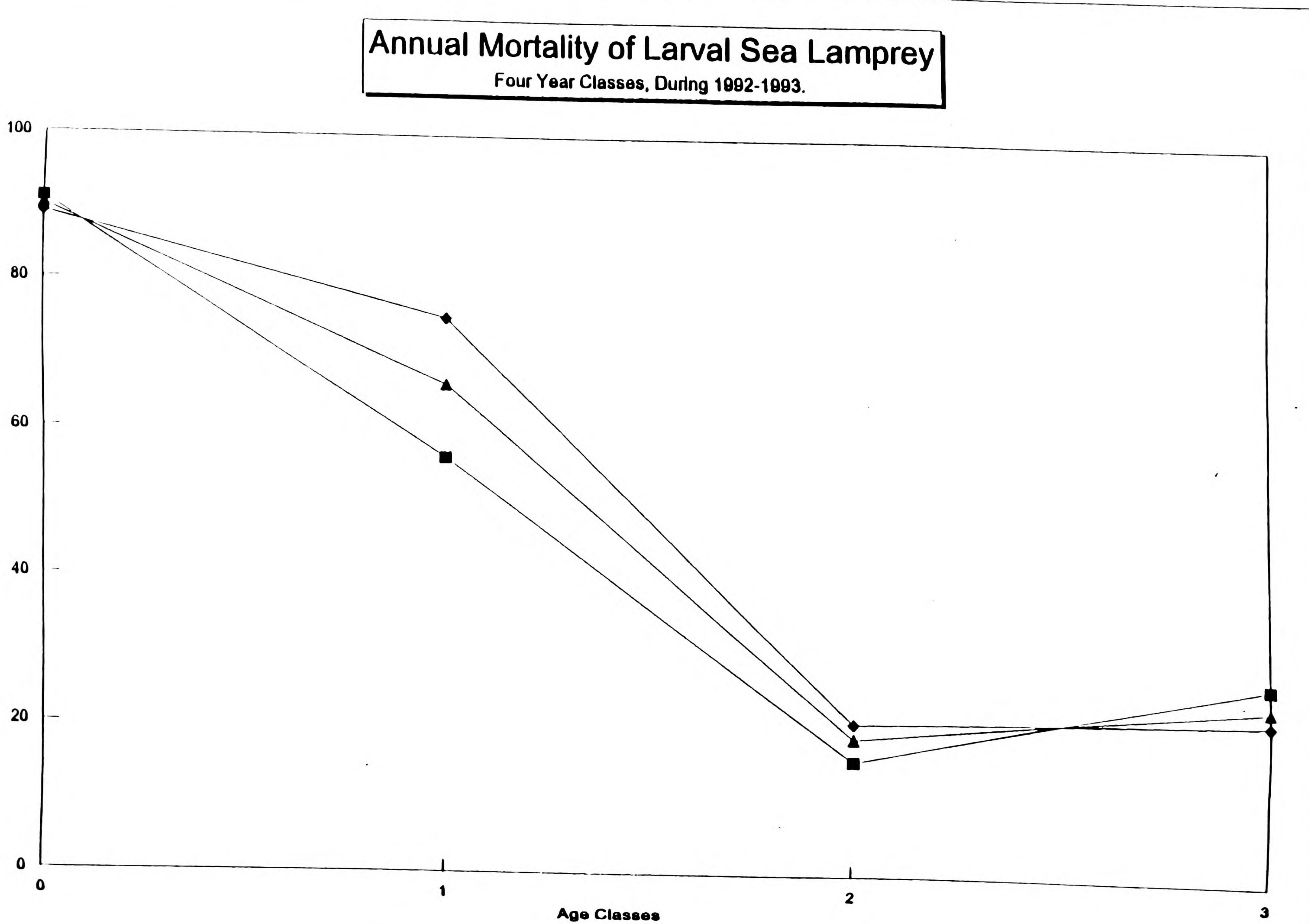
Table 18 . Population and habitat estimates, Lake Ontario, 1993

Stream	Distance km	Width m	Area ha	% Larval Habitat	Density #/m^2	Population (95%)
Salmon Cr.	33.4	6.8	41.9	67	1.7	482968 (236233-933356)
Little Salmon R.	42.3	16.3	75.0	66	0.1	72194 (16057-172821)
Sterling Cr.	6.6	10.6	9.4	35	0.2	3474 (0-144669)
Ninemile Cr.	12.1	8.4	11.7	65	0.02	1638 (0-3645)
Lynde Cr.	9.7	6.6	8.2	81	0.3	16970 (9432-26999)
Port Britain Cr.	1.1	10.6	1.5	74	0.02	183 (0-519)
Credit R.	62.8	29.5	176.8	15	0.005	1369 (187-2753)

Mortality Estimates:

Age-class densities of larval sea lamprey in Salem Creek were estimated in April, June, August and October, 1992 and April and July, 1993, to determine annual mortality for 4 year classes. Mortality estimates were 91%, 56%, 16%, and 27% for age-classes 0, 1, 2 and 3 respectively. Mortality for young-of-the-year appeared highest between October and April whereas age-classes 1-3 experienced the heaviest mortality from April to July.

A comparison of mortality levels from the same age-class larvae in Salem Creek and the Pancake River, a Lake Superior tributary, indicated that during 1992-1993 rates were similar (Figure 17).


Annual Mortality of Larval Sea Lamprey
Four Year Classes, During 1992-1993.
100
80
60
40
20
0
0
1
2
3
Age Classes

LAMPRICIDE MANAGEMENT

Canada

Lampricides were effectively applied to Wilmot, Oshawa, and Duffins creeks (Table 19, Figure 18). All treatments were conducted in the spring at moderately high discharge, thereby providing effective coverage in estuarine areas, despite the high level of Lake Ontario.

Observed larval sea lamprey abundance in the treated streams remained similar to densities recorded in recent years. Mortality of non-target organisms appeared insignificant in all treatments.

United States

South Sandy, Skinner, Catfish, Lindsey and Salmon creeks, all immediate tributaries to Lake Ontario, received lampricide treatment in May. In addition two Oneida Lake tributaries, Fish and Big Bay creeks underwent treatment in September (Table 19, Figure 18).

High Lake Ontario water levels inundated mouth areas, enhancing escapement potential in streams flowing directly into the lake.

Heavy rains negated treatment effectiveness on Fish Creek below the confluence of the East and West branches. The extreme increase in discharge precluded any attempt to apply lampricide to the East branch. The entire West branch and Little River, a major tributary, received an effective treatment. The majority of sea lamprey larvae in Fish Creek traditionally inhabit the West branch. Assessment of the ineffectively treated area will be conducted in 1994 to determine the requirement for retreatment.

High numbers of larvae were present in Salmon Creek, while moderate densities were observed in the remainder of the treated streams.

Observed non-target mortality appeared low on all treatments.

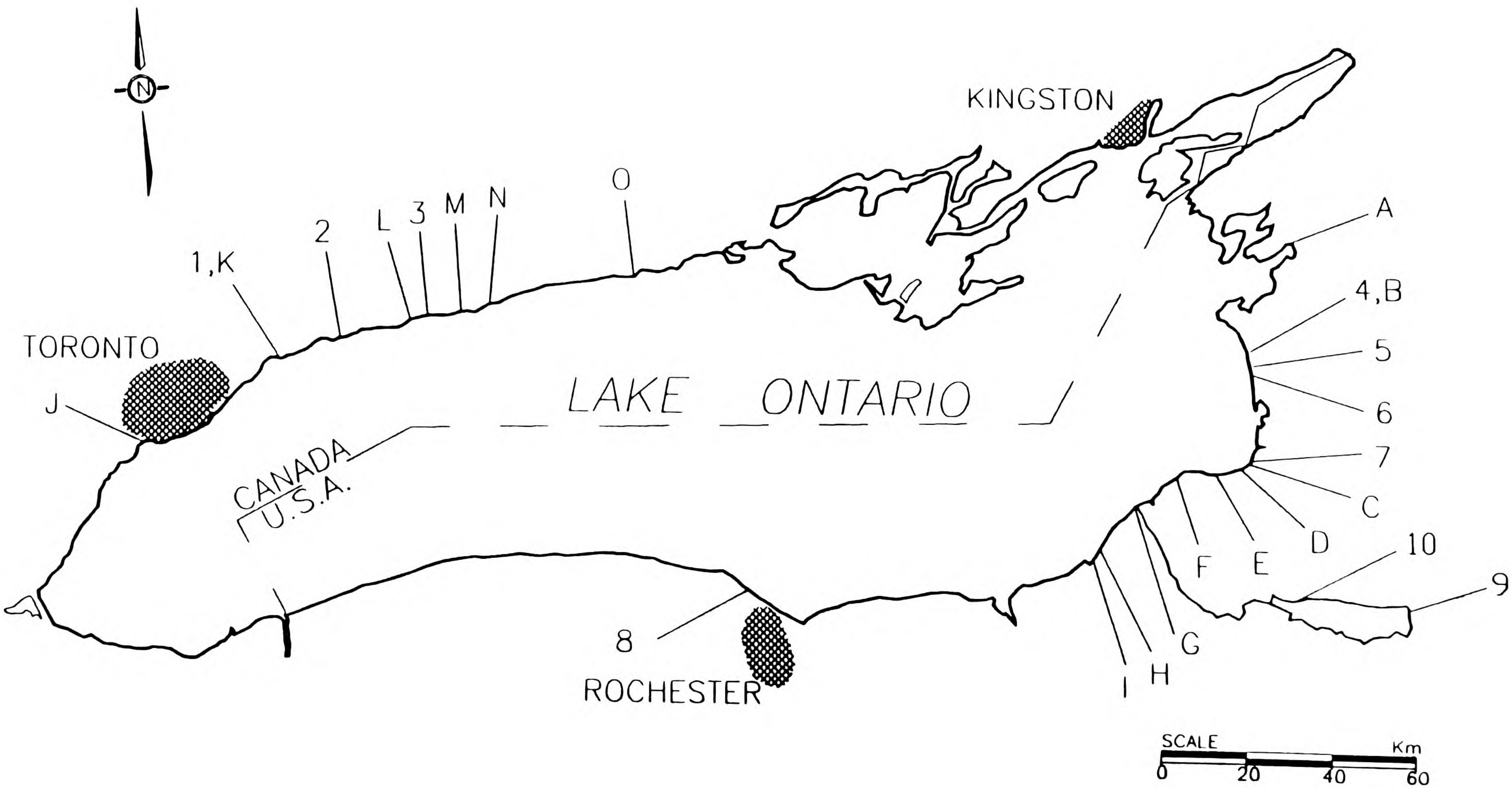


Figure 18: Location of Lake Ontario tributaries treated with lampricides (numerals; see Table 19 for names of streams) and of streams where assessment traps were operated (letters; see Table 20 for names of streams) in 1993.

Table 19. Details on the application of lampricides to streams of Lake Ontario, 1993.
[Lampricides used are in kg of active ingredient]
[Number in parentheses corresponds to location of stream in Figure 18]

Stream/Lake	Date	DISCHARGE $m^3 \cdot s^{-1}$	TFM(a) kg	Bayer 73 kg	Distance treated km
CANADA					
Duffins Cr. (1)	June 11	2.5	430	3.3	6.2
Oshawa Cr. (2)	April 27	2.0	673	-	19.7
Wilmot Cr. (3)	April 22	1.8	421	-	5.2
TOTAL		**6.3**	**1,524**	**3.3**	**31.1**
UNITED STATES					
Skinner Cr. (5)	May 7	1.8	242	-	9.1
Lindsey Cr. (6)	May 8	0.8	114	-	11.1
South Sandy Cr. (4)	May 10	4.6	692	-	10.7
Salmon Cr. (8)	May 14	0.8	254	-	31.0
Catfish Cr. (7)	May 19	0.6	97	-	1.2
Fish Cr. (9)	Sept. 25	12.7	1,209	-	54.6
Big Bay Cr. (10)	Sept. 29	1.1	149	-	11.1
TOTAL		**22.4**	**2,757**	**0.0**	**128.8**
GRAND TOTAL		**28.7**	**4,281**	**3.3**	**159.9**

(a) Includes 1 bar used on Mayhew Cr. (0.2 kg)

SPAWNING-PHASE ASSESSMENT

United States

A total of 574 sea lampreys were captured in assessment traps placed in 10 tributaries of Lake Ontario in 1993 (Table 20, Figure 18). This is lower than the 5-year (1988-1992) average of 959 (139-1,981).

Mark/recapture studies to estimate populations of spawning-phase sea lampreys were conducted in the Black (1,697) and Little Salmon (99) rivers, and in Sterling Valley (1,675) and South Sandy (1,960) creeks.

Efforts continued to estimate the total number of spawning-phase sea lampreys in Lake Ontario using a method developed in Lake Superior. This technique is based on the relation between average stream discharge and the number of lampreys that enter tributaries to spawn. While flow data necessary to conduct the estimate was available, corresponding instream population estimates required to establish the mathematical relation were insufficient.

Table 20. Number and biological characteristics of adult sea lampreys capture assessment traps in tributaries of Lake Ontario, 1993.
[Letter in parentheses corresponds to location of stream in Fig. 18]

Stream	Number captured	Number sampled	Percent Males	Mean Length (mm) Males	Mean Length (mm) Females	Mean Weight (Males	Mean Weight (Femal
UNITED STATES							
Black River (A)	241	19	89	446	462	252	199
South Sandy River (B)	101	3	100	536	-	342	-
Beaverdam Brook (C)	0	0	-	-	-	-	-
Grindstone Creek (D)	50	0	-	-	-	-	-
Little Salmon River (E)	17	2	100	480	-	219	-
Catfish Creek (F)	0	0	-	-	-	-	-
Oswego River (G)	0	0	-	-	-	-	-
Sterling Creek (H)	46	0	-	-	-	-	-
Sterling Valley Creek (I)	119	0	-	-	-	-	-
Total or average	574	24	92	461	462	261	199
CANADA							
Humber R. (J)	4,570	726	58	483	471	253	253
Duffins Cr. (K)	1,313	272	57	502	498	275	286
Bowmanville Cr. (L)	193	41	54	498	493	280	272
Graham Cr. (M)	32	11	55	509	509	295	260
Port Britain Cr. (N)	85	19	68	509	497	275	280
Shelter Valley Cr. (O)	368	79	56	509	504	276	291
Total or average	6,561	1,148	58	491	482	262	265
GRAND TOTAL OR AVERAGES	7,135	1,172	59	490	482	262	265

Canada

Trap Operations:

Traps on six streams produced a combined catch of 6,561 spawning-phase adults in 1993 (Table 20, Figure 18). A similar trapping effort in 1992 provided a catch of 5,136. The Humber River catch was up considerably form 1992, accounting for most of the increase.

High lake levels may have affected the efficiency of traps fished on Graham and Shelter Valley creeks. Current action indicates that the dam on Graham Creek failed as a barrier to spawning sea lamprey in 1993.

Over the past five years (1988-1993) numbers of adults caught in traps on the west side of the network have remained fairly stable, whereas a continuing decline is evident in the eastern streams.

BARRIER DAMS

Canada

No new barrier dam initiatives were undertaken on Lake Ontario in 1993. Required maintenance was conducted on all six existing low-head structures (Duffins, Graham, Lakeport, Shelter Valley, Grafton, and Port Britain creeks).

LAKES SUPERIOR, MICHIGAN AND HURON

Treatment effects on non-target organisms (long-term test)

Mayflies-Hexagenia--A long-term study to assess the effects of lampricide treatments on the Hexagenia population in the East Branch of the Whitefish River (Lake Michigan) was concluded. The 10-year study began in 1984 and monitored the mayfly population through 1993. A total of 3 lampricide treatments were conducted during the study: June 1986, July 1990, and September 1992.

Since 1984, samples of Hexagenia have been collected in the spring and fall in the East Branch of the Whitefish River. Additional sets of samples also were collected before and after each treatment. A control site was selected in Scott Creek in 1984 but changes in water flows and habitat in the study area prompted the selection of an alternate control site in 1986 in a portion of the nearby Indian River, a tributary of the Manistique River.

The Hexagenia populations fluctuated in the East Branch of the Whitefish River and the control site in the Indian River. The population in the East Branch of the Whitefish River was affected by the 1986 lampricide treatment and also by environmental factors. In 1986, posttreatment samples in the East Branch indicated a significant decline ($U_{0.05}$ = 2.00) in the abundance of nymphs. No significant decline in the population was observed in the posttreatment samples collected after the 1990 or 1992 treatment. Lampricide has a greater effect on the older Hexagenia nymphs; mortality was higher in Age 2 and Age 1 than the Age 0 cohorts.

Environmental factors caused significant fluctuations in the control population of Hexagenia in the Indian River and the treated site of the East Branch of the Whitefish River (Fig. 18). Generally, nymphs were more abundant in the fall than in the spring.

Recovery of Hexagenia populations from a lampricide treatment and environmental effects can require several years. Populations in the East Branch of the Whitefish River had recovered from impacts of the 1986 treatment after five years. Spring samples totalled 236 and 221 nymphs/m^2 in 1986 and 1991 respectively. Environmental effects failed to allow the population in the Indian River to return to the peak level of the fall of 1986 (1,309 nymphs/m^2) even seven years later ($U_{0.05}$ = 2.37).

This study indicates two ways to reduce the effect of lampricide treatments on Hexagenia populations. First, a treatment should be scheduled after the emergence of adult mayflies. Second, the frequency of years between treatments should be in even year increments, preferably once every four years or more to reduce the effects of lampricide treatments on the Hexagenia population.

Riffle Community Index--Index areas of macroinvertebrate riffle communities were established in the West Branch of the Whitefish (Lake Michigan) and the Brule (Lake Superior) rivers in 1985 and Sturgeon (Lake Huron) River in 1986. Samples have been collected in the spring and fall and before and after lampricide treatments using the standard travelling kick method. Samples have been taken upstream (control) and downstream (treated) of lamprey barriers in the Brule and Whitefish rivers. Samples were collected from a treated area of the Sturgeon River. Due to problems with comparability of control and treated areas in the Sturgeon River a control area was selected in an untreated portion upstream of a barrier in the Boardman River (Lake Michigan). The study of Sturgeon River macroinvertebrate riffle communities is scheduled for completion in 1995. In 1993, studies of the macroinvertebrate riffle communities in the Whitefish and Brule rivers were completed. Preliminary results from the long-term community structure studies have shown little difference in macroinvertebrate populations between control and treated areas (Tables 21-24).

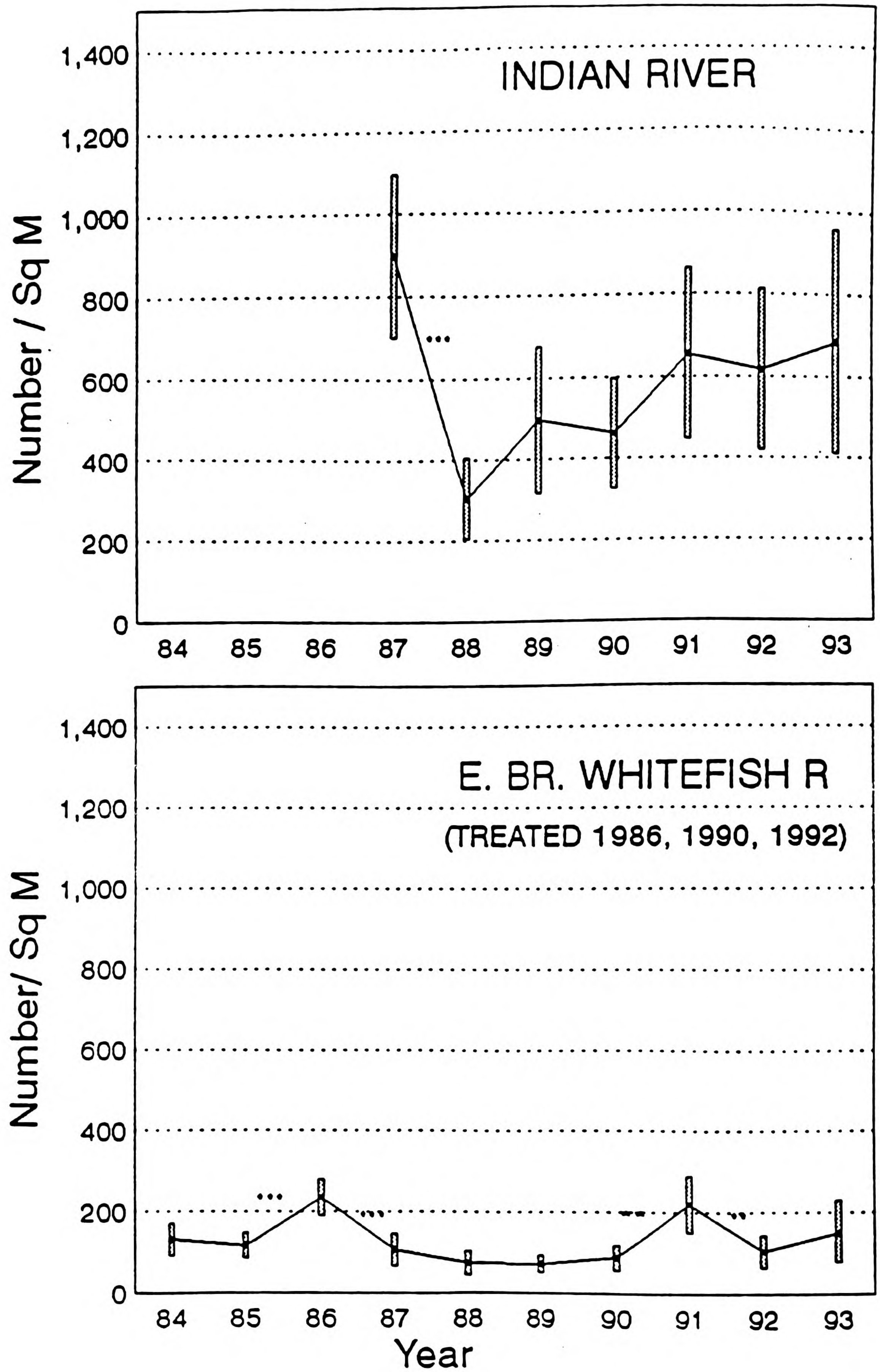


Figure 19. Mean abundance of Hexagenia collected in spring samples in the Indian and East Branch of the Whitefish rivers.

Table 21. Mean number of organisms from five samples taken by kick nets in riffle communities in the Whitefish River in 1990 in areas that are periodically treated and in areas that are not treated (control).

	Whitefish River	
Taxa	Treated Area Spring 1990	Control Area Spring 1990
Ephemeroptera		
Baetidae		
Baetis	28.2	11.2
Oligoneuriidae		
Isonychia	5.0	0.8
Heptageniidae		
Epeorus	32.0	19.8
Leurocuta	17.2	15.4
Stenacron	0.2	0.0
Stenonema	17.0	13.4
Ephemerellidae		
Drunella	94.2	14.0
Ephemerella	365.8	232.8
Eurylophella	3.8	1.6
Serratella	38.2	19.0
Caenidae		
Caenis	11.6	2.2
Leptophlebiidae		
Paraleptophlebia	28.0	16.8
Ephmeridae		
Ephemera	0.6	0.2
Odonata		
Gomphidae		
Ariogomphus	0.2	0.0
Ophiogomphus	6.6	4.4
Stylogomphus	1.4	1.
Aeshnidae		
Boveria	0.2	0.0
Plecoptera		
Taeniopterygidae		
Strophopteryx	47.2	43.8
Nemouridae		
Ostrocerca	307.4	163.8
Capniidae		
Paracapnia	2.4	2.2

(continued)

Table 21. Continued

Taxa	Whitefish River Treated Area Spring 1990	Whitefish River Control Area Spring 1990
Plecoptera (continued)		
Perlidae		
Neoperla	0.2	0.2
Paragnetina	0.8	2.0
Phasganophora	10.6	4.4
Acroneuria	15.0	14.6
Perlinella	1.8	1.2
Perlodidae		
Isoperla	20.8	14.0
Unknown	0.4	0.2
Megaloptera		
Corydalidae		
Nigronia	3.0	2.8
Trichoptera		
Philopotamidae		
Chimarra	1.4	0.8
Psychomyiidae		
Psychomyia	2.2	0.4
Hydropsychidae		
Ceratopsyche	26.8	30.4
Cheumatopsyche	3.6	3.2
Rhyacophilidae		
Rhyacophila	0.4	0.2
Glossosomatidae		
Glossosoma	33.2	8.2
Hydroptilidae		
Agraylea	0.6	0.0
Dibusa	10.0	1.4
Hydroptila	0.6	1.8
Stactobiella	1.0	0.2
Leucotrichia	2.0	0.8
Brachycentridae		
Brachycentrus	1.0	1.2
Micrasema	1.2	1.8
Lepidostomatidae		
Lepidostoma	7.4	5.0
Limnephilidae		
Neophylax	60.4	32.4
Odontoceridae		
Psilotreta	7.4	9.4
Helicopsychidae		
Helicopsyche	3.6	2.8
Leptoceridae		
Ceraclea	3.8	3.0
Mystacides	0.0	0.4

(continued)

Table 21. Continued

Taxa	Whitefish River Treated Area Spring 1990	Whitefish River Control Area Spring 1990
Trichoptera (continued)		
Pupae	0.6	0.4
Coleoptera		
Halipidae	0.0	0.2
Dytiscidae	0.2	0.0
Hydrophilidae	0.2	0.0
Psephenidae		
Psephenus	0.6	4.2
Ectopria	0.8	0.8
Elmidae		
Macronychus larvae	0.2	0.0
Optioservus larvae	41.4	30.6
Optioservus adult	7.8	3.6
Stenelmis larvae	0.6	0.6
Stenelmis adult	2.0	1.2
Diptera		
Tipulidae		
Tipula	0.2	0.0
Antocha	5.2	3.8
Dicranota	2.0	1.0
Hexatoma	4.0	2.0
Simulidae		
Ectemnia	0.2	1.6
Prosimulium	279.2	183.4
Simulium	2.0	0.0
Chironomidae	400.2	122.4
Athericidae		
Atherix	13.8	9.4
Empididae		
Chelifera	0.2	0.2
Hemerodromia	2.8	0.8
Clinocera	1.4	0.2
Pupae	6.0	2.0
Adult	0.2	0.0
Turbellaria		
Planaria	0.2	0.0
Annelida		
Oligochaeta	4.0	10.2
Branchiobdellida	1.0	1.4
Amphipoda		
Hyalella	0.2	0.2

(continued)

Table 21. Continued

Taxa	Whitefish River: Treated Area Spring 1990	Whitefish River: Control Area Spring 1990
Decapoda		
Astacidae	0.4	0.4
Hydracarina	4.6	1.6
Gastropoda		
Physidae		
Physa	1.0	2.6
Pelecypoda		
Sphaeriidae		
Sphaerium	1.8	1.0
Terrestrials	0.0	0.2
Pisces	0.6	0.0
Total organisms	2011.4	1091.0
Total taxa	79	69

Table 22. Mean number of organisms from five samples taken by kick nets in riffle communities in the Whitefish River in 1990 in areas that are periodically treated and in areas that are not treated (control).

	Whitefish River	
	Treated Area Fall 1990	Control Area Fall 1990
Taxa		
Ephemeroptera		
Baetidae		
Baetis	1.0	1.0
Pseudocloeon	13.2	16.4
Oligoneuriidae		
Isonychia	34.4	23.6
Heptageniidae		
Epeorus	49.2	56.8
Leurocuta	38.4	43.6
Stenacron	0.0	0.4
Stenonema	42.2	34.2
Ephemerellidae		
Ephemerella	343.4	407.4
Eurylophella	2.2	4.0
Serratella	39.0	51.4
Caenidae		
Caenis	11.4	11.6
Leptophlebiidae		
Paraleptophlebia	38.4	48.8
Ephmeridae		
Ephemera	0.4	0.6
Odonata		
Gomphidae		
Ophiogomphus	6.2	4.8
Stylogomphus	1.0	0.4
Plecoptera		
Taeniopterygidae		
Taniopteryx	2.4	2.4
Strophopteryx	0.8	1.0
Nemouridae		
Ostrocerca	0.6	0.6
Capniidae		
Paracapnia	1.8	2.4
Perlidae		
Neoperla	0.4	0.0
Paragnetina	1.0	1.8
Phasganophora	9.4	6.8
Acroneuria	20.0	19.6
Perlinella	1.0	1.2

(continued)

Table 22. Continued

	Whitefish River	
	Treated Area Fall 1990	Control Area Fall 1990
Taxa		
Plecoptera (continued)		
Perlodidae		
Isoperla	9.4	11.2
Megaloptera		
Corydalidae		
Nigronia	2.2	1.8
Trichoptera		
Philopotamidae		
Chimarra	8.6	10.8
Dolophilodes	1.2	1.6
Psychomyiidae		
Psychomyia	2.0	0.4
Hydropsychidae		
Ceratopsyche	58.4	64.8
Cheumatopsyche	6.0	8.0
Rhyacophilidae		
Rhyacophila	0.8	1.4
Glossosomatidae		
Glossosoma	21.4	17.0
Hydroptilidae		
Agraylea	1.4	1.8
Hydroptila	5.8	9.2
Stactobiella	0.0	0.2
Leucotrichia	6.0	6.6
Brachycentridae		
Brachycentrus	3.4	4.4
Lepidostomatidae		
Lepidostoma	7.4	6.4
Limnephilidae		
Hydatophylax	0.4	1.2
Odontoceridae		
Psilotreta	11.8	14.2
Helicopsychidae		
Helicopsyche	6.2	6.8
Leptoceridae		
Ceraclea	5.4	1.4
Oecetis	0.4	1.0
Setodes	1.8	2.8
Pupae	3.0	4.8
Coleoptera		
Psephenidae		
Psephenus	2.4	2.2

(continued)

Table 22. Continued

	Whitefish River	
	Treated Area	Control Area
	Fall	Fall
Taxa	1990	1990
Coleoptera (continued)		
Elmidae		
Optioservus larvae	64.8	77.8
Optioservus adult	16.8	18.8
Stenelmis larvae	0.2	1.8
Stenelmis adult	1.4	0.6
Diptera		
Tipulidae		
Tipula	0.2	0.2
Antocha	9.6	13.4
Dicranota	0.0	0.4
Hexatoma	3.4	6.2
Ceratopogonidae	0.4	1.2
Simulidae		
Simulium	3.6	4.4
Chironomidae	172.6	119.6
Athericidae		
Atherix	15.6	17.8
Empididae		
Hemerodromia	2.6	3.4
Pupae	6.6	7.4
Turbellaria		
Planaria	1.0	1.4
Nematoda	0.0	0.2
Annelida		
Oligochaeta	12.2	14.6
Branchiobdellida	0.0	0.4
Decapoda		
Astacidae	0.0	0.2
Hydracarina	2.4	4.0
Gastropoda		
Physidae		
Physa	11.0	9.0
Ancylidae		
Ferrisia	0.6	2.6
Pelecypoda		
Sphaeriidae		
Sphaerium	2.0	1.6
Terrestrials	1.6	1.4
Pisces	0.0	0.6
Total organisms	1151.8	1229.6
Total taxa	65	

(continued)

Table 23. Mean number of organisms from five samples taken by kick nets in riffle communities in the Sturgeon River in April 1991 in areas that are periodically treated and in areas that are not treated (control).[a]

[The Sturgeon River, a tributary of the Cheboygan River on Lake Huron, was treated in October 1988; the control area is in the Boardman River on Lake Michigan.]

Taxa	Treated Area (Sturgeon River) Spring	Control Area (Boardman River) Spring
Ephemeroptera		
Baetidae		
Baetis	239.8	211.4
Pseudocloeon	3.6	2.0
Oligoneuriidae		
Isonychia	0.2	0.0
Heptageniidae		
Epeorus	0.0	0.6
Rithrogena	78.4	11.6
Stenonema	2.8	0.6
Ephemerellidae		
Drunella	21.6	65.6
Ephemerella	167.4	964.6
Serratella	4.4	4.2
Leptophlebiidae		
Paraleptophlebia	0.8	8.6
Odonata		
Gomphidae		
Ophiogomphus	0.0	0.8
Plecoptera		
Pteronarcyidae		
Pteronarcys	0.8	1.0
Taeniopterygidae		
Strophopteryx	1.8	0.0
Nemouridae		
Nemoura	0.0	0.2
Ostrocerca	7.8	0.0
Capniidae		
Paracapnia	0.2	0.0
Perlidae		
Paragnetina	0.6	0.6
Acroneuria	1.8	0.2
Perlinella	0.2	0.0
Perlodidae		
Isogenoides	16.4	4.2
Isoperla	11.6	0.8

(continued)

Table 23. Continued.

Taxa	Treated Area (Sturgeon River) Spring	Control Area (Boardman River) Spring
Hemiptera		
Corixidae	0.0	0.2
Megaloptera		
Corydalidae		
Nigronia	1.0	0.4
Trichoptera		
Hydropsychidae		
Ceratopsyche	4.0	1.6
Cheumatopsyche	0.0	0.4
Rhyacophilidae		
Rhyacophila	5.0	0.8
Glossosomatidae		
Glossosoma	0.0	0.2
Protoptila	2.8	89.6
Hydroptilidae		
Hydroptila	0.2	4.4
Brachycentridae		
Brachycentrus	4.2	14.4
Micrasema	18.0	42.2
Lepidostomatidae		
Lepidostoma	2.0	6.2
Limnephilidae		
Neophylax	1.0	5.0
Helicopsychidae		
Helicopsyche	11.0	0.0
Leptoceridae		
Oecetis	0.0	0.2
Coleoptera		
Elmidae		
Optioservus larvae	163.6	67.0
Optioservus adult	52.8	41.2
Diptera		
Tipulidae		
Tipula	0.0	0.4
Antocha	21.0	3.2
Simulidae		
Ectemnia	0.0	0.2
Prosimulium	1.4	5.2
Simulium	0.6	2.2
Chironomidae	213.8	301.8
Athericidae		
Atherix	9.4	52.0
Empididae		
Chelifera	2.0	15.8
Hemerodromia	1.2	0.0
Pupae	0.4	12.4

(continued)

Table 23. Continued.

Taxa	Treated Area (Sturgeon River) Spring	Control Area (Boardman River) Spring
Turbellaria		
Planaria	0.0	0.2
Nematoda	0.2	0.4
Annelida		
Oligochaeta	79.2	23.0
Isopoda		
Asellus	2.2	0.2
Amphipoda		
Gammarus	0.0	1.6
Hydracarina	3.6	4.2
Gastropoda		
Physidae		
Physa	0.0	11.2
Hydrobildae		
Amnicola	0.0	0.2
Ancylidae		
Ferrisia	0.4	0.0
Pelecypoda		
Sphaeriidae		
Sphaerium	0.0	1.2
Pisces	0.2	0.2
Total	1161.2	1986.2
Total taxa	44	50

Table 24. Mean number of organisms from 5 samples taken by kick nets in riffle communities in the Sturgeon River in September 1991 in areas that are periodically treated and in areas that are not treated (control).[a]

[The Sturgeon River, a tributary of the Cheboygan River on Lake Huron, was treated in October 1988; the control area is in the Boardman River on Lake Michigan.]

Taxa	Treated Area (Sturgeon River) Fall	Control Area (Boardman River) Fall
Ephemeroptera		
Baetidae		
Baetis	84.4	34.6
Pseudocloeon	16.4	2.8
Oligoneuriidae		
Isonychia	2.2	0.0
Heptageniidae		
Rithrogena	10.8	0.0
Stenonema	44.2	2.8
Ephemerellidae		
Ephemerella	11.6	15.0
Serratella	21.8	0.8
Leptophlebiidae		
Paraleptophlebia	0.4	2.6
Odonata		
Gomphidae		
Ophiogomphus	0.0	1.4
Plecoptera		
Pteronarcyidae		
Pteronarcys	2.0	1.0
Perlidae		
Paragnetina	3.4	0.0
Acroneuria	3.4	0.2
Perlinella	0.8	0.2
Perlodidae		
Isogenoides	30.4	10.6
Isoperla	2.2	0.8
Unknown	0.2	0.0
Hemiptera		
Corixidae	0.2	0.2
Megaloptera		
Corydalidae		
Nigronia	1.4	0.6
Trichoptera		
Philopotamidae		
Dolophilodes	42.6	0.8
Polycentropodidae		
Polycentropus	0.2	0.0

(continued)

Table 24. Continued.

Taxa	Treated Area (Sturgeon River) Fall	Control Area (Boardman River) Fall
Trichoptera (continued)		
Hydropsychidae		
Ceratopsyche	121.4	17.8
Rhyacophilidae		
Ryacophila	0.8	2.2
Glossosomatidae		
Glossosoma		
Protoptila	70.8	125.0
Hydroptilidae		
Hydroptila	0.8	0.8
Brachycentridae		
Brachycentrus	15.8	5.2
Micrasema	7.8	3.0
Lepidostomatidae		
Lepidostoma	4.4	11.2
Helocopsychidae		
Helicopsyche	155.6	0.2
Pupae	0.4	0.2
Lepidoptera	0.0	0.2
Coleoptera		
Elmidae		
Optioservus larvae	472.6	159.6
Optioservus adult	161.8	58.0
Diptera		
Tipulidae		
Tipula	0.0	0.4
Antocha	30.0	4.6
Hexatoma	0.2	0.0
Simulidae		
Prosimulium	0.4	0.0
Simulium	6.4	19.4
Chironomidae	247.0	54.0
Athericidae		
Atherix	30.0	104.0
Empididae		
Chelifera	2.0	2.2
Hemerodromia	3.0	0.0
Pupae	8.8	5.6
Turbellaria		
Planaria	0.2	0.0
Annelida		
Oligochaeta	76.0	18.6
Isopoda		
Asellus	35.0	0.4
Amphipoda		
Gammarus	0.0	2.2
Hydracarina	3.4	1.0

(continued)

Table 24. Continued.

Taxa	Treated Area (Sturgeon River) Fall	Control Area (Boardman River) Fall
Gastropoda		
Physidae		
Physa	1.0	9.2
Hydrobildae		
Amnicola	2.2	0.2
Ancylidae		
Ferrisia	0.4	0.6
Pelecypoda		
Sphaeriidae		
Sphaerium	0.2	0.2
Terrestrials	0.0	0.2
Pisces	0.0	0.8
Total	1737.0	680.6
Total taxa	47	44

(continued)

TASK FORCE REPORTS

The Great Lakes Fishery Commission has established Task Forces to recommend direction and coordinate actions in three focus areas: St. Marys River Control, Sterile Male Release Technique, and Barriers. The following outlines the progress and major actions of each Task Force for 1993.

STERILE MALE RELEASE TECHNIQUE

- Task Force established April 1984
- Charge is: to implement and assess the sterile male release technique as an experimental alternative technology of sea lamprey control.
- Members are: John Heinrich (Chair) and Michael Twohey from U.S. Fish and Wildlife Service; Rob Young and Rod McDonald from Department of Fisheries and Oceans Canada; Jim Seelye and Michael Hansen (Lake Technical Committee representative) from U.S. National Biological Survey; Jim Smith (Outside Expert) from U.S. Agriculture Research Service; and Gavin Christie from Great Lakes Fishery Commission Secretariat.
- Meetings held on: March 16-17, September 29, and December 14.
- Progress on the charge in 1993:

Successful implementation of the sterile male release technique continued in Lake Superior and in the St. Marys River. Male sea lampreys were captured in six tributaries of Lakes Michigan and Huron and transported to the Hammond Bay Biological Station. Captured lampreys were sterilized with the chemosterilant bisazir, decontaminated, and released into 26 major lamprey-producing tributaries of Lake Superior (U.S.-20, Canada-6) and the St. Marys River. In addition, the success of the interaction of sterilized males with resident female lampreys was monitored in two tributaries of Lake Superior and the St. Marys River.

The sterilization facility at Hammond Bay continued to meet the needs of the Sea Lamprey Control Program. A total of 36,045 spawning-phase male lampreys were transported to the sterilization facility during May 2 to August 4. Male lampreys were selected from the assessment traps on the Manistique River of Lake Michigan (8,071) and the following tributaries of Lake Huron: Cheboygan and Ocqueoc (19,049 combined), Echo and Thessalon (3,650 combined), and St. Marys (5,275) rivers. The lampreys were injected with bisazir at a dosage of 100 mg/kg of body weight. After 48 hours lampreys were transported to streams for release. Sterilized males that were destined for streams with trapping operations were uniquely marked with a dorsal fin clip. A total of 34,808 lampreys were sterilized and 33,256 were released into streams. The Hammond Bay Biological Station used 68 sterilized male lampreys for efficacy and behaviour studies. Mortality of 1,484 (4%) sterilized lampreys occurred prior to release because of escapement from tanks due to drain constriction (255), death during transport (754; 752 died in a trip to the Nipigon, Wolf and Pigeon Rivers), or from unknown causes that were probably stress related (475).

Water from Lake Huron was pumped continually through the facility to provide fresh water for lampreys and processes such as waste, rinse, and clean-up within contained areas. Waste water where bisazir could potentially occur was collected in a sump, then pumped through carbon filters to remove the bisazir. The filtered effluent then was released back to Lake Huron.

Water in the facility was monitored for presence of bisazir to comply with Michigan Department of Natural Resources permit requirements, to insure safe working conditions for personnel, and to confirm that lampreys were no longer excreting bisazir prior to release. A series of two protocols monitored for presence of bisazir. First, the effluent was monitored daily. Each day four samples were drawn from filtered facility effluent and combined into a sample bottle. Second, water was randomly sampled from holding tanks immediately prior to the removal of lampreys from the facility (sterilized lampreys are held in the facility for >48 hours after injection to metabolize or excrete all bisazir from their bodies prior to release). Each week seven water samples were collected from these holding tanks.

The requirements of the discharge permit were met and safe operation of the facility was maintained. Bisazir was not detected in facility effluent. Measurable concentrations of bisazir were not detected in holding tanks just prior to removal of sterilized lampreys from the facility, however, trace amounts of bisazir (<25μg) were detected in 3 tanks, each containing a high number of dead lampreys (13-28). Samples were collected from these tanks during 50-67 hours after injection of the lampreys. Dead lampreys present in the tanks probably were the source of the bisazir residue. Metabolic activities that remove bisazir from live lampreys are not at work on dead lampreys. The facility plan of operations was modified to require removal of dead lampreys from tanks at least 6 hours before the completion of the decontamination period when more than 5 dead lampreys were present.

A total of 21,000 sterile male sea lampreys were predicted to be released in Lake Superior streams. Due to the occurrence of greater than the predicted number of lampreys from the Lake Huron streams, the actual number of sterilized males released was 28,424 (Table 25). An average ratio of 1.8 sterile:1 resident male lamprey was predicted and the estimated ratio was 2.7:1. The first release of sterilized males was scheduled for May 13 and occurred on May 16. The predicted final day of release in Lake Superior was June 11. Due to a lengthy Lake Huron lamprey run, the actual final release was July 2.

The predicted number of sterilized males for release into the St. Marys River was 5,600 and 4,832 were released. The first release of sterile males was predicted to be on June 14 and occurred on July 2. The final release was predicted for July 22 and occurred on August 9. Unseasonably cool water temperatures delayed the spawning run.

The estimated resident population of spawning-phase sea lampreys in the St. Marys River was 45,620 (25,535 males). Assessment traps removed 10,532 lampreys (5,895 male lampreys; a theoretical reduction of 23% from trapping). An estimated 19,640 resident males remained in the river and the release of 4,832 sterilized males achieved a ratio of 0.2 sterile:1 normal (theoretical reduction of 20% from sterilization). The combination of removal by traps and release of sterile males resulted in a theoretical reduction of reproductive potential of 38%.

Table 25. The predicted and actual number of sterile male sea lampreys released i tributaries of Lake Superior and the St. Marys River in 1993 (listed by order of loc west to east, by country), and the theoretical reduction in sea lamprey progeny based estimated number of resident males. The predicted ratio of sterile to normal males i was 1.8:1 and the predicted theoretical reduction in sea lamprey progeny was 64%. St males were scheduled for release beginning May 13 and ending June 11, and were act released beginning May 16 and ending July 2. Cool weather extended the spawning sea

River	Predicted Resident Males	Predicted Sterilized Males	Estimated Resident Males	Released Sterilized Males	Estimated Ratio	Theoret Reduct (%)
United States						
Nemadji	860	1,563	1,380	1,563	1.1:1	52
Amnicon	1,187	2,157	676	2,157	3.2:1	76
Middle	247	449	141	449	3.2:1	76
Poplar	173	315	10	315	32.0:1	97
Bad	2,161	3,928	1,231	3,927	3.2:1	76
Cranberry	30	54	17	54	3.2:1	76
Potato	18	32	10	32	3.2:1	76
Ontonagon	2,150	3,908	2,905	6,178	2.1:1	68
Firesteel	332	603	189	783	4.1:1	80
East Sleeping	129	234	73	330	4.5:1	82
Misery	243	441	138	571	4.1:1	80
Traverse	26	48	25	48	1.9:1	66
Sturgeon	757	1,375	707	2,262	3.2:1	76
Huron	136	247	127	222	1.7:1	63
Salmon Trout	70	127	65	127	2.0:1	67
Chocolay	129	234	120	484	4.0:1	80
Au Train	133	242	125	562	4.5:1	82
Sucker	94	170	87	395	4.5:1	82
Two Hearted	270	492	253	1,006	4.0:1	80
Waiska	68	123	63	317	5.0:1	83
Canada						
Pigeon	86	156	86	255	3.0:1	75
Wolf	215	391	215	555	2.6:1	72
Nipigon	1,075	1,954	1,075	3,023	2.8:1	74
Pancake	108	195	108	201	1.9:1	66
Batchawana	430	781	430	1,271	3.0:1	75
Goulais	430	781	430	1,337	3.1:1	76
Total	11,557	21,000	10,686	28,424	2.7:1	73

The short-term effectiveness of the Sterile Male Release Technique was studied on two tributaries to Lake Superior (Bad River, Wisconsin; Pancake River, Ontario). The objectives of the study were (1) to determine if the ratios of sterile to resident males observed on the nests were consistent with the predicted ratios and (2) to determine if reductions in the proportion of viable prolarvae were consistent with expected reductions, given the observed ratio of sterile to normal males. The study was conducted according to the protocol "Short-term Evaluation of Sterile-Male-Release in Selected Lake Superior Tributaries" by Roger Bergstedt and Kim Fredricks. The study required a minimum of 100 observations of mating pairs by statistical design.

Observations in the streams began in the Bad River on May 4 and in the Pancake River on May 17 with the first nests respectively sighted on June 4 and June 17. Spawning activity appeared to peak on June 22 on the Pancake River and on June 6 and 16 on the Bad River. Nests were categorized as sterile or resident based on the presence of females with sterile or resident males, or unknown when no lampreys were present. Eggs were collected from all nests when they were about to hatch. Success was calculated for each category of nest based on the percentage of eggs that were found to be viable.

Sterile male lampreys successfully mated with resident females and resulted in matings that produced no viable eggs. However, these matings were not observed in the predicted ratios (Table 25). Fewer than the required 100 observations of paired matings were observed in each of the Lake Superior study streams (Bad River 20, Pancake River 7). The estimated ratios of sterile to resident males were 3.2:1 in the Bad River and 1.9:1 in the Pancake River, and the ratios for observed matings were 0.7:1 in the Bad River and 0.2:1 in the Pancake River. Flood conditions destroyed many nests before eggs could progress to the required stage of development (hatching, about 13 days). In the Bad River eggs from 2 sterile nests had an average viability of 8% (fertile eggs probably drifted into sterile nests). In the Pancake River one sterile nest had no viable eggs.

The interaction of sterile and resident male lampreys also was observed in the St. Marys River. Objectives of this study were the same as for the Lake Superior studies and followed the protocol "Short-term Evaluation of Sterile-Male Release in the St. Marys River, Lake Huron" by Robert Young and Rod McDonald. Observations of paired matings were less than the required 100 needed for significant results. Observations began on July 7, and the first nest was sighted on July 20. Spawning activity appeared to peak on July 30 and August 4. The ratio of sterile to resident male lampreys was estimated at 0.2:1. This compares to an observed ratio of sterile to resident males (paired nesting) of 0.2:1 (Table 26). Examination of nests in the 3 categories (resident, sterile, unobserved) indicated that sterile males reduced the production of larvae by about 14% in the St. Marys River (consistent with a sterile to resident male ratio of 0.2:1). In the St. Marys River eggs from 3 sterile nests had an average viability of 1%.

The Sterile Male Release Technique Task Force continues to monitor the progress of the technique, adjust operations, and revise short and long-term assessment plans. Planned actions that will achieve progress in 1994 include: 1) modifications in the sterilization facility that continue to ensure safe, efficient, and effective treatment of male lampreys; 2) development of a quality assurance technique to measure the efficiency rate for the administration of bisazir dosage to lampreys; 3) tests to determine lowest effective dose of bisazir; 4) proposed construction of a weir and trap on the Carp River (Lake Huron) to increase the number of males available for sterilization by 2,000-4,000; 5) increased effort on short-term assessment in the field; and 6) development of a plan for Fiscal Years 1994-97 for implementation and assessment of the tech

Table 26. Observations of sterilized and resident male sea lampreys, numbers of nests with egg and percentage of viable eggs in the Bad (U.S.), Pancake (Canada), and St. Marys rivers in 1993 Nests were categorized by the type of mating observed: resident, sterile, or unobserved. Eggs wer not found in all observed nests. Some nests with eggs were lost or destroyed before eggs could b removed to determine viability. Eggs were retrieved from nests after developing to the hatching stag (about 12 days) and examined for viability to determine the percent viable. The study designs wer entitled "Short-term Evaluation of Sterile-Male-Release in Selected Lake Superior Tributaries," Roge Bergstedt and Kim Fredricks, Hammond Bay Biological Station, Michigan, and "Short-term Evaluation of Sterile-Male Release in the St. Marys River, Lake Huron," Robert Young and Roc McDonald, Sea Lamprey Control Centre, Ontario. Both studies called for over 100 observations o nesting pairs in each stream to meet statistical design.

	Bad	Pancake	St. Marys
Estimated resident males[1]	1,231	108	19,640
Sterile males released	3,927	201	4,832
Estimated ratio	3.2:1	1.9:1	0.25:1
Theoretical reduction (%)	76	66	38[2]
Observed paired nestings with:			
Resident male	12	6	56
Sterile male	8	1	13
Average percent of viable eggs in nests resulting from matings with:			
Resident males	51 (n=8)	49 (n=6)	36 (n=8)
Range	2-90	25-81	3-78
Sterile males	8 (n=2)	0 (n=1)	1 (n=3)
Range	0-15	--	0-4
Unobserved males	49 (n=17)	28 (n=19)	31 (n=35)
Range	1-92	0-83	0-81

[1]Resident males in Lake Superior tributaries were estimated from records of catch data. Resident males in the St. Marys River were estimated from mark/recapture data.
[2]Combined theoretical reduction: percent removal from traps and percent removal from sterilization.

ST. MARYS RIVER CONTROL STRATEGY

- Task Force established January 1992
- Charge (Revised 1993) is:

  a) Define scope of problem in terms of size and distribution of larval sea lamprey population and production of parasitic phase animals

  b) For all recommended control options determine:

  - Feasibility
  - Effectiveness (% reduction in transformer contribution)
  - Costs
  - Information needs to estimate effectiveness and costs
  - Environmental assessment requirements
  - Evaluation plans

  c) If effectiveness of control options cannot be predicted, develop experimental or adaptive design that does not conflict with other options and includes evaluation.

- Members are: Larry Schleen (Chair) and Robert Young from Department of Fisheries and Oceans Canada; John Heinrich, Dennis Lavis and Terry Morse from U.S. Fish and Wildlife Service; Roger Bergstedt from U.S. National Biological Survey; Mark Ebener (Lake Technical Committee Representative) from Chippewa Ottawa Tribal Fishery Management Authority; Richard Fleming (Outside Expert) from Forestry Canada; and Gavin Christie from Great Lakes Fishery Commission Secretariat.
- Meetings held on: January 19-20, June 3, July 15-16, October 14.
- Progress on the charge in 1993:

These actions were identified in the original Task Force report of 1992.

1. Continue adult trapping and introduction of sterile males.

The St. Marys River, experienced a less-than-average catch. We speculate that the shutdown of the Great Lakes Power generating station for parts of four different weekends effected trap results.

A stratified mark/recapture estimate was conducted on the St. Marys River population. About five percent (409) of the adults removed from the Canadian traps were marked by week of capture and released at the Pim Street docks. Eighty-eight were recovered in the combined traps (Canada 79, US 9). The resulting estimate was 45,620. The trap efficiency is well below the 1985-90 mean of 42.1% (35.1 - 47.0%). Any sterile males trapped alive were returned to the river without additional marking. We captured 1,398 sterile males (12 were dead in the trap). Based on a marking scheme conducted last year, about three-quarters of these lamprey were recovered for t[illegible] lized.

2. Continue index surveys

   - Index sites not surveyed in 1993 - effort reprogrammed to distribution/density surveys (see 8 below)

3. Construct enlarged trap to enhance capture of adult lamprey at Great Lakes Power (GLP) facility

   - $20,000 dedicated by GLFC towards design of enhanced trap

   - trap concepts provided by two Sault Ste. Marie engineering firms

   - design of Walker Engineering firm, which incorporates attractant water flow and fish pump to empty trap, supported by Task Force

   - contract awarded to Walker Engineering to refine design and test fish pump concept, leading to final design, scheduled for 1994

   - no construction until 1995 (funds permitting) pending study by Canadian Agent to see if increase in lifting of present traps will increase trap efficiency.

   - construction costs will be determined after final design completed

4. Design and implement short-term assessment studies to monitor abundance of young-of-the-year and yearling larvae (determine effects of trapping and sterile male release)

   - some progress in identifying suitable assessment sites gained during evaluation of sterile male release technique and the larval assessment work as described in item 8.

5. Increase the annual assessment of spawners in rivers of Lake Huron (increase trap network)

   - three streams (Tittabawassee, Cass and Chippewa rivers) added to U.S. trap network

6&7 Conduct engineering study for construction of barrier in rapids. Continue solicitation of assistance from U.S. Corps of Engineers. Begin process of securing funds for construction of barrier.

   - upon examination of preliminary engineering concepts and cost estimates from the COE and discussion of benefits and likely environmental assessment concerns, the Task Force has recommended that this action item be deleted from the list of control options.

8. Conduct surveys to determine quantitative spatial distribution of larvae throughout river.

In 1992, a pilot study was successfully completed to determine the feasibility of using a make quantitative estimates of the larval sea lamprey population in the St. Marys River. This is critical information needed to plan and predict the effectiveness of either full or section TFM treatments or spot treatments using antimycin or granular Bayer 73. At the direction of the Commission, funds were reprogrammed to complete the first phase of this multi-year task.

From information collected in 1992, two requirements emerged that were met in 1993. The intensity of sampling was increased from about 200 meters to 65 meters to facilitate density mapping through use of current Geographical Information Systems technology (GIS) and real-time differential GPS was used for increased positioning accuracy. Three pontoon boats (2 U.S. operated and 1 Canada) were outfitted with deepwater electrofishers and differential GPS equipment. Areas of highest density were selected for sampling in 1993 and included Lake Nicolet and the North Channel. Sampling was accomplished by using a systematic approach of navigating transects aligned perpendicular to the flow of the river. Transects and sampling points along those transects were spaced 65 meters apart creating a grid of sampling stations. At each sampling station geographic position was recorded, substrate was classified, habitat type was determined, and water velocity and direction were measured. The deepwater electrofisher was energized four separate times at each sampling station and captured lampreys were identified by species and their lengths recorded.

In 1993, a total of 1,694 stations were sampled over an area of 7.49 sq. km; 960 stations over 4.37 sq. km in Lake Nicolet, and 734 stations over 3.12 sq. km in the North Channel. A total of 438 sea lamprey larvae (range 17-164 mm) were captured. Optimal or acceptable habitat for sea lamprey larvae was encountered at 95% of the stations (61 and 34%, respectively) while completely unacceptable habitat was encountered at 5% of the stations examined.

The analysis of data was made in a customized GIS software package, Survey Designer Software System. The system incorporates the use of supplementary environmental layers of correlated data in its analysis including bathometry, habitat, and current velocity. Maps of the supplementary environmental variables and density maps of 4 different size groups of larval sea lampreys by surveyed area were prepared using this software and an estimated stock abundance of 1,135,000 larval sea lampreys was made for the 2 areas combined (Table 27).

Table 27. Estimated stock abundance of larval sea lampreys in Lake Nicolet and the North Channel of the St. Marys River, 1993.

Size Group (mm)	Catchability Coefficient	Estimated Abundance		Corrected Estimate	
		Lake Nicolet	North Channel	Lake Nicolet	North Channel
20-50	0.83	109,000	112,000	131,000	135,000
51-85	0.77	211,000	171,000	274,000	222,000
86-120	0.63	78,000	85,000	124,000	135,000
>120	0.52	28,000	31,000	54,000	60,000
Total		426,000	399,000	583,000	552,000

9. Continue development of flow/velocity model for theoretical lampricide treatment.

- contract let by GLFC to Dr. Hung Tao Shen of Clarkson University to develop flow model - cost of development $20,000; completion date December, 1994

- model should be able to predict the distribution and effectiveness of TFM applied to the river under different flow and wind directions

- may not preclude rhodamine dye study but should help significantly in design of an effective dye study and possibly reduce cost of dye study

- may help predict where section treatments utilizing bottom toxicants should be effective.

10. Continue bottom toxicant research/registration

- no formal testing of improved Bayer product or antimycin in 1993

- registration activities for new formulation of granular Bayer 73 continued in 1993

- sample of new formulation should be available for testing of current effects in 1994

11. Begin investigations on target/non-target treatment levels.

- no specific toxicity data studies were conducted in 1993

12. Continue cooperation support and public relations and begin process of preparing environmental assessments for treatment options.

- ongoing discussions with cooperators suggests support for present St. Marys River control strategy

- Task Force uncertain as to environmental assessment required

The following action item was not identified in the original options list:

13. Investigate the possibility of constructing an enhanced trapping facility at the USCOE hydroelectric location.

- meetings were held throughout 1993 between Task Force members and COE representatives regarding the possibility of improving trapping at the US hydroelectric facilities

- interest and support by Corps and possibility of utilizing present water leakage at No. 10 power house as some form of 'attractant' water for trap led to serious consideration

- potential funding of 75% of project by Corps and chance to incorporate some kind of valved piping system to the trap during future leakage repairs furthered discussions

- various outside agencies were solicited for interest and financial support for a combination sea lamprey/salmonid trap

- MDNR and Lake Superior State University expressed interest and possibility of funding the remaining 25% for construction of joint sea lamprey/Atlantic salmon trapping facility

- the GLFC recommends proceeding with a design phase involving the Corps, Barrier Coordinators and interested outside agencies.

SEA LAMPREY BARRIER TASK FORCE

- Task Force established April 1991.

- Charge is: to expand the development and use of sea lamprey barriers throughout the Convention Area.

- Members are: Dennis Lavis (Chair) and Ellie Koon from U.S. Fish and Wildlife Service; Tom McAuley and Ed DeBruyn from Department of Fisheries and Oceans Canada; Bill Swink from U.S. National Biological Survey; Doug Dodge from Ontario Ministry of Natural Resources; Bill Culligan from New York Department of Environmental Conservation; Dave Weaver from Michigan Department of Natural Resources; Les Weigum from U.S. Army Corps of Engineers; and Gavin Christie from Great Lakes Fishery Commission Secretariat.

- Meetings held on: March 4, July 20-21, and October 5-6.

- Progress on the charge in 1993:

    - Barrier Policy and Program Guidelines revised and adopted by the Commission in May.

    - Appointment of Sea Lamprey Barrier Coordinators for each agent proposed, approved and established as Task Force members.

    - Analytic Hierarchy Process proposed and approved as mechanism by which streams will be ranked for barrier projects.

    - Data compilation began for ranking process.

    - Sea lamprey barrier research strategy team formed (1 meeting held July 19-20), draft research strategy document prepared, and barrier research workshop planned for 1994.

    - Barrier projects proposed and accepted for FY 1994 funds: Jordan River (Lake Michigan) electric barrier operations, Misery River (Lake Superior) barrier improvement, Fish Creek (Lake Ontario) barrier improvement, and Black River (Lake Ontario) telemetry study to determine passage through barrier.

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