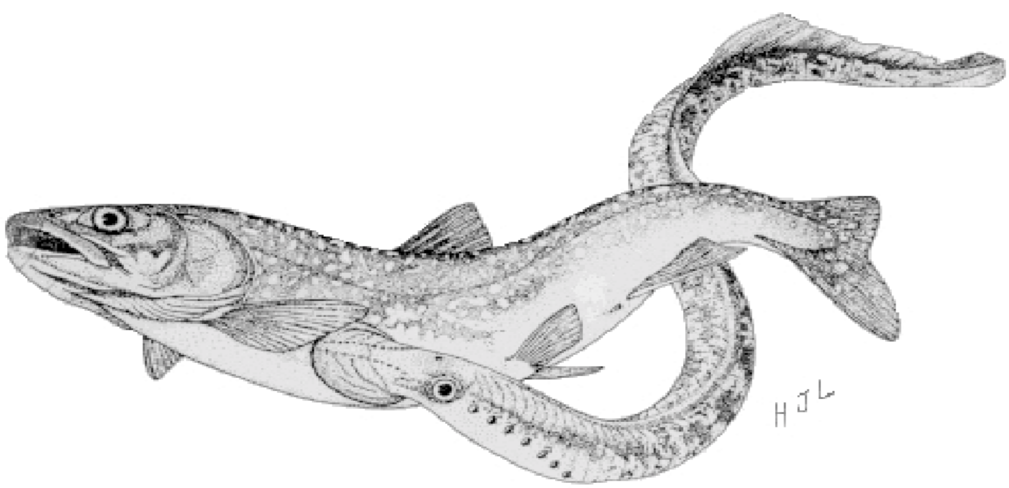
INTEGRATED MANAGEMENT OF SEA LAMPREYS IN THE GREAT LAKES 1998

ANNUAL REPORT TO

GREAT LAKES FISHERY COMMISSION



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GLFC Annual Meeting
June 7-8, 1999

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INTEGRATED MANAGEMENT OF SEA LAMPREYS IN THE GREAT LAKES 1998[1]

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Executive Summary

This report summarizes activities in the integrated management of sea lampreys conducted by the U.S. Fish and Wildlife Service (Service) and the Department of Fisheries and Oceans Canada (Department) in the Great Lakes during 1998. Lampricide treatments were conducted in 57 tributaries (Table 1). Larval assessment crews surveyed 357 tributaries, inland lakes, and lentic areas to assess control effectiveness, plan future TFM treatments, and establish production capacity of streams. Assessment traps were operated in 63 tributaries to estimate the spawning-phase population in each Great Lake (Table 2).

This report evaluates sea lamprey population versus fish community objectives in each of the lakes. Lake Superior is near the target level for sea lamprey abundance (at present a 40% decline versus a target of 50% decline by the year 2000). In Lake Michigan, the fish community objective has been met with abundance of spawning sea lampreys relatively stable during 1986-1998, although lampreys are more abundant in the northern part of the lake than the southern. Populations of parasitic lampreys remain significantly higher than the fish community objective in Lake Huron because of the continued high production of transformers from the St. Marys River. The lamprey management program met the fish community objective in Lake Erie and was slightly above the objective for Lake Ontario during 1998. The Lake Erie and Lake Ontario Committees currently are refining the Fish Community Goals and Objectives for each lake.

Risk assessment focused on environmental risk management as related to regulatory agency permits for control actions and on studies on the effects of lampricide treatments to lake sturgeon (Acipenser fluvescens) and fresh water mussels. After two years of field work, it was determined that some juvenile lake sturgeons were present in the Bad, Sturgeon, and Peshtigo rivers during July and August.

The St. Marys River Control Task Force coordinated the beginning of the 2-year (1998-1999) granular Bayluscide treatment during 1998. A total of 459.8 kg of Bayluscide was applied to 82.2 ha with a helicopter by a contracted pesticide application firm. Personnel from both the Service and Department cooperated in the successful treatment application. Evaluation of the treatment indicated a 76% reduction of pretreatment larval densities.

The Sterile Male Release Technique (technique) Task Force focused on the 3rd year of a 4-year assessment project (long-term study) in Lake Superior streams and the 2nd year of enhanced release of sterile males as a part of the integrated control program in the St. Marys River. The long-term study, which is addressing the success of the Technique, has released lampreys into eight Lake Superior streams and determined nesting success in the streams, and is in the process of determining density dependent effects within the larval lamprey populations. The St. Marys River received 16,743 sterilized males, creating a 2.2:1 sterile:untreated male ratio. The operation of the sterilization facility continued to meet the demands of the program.

The Barrier Task Force began a two-year transition of the barrier program from a developmental process to a fully operational part of the sea lamprey control program. The task force continued to direct research efforts into the combination fixed-crest and electrical barrier and biological impacts of barriers. To date, 61 barriers have been constructed or modified on Great Lakes tributaries to stop sea lamprey migration. During 1998, 4 barriers were in the process of construction, 5 existing barriers were modified to prevent passage of spawning sea lampreys, and construction of a fishway began at an electrical barrier.

[1]Presented during Annual Meeting by Michael B. Twohey, U.S. Fish and Wildlife Service, Marquette, Michigan.

The Sea Lamprey Integration Committee established its Assessment Task Force during 1996 to optimize operations of the larval and adult assessment programs. The Task Force completed the review of the St. Marys Assessment Plan by an external review panel and began implementation of the recommendations during 1998. Recommendations of the adult assessment review (peer reviewed during 1997) continued implementation and include estimation of the parasitic population in Lake Huron, estimation of the transformer population in Lake Superior, and redistribution of trapping effort from small to large streams. The task force, in cooperation with the Secretariat and a contracted private company, developed an Empirical Stream Treatment Ranking Model designed to rank streams for lampricide treatment. Also, the Task Force developed projections of transformer production and submitted TFM treatment recommendations for the 1999 field season to the Sea Lamprey Integration Committee.

The Lampricide Control Task Force continued to implement options for reducing lampricide use. The Manistee River (Lake Michigan) was treated by an international crew in a single coordinated effort which saved about 4,000 kg of TFM (active ingredient).

The sea lamprey management program conducted 1,290 outreach activities that required 258 staff days.

Table 1. Summary of lampricide applications in tributaries of the Great Lakes during 1998.

Lake	Number of Streams	Flow m^3/s	TFM[1,2] kg	Bayluscide[1] kg	Distance km
Superior	15	29.5	3,527.7	3.8	348.6
Michigan	13	60.2	10,116.9	69.6	410.6
Huron	18	117.6	14,864.5	506.7	466.3
Erie[3]	1	1.3	60.7	-	3.2
Ontario	10	40.5	4,586.5	-	160.3
Total	**57**	**249.1**	**33,156.3**	**580.1**	**1,389.0**

[1]Lampricides are in kg active ingredient.
[2]Includes 820 TFM bars (170.2 kg active ingredient) applied in 24 streams.
[3]A treatment of Crooked Creek was incomplete.

Table 2. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of the Great Lakes during 1998.

Lake	Number of Streams	Total captured	Number sampled	Percent males	Mean Length (mm)		Mean Weight (g)	
					Males	Females	Males	Females
Superior	19	3,754	626	34	433	423	194	19
Michigan	12	24,754	957	41	490	484	351	252
Huron	13	36,964	2,158	55	471	476	223	239
Erie	5	396	18	72	494	478	284	242
Ontario	14	7,996	1,087	50	470	475	238	256
Total	**63**	**73,864**	**4,846**					

INTRODUCTION

Sea lamprey control is a critical fishery management action delivered to support the Fish Community Objectives developed by the Lake Committees as part of the Strategic Plan for Great Lakes Fishery Management. Objectives for acceptable levels of mortality that allow the establishment and maintenance of self-sustaining stocks of lake trout and other salmonids have been established on all of the lakes. In some cases, the Lake Committees have established specific targets for sea lamprey populations in the Fish Community Objectives or the lake trout rehabilitation plans. The current control program reflects actions by the U.S. Fish and Wildlife Service (Service) and Department of Fisheries and Oceans Canada (Department) as contract agents of the Great Lakes Fishery Commission (Commission) to meet these targets.

The Commission is working in partnership with the Lake Committees through their Lake Technical Committees to refine the target statements and to develop common target formats for each of the lakes. The target for each lake will define the abundance of sea lampreys that can be tolerated and the economically viable level of control required to reach the desired suppression. The Commission and cooperators will consider the costs of control along with the benefits to define an optimum control program. The program must support the Fish Community Objectives, be ecologically and economically sound, and be socially acceptable.

This report presents the actions of the Service and Department in the integrated management of sea lampreys in the Great Lakes during 1998. Also presented are actions to meet milestones of the Commission vision and trends in sea lamprey abundance as related to Fish Community Objectives.

COMMISSION VISION

The Commission established the "Strategic vision of the Great Lakes Fishery Commission for the decade of the 1990s" during 1992, and established the following integrated management of sea lamprey vision statement:

> *The Commission will provide an integrated sea lamprey management program that supports the fish community objectives for each of the Great Lakes and that is ecologically and economically sound and socially acceptable.*

To achieve the vision, the Commission set milestones. The following are the milestones and the accomplishments to those milestones:

1) *Establish target levels of sea lamprey abundance by 1994 that maximize net benefits of sea lamprey and fisheries management.*

Beginning in 1993 and ending in 1998 each Lake Committee had established Fish Community Objectives for sea lamprey abundance that were based on their subjective judgement of levels necessary for lake trout rehabilitation. The sea lamprey portion of the process to set economic injury levels is largely complete. The Commission and Lake Committees are initiating discussion and planning to focus fish community objectives on economic injury levels.

2) *Suppress sea lamprey populations to target levels through an optimal program of control, assessment, and research. This program will be characterized by:*

   a) *maintenance of lampricide registrations with environmental agencies,* The Service has become the registrant for all lampricides used in the United States and Canada. The U.S. Geological Survey-Biological Resources Division (USGS-BRD) has provided technical support for establishment and maintenance of registrations.

b) development and use of alternative control techniques to reduce reliance on lampricides to 50 percent of current levels,

Since the beginning of the use of lampricides in the management program, the Service and Department continually have increased their efficiency in the use of TFM. The combination of improved analytical, application, and assessment techniques and construction of barriers has reduced the use of TFM from 1980-1989 (annual avg. of 52,000 kg) to 1990-1998 (annual avg. of 39,350 kg; Fig. 1), a reduction of about 30% [the TFM formulation is about 36% active ingredient]. This decrease has occurred through a combination of program efficiencies and implementation of alternative controls, and has occurred despite the addition of streams to the treatment program with higher TFM requirements due to high pH and total alkalinity.

c) development of quantitative assessment and improved control technologies for lentic areas and connecting channels, and

This has been implemented as two separate milestones: 1) development of quantitative assessment of sea lamprey populations in all areas, and 2) improved control in lentic and connecting channels. Both have been met and further refinements are continuing.

d) improvement of information gathering and research through program coordination among sea lamprey control agents, fish management agencies, other agencies and private groups, and researchers.

Research primarily has been met through delivery of outstanding work products of the internal research team of USGS-BRD centers (Great Lake Science Center and its Hammond Bay Biological Station, and Upper Midwest Environmental Sciences Center) and PERM scientists at Michigan State University, and of the external research through alternative control and IMSL research contracts. Information gathering has been met through Service and Department representation on lake technical committees, the Sea Lamprey Integration Committee organization of task forces and working groups, and outreach activities with private groups.

FISH COMMUNITY OBJECTIVES

Lake Superior

The Lake Superior Committee during 1990 established the following specific targets for sea lamprey populations in their Fish Community Objectives:

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

Based on estimates of the damage caused by the parasitic-phase population during the mid-1980s, these reductions were established to reflect the need for enhanced control on Lake Superior, with full recognition of the need for further evaluation of the costs of suppressing lamprey to these levels.

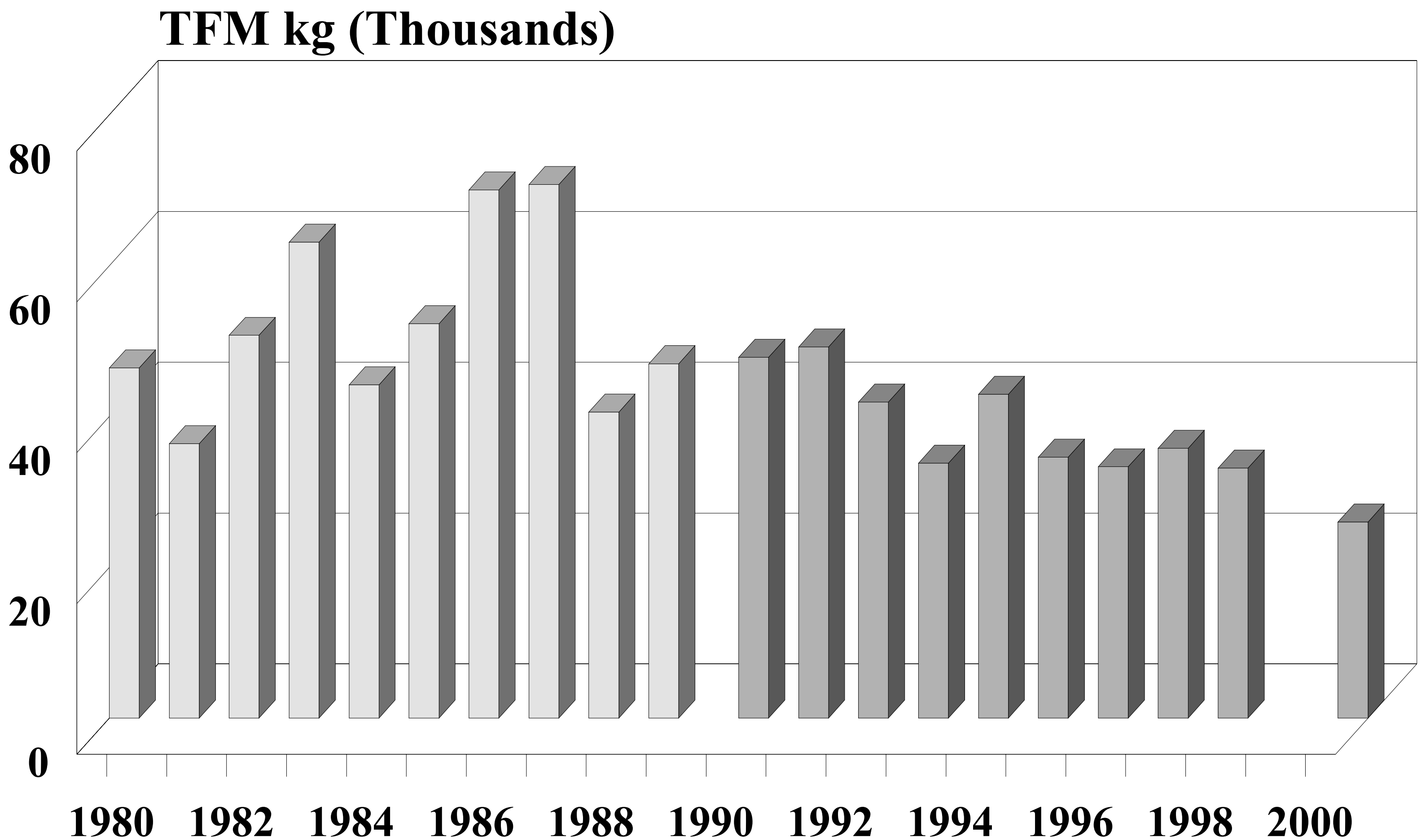

Fig. 1. Average annual use of TFM (active ingredient) during 1980-89 was 52,000 kg and during 1990-98 was 39,350 kg. Target use for 2000 is 26,000 kg.

This sea lamprey target was developed to support the following objective for the community of lake trout and other salmonids.

> *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.*

Naturally reproducing stocks of lake trout can be maintained only with a total annual mortality of less than 45%. Reaching this objective for total mortality requires a combination of fishery exploitation regulation and control of sea lamprey abundance.

The Lake Committee currently is in the process of revising the Fish Community Objectives.

The Service maintains an extensive trapping network for spawning-phase sea lampreys in index streams of the south shore of Lake Superior and estimates populations east and west of the Keweenaw Peninsula (Fig. 2). Populations east of the peninsula generally have remained stable throughout the 1990s. Populations to the west generally declined during 1989-1995, increased during 1996, and returned to a downward trend during 1997 and 1998. The 1998 combined U.S. estimate of 24,566 spawning-phase sea lampreys is below the 1986-1990 average of 42,500.

At present, the program is near the target for sea lamprey abundance (50% decline by 2000). For 1998 and for the annual average during 1991-98 (26,000), the population is about 40% less than during 1986-1990.

Lake Michigan

The Lake Michigan Committee during 1995 established the following specific targets for sea lamprey populations in their Fish Community Objectives:

> *Suppress the sea lamprey to allow the achievement of other fish-community objectives.*

In general, treatment of Lake Michigan tributaries over the years has provided sufficient control of sea lampreys, yet increases in lamprey wounding rates on lake trout in northern waters of the lake is a concern.

The sea lamprey objective was developed to support the other fish community objectives for Lake Michigan, specifically those for lake trout and other salmonids.

> *Establish a diverse salmonine community capable of sustaining an annual harvest of 2.7 to 6.8 million kilograms (6 to 15 million pounds), of which 20-25% is lake trout. Establish self-sustaining lake trout populations.*

Control of fishery exploitation and sea lamprey populations is necessary to meet these objectives. The lake-wide management plan specifies four different areas where the chances of successful lake trout rehabilitation exist: refuges, primary, secondary, and deferred rehabilitation zones. The primary zones and refuges where priority should be given to control sea lamprey populations include the mid-northern region of the lake, the mid-lake reef zone, and an offshore reef area in the southwest portion of the lake.

The Service has trapped spawning-phase sea lampreys in 12-14 tributaries of Lake Michigan and estimated the number of spawning lampreys in the Manistique River during 1986-1998 (Fig. 3). The index shows a relatively stable trend throughout the period, although the index was highest during 1998. Sea lampreys are more abundant in the northern part of the lake than in the southern. Also presented in Fig. 3 is the beginning of a series of lake-wide estimates of adult lamprey abundance (1996-1998).

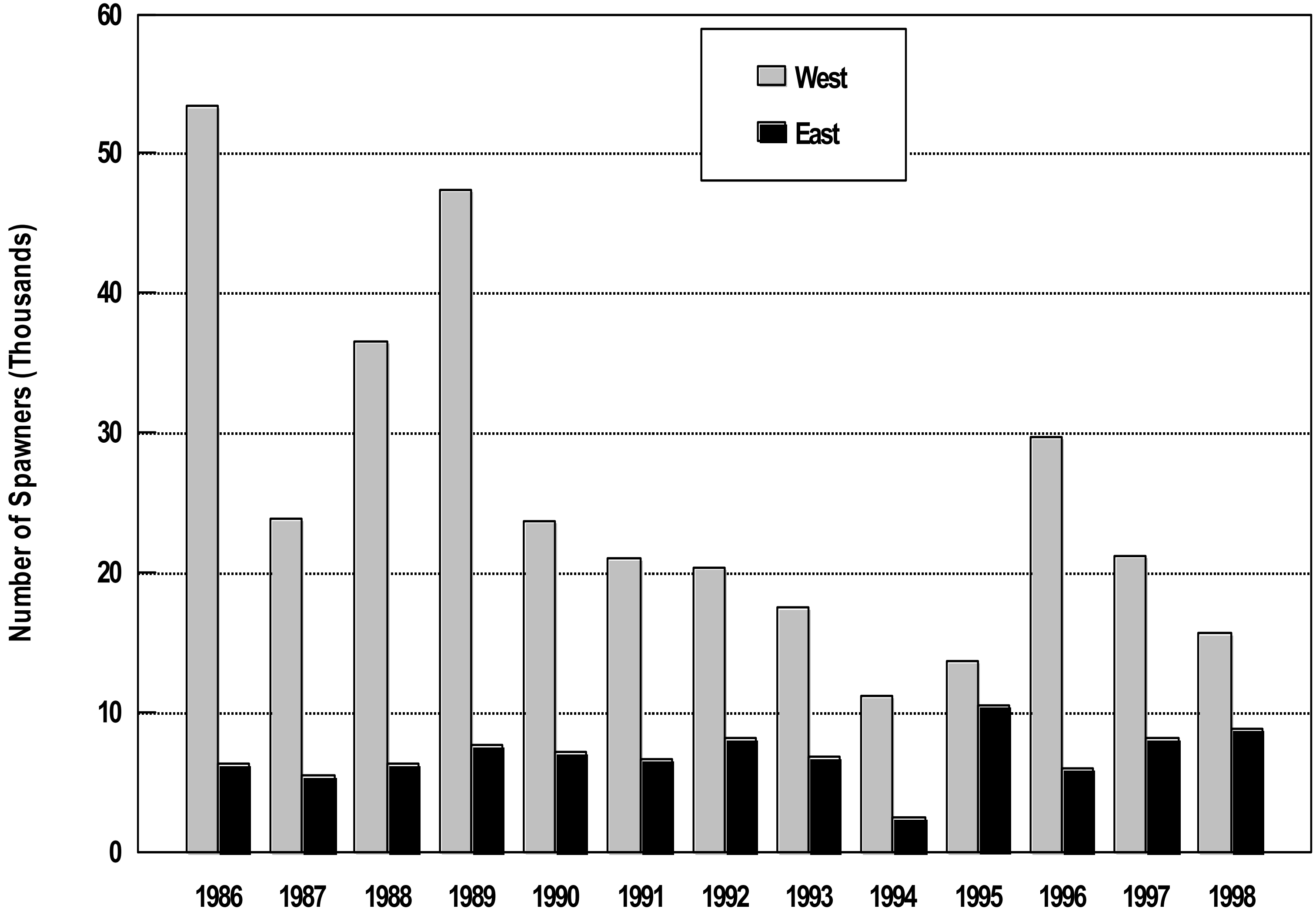

Fig. 2. Estimated number of spawning-phase sea lampreys in U.S. waters, west and east of the Keweenaw Peninsula, in Lake Superior.

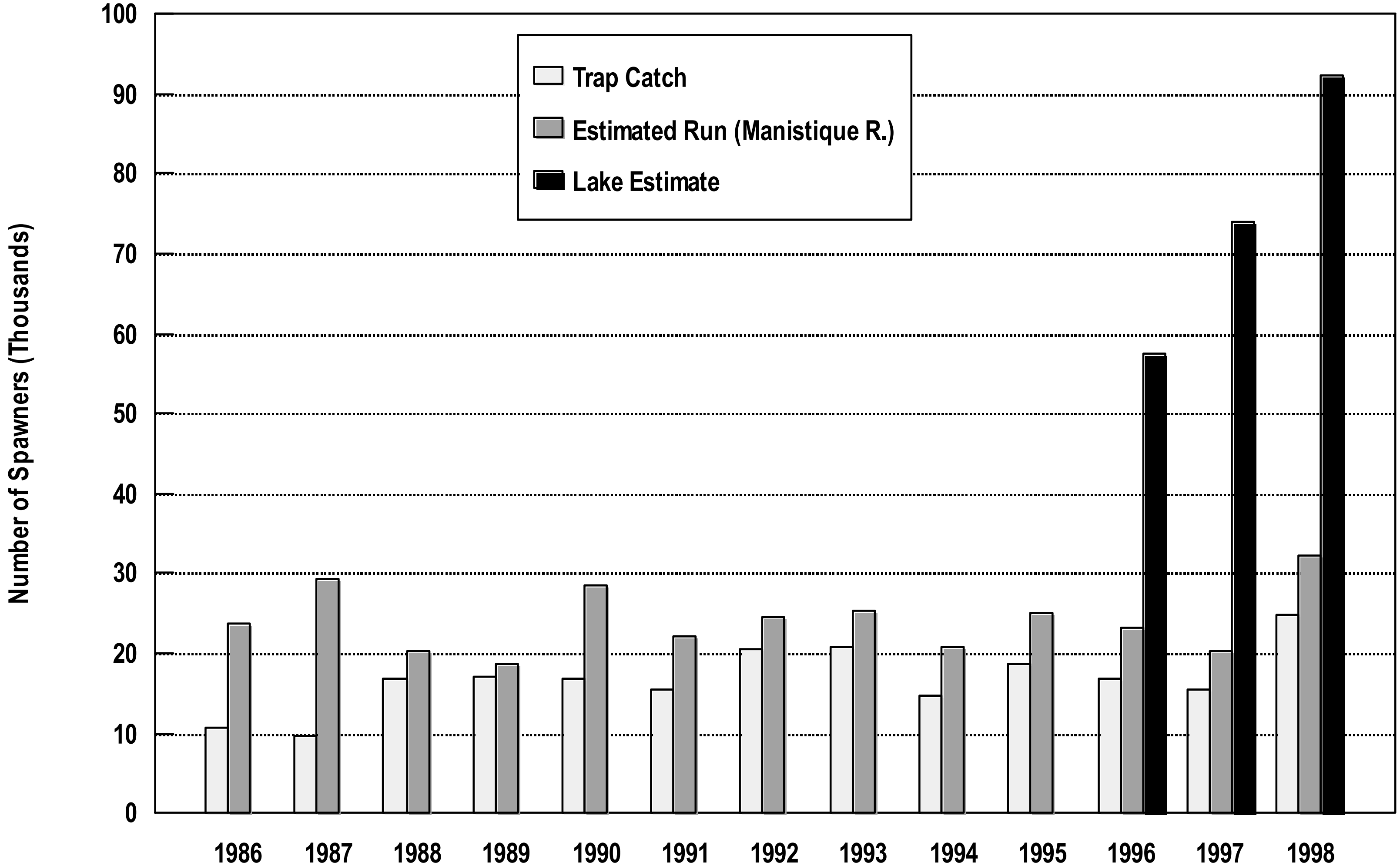

Fig. 3. Number of spawning-phase sea lampreys captured in assessment traps from an annual average of 13 Lake Michigan streams (range 12-14), estimated population of spawning lampreys in the Manistique River, 1986-1998, and estimated population of Lake Michigan, 1996-1998.

Lake Huron

During 1993 the Lake Huron Committee 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.*

The progress toward this objective is measured by the abundance of spawning sea lampreys in 4 index streams (Thessalon, St. Marys, Cheboygan, and Ocqueoc rivers) in northern Lake Huron.

This sea lamprey target supports the objectives for the other species groups in the fish community including, for example, the salmonine community objective:

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

To attain and maintain a self-sustaining lake trout population, capable of supporting 3-4 million pounds of this overall yield objective, the total annual mortality should not exceed 45%. The lake-wide management plan identifies refuges and priority zones in which rehabilitation is most likely to succeed. The plan specifies that these will be priority areas for the suppression of lampreys and control of fishery exploitation. The zones, which are distributed throughout the lake, include the northern section of Lake Huron and the North Channel of the St. Marys River.

The Service and Department annually have trapped an average of 12 streams during 1986-1998 to monitor the abundance of sea lampreys in northern Lake Huron (Fig. 4). Lamprey abundance generally increased during 1986-1993, and declined and stabilized during 1994-1998. Also presented in Fig. 4 is the beginning of a series of lake-wide estimates of adult lamprey abundance (1995-1998).

Lake Erie

The Lake Erie Committee is currently developing Fish Community Goals and Objectives for the lake. The Committee 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.

A specific management plan for sea lampreys in Lake Erie was developed prior to the implementation of stream treatments during 1986. The plan defined an "experimental program" of control to reduce sea lamprey populations to levels where wounding on lake trout would be less than 5%, assessment trap catches of lampreys would be less than 10% of pretreatment levels, and nest densities would be less than 2 nests per km of spawning habitat. By 1989 the first 2 of these objectives had been met in the eastern basin of Lake Erie. Based on this success, the Commission declared the “experimental program” a control program on Lake Erie.

The lake trout management plan for rehabilitation of self-sustaining stocks in the eastern basin of Lake Erie prescribed a maximum annual mortality rate of less than 40% to permit the establishment and maintenance of suitable stocks of spawning adults. Mortality would be controlled through management of fishery exploitation and continued suppression of sea lampreys.

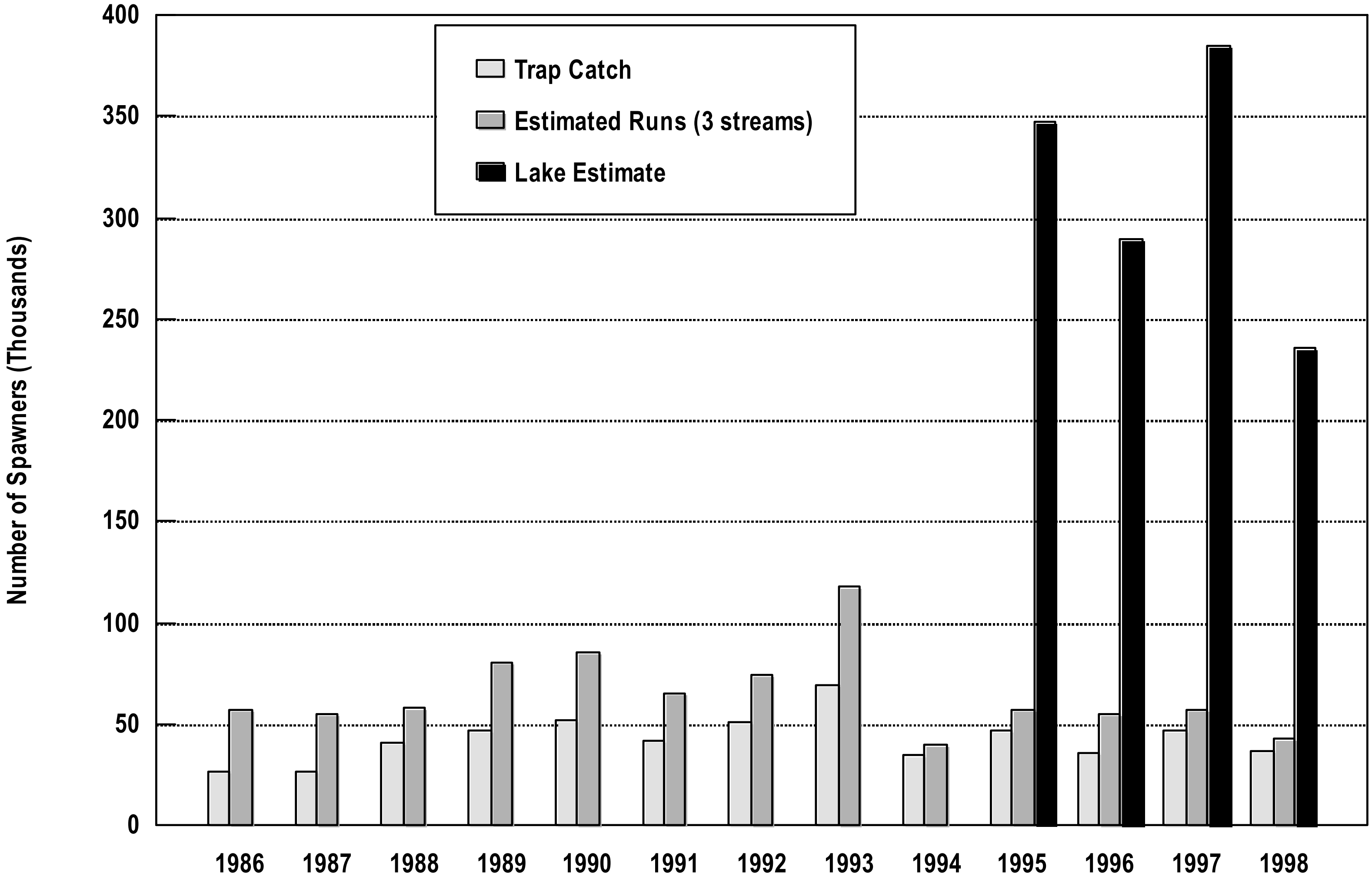

Fig. 4. Number of spawning-phase sea lampreys captured in assessment traps from an annual average of 12 Lake Huron streams (range 9-16) and estimated population of spawning lampreys in the Cheboygan, St. Marys, and Thessalon rivers, 1986-98 (population in Thessalon River not estimated in 1988 and 1991), and estimated population of Lake Huron, 1995-1998.

The Service and Department annually have trapped spawning-phase sea lampreys in an average of 7 tributaries during 1986-1998 and estimated the number of spawning lampreys in Cattaraugus Creek during 1991-1998 (Fig. 5). Current catch is less than the catch prior to the start of lampricide control (started during 1986 and showed effect in spawner population during 1989), but is greater than the target of 10% pretreatment catch. When the management plan for sea lampreys in Lake Erie was developed (prior to the implementation of stream treatments during 1986), the target level of less than 5% wounding on lake trout was for fish of 533-633 mm. During 1998, there were 0 wounds per 100 lake trout of 533-633 mm, and therefore the established target level technically was met. Yet, lake trout that were 634-734 mm had 23 wounds per 100 fish, and those >734 mm had 39 wounds per 100 fish. The present fish community objective for sea lamprey abundance requires further review.

Lake Ontario

During 1998, the Lake Ontario Committee supported the continuation of sea lamprey control and defined a specific objective for lampreys in terms of mortality to lake trout in the Community Objectives:

> *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.

The Lake Ontario Committee has revised its Lake Ontario Lake Trout Rehabilitation Plan from the original plan developed during 1983. The goal of the plan is to rehabilitate the population of lake trout to a self-sustaining level 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 lampreys of:

> *Controlling sea lamprey so that fresh wounding rates (A1) of lake trout larger than 431 mm is less than 2 marks/100 fish.*

This specific objective is meant to maintain the annual survival rate of 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 also will be controlled so that annual harvest does not exceed 120,000 fish in the near term.

The rate of fresh sea lamprey wounds on lake trout was greater than the objective during 1997-1998. The rate during 1989-1996 averaged about 1.5 marks/100 fish, while during 1997-1998 has increased to about 3 marks/100 fish. Yet, average age of lake trout is increasing in Lake Ontario and therefore more fish may have survived sea lamprey attacks during recent years.

The Service and Department annually have operated traps to index abundance of spawning-phase sea lampreys in an average of 14 tributaries of Lake Ontario during 1986-1998, and estimated the spawning runs in 5 of the streams during 1992-1998. Based on these indices, sea lamprey abundance in Lake Ontario has remained relatively stable during the 1990s (Fig. 6).

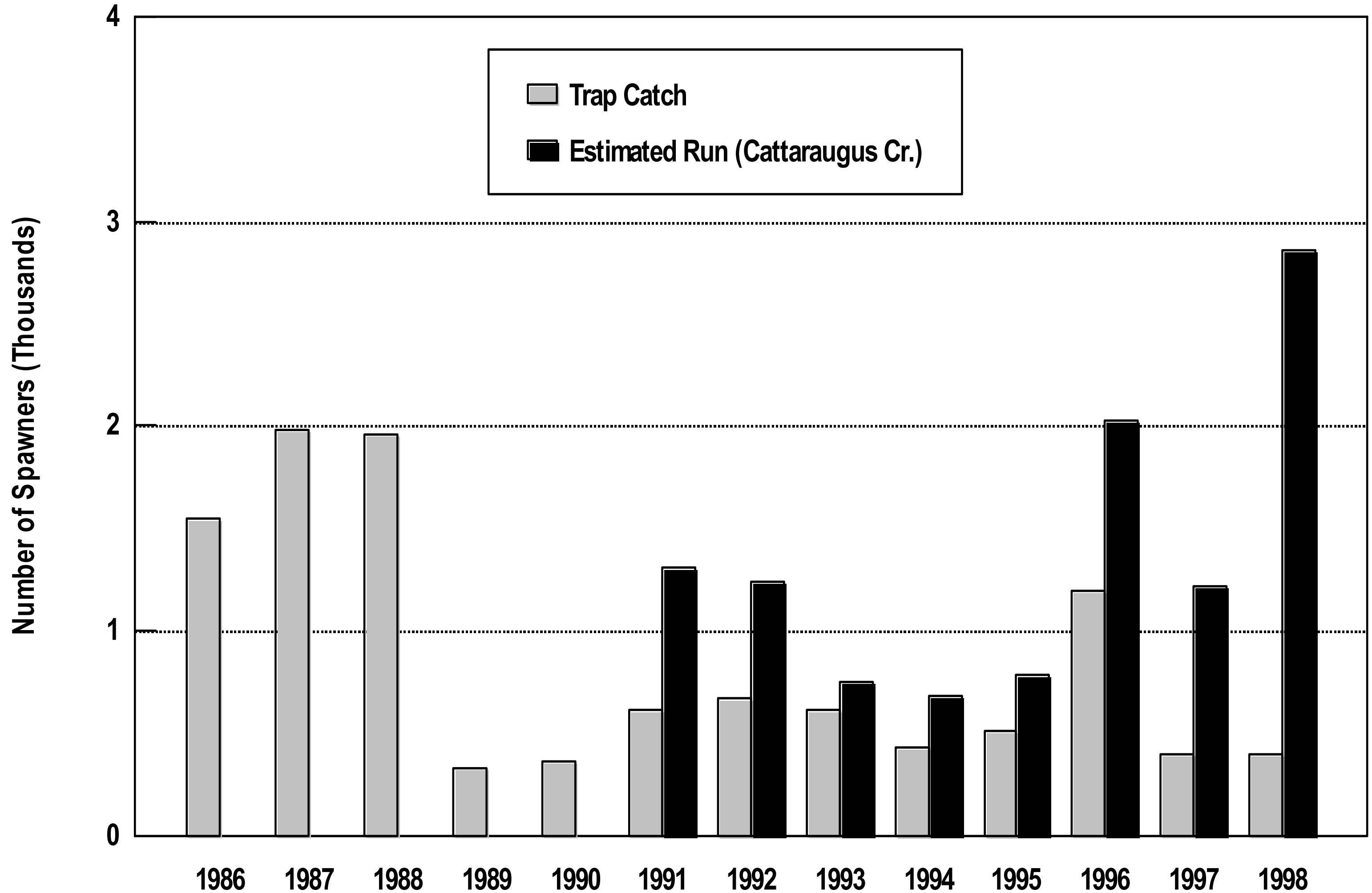

Fig. 5. Number of spawning-phase sea lampreys captured in assessment traps from an annual average of 7 Lake Erie streams (range 4-11), 1986-98, and estimated population in Cattaraugus Creek, 1991-98.

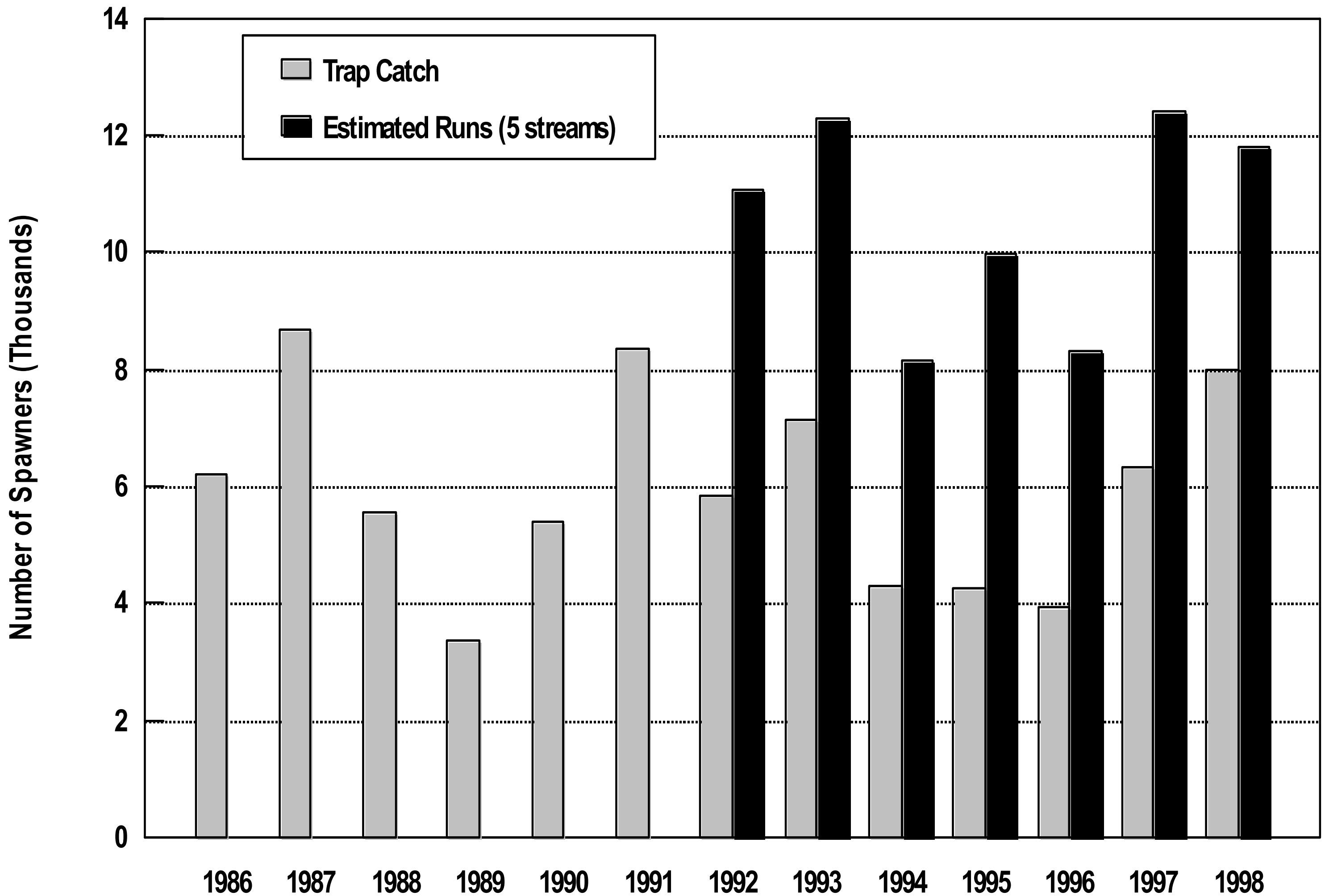

Fig. 6. Number of spawning-phase sea lampreys captured in assessment traps from an annual average of 14 Lake Ontario streams (range 13-16), 1986-98, and estimated populations in the Black and Humber rivers and Duffins, Port Britain, and Shelter Valley creeks, 1992-98.

LAMPRICIDE CONTROL

Tributaries harboring larval sea lampreys periodically are treated with lampricides to eliminate or reduce the populations of larvae before recruitment to the lake as parasitic adults occurs. Service and Department treatment units administer and monitor doses of the lampricide TFM, sometimes augmented with the 70% wettable powder formulation of Bayluscide, to scheduled tributaries. Specialized equipment and techniques are employed to provide concentrations of TFM that eliminate about 95% of the lamprey larvae and minimize the risk to nontarget species. During recent years, the combination of improved analytical and predictive techniques has contributed significantly to the reduced use of the lampricide TFM (kg active ingredient/yr) in the Great Lakes.

The Lampricide Control Task Force was established during December 1995 with charges to improve the efficiency of lampricide control, to maximize sea lampreys killed in stream and lentic treatments while minimizing lampricide use, costs, and impacts on stream/lake ecosystems, and to define lampricide control options for near and long-term stream selection and target setting. The report of progress on the charges during 1998 is presented on pages 70-71.

Lake Superior

Tributary Information

- Lake Superior has 1,566 (733 United States, 833 Canada) tributaries.
- 136 (89 United States, 47 Canada) tributaries have historical records of production of sea lamprey larvae.
- 74 (41 United States, 33 Canada) tributaries have been treated with lampricide at least once during 1989-98.
- Of these, 53 (30 United States, 23 Canada) tributaries are treated on a regular 3-5 year cycle.

Table 3 provides details on the application of lampricides to 15 tributaries of Lake Superior (Fig. 7) during 1998. The following are highlight statements:

- Treatments were completed successfully in 15 scheduled streams (11 United States, 4 Canada).
- Bayluscide 70% wettable powder was used for the first time on the Chocolay River, which saved about 100 kg TFM.
- Mortality of nontarget species was minimal on most treatments. About 25 brook trout were killed during the Five Mile Creek treatment.
- To fulfill a requirement of the Michigan 1998 Certification of Approval, public water supplies in Marquette and L'Anse were monitored for presence of lampricides during the Chocolay River treatment and during the survey of the lentic area of the Falls River. No lampricides were detected.

Table 3 . Details on the application of lampricides to tributaries of Lake Superior, 1998.
(Number in parentheses corresponds to location of stream in Fig. 7.)

Stream	Date	Flow m^3/s	TFM kg[1,2]	Bayluscide kg[1]	Distance treated km
United States					
Sucker R. (29)	May 30	2.3	293.5	0	53.1
Laughing Whitefish R. (32)	Jun 09	0.4	61.3	0	8.0
Miners R. (30)	Jun 09	0.6	102.1	0	3.2
Chocolay R. (33)	Jun 15	5.4	570.9	2.5	40.2
Silver R. (35)	Sep 03	0.4	60.5	0	8.0
Ravine R. (34)	Sep 04	0.1	21.1	0	8.0
Trap Rock R. (36)	Sep 06	0.4	62.5	0	14.5
Bad R. (37)	Sep 18	7.4	1,382.0	0	148.0
Amnicon R. (39)	Oct 02	0.2	63.1	0	17.7
Red Cliff Cr. (38)	Oct 14	0.1	24.6	0	4.8
Five Mile Cr. (31)	Oct 27	0.1	2.3	0	1.6
Total		17.4	2,643.9	2.5	307.1
Canada					
Pancake R. (41)	Jul 15	1.4	68.0	0	8.4
Chippewa R. (43)	Jul 22	1.6	109.6	1.3	4.0
Gravel R. (40)	Aug 25	1.3	204.3	0	16.1
Batchawana R. (42)	Oct 14	7.8	501.9	0	13.0
Total		12.1	883.8	1.3	41.5
Grand Total		29.5	3,527.7	3.8	348.6

[1]Lampricides are in kg active ingredient.
[2]Includes a total of 226 TFM bars (47.1 kg active ingredient) applied in 8 streams.

Lake Michigan

Tributary Information

- Lake Michigan has 511 tributaries.
- 121 tributaries have historical records of sea lamprey larvae production.
- 67 tributaries have been treated with lampricide at least once during 1989-1998.
- Of these, 33 tributaries are treated on a regular 3-5 year cycle.

Table 4 provides details on the application of lampricides to 13 tributaries of Lake Michigan (Fig. 7) during 1998. The following are highlight statements:

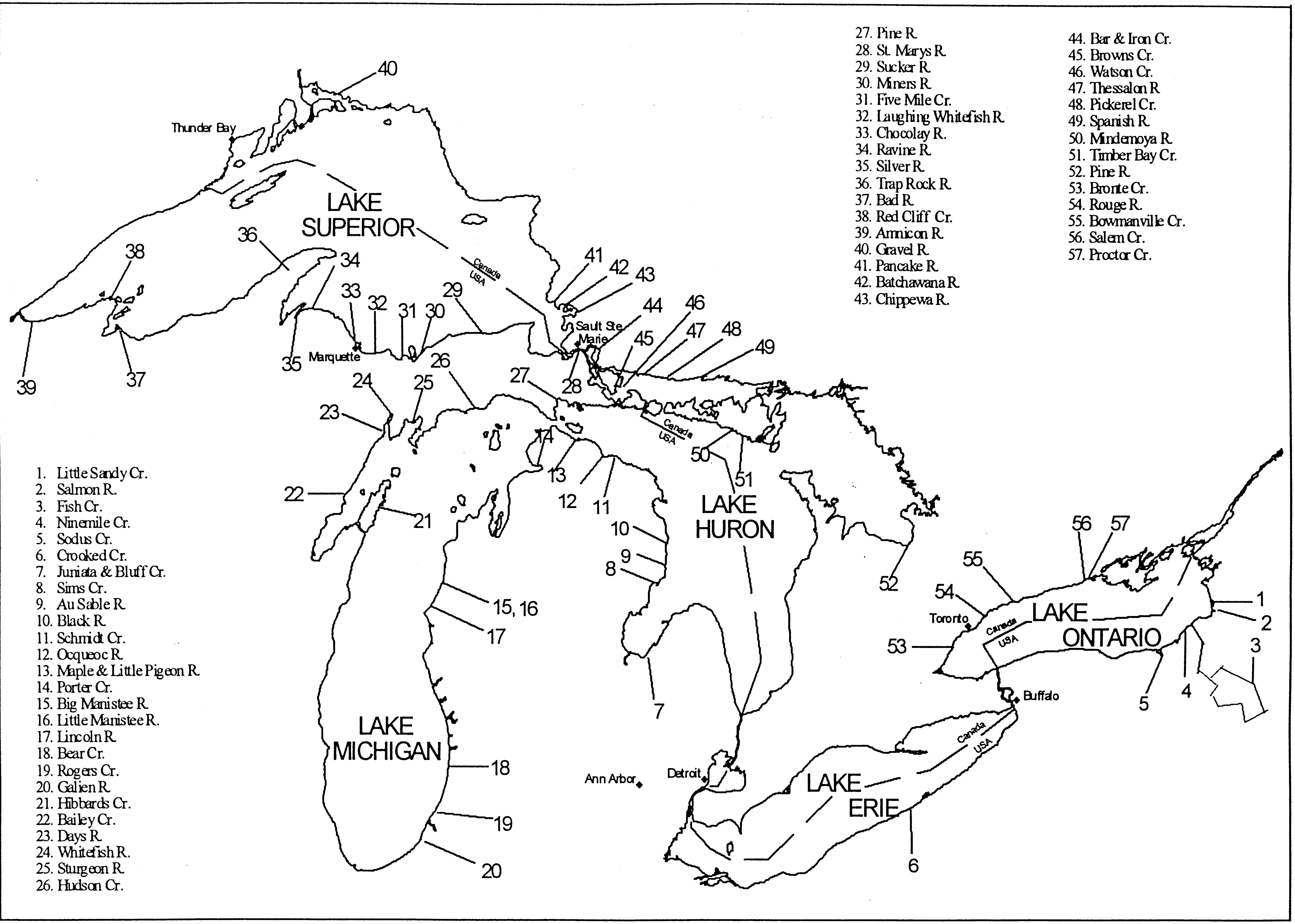

Fig. 7. Location of tributaries treated with lampricide during 1998.

- Treatments were completed successfully in 13 streams. Rapid River was scheduled but not treated due to low stream discharge throughout 1998.

- To fulfill a requirement of the Michigan 1998 Certification of Approval, public water supplies at Gladstone and Escanaba were monitored for the presence of lampricides for 1 month following the treatment of the Days and Whitefish rivers. Lampricide was not detected in the water supplies throughout the month.

- A combined crew of Service and Department personnel completed treatment of the Manistee River in a single coordinated effort. The treatment was completed with about 4,000 kg less TFM (active ingredient) than that applied during 1994.

- An interim protocol was developed for treatment of the Manistee and Sturgeon rivers to protect juvenile lake sturgeon. Maximum concentrations of lampricides were limited to 1.2 times the pH minimum lethal concentration for larval sea lampreys. Due to the restrictive protocol, concentrations of lampricides were at less than minimum lethal levels at the mouth of the Manistee River. However, a post-treatment assessment survey found no residual sea lamprey larvae in the lower Manistee River.

- Mortality of nontarget fish species was minimal on all treatments.

Table 4. Details on the application of lampricides to tributaries of Lake Michigan, 1998. (Number in parentheses corresponds to location of stream in Fig. 7).

Stream	Date	Discharge m^3/s	TFM kg[1,2]	Bayluscide kg[1]	Distance treated km
Hibbards Cr. (21)	May 02	0.8	93.2	0	11.3
Rogers Cr. (19)	May 02	0.3	30.6	0	3.7
Galien R. (20)	May 05	0.3	91.9	0	4.9
Bailey Cr. (22)	May 05	0.1	20.3	0	3.2
Hudson Cr. (26)	May 15	0.1	1.7	0	3.2
Lincoln R. (17)	May 30	1.6	358.3	0	22.8
Whitefish R.(24)	Jun 27	4.5	1,485.1	0	88.5
Kalamazoo R.					
Bear Cr. (18)	Jun 27	0.2	51.1	0	3.2
Little Manistee R. (16)	Jul 27	4.1	686.4	6.7	37.5
Big Manistee R. (15)	Aug 10	40.1	6,687.3	58.7	121.0
Porter Cr. (14)	Oct 01	0.3	74.1	0	0.3
Sturgeon R. (25)	Oct 02	7.6	469.4	4.2	104.6
Days R. (23)	Oct 15	0.3	67.5	0	6.4
Total		60.3	10,116.9	69.6	410.6

[1]Lampricides are in kg active ingredient.
[2]Includes a total of 274 TFM bars (57.1 kg active ingredient) applied in 6 streams.

Lake Huron

Tributary Information

- Lake Huron has 1,761 (427 United States, 1,334 Canada) tributaries.

- 116 (62 United States, 54 Canada) tributaries have historical records of sea lamprey larvae production.

- 70 (34 United States, 36 Canada) tributaries have been treated with lampricide at least once during 1989-1998.

- Of these, 46 (22 United States, 24 Canada) tributaries are treated on a regular 3 to 5 year cycle.

Table 5 provides details on the application of lampricides to 18 tributaries of Lake Huron during 1998 (Fig. 7). The following are highlight statements:

- Treatments were completed successfully in 18 of 20 scheduled streams (9 United States, 9 Canada). Low stream discharge resulted in a deferral of the Magnetawan and Naiscoot rivers (Canada).

- An interim protocol was developed for treatment of the AuSable River to protect young-of-the-year lake sturgeon. The past several treatments of the AuSable River (prior to 1998) typically used powdered Bayluscide with TFM to decrease the amount of TFM used. The interim protocol to protect lake sturgeon was developed only for TFM. As a result, the treatment required more TFM than what had been used during previous treatments.

- Mortality of nontarget fishes was minimal in the majority of treatments, although mortality of some troutperch occurred in the Spanish River. About 200-300 spawning chinook salmon were found dead in 2 km of the 41.5 km treatment of the Pine River, a tributary of the Nottawasaga River.

- Granular Bayluscide (3.2% active ingredient) treatment of the St. Marys River began during 1998. A total of 82.2 ha were treated (in U.S. waters) with a helicopter by a contracted pesticide application firm. Joint crews from the Service and Department participated in the flawless operation. The target acreage for the 2-year treatment is 864.1 ha, with the remaining 781.9 ha scheduled for treatment during 1999. Treatment effects to nontarget organisms were insignificant.

Lake Erie

Tributary Information

- Lake Erie has 842 (317 United States, 525 Canada) tributaries.
- 20 (9 United States, 11 Canada) tributaries have historical records of sea lamprey larvae production.

- 9 (4 United States, 5 Canada) tributaries have been treated with lampricide at least once during 1989-1998.

- Of these, 5 (3 United States, 2 Canada) tributaries are treated on a regular 3-5 year cycle.

Table 6 provides details on the application of lampricide to 1 tributary of Lake Erie (Fig. 7) during 1998. The following is a highlight statement:

- Crooked Creek was the only tributary scheduled for treatment during 1998. Treatment of the tributary was abandoned due to excessive rainfall.

Table 5. Details on the application of lampricides to tributaries of Lake Huron, 1998.
(Number in parentheses corresponds to location of stream in Fig. 7.)

Stream	Date	Flow m^3/s	TFM kg[1,2]	Bayluscide kg[1]	Distance treated km
United States					
Pine R. (27)	May 16	2.8	629.0	0	160.9
Black R. (10)	Jun 14	1.1	223.8	0	15.1
Tawas Lake Outlet					
Sims Cr. (8)	Jul 10	0.1	21.3	0	3.2
AuSable R. (9)	Jul 13	32.4	7,988.2	0	23.3
St. Marys R. (28)	Jul 13	-	-	459.8[3]	-
Ocqueoc R. (12)	Aug 24	1.4	404.7	0	41.8
Little Pigeon R. (13)	Aug 24	0.4	91.9	0	3.7
Schmidt Cr. (11)	Sep 5	0.3	21.4	0	4.7
Saginaw R.					
Juniata Cr. (7)	Sep 18	0.1	32.9	0	6.9
Bluff Cr. (7)	Sep 21	0.1	36.2	0	10.0
Cheboygan R.					
Maple R. (13)	Oct 14	2.1	427.9	0	12.9
Total		40.8	9,877.3	459.8	282.5
Canada					
Timber Bay Cr. (51)	Jun 17	0.1	21.8	0	2.8
Mindemoya R. (50)	Jun 17	0.8	158.8	0	5.1
Spanish R. (49)	Oct 19	67.6	3,882.5	46.9[4]	55.5
LaCloche Cr. (49)	Jun 19	1.0	55.9	0	11.0
Birch Cr. (49)	Jun 20	2.6	116.0	0	17.4
Mississagi R.					
Pickerel Cr. (48)	Jun 23	0.1	1.8	0	1.2
Echo R.					
Bar/Iron Cr. (44)	Jun 24	0.3	22.9	0	9.8
Thessalon R. (47)	Jul 6	2.3	127.6	0	36.5
Watson Cr. (46)	Jul 29	0.1	4.7	0	1.6
Nottawasaga R.					
Pine R. (52)	Sep 17	1.8	590.8	0	41.5
Brown's Cr. (45)	Sep 30	0.1	4.4	0	1.4
Total		76.8	4,987.2	506.7	183.8
Grand Total		117.6	14,864.5		466.3

[1]Lampricides are in kg active ingredient.
[2]Includes a total of 260 TFM bars (54.2 kg active ingredient) applied in 6 streams.
[3]Granular formulation; applied to 82.2 ha.
[4]Wettable powder formulation.

Table 6. Details on the application of lampricide to 1 tributary of Lake Erie, 1998.
(Number in parentheses corresponds to location of stream in Fig. 7.)

Stream	Date	Flow m^3/s	TFM $kg^{1,2}$	Bayluscide kg^1	Distance treated km
Crooked Cr. (6)	May 4	1.3	60.7	0	3.2
Total		1.3	60.7	0	3.2

[1]Lampricide is in kg active ingredient.
[2]Includes a total of 15 TFM bars (3.1 kg active ingredient).

Lake Ontario

Tributary Information

- Lake Ontario has 659 (254 United States, 405 Canada) tributaries.
- 57 (28 United States, 29 Canada) tributaries have historical records of production of sea lamprey larvae.
- 39 (20 United States, 19 Canada) tributaries have been treated with lampricide at least once during 1989-1998.
- Of these, 36 (17 United States, 19 Canada) tributaries are treated on a regular 3-5 year cycle.

Table 7 provides details on the application of lampricides to 10 tributaries of Lake Ontario (Fig. 7) during 1998. The following are highlight statements:

- Treatments were completed in 10 streams (5 United States, 5 Canada).
- Heavy rain negated treatment effectiveness on the lower section of the Rouge River, but sea lamprey larvae were scarce in the area.
- Treatment effort required on Fish Creek, a tributary to Oneida Lake, was reduced due to the absence of sea lamprey larvae in Little River, a complex tributary.
- Mortality of nontarget fishes was minimal in all treatments.

Table 7 . Details on the application of lampricides to tributaries of Lake Ontario, 1998.
(Number in parentheses corresponds to location of stream in Fig. 7.)

Stream	Date	Flow m^3/s	TFM kg[1,2]	Bayluscide kg[1]	Distance treated km
United States					
Little Sandy Cr. (1)	Apr 30	0.7	86.0	0	10.1
Sodus Cr. (5)	May 2	0.2	51.9	0	1.8
Ninemile Cr. (4)	May 2	0.6	103.9	0	11.5
Salmon R. (2)	May 24	21.6	1,304.7	0	25.5
Orwell Br.	May 4	1.1	97.0	0	7.6
Trout Br.	May 22	0.4	39.1	0	7.6
Fish Cr. (3)	May 27	8.9	744.1	0	40.7
Total		33.5	2,426.7	0	104.8
Canada					
Bronte Cr. (53)	Apr 23	4.2	1,209.0	0	28.7
Bowmanville Cr. (55)	Apr 26	1.8	674.0	0	9.1
Rouge R. (54)	Jun 2	0.8	207.4	0	9.7
Salem Cr. (56)	Aug 19	0.1	38.2	0	2.1
Proctor Cr. (57)	Aug 19	0.1	31.2	0	5.9
Total		7.0	2,159.8	0	55.5
Grand Total		40.5	4,586.5	0	160.3

[1]Lampricides are in kg active ingredient.
[2]Includes a total of 45 TFM bars (8.7 kg active ingredient) applied in 3 streams.

ALTERNATIVE CONTROL

Sterile Male Release Technique

Research on the use of the sterile male release technique (technique) in sea lamprey control began during 1971. The technique has been used experimentally in Lake Superior and the St. Marys River since 1991. Male sea lampreys were captured during their spawning migrations in 14 Great Lakes tributaries, and were transported to the sterilization facility at the Hammond Bay Biological Station. At the facility, lampreys are were sterilized with the chemosterilant bisazir, decontaminated, and released into selected tributaries of Lake Superior and into the St. Marys River. Laboratory and field studies have shown that treated male lampreys are sterile, sexually competitive, and the number of larvae that hatch in streams is reduced.

The Sterile Male Release Technique Task Force was established during 1984 to refine the long-term strategy for application of the technique and to coordinate a large-scale research program for evaluating the success of the technique. The report of progress of the Task Force is presented on pages 64-67.

The following statements highlight the sterile male release program during 1998:

- Male lampreys were collected from assessment traps in 14 Great Lakes tributaries and 26,317 were delivered to the Hammond Bay Biological Station for use in the sterilization program.

- A total of 16,743 sterilized male lampreys were released in the St. Marys River during May 9 - July 17. The estimated resident population of spawning-phase sea lampreys in the St. Marys River was 20,235 (11,485 males). Assessment traps removed 7,555 lampreys (4,288 male lampreys; a theoretical reduction of 37% from trapping). An estimated 7,482 resident males remained in the river. The ratio of sterile to untreated male lampreys that was achieved in the St. Marys River was estimated at 2.2:1 (16,743 sterile:7,482 untreated males).

- The implementation of the technique in the St. Marys River was enhanced during 1997, and the release in 1998 included 13,622 sterilized lampreys that previously would have been released in Lake Superior tributaries.

- The theoretical reduction from trapping and enhanced sterile male release was estimated at 80% during 1998 (89% during 1997). The theoretical reduction in reproduction from sterile male release combined with the number of lampreys removed by traps averaged 62% during 1991-1996.

- With the enhanced release, the theoretical reduction in reproduction from sterile male release (on the population of spawning lampreys remaining after trapping) in the St. Marys River was 69% during 1998 (84% during 1997). The theoretical reduction in reproduction from sterile male release (on the population of spawning lampreys remaining after trapping) averaged 32% during 1991-1996.

- Egg viability of 52 nests sampled in the St. Marys River rapids averaged 37%.

- Assessment of the technique continued during the 3rd year of a 4-year study which is testing survival of yearling larvae and density dependant factors in 8 tributaries of Lake Superior (U.S. - Middle, Misery, Big Garlic, and Rock rivers; Canada - Carp, Wolf, and Big Carp rivers and Stokely Cr.). During May 12 - 20, untreated male and female lampreys were released into each study stream in proportion to the estimated area of available larval habitat (range, 130-1,000 each males and females). In addition, sterile male lampreys were released in 5 of the streams at a ratio of 3:1 sterile to untreated males (range, 390-2,100). Assessments for egg viability and strengths of larval year classes were made in all study streams. Preliminary data are presented in Table 8.

- Water effluent from the sterilization facility and water from holding tanks that held lampreys following injection were monitored for bisazir contamination. Bisazir was not detected in any samples.

- Quality assurance testing was conducted to determine the precision of volume of bisazir solution injected into lampreys. The amount of bisazir stock solution injected was measured systematically in about two percent of the injections. The injector continues to deliver an average dose error of +0.2 ml per injection (range, -0.7 to 1.8). The average injection was 2.8 ml and the average lamprey weighed 258g.

- Construction of a trapping weir was completed in Bridgeland Creek to supplement supply of male sea lampreys for sterilization. The trap will be operational during 1999.

- About 10,000 male lampreys and 14,000 female lampreys were used in studies and outreach activities.

Table 8. Interim results of the long-term study including river, number of lampreys released, number of nests observed, percent egg viability, and estimated stream habitat (types I, II, and III). These are provisional data from the 3rd year of a 4-year study.

River	Spawner Lampreys Released			Number of Nests	Percent Egg Viability	Area of Habitat (m^2)[1]		
	Males		Females					
	Sterile	Untreated				I	II	III
Middle	0	1,000	1,000	115	53	5,994	63,394	123,896
Misery[2]	2,100	700	700	29	59	29,377	180,041	55,576
Big Garlic	390	130	130	62	29	6,983	17,388	10,218
Rock[2]	0	476	476	11	89	56,952	49,749	43,374
Carp	390	130	130	24	10	996	14,680	17,740
Stokely	0	130	130	54	66	448	9,998	41,562
Wolf	600	200	200	64	26	713	18,110	85,729
Big Carp[3]	390	130	130	19	29	2,524	28,836	7,558

[1]The area of each habitat type (I, II, and III) was estimated by multiplying the average width of each habitat type by the total stream length in which the habitat was measured. Type I habitat is preferred by sea lamprey larvae, type II habitat is acceptable though not preferred, and larvae cannot burrow in type III habitat.
[2]The study areas on the Misery and Rock rivers were expanded from the areas studied during 1996 after distribution surveys during 1997 identified additional infested areas.
[3]The Big Carp River sampled during 1997 replaced the Whitefish River which was sampled during 1996.

Barriers

The Commission is committed to reducing the use of TFM through the implementation of alternative lamprey control strategies, which include the use of barriers to sea lamprey migration. During the June 1997 annual meeting, the Commission agreed to begin a two-year transition phase from a developmental program to an operational barrier program. A barrier transition team of control agent barrier program staff, a Commission Secretariat representative, and consultants Ian Ross and M.S. Millar, is responsible for developing standard operation protocols, standard design criteria, and a long-term barrier program plan.

A total of 61 barriers have been constructed or modified to stop sea lampreys on tributaries of the Great Lakes (Fig. 8; 13 on Lake Superior, 12 on Lake Michigan, 16 on Lake Huron, 7 on Lake Erie, 13 on Lake Ontario). The Barrier Task Force was established during 1991 to coordinate optimized implementation and establish research priorities for the barrier program throughout the Great Lakes. The report on progress of the Task Force is presented on 68-70.

The following statements highlight the barrier projects on each lake during 1998:

Lake Superior

- Iron River - A Wisconsin judge ruled that an abandonment permit could be issued to remove the Orienta dam. An opposition group appealed. If the appeal is overturned, the dam could be removed and replaced by a fish and lamprey barrier during 1999.

- Bad River - The U.S. Army Corps of Engineers (Corps) accepted a site survey and hydrology study at Elm Hoist Bridge, (a candidate barrier site) as a qualified project under Section 22 of the Water Resources Development Act of 1974 (Planning Assistance to States and Tribes). Under this Act, the Corps will fund 50% of the cost of the project.

- Wolf River - Major improvements to the access road were completed.

Lake Michigan

- Pere Marquette River - Construction of the fishway around the electrical weir began during November and testing is scheduled for spring 1999. A preliminary study of steelhead movements by the Michigan Department of Natural Resources (MDNR) and Michigan State University continued during 1998.

- Paw Paw River - Work to secure easements continued during 1998. This project is a partnership with the Corps (under Section 1135 of the Water Resources Development Act of 1986), MDNR, and the Commission. The Corps will provide 75% of the project cost.

- Kids Creek (tributary of Boardman River) - The Corps approved a barrier project under Section 206 of the Water Resources Development Act of 1996 (Aquatic Ecosystem Protection and Restoration), under which the Corps supplies 50% of the project cost. The MDNR is the local sponsor.

Lake Huron

- Browns Creek - A fixed-crest sea lamprey barrier was built of steel sheet piling on private property. Construction was completed in 4 days for $15,800.

- Blind River - A dam owned by Ontario Hydro is in the process of being modified with a new gate and turbines to produce electricity. This project is partnered by the Ontario Ministry of Natural Resources, Ontario Hydro, the town of Blind River, and the Department. Barrier staff reviewed plans and made recommendations for continued blockage of sea lampreys at the structure.

- Ocqueoc River - Construction of an experimental barrier began in mid-December. The barrier is a combination fixed-crest barrier with a gradient field electrical weir that is activated only when the tailwater rises to the point that sea lampreys would swim over the crest.

- Shiawassee River (tributary of Saginaw River) - A small concrete wall was constructed next to Chesaning Dam to block lampreys during high water. The Village of Chesaning did the work with no cost to the Commission.

- Bridgeland Creek (tributary of Little Thessalon River) - Barrier engineers cooperated with staff of the sterile male release technique program to design and construct a permanent concrete-base trapping weir with abutments for the purpose of trapping adult lampreys for sterilization.

Lake Erie

- Big Creek - The inflatable barrier was modified to provide about 14 inches of additional head, a crushed air pressure line was repaired, and the 5-panel gate was divided into modules for easier maintenance.

- Little Otter Creek - Steel sheet piling was used to stop seepage created by an 80 cm high beaver dam that had been constructed on top of the fixed-crest barrier. A local trapper was contracted to remove the nuisance beavers.

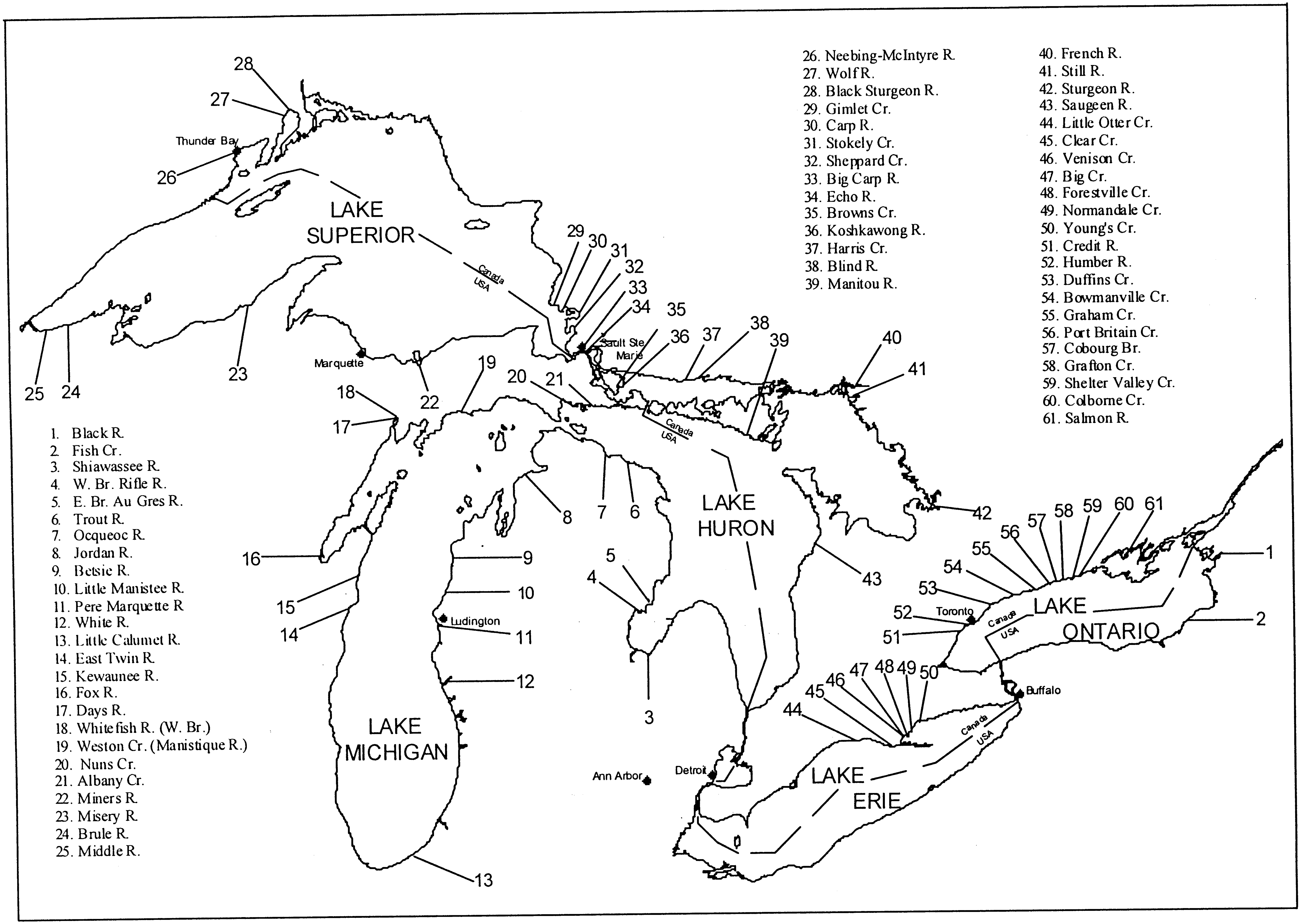

Fig. 8. Location of tributaries with sea lamprey barriers.

Lake Ontario

- Don River - Barrier program staff provided advice on hydrology and crest design to the Toronto Regional Conservation Authority. Pottery Road dams were replaced by armor stone riffles and a fixed-crest barrier to stop sea lampreys and promote fish passage into headwaters.

- Humber River - The Toronto Regional Conservation Authority modified the Old Mill dam to promote fish passage into the headwaters. Barrier program staff provided advice for the project design to assure continuation of the high efficiency of capture of adult sea lampreys in traps at the site.

ASSESSMENT

Larval

Tributaries of the Great Lakes systematically are assessed for abundance and distribution of sea lamprey larvae, and to determine when and where lampricide treatments are required and the effectiveness of past treatments. Surveys are conducted with backpack electrofishers in waters that are <1 m deep. Waters >1 m deep are surveyed with deepwater electrofishers or the granular formulation of Bayluscide. Data collected from these surveys are used to estimate the numbers of transforming larvae that will leave individual tributaries the following year and to define the up- and downstream distribution of the larvae.

Streams considered for lampricide treatment during 1999 were surveyed during 1998 to estimate larval density and habitat. Survey plots were randomly selected in each stream, catches of larvae were adjusted for gear efficiency, and lengths of larvae were standardized to the end of the growing season. Populations of larvae in each tributary were estimated by multiplying the mean density of larvae in the plots by the estimated total habitat suitable to larvae. A curve for probability of transformation derived from historical data was used to estimate the number of larvae that would transform and leave the stream during 1999. Streams were scheduled for treatment during 1999 based on an estimated cost per kill of transformers.

The Assessment Task Force was established during 1996 to develop an optimal assessment program through the review of established protocols and the development of new techniques for assessment in the control program. The report on progress of the task force is presented on pages 69-70.

Lake Superior

- Larval surveys were conducted in 56 tributaries (28 U.S., 28 Canada) and offshore of 4 U.S. tributaries. The status of tributaries that have been treated for sea lampreys within the past 10 years is presented in Table 9.

- Larval populations were estimated in 28 tributaries (8 U. S., 20 Canada; Table 9).

- Surveys were conducted in 4 tributaries (3 U.S., 1 Canada) to establish stock recruitment relations as part of a Great Lakes wide study to determine if sea lamprey populations compensate to mitigate the effects of lampricide treatments.

Table 9. Status of Lake Superior tributaries that have been treated for sea lamprey larvae during 1989-1998, and sea lamprey population estimates for tributaries surveyed during 1998.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
<u>United States</u>							
Galloway Cr.	Jun-92	1998	No	1997			
Tahquamenon R.	Jun-97	1997	No	None			
Betsy R.	Aug-94	1998	Yes	1995	10,204	2	No
Little Two Hearted R.	Jul-91	1998	No	1994	25,575	22	No
Two Hearted R.	Oct-95	1998	Yes	1996	472,882	4,229	Yes
Sucker R.-Entire	May-98	_[1]					
lower	Oct-96	1997					
Sable Cr.	Sep-89	1995	No	None			
Miners R.	Jun-98	_[1]					
Furnace Cr.	Aug-93	1998	No	1995			
Fivemile Cr.	Oct-98	_[1]					
AuTrain R.							
upper	Aug-96	_[1]					
lower	Aug-97	_[1]					
Rock R.	Jul-90	1997	No	1996			

Table 9. Continued

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Laughing Whitefish R.	Jun-98	_[1]					
Chocolay R.	Jun-98	_[1]					
Carp R.	Aug-96	_[1]					
Harlow Cr.	Aug-97	_[1]					
Little Garlic R.	Jul-96	_[1]					
Big Garlic R.	Jul-93	1998	No	1995	171,818	1,862	Yes
Iron R.	Jul-96	_[1]					
Salmon Trout R.	Jun-95	1998	No	1995	382,305	2	No
Huron R.	Sep-94	1998	Yes	1995	311,135	467	Yes
Ravine R.	Sep-98	1998[2]					
Falls R.	Sep-96	1998[2]					
Sturgeon R.	Oct-94	1998	Yes	1995	1,593,384	9,859	Yes
Trap Rock R.	Sep-98	_[1]					
Traverse R.	Sep-97	_[1]					
Salmon Trout R.	Aug-92	1998	No	1994			
Misery R.	Sep-93	1995	No	1994			
East Sleeping R.	Jun-95	1998	No	1995	69,919	1,431	Yes

Table 9. Continued

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Firesteel R.	Sep-96	-[1]					
Ontonagon R.	Sep-96	-[1]					
Potato R.	Jun-97	-[1]					
Cranberry R.	Oct-96	-[1]					
Bad R.	Sep-98	-[1]					
Red Cliff Cr.	Oct-98	1998[2]	Yes				
Sand R.	Oct-91	1996	No	None			
Brule R.	Jul-97	-[1]					
Poplar R.	Oct-96	-[1]					
Middle R.	Sep-94	-[1]					
Amnicon R.	Oct-98	-[1]					
Nemadji (Black) R.	Jul-97	-[1]					
West Davignon Cr.	May-89	1998	No	-[3]			
Little Carp R.	Jun-93	1998	No	1994	1,991	65	No
Big Carp R.	Jun-93	1998	No	1993	18,378	1,597	No
Cranberry Cr.	Jun-90	1997	No	None			
Goulais R.	Aug-95	1998	1996		5,309,828	32,306	Yes

Table 9. Continued

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Westman Cr.	Never	1998	N/A	–[3]	204	13	No
Haviland Cr.	Never	1998	N/A	–[3]			
Stokely Cr.	Jun-80	1998		1996	6,482	0	No
Harmony R.	Jun-90	1997	Yes[4]	None			
Chippewa R.	Jul-98	–[1]	–[4]				
Batchawana R.	Oct-98	–[1]	–[4]				
Carp R.	Jun-94	1997	No[4]	1996	54,752	98	No
Pancake R.	Jul-98	–[1]	–[4]				
Agawa R.	Sep-97	1998	Yes				
Gargantua R.	Jun-95	1998	Yes	1995	26,403	327	Yes
Michipicoten R.	Jul-95	1998	Yes	1995	219,439	807	Yes
White R.	Sep-88	1997	No	1993			
Pic R.	Sep-97	1998	No	1997	21,264	0	No
Little Pic R.	Sep-94	1998	No	1995	4,270	3	No
Prairie R.	Jul-94	1998	No	None			
Steel R.	Jul-89	1998	No	1989	5,141	17	No
Pays Plat R.	Jul-97	–[1]					
Gravel R.	Aug-98	–[1]	–[4]				
Little Gravel R.	Jul-95	1998	No[4]	1995	3,184	7	No
Cypress R.	Jul-94	1998	Yes[4]	1994	105,334	160	Yes

Table 9. Continued

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Jackpine R.	Never	1994	N/A[4]	-[3]			
Jackfish R.	Jul-96	1998	No	1996			
Nipigon R. (upper)	Aug-92	1998	Yes[4]	1992	267,783	7,867	Yes
Nipigon R. (lower)	Jul-83	1998	Yes	1983	172,369	38,950	No[5]
Cash Cr.	Jul-96	-[1]	-[4]				
Polly Cr.	Jul-87	1994	Yes	1988			
Stillwater Cr.	Jul-96	-[1]					
Black Sturgeon R.	Jul-95	1998	Yes	1995	83,502	572	Yes
Wolf R.	Jul-94	1997	Yes[4]	1994	159,436	2	No
Pearl R.	Jul-91	1998	No	1991			
MacKenzie R.	Sep-78	1997	No[4]	-[3]			
Current R.	Never	1994	N/A[4]	-[3]			
McIntrye R.	Aug-97	-[1]					
Neebing R.	Jul-94	1998	Yes	1995	740	0	No
Kaministiquia R.	Aug-97	1998	Yes	1998	22,619	270	No
Cloud R.	Jul-94	1998	No	None			
Pigeon R.	Jul-94	1998	Yes	1995	13,433	371	Yes

[1]Not surveyed since last lampricide treatment.
[2]Lentic survey during 1998.
[3]Larval sea lampreys present but unable to determine age of older cohorts.
[4]Stream has a known lentic population.
[5]Estimates of larvae and transformers developed from incomplete data. Decision for treatment will be reevaluated following further assessment during 1999.

Lake Michigan

- Larval surveys were conducted in 56 tributaries and offshore of 6 tributaries. The status of tributaries that have been treated for sea lampreys within the past 10 years is presented in Table 10.

- Larval populations were estimated in 29 tributaries.

- Surveys were conducted in 3 tributaries to establish stock recruitment relations as part of a Great Lakes wide study to determine if sea lamprey populations compensate to mitigate the effects of lampricide treatments.

Lake Huron

- Larval surveys were conducted in 64 tributaries (33 U.S., 31 Canada) and offshore of 2 U.S. tributaries. The status of tributaries that have been treated for sea lampreys within the past 10 years is presented in Table 11.

- Abundance of populations of sea lamprey larvae and transformers was estimated in 32 tributaries (15 U. S., 17 Canada; Table 11).

- Surveys were conducted in 4 tributaries (2 U.S., 2 Canada) to establish stock recruitment relations as part of a Great Lakes wide study to determine if sea lamprey populations compensate to mitigate the effects of lampricide treatments.

- Several age classes of larval sea lampreys were found above the fixed-crest barrier on the upper Echo River. Only a few larvae were present and their entry route upstream of the barrier has yet to be determined.

- An Expert Panel peer reviewed the St. Marys River assessment plan. The plan focuses on the long-term evaluation of the integrated control program in the river, and in general, the Expert Panel concluded the plan had a high probability of determining long-term success of control actions in the river.

- Evaluation of the granular Bayluscide treatment of 82.2 ha in the St. Marys River showed an average reduction of 76% of pretreatment larval densities.

- As a long-term measure of density of larvae in the St. Marys River, index stations were established at 13 sites during 1994-1996. During 1998, 9 of these sites were sampled prior to and after the Bayluscide treatment.

- As a measure of the current validity of the distribution and density map of larvae in the St. Marys River (data collected during 1994-1996), about 850 ha of the river was sampled and remapped during 1998. The distribution of larvae remained relatively unchanged and density showed a general decrease. The decrease in density is consistent with a trend observed at the index sites during 1996-1998.

- Distribution and density mapping of the St. Marys River upstream of the compensating works began during 1998. A total of 585 ha were mapped and no sea lamprey larvae were collected.

Table 10. Status of Lake Michigan tributaries that have been treated for sea lamprey larvae during 1989-98, and sea lamprey population estimates for tributaries surveyed in 1998.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Brevort R.	May-89	1998	No	1991			
Hog Island Cr.	Jun-96	-[1]					
Black R.	Jun-96	1998	Yes	1996	198,458	801	Yes
Millecoquins R.	Jun-96	1998	Yes	1996	51,055	21	No
Rock R.	Jun-95	1998	No	1996	2,012	1	No
Hudson Cr.	May-98	_[1]					
Milakokia R.	Jun-94	1998	No	1994	212,124	3,951	Yes
Bulldog Cr.	Jun-97	-[1]					
Marblehead Cr.	Jun-96	-[1]					
Manistique R.	Aug-89	1998[2,3]		1992			
Johnson Cr.[4]	Aug-81	1998	No	1995	576	0	No
Deadhorse Cr.	May-91	1997	No	1992			
Bursaw Cr.	May-97	-[1]					
Parent Cr.	Jun-91	1998	No	1995	876	1	No
Poodle Pete Cr.	Jun-91	1998	No	1994	343	6	No
Valentine Cr.	Jun-97	_[1]					

Table 10. Continued.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Little Fishdam R.	Jul-92	1998	No	1995	2,817	37	No
Big Fishdam R.	May-95	1998	No	1995	60,355	4,159	Yes
Sturgeon R.	Oct-98	_[1]					
Ogontz R.	Oct-96	_[1]					
Whitefish R.	Jun-98	_[1]					
Rapid R.	Jun-95	1998	Yes	1995	402,448	3,391	Yes
Tacoosh R.	Oct-96	_[1]					
Days R.	Oct-98	1998[2,3]					
Portage Cr.	Jun-97	_[1]					
Ford R.	Jun-96	1998	Yes	1996	907,085	2,150	No
Bark R.	Oct-92	1998		1994	46,080	522	Yes
Cedar R.	May-97	_[1]					
Bailey Cr.	May-98	_[1]					
Springer Cr.[4]	Aug-77	1998	No	1993	7,692	408	Yes
Peshtigo R.	Aug-96	1998	No	1996			
Oconto R.	Sep-97	_[1]					
Hibbards Cr.	May-98	_[1]					
East Twin R.	May-95	1998	No	1995	6,391	2	No
Carp Lake R.	Sep-94	1997	No	None			

Table 10. Continued.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Big Stone Cr.	May-97	_[1]					
Big Sucker Cr.	May-89	1997	No	None			
Horton Cr.	Sep-93	1998	No	1994			
Boyne R.	Sep-97	1998[2,3]	No	1998	3,667	31	No
Porter Cr.	Sep-98	1998[2,3]	No	None			
Jordan R.	Aug-97	1998	No	_[5]			
McGeach Cr.[4]	Aug-77	1998	No	_[5]	28,127	1,030	Yes
Elk Lake Outlet	May-97	_[1]					
Mitchell Cr.	Jun-94	1998	No	1994	2,399	143	Yes
Boardman R.					14,371	528	No
Hospital Cr.	Aug-96	_[1]					
Lower	Aug-96	_[1,2,3]					
Goodharbor Cr.	May-97	_[1]					
Platte R.	Sep-96	_[1]					
Betsie R.	Jun-95	1998	No	1995	529,079	1,472	Yes
Big Manistee R.	Aug-98	1998	Yes	None	96,904	1	No
L. Manistee R.	Jul-98	_[1]					

Table 10. Continued.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Gurney Cr.	Sep-93	1997	Yes	1994			
Lincoln R.	Jun-98	-[1]					
Pere Marquette R.	Aug-95	1998	Yes	1996	689,549	3,592	No
Pentwater R.	Jul-97	-[1]					
Flower Cr.[4]	Sep-81	1998	No	1994	2,703	71	No
White R.	Aug-95	1998	Yes	1996	906,990	13,271	Yes
Muskegon R.	Jul-96	1998	Yes	1997	1,907,342	64	No
Bigelow Cr.	May-95	1998	No	1996	46,702	42	No
Grand R.							
Norris Cr.[4]	Jun-87	1998	No	1994			
Sand Cr.	Sep-96	-[1]					
Crockery Cr.	Sep-91	1998	No	1992			
Kalamazoo R.							
Bear Cr.	Jun-98	-[1]					
Sand Cr.	May-92	1998	Yes	1996	1,203	1	No
Mann Cr.	Aug-97	-[1]					
Black R.	Aug-97	-[1]					
Brandywine Cr.[4]	Jun-85	1998	No	1994			

Table 10. Continued.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Rogers Cr.	May-98	-[1]					
St. Joseph R.							
Paw Paw R.	Jun-97	-[1]					
Mill Cr.	Jun-97	-[1]					
Brandywine Cr.	Jun-97	-[1]					
Brush Cr.	Jun-97	-[1]					
Galien R.	Jun-93	1998	No	1993			
S. Br. Spring Cr.	May-98	-[1]					
Galena Cr.	Jun-93	1998	No	1994	32,008	4,345	Yes
Trail Cr.	May-92	1998	Yes	-[5]	13,879	154	No
Burns Ditch	Jun-93	1998	Yes	1994	2,060	740	Yes

[1]Not surveyed since last lampricide treatment.
[2]Stream has a known lentic population.
[3]Lentic survey during 1998.
[4]Not treated during the past 10 years but quantitative larval surveys were conducted during 1998.
[5]Larval sea lampreys present but unable to determine age of older cohorts.

Table 11. Status of Lake Huron tributaries that have been treated for sea lamprey larvae during 1989-1998, and sea lamprey population estimates for tributaries surveyed during 1998.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
United States							
Little Munuscong R.	May-95	1998	No	1995	27,151	210	Yes
Big Munuscong R.	May-96	1998	Yes	1996	47,404	1,112	Yes
Caribou Cr.	May-91	1998	No	1995	2,490	9	No
Albany Cr.	May-94	1998	Yes	1994	53,024	17	No
Trout Cr.	May-94	1998	Yes	1995	36,863	33	No
Beavertail Cr.	May-96	- [1]					
Prentiss Cr.	Oct-93	1996	Yes				
McKay Cr.	May-95	1998	No	1995	3,350	0	No
Flowers Cr.	Sep-91	1995	No	1993			
Ceville Cr.	May-94	1998	No	1996	3,841	0	No
Hessel Cr.	May-91	1997	No				
Nunns Cr.	May-96	1996	No				
Pine R.	May-98	- [1,2]					
Martineau Cr.	Oct-93	1997	No	None			
Carp R.	May-96	1998[2]		1996	191,674	1	No

Table 11. Continued.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Cheboygan R.							
Maple R.	Oct-98	-[1]					
Pigeon R.	Sep-97	-[1]					
Sturgeon R.	Aug-94	1998	No	1995	504,363	10,531	Yes
Laperell Cr.	May-89	1998	No	1994	1,388	0	No
Meyers Cr.	May-89	1998	No	1993	1,544	453	Yes
L. Pigeon R.	Aug-98	-[1]					
Elliot Cr.	May-96	1997	Yes	1996			
Greene Cr.	May-96	-[1]					
Mulligan Cr.	May-94	1998	No	None			
Black Mallard R.	May-92	1998	No	1992	68,369	1,094	Def. for Res.
Ocqueoc R.							
Lower	Sep-97	-[1]					
Upper	Aug-98	-[1]					
Schmidt Cr.	Sep-98	-[1]					
Trout R.	May-97	-[1]					
Swan R.	May-96	-[1]					

Table 11. Continued.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Grand Lake Outlet	Never	1998	N/A	-[3]	1,144	726	Yes
Devils R.	May-95	1998	Yes	1995	3,315	617	Yes
Black R.	June-98	-[1]					
Au Sable R.	Jul-98	-[1]					
Tawas Lake Outlet	Jul-96	-[1]					
Silver Cr.	Aug-97	Yes	1998	1998	31,101	69	No
Cold Cr.	Jul-96	-[1]					
Sims Cr.	Jul-98	-[1]					
East Au Gres R.	May-97	-[1]					
Au Gres R.		-[1]					
Hope Cr.	Jul-96	-[1]					
Rifle R.	Jul-97	1998	Yes	1998	9,457	2,502	No
Saginaw R.							
Cass R.							
Juniata Cr.	Sep-98	-[1]					
Chippewa R.	Sep-95	1998	Yes	1996	182,306	38,051	Yes
Big Salt Cr.	May-96	1998	No	None			

Table 11. Continued.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Big Salt R.	May-93	1997	No	1995			
Bluff Cr.	Sep-98	-[1]					
Shiawassee R.	Jun-97	-[1]					
Canada							
Root R.	Sep-95	1998	Yes	1996	77,472	3,934	Yes
Garden R.	Jul-97	_[1]					
Echo R.					21,999	181	Yes
Echo R. (upper)	Jun-90	1998	Yes	_[3]			
Echo R (lower)	Jul-94	1998	Yes[4]	1994			
Bar Cr.	Jun-98	_[1]					
Sucker Cr.	Jul-95	1997	Yes[4]	1996			
Two Tree R.	May-90	1996	No	1993			
Richardson Cr.	Aug-96	_[1]					
Watson Cr.	Sept-98						
Gordon Cr.	Oct-96	-[1]	-[4]				
Brown's Cr.	Oct-98	-[1]	_[4]				
Koshkawong R.	Aug-97	-[1]					
Unnamed (H-68)	Sep-75	1995	No[4]	pre 1990			
Thessalon R.							

Table 11. Continued.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Upper Thessalon R.	Jul-98	-[1]					
Middle Thessalon R.	Aug-90	1997	No	None			
Lower Thessalon R.	Jun-96	-[1]					
Livingstone Cr.	Aug-94	1998	No	1995	1,150	24	No
Mississagi R.							
Mississagi R. (main)	Aug-95	1997	No[4]	1996			
Pickerel Cr.	Jun-98	-[1]					
Blind R.	May-84	1998	No	-[3]	2,776	75	No
Lauzon R.	Sep-97	-[1]					
Spragge Cr.	Oct-95	1998	Yes	1996			
Unnamed (H-114)	Sep-97	1998	Yes	1997	239	30	No
Serpent R.							
Serpent R. (main)	Jul-93	1998	No[4]	1993	100,810	808	Yes
Grassy Cr.	Jun-96	1998	Yes	1996			
Spanish R.	Oct-98	-[1]					
Kagawong R.	Aug-67	1997	No[4]	-[3]			
Silver Cr.	May-94	1998	Yes	none			
Sand Cr.	Oct-94	1998	Yes	1995	6,005	34	No
Mindemoya R.	Jun-98	1998	Yes[4]	1998	1,323	0	No
Timber Bay Cr.	Jun-98	1998	Yes	1998	8,009	965	No

Table 11. Continued.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Manitou R.	May-94	1998	No[4]	1994	6,205	227	Yes
Blue Jay Cr.	Jun-94	1998	Yes[4]	1994	95,666	756	Yes
Chikanishing R.	Jun-95	1998	Yes	None			
French R.							
Main	Never	1992	N/A	–[3]			
French (O.V. Chan)	Jun-92	1998	No	1992	301	101	No
French (Wanapitei)R.	Aug-94	1998	Yes	1995			
Still R.	Jun-96	1998	No	None			
Magnetawan R.	Jul-93	1997	Yes[4]	1993			
Naiscoot R.	Jun-93	1998	No	1993	151,365	2,982	Yes
Shebeshekong R.	Never	1998	N/A	–[3]	5,446	3,560	Yes
Boyne R.	Jun-95	1998	No	1995	151,446	340	Yes
Musquash R.	Aug-96	1996	Yes	–[3]			
Sturgeon R.	Jun-95	1998	No[4]	1995	14,273	1,316	Yes
Nottawasaga R.					1,458	0	No
Main Nottawasaga R.	Jun-97	1998	Yes	1997			
Pine R	Sept-98	–[1]					
Beaver R.	Never	1998	N/A	–[3]			
Sauble R.	Jun-96	–[1]					
Saugeen R.	Jun-71	1998	No	–[3]			

[1]Not surveyed since last lampricide treatment.
[2]Lentic survey during 1998.
[3]Larval sea lampreys present but unable to determine age of older cohorts.
[4]Stream has a known lentic population

Lake Erie

- A comprehensive larval assessment plan was implemented to review the status of sea lamprey abundance of all known populations of larvae and to survey previously uninhabited streams for larvae.

- A total of 33 streams and the St. Clair River (the interconnecting waterway from Lake Huron into Lake St. Clair) were assessed. During a routine year, about 10 streams would have been examined.

- Sea lampreys presently exist in 9 tributaries (6 U.S., 3 Canada; Table 12) and the St. Clair River. Of these, larvae are abundant in 4 tributaries (3 U.S., 1 Canada) and were detected in Youngs Creek for the first time since 1991.

- As a result of the comprehensive assessment, lampricide treatments are scheduled for 5 tributaries (4 U.S., 1 Canada; Table 12) during 1999.

- Larval assessment (with granular Bayluscide) of the St. Clair River found 7 sea lamprey larvae in 1.2 km^2. This information is consistent with assessment data collected during 1992, and illustrates that larvae remain scarce within the river.

Lake Ontario

- Larval surveys were conducted on 36 tributaries (17 U.S., 19 Canada; Table 13).

- Larval populations were estimated in 11 tributaries (6 U.S., 5 Canada; Table 13).

- Quantitative assessment in the Black River (New York) demonstrated larvae were abundant up and downstream of Dexter dam. A lampricide treatment is scheduled during 1999.

- The second phase of a lampricide treatment efficiency study was completed on tributaries to the Salmon River (New York). The final phase will be completed during 1999.

Table 12. Status of Lake Erie tributaries that have been treated for sea lamprey larvae during 1989-98, and sea lamprey population estimates for tributaries surveyed during 1998.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-Class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
United States							
Cattaraugus Cr.	Oct-94	1998	No	1995			
Clear Cr.					32,187	1,489	Yes
Canadaway Cr.[1]	Oct-86	1998	No	1996			
Crooked Cr.	Oct-90	1998	Yes	1991	2,212	68	Yes
Raccoon Cr.	Oct-90	1998	No	1997			
Conneaut Cr.	Oct-95	1998	Yes	1996	49,937	4,250	Yes
Grand R.	Apr-87	1998	No		10,728	2,726	Yes
Canada							
Big Otter Cr.	Sep-97	1998	No	None			
Big Cr.	Jun-96	1998	Yes	1996	101,106	7,860	Yes
Youngs Cr.	May-91	1998	No	1997			

[1]Not treated during the last 10 years but larval surveys were conducted during 1998.

Table 13. Status of Lake Ontario tributaries that have been treated for sea lamprey larvae during 1989-1998, and sea lamprey population estimates for tributaries surveyed during 1998.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
Canada							
Bronte Cr.	Apr-98	1998	Yes	1998			
Credit R.	Jun-96	1998	Yes	1996	27,798	1,142	Yes
Rouge R.	Jun-98	-[1]					
Duffins Cr.	Oct-97	-[1]					
Lynde Cr.	Sep-95	1998	No	1996	8,880	881	Yes
Oshawa Cr.	Oct-96	1998	Yes	1997			
Farewell Cr.	Sep-95	1998	No	1996	1,916	77	No
Bowmanville Cr.	Apr-98	1997	No	1995			
Wilmot Cr.	Oct-96	1998	No	1997			
Graham Cr.	May-96	1998	No	None			
Port Britain Cr.	Sep-96	1998	No	None			
Cobourg Br.	Sep-96	1998	Yes	None			
Covert Cr.	Apr-94	1998	No	1994	2,136	437	Yes
Grafton Cr.	Sep-96	1997	No	None			
ShelterValley Br.	Sep-96	1998	No	1998			
Colborne Cr.	Jun-95	1998	No	1995	84	41	No
Salem Cr.	Aug-98	1997	No	1995			
Proctor Cr.	Aug-98	-[1]					
Mayhew Cr.	Oct-96	1998	Yes	1997			
Salmon R.	Jun-97	1998	Yes	1997			
United States							
Black R.	Jun-91	1998	No	1995	114,423	12,506	Yes

Table 13. Continued.

Stream	Last Treated	Last Surveyed	Residuals Found (Yes/No)	Oldest Reestablished Year-class	Estimate of 1998 Larval Population	1999 Transformer Estimate	On 1999 Treatment Schedule
South Sandy Cr.	May-96	1998	Yes	1996	141,448	24,206	Yes
Skinner Cr.	May-93	1998	No	1995			
Lindsey Cr.	Apr-97	1998	Yes	1997	8,880	881	Yes
Little Sandy Cr.	Apr-98	-[1]					
Deer Cr.	May-95	1998	Yes	1996	31,789	2,115	Yes
Salmon R.	May-98	-[1]					
Salmon R. tributaries	May-98	-[1]					
Grindstone Cr.	May-97	1998	Yes	1997	25,798	1,142	Yes
Snake Cr.	May-95	1998	No	1996	147,597	4,646	Yes
Little Salmon R.	May-97	1998	Yes	1997			
Catfish Cr.	May-97	1998	Yes	1997			
Oswego River System							
Big Bay Cr.	Sep-93	1997	No	None			
Fish Cr.	May-98	1997	Yes	1995			
Carpenters Br.	May-94	1998	No	None			
Putnam Br.	May-96	1998	No	1996			
Ninemile Cr.	May-98	-[1]					
Sterling Cr.	May-97	1998	Yes	1997			
Red Cr.	Apr-94	1996	No	None			
Sodus Cr.	May-98	1997	No	1995			
First Cr.	May-95	1996	No	None			
Salmon Cr.	May-96	1998	Yes	1996			
Oak Orchard Cr.	May-88	1997	No	None			

[1]Not surveyed since last lampricide treatment.

Spawning-Phase

The long-term effectiveness of the control program is measured through the assessments of abundance of spawning- and parasitic-phase sea lampreys. Traps are used to monitor sea lamprey spawning migrations during spring and early summer. Traps are portable (rectangular steel or aluminum mesh, hoop or fyke nets) or permanent (generally concrete) and usually are associated with a physical or electrical barrier. Total catch of sea lampreys is a measure of relative abundance and biological characteristics (sex, weight, length) are recorded from lampreys captured from some streams.

Mark/recapture studies are conducted in most streams to estimate the spawning population for the year. These estimates are computed using a modified version of Schaefer (1951). Lake estimates are computed based on a relation (y=ax) of discharge (x) to the estimated number of adult lampreys that enter tributaries (y).

Lake Superior

- 3,754 sea lampreys were trapped in 19 tributaries during 1998 (Table 1, Fig. 9).

- Estimated population of spawning-phase sea lampreys for the south shore of Lake Superior was 24,556 [15,701 west (y=50.13; r^2=.86, P<0.01) and 8,855 east [y=24.17; r^2=.67, (P<0.05) of the Keweenaw Peninsula; Table 15].

- Spawning runs were monitored in the Amnicon, Middle, Bad, Firesteel, Misery, Silver, and Ontonagon rivers through cooperative agreements with the Great Lakes Indian Fish and Wildlife Commission, in the Brule River with the Wisconsin Department of Natural Resources, and in the Miners River with the National Park Service, Pictured Rocks National Lakeshore.

- An Expert Panel peer-reviewed the existing adult sea lamprey assessment program during 1997 and recommended actions to optimize the program. The recommendations included implementing assessment of parasitic-phase or transformer-phase sea lampreys through an in-lake mark recapture approach. Implementation of these recommendations continued during 1998. During September-November, 1,038 transformer-phase sea lampreys were marked with coded wire tags and released into Lake Superior rivers (Brule-247, Misery-246, AuTrain-96, Two Hearted-74, Chippewa-82, Michipicoten-45, Nipigon-83, Wolf-82, and McIntyre-83).

- Fig. 2 shows a downward trend of spawning populations in the U.S. waters of western Lake Superior during 1989-1995, an increase during 1996, and another downward trend during 1997 and 1998. Spawning populations in U.S. waters of eastern Lake Superior have remained relatively stable during 1989-1998.

Table 14. Stream, number caught, estimated spawner population, trap efficiency, number sampled, percent males, and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Superior, 1998. (Number in parentheses corresponds to location of stream in Fig. 9).

Stream	Number Caught	Spawner Estimate	Trap Efficiency	Number Sampled[1]	Percent Males[2]	Mean Length (mm)		Mean Weight (g)	
						Males	Females	Males	Females
United States									
Tahquamenon R. (31)	224	1,911	12	21	38	421	322	248	232
Betsy R. (32)	83	1,191	7	3	67	437	421	-	-
Miners R. (33)	4	-	-	-	-	-	-	-	-
Rock R. (34)	991	1,990	50	-	-	-	-	-	-
Big Garlic R. (35)	23	144	31	3	67	420	420	176	278
Silver R. (36)	42	157	27	6	33	436	404	234	168
Misery R. (37)	406	1,073	38	292	25	442	429	201	198
Firesteel R. (38)	79	281	28	21	52	454	388	220	199
Ontonagon R (39)	0	-	-	-	-	-	-	-	-
Bad R. (40)	460	4,064	11	96	36	412	418	168	171
Brule R. (41)	15	22	68	0	-	-	-	-	-
Middle R. (42)	401	1,081	37	160	43	437	433	196	192
Amnicon R. (43)	102	605	17	24	42	404	392	168	164
Total or Mean (South Shore)	**2,830**	**12,519**		**626**	**34**	**433**	**423**	**194**	**192**
Canada									
McIntyre R. (44)	153	2,433	6	0	-	-	-	-	-
Wolf R. (45)	668	842	79	0	-	-	-	-	-
Pancake R. (46)	1	-	-	0	-	-	-	-	-
Carp R. (47)	64	93	69	0	-	-	-	-	-
Stokely Cr. (48)	30	-	-	0	-	-	-	-	-
Big Carp R. (49)	8	-	-	0	86	-	-	-	-
Total or Mean (North Shore)	**924**	**3,368**		**0**	**86**				
Total or Mean (for Lake)	**3,754**	**15,887**		**626**	**34**	**433**	**423**	**194**	**19**

[1]The number of lampreys from which all length and weight measurements were determined.
[2] Percent males generally are determined from internal body examination of the number sampled.

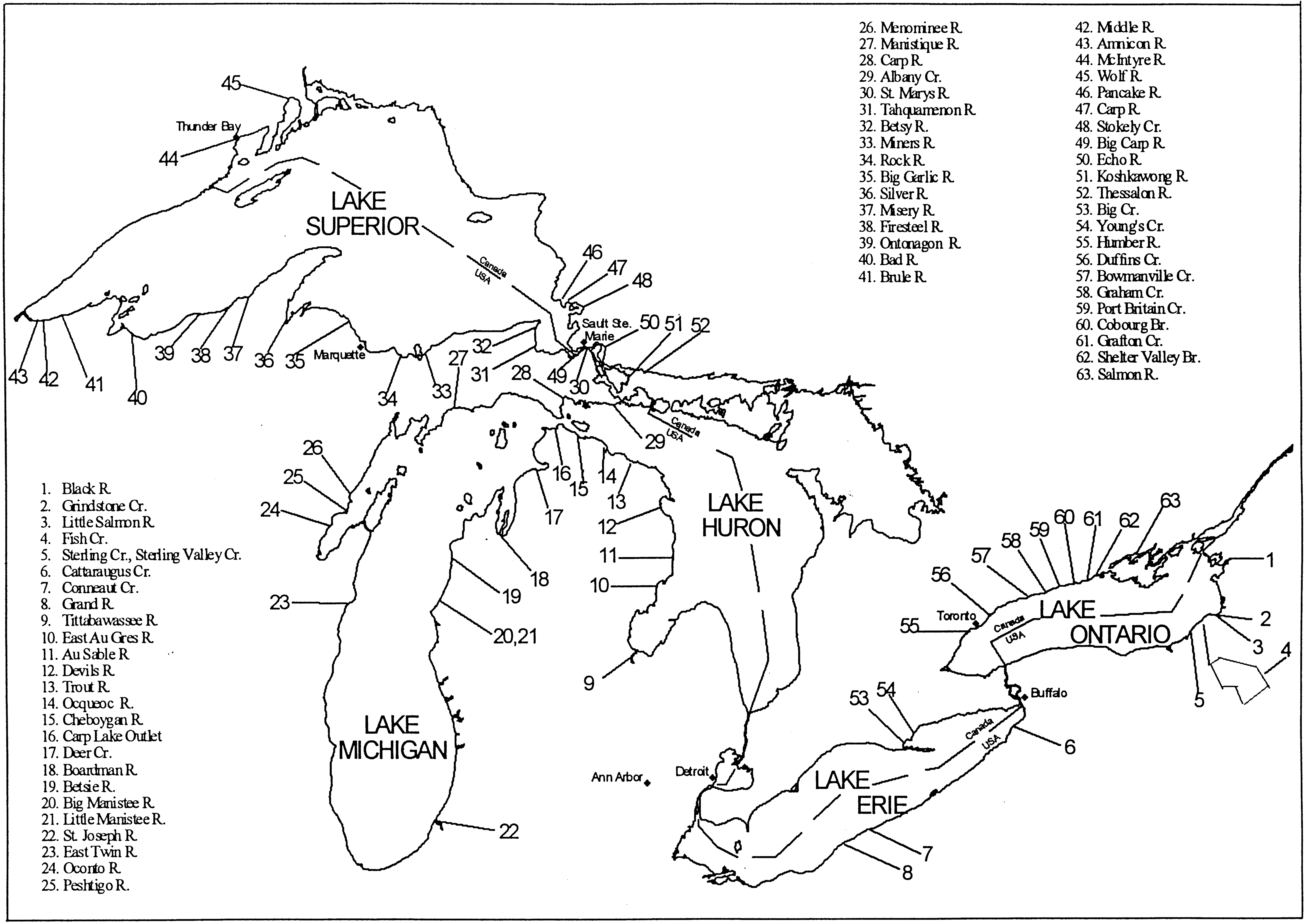

Fig. 9. Location of tributaries where assessment traps were operated during 1998.

Table 15. Spring mean discharge for U.S. streams, east and west of Keweenaw Bay in Lake Superior, ranked as primary[1] and secondary[2] producers of sea lampreys, and the estimated number of spawning-phase sea lampreys during 1998.

Primary Streams				Secondary Streams		
	Discharge	Population Estimate[3]			Discharge	Population Estimate
Stream	m^3/s	Mark/Recapture	Regression	Stream	m^3/s	Regression
EAST				**EAST**		
Tahquamenon R.	83.66	1,911	2,022	Waiska R.	14.79	36
Betsy R.	10.11	1,191	244	Pendills Cr.	1.51	4
Little Two Hearted R.	5.22		126	Galloway Cr.	0.74	2
Two Hearted R.	22.83		552	Sable Cr.	1.55	4
Sucker R.	12.60		305	Sullivans Cr.	0.45	1
Miners R.	2.95	9	71	Beaver Lake Outlet	1.26	3
Furnace Cr.	1.39		34	Sand R. (Alger Co.)	2.51	6
Au Train R.	8.50		205	Carp R. (Marquette Co.)	5.94	14
Rock R.	3.83	1,990	1,990[3]	Little Garlic R.	1.72	4
Chocolay R.	16.09		389	Pine R. (Marquette Co.)	4.39	11
Harlow Cr.	1.82		44	Ravine R.	3.26	8
Big Garlic R.	1.73	144	42	Slate R.	2.03	5
Iron R. (Marquette Cnty.)	10.24		248			
Salmon Trout R. (Marquette Cnty.)	4.83		117			
Huron R.	7.08		171			
Silver R.	7.88	157	190			
Falls R.	4.99		121			
Sturgeon R.	70.12		1,695			
Traverse R.	2.52		61			
Salmon Trout R. (Houghton Co.)	5.38		130			
Subtotal (East)	**283.77**	**5,402**	**8,757**	**Subtotal(East)**	**40.15**	**98**
(w/traps)	**110.16**	**5,402**	**4,559**			
(wo/traps)	**173.61**	**0**	**4,198**			
WEST				**WEST**		
Misery R.	4.18	1,073	1,073[3]	Sand R. (Bayfield Co.)	3.79	19
East Sleeping R.	5.00		250			
Firesteel R.	7.95	281	398			
Ontonagon R.	122.66		6,149			
Potato R.		1.94		97		
Cranberry R.	1.77		89			
Bad R.	77.39	4,064	3,880			
Red Cliff Cr.	0.69		35			
Brule R.	19.58	22	982			
Middle R.	6.94	1,081	348			
Amnicon R.	11.49	605	576			
Nemadji R.	35.96		1,803			
Subtotal (West)	**295.55**	**7,126**	**15,682**	**Subtotal (West)**	**3.79**	**19**
(w/traps)	**250.19**	**7,126**	**13,407**			
(wo/traps)	**45.36**	**0**	**2,275**			

TOTAL SOUTH SHORE POPULATION ESTIMATE: 24,556

[1]Primary streams are streams that are treated on a regular cycle (≤ once every five years).
[2]Secondary streams are streams that are treated on an irregular cycle (> once every five years).
[3]Population estimates were calculated from stratified multiple mark/recapture studies, linear regressions relating past years trap catch to mark/recapture estimates, or trap efficiencies from mark/recapture studies conducted from 1986-93 in 9 of 15 streams with traps. Simple linear regressions estimate populations for all streams by the relation of drainage area to the number of lampreys entering the 11 tributaries.
[4]The Rock and Misery rivers annually receive a substantial number of spawning sea lampreys, but do not meet the criteria of a primary stream. The rivers have a barrier at the mouth and are not treated. The estimate of spawners in the rivers is an addition to the regression estimate.

Lake Michigan

- 24,754 sea lampreys were trapped at 12 sites in 11 tributaries during 1998 (Table 16, Fig. 9).

- The estimated population of spawning-phase sea lampreys for Lake Michigan was 92,430 [54,064 north (y=305.23; r^2=0.94, P<0.01) and 38,366 south (y=52.74; r^2=0.42, P<0.50); Table 17)]. The estimated lake-wide population for 1996-1998 is presented in Fig. 3.

- Spawning runs were monitored in the Boardman River through a cooperative agreement with the Grand Traverse Band of Ottawa and Chippewa Indians, and in the Little Manistee River through a cooperative agreement with the Little River Band of Ottawa Indians.

- Fig. 3 shows the relatively stable long-term trend of spawning populations in 13 trapped streams and the Manistique River during 1986-1998, and begins to phase in lake-wide estimates of abundance (1996-1998).

Table 16. Stream, number caught, estimated spawner population, trap efficiency, number sampled, percent males, and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Michigan, 1998. (Number in parentheses corresponds to location of stream in Fig. 9).

Stream	Number Caught	Spawner Estimate	Trap efficiency	Number sampled	Percent Males	Mean Length (mm) Males	Mean Length (mm) Females	Mean Weight (g) Males	Mean Weight (g) Females
United States									
Carp Lake Outlet (16)	11	-	-	0	-	-	-	-	-
Deer Cr. (17)	115	346	33	34	68	473	462	259	243
Boardman R. (18)	209	485	43	71	42	478	472	240	232
Betsie R. (19)	642	2,402	27	163	34	465	471	231	249
Big Manistee R. (20)	286	3,448	8	286	43	495	490	266	265
Little Manistee R. (21)	38	96	40	11	27	497	484	273	249
St. Joseph R. (22)	32	-	-	30	20	426	491	161	258
East Twin R. (23)	102	484	21	19	37	484	418	250	174
Oconto R. (24)	19	25	76	19	89	482	425	-	-
Peshtigo R. (25)	1,791	7,319	24	249	49	504	501	248	253
Menominee R. (26)	402	1,718	23	75	75	494	459	248	244
Manistique R. (27)	21,107	32,365	65	0	41	-	-	-	-
Total or mean		**24,754**	**8,688**	**957**	**41**	**490**	**484**	**251**	**252**

[1]The number of lampreys from which all length and weight measurements were determined.
[2]Percent males generally are determined from internal body examination of the number sampled. In the Manistique River, 13,274 additional lampreys were examined externally for secondary sexual characteristics to determine percent males.

Table 17. Spring discharge for U.S. streams north and south of Manistique, Michigan - Elberta, Michigan in Lake Michigan, ranked as primary[1] and secondary[2] producers of sea lampreys, and the estimated number of spawning-phase sea lampreys during 1998.

Primary Streams				Secondary Streams		
	Discharge m^3/s	Population Estimate[3] Mark/Recapture	Population Estimate[3] Regression		Discharge m^3/s	Population Estimate Regression
NORTH				**NORTH**		
Hog Island Cr.	0.34		104	Brevort R.	4.24	129
Black R.	1.78		543	Paquin Cr.	0.66	20
Millecoquins R.	6.67		2,036	Rock R.	0.98	30
Hudson Cr.	0.17		52	Crow R.	0.54	16
Milakokia R.	4.70		1,435	Bulldog Cr.	0.88	27
Marblehead Cr.	0.46		140	Gulliver Lake Outlet	0.34	10
Manistique R.	100.80	32,365	32,365[3]	Big Sucker Cr.	0.12	4
Carp Lake R.	2.48		757	Wycamp Lake Outlet	1.05	32
Horton Cr.	0.77		235	Elk Lake Outlet	27.88	851
Boyne R.	3.03		925	Mitchell Cr.	0.75	23
Porter Cr.	1.04		317			
Deer Cr.	6.18	346	1,886			
Boardman R.	20.30	485	6,196			
Platte R.	4.00		1,221			
Betsie R.	15.43	2,402	4,710			
Subtotal (North)	**168.15**	**35.598**	**52,922**	**Subtotal (North)**	**37.44**	**1,142**
(w/traps)	**145.19**	**35,598**	**45,914**			
(w/o traps)	**22.96**		**7,008**			
SOUTH				**SOUTH**		
Fishdam R.	4.13		218	Deadhorse Cr.	0.20	1
Sturgeon R.	14.90		786	Parent Cr.	0.27	1
Ogontz R.	2.03		107	Poodle Pete Cr.	0.27	1
Whitefish R.	17.43		919	Valentine Cr.	0.42	2
Rapid R.	7.71		407	Little Fishdam R.	0.69	4
Tacoosh R.	1.92		101	Bark R.	2.54	13
Days R.	4.79		253	Bailey Cr.	0.10	1
Ford R.	47.50		2,505	Beattie Cr.	0.29	2
Cedar R.	13.72		724	Menominee R.	219.00	1,155
Peshtigo R.	68.50	7,319	3,613	Hibbards Cr.	0.12	1
Oconto R.	48.10		2,537	Fischer Cr.	0.61	3
East Twin R.	5.80	484	306	Gurney Cr.	0.70	4
Big Manistee R.	108.38	3,448	5,716	Stoney Cr.	3.45	18
Little Manistee R.	14.10	96	744	Grand R.	190.00	1,002
Lincoln R.	5.72		302	Kalamazoo R.	29.40	155
Pere Marquette R.	44.36		2,340	Brandywine Cr.	0.82	4
Pentwater R.	9.92		523	Trail Cr.	3.20	17
White R.	15.00		791	State Cr.	0.01	0
Muskegon R.	75.50		3,982			
Black R. (Van Buren)	15.25		804			
St. Joseph R.	145.00		7,647			
Galine R.	8.44		445			
Burns Ditch	4.02		212			
Subtotal (South)	**682.22**	**12,187**	**35,982**	**Subtotal (South)**	**452.09**	**2,384**
(W/traps)	**389.88**	**12,187**	**20,563**			
(W/o traps)	**292.34**		**15,419**			
Primary Lake Total	**850.37**	**47,785**	**88,904**	**Secondary Lake Total**	**489.53**	**3,526**
TOTAL LAKE MICHIGAN POPULATION ESTIMATE:				**92,430**		

[1]Primary streams are streams with consistent and significant larval production that are treated on a regular cycle (≤ once every five years).
[2]Secondary streams are streams with significant but sporadic larval production that are treated on an irregular cycle (> once every five years).
[3]Population estimates were calculated from stratified multiple mark/recapture studies, linear regressions relating past years trap catch to mark/recapture estimates, or trap efficiencies from mark/recapture studies conducted from 1986-93 in 9 of 15 streams with traps. Simple linear regressions estimate populations for all streams by the relation of mean stream discharge to the number of lampreys entering the 10 tributaries.
[4]The Manistique River annually receives a substantial number of spawning sea lampreys, but does not meet the criteria of a primary stream. The river has a barrier near the mouth. The estimate of spawners in the river is an addition to the regression estimate.

Lake Huron

- 36,964 sea lampreys were trapped at 14 sites in 13 tributaries during 1998 (Table 18, Fig. 9).

- The estimated population for Lake Huron is 235,086 [218,311 north (y=744.10; r^2=.72, P<0.05) and 16,775 south (y=111.44; r^2=.85; P<0.05) of a line from Alpena, Michigan to South Baymouth, Ontario to Espanola, Ontario; Table 19]. The estimate is the result of a cooperative effort between the Service and the Department.

- Spawning runs were monitored in the Albany River through cooperative agreement with the Chippewa/Ottawa Treaty Fishery Management Authority, and in the Tittabawassee River through a cooperative agreement with Dow Chemical USA.

- A telemetry study was conducted on the Spanish River to assist in determining the location of potential sites to place lamprey traps. The work demonstrated that adult lampreys in the main stream congregated at a location not amenable to trapping. Several tagged lampreys entered tributaries where further investigations could be conducted.

- An Expert Panel peer-reviewed the existing adult sea lamprey assessment program during 1997 and recommended actions to optimize the program. The recommendations included implementing assessment of parasitic-phase or transformer-phase sea lampreys through an in-lake mark recapture approach. Implementation of these recommendations continued during 1998. During August-December, 775 parasitic-phase sea lampreys were marked with coded wire tags and released into Lake Huron (269 in Hammond Bay, 160 in St. Martin Bay, 243 southeast of Blind River, and 103 east of St. Joseph Island).

- Fig. 4 shows spawning populations in Lake Huron generally increased from 1986 to 1993, and declined and stabilized during 1994-1998. Also presented in Fig. 4 is the beginning of a series of lake-wide estimates of adult lamprey abundance (1995-1998).

- Traps operated in the St. Marys River at the Great Lakes Power facility in Canada and the U.S. Army Corps of Engineers facility in the U.S. captured 7,555 spawning-phase sea lampreys. The estimated spawning lamprey population in the river was 20,235 and trap efficiency was 37%. Further design, structural, and operational modifications are planned for both sites on the St. Marys River to increase trap efficiency during 1999.

Table 18. Stream, number caught, estimated spawner population, trap efficiency, number sampled, percent males, and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Huron, 1998. (Number in parentheses corresponds to location of stream in Fig. 9).

	Number	Spawner	Trap	Number	Percent	Mean Length (mm)		Mean Weight (g)	
Stream	Caught	Estimate	efficiency	sampled	Males	Males	Females	Males	Females
United States									
Tittabawassee R. (9)	1,844	5,656	36	49	-	-	-	-	-
East Au Gres R. (10)	335	1,916	17	162	75	469	475	220	237
Au Sable R. (11)	861	4,601	19	228	71	475	483	225	249
Devils R. (12)	66	206	30	21	50	469	499	241	269
Trout R. (13)	77	481	15	9	11	368	458	110	191
Ocqueoc R. (14)	1,723	3,191	15	24	50	-	-	-	-
Cheboygan R. (15)	18,600	21,029	88	1,602	49	-	-	-	-
Carp R. (28)	1,210	2,754	44	36	-	-	-	-	-
Albany Cr. (29)	130	422	31	27	47	422	438	197	206
St. Marys R. (30)	1,022	See Canada	See Canada	0	63	-	-	-	-
Total or Mean (U.S.)	**25,868**	**40,256**		**2,158**	**56**	**471**	**476**	**223**	**239**
Canada									
St. Marys R. (30)	6,533	20,235	37	0	56				
Echo R. (50)	3,404	7,389	46	0	50	-	-	-	-
Koshkawong R. (51)	387	455	85	0	48	-	-	-	
Thessalon R. (52)	772	1,809	31	0	59	-	-	-	-
Total or Mean (Canada)	**11,096**	**29,888**		**0**	**54**	**-**	**-**	**-**	**-**
Total or Mean (for lake)	**36,964**	**70,144**		**2,158**	**55**	**471**	**476**	**223**	**239**

[1]The number of lampreys from which all length and weight measurements were determined.
[2]Percent males generally are determined from internal body examination of the number sampled. However, there were 7 trapping sites where sampling was not conducted and males were determined by external examination (Ocqueoc-1,723, Cheboygan-18,600, St. Marys US-1,022, St. Marys Can.-6,533, Echo-3,404, Thessalon-772, and Koshkawong-387).

Table 19. Annual mean discharge for U.S. and Canadian streams north and south of a line from Alpena, Michigan to South Baymouth, Ontario to Espanola, Ontario in Lake Huron, ranked as primary[1] and secondary[2] producers of sea lampreys, and the estimated number of spawning-phase sea lampreys during 1998.

Primary Streams				Secondary Streams		
	Discharge m^3/s	Population Estimate[3] Mark/Recapture	Regression		Discharge m^3/s	Population Estimate Regression
NORTH				**NORTH**		
St. Marys R.	2,122.50	20,235	20,235[4]	Munuscong R.	1.44	107
L. Munuscong R.	0.62		461	Carlton Cr.	0.14	10
Caribou Cr.	0.42		313	Ceville Cr.	1.08	80
Albany Cr.	0.76	422	566	Hessel Cr.	0.20	15
Trout Cr.	0.31		231	Steeles Cr.	0.23	17
Beavertail Cr.	0.68		506	Nunns Cr.	0.62	46
McKay Cr.	0.51		379	Mulligan Cr.	0.40	30
Pine R.	6.34		4,718	Sucker Cr.	0.20	15
Carp R.	8.12	2,754	6,042	Two Tree R.	0.45	33
Cheboygan R.	23.97	21,029	17,836	Richardson Cr.	0.31	23
Elliot Cr.	0.42		313	H-68	0.08	6
Greene Cr.	0.17		126	Livingstone Cr.	0.06	4
Black Mallard Cr.	0.28		208	Blind R.	6.34	472
Ocqueoc R.	2.75	3,191	2,046	Lauzon R.	0.37	28
Schmidt Cr.	0.74		551	Spragge Cr.	0.20	15
Trout R.	0.91	481	677	Serpent R.	9.85	733
Root R.	2.29		1,704	Spanish R.	215.84	16,061
Garden R.	7.98		5,938	Silver Cr.	0.48	36
Echo R.	1.61	7,389	1,198	Sand Cr.	0.28	1
Watson Cr.	0.14		104	Manitou R.	1.90	41
Gordon Cr.	0.11		82	Blue Jay Cr.	0.59	44
Browns Cr.	0.20		149			
Koshkawong R.	0.68	455	506			
Thessalon R.	10.47	1,809	7,791			
Mississagi R.	170.37	126,772				
Mindemoya R.	0.96		714			
Timber Bay Cr.	0.28		208			
Subtotal (North)	2,364.59	57,765	200,374	Subtotal (North)	241.06	17,937
(w/traps)	2,171.77	57,765	56,897			
(w/o traps)	192.82	143,477				
SOUTH				**SOUTH**		
Devils R.	0.71	206	79	Shiawassee R.	13.19	147
Au Sable R.	43.70	4,601	4,870	Cass Cr.13.56	151	
Tawas Lake Outlet	2.21		246	Mill Cr.	0.06	1
Au Gres R.	5.16		574	Pine R.	1.42	16
E. Au Gres R.	2.52	1,916	281	Chikanishing R.	0.34	4
Rifle R.	9.68		1,079	French R.	216.83	2,416
Tittabawassee R.	49.38	5,656	5,503	Still R.	1.75	20
				Magnetawan R.	52.64	587
				Naiscoot R.	1.98	22
				Boyne R.	1.12	13
				Musquash R.	56.60	631
				Sturgeon R.	0.88	10
				Nottawasaga R.	7.78	87
				Sauble R.	3.42	38
Subtotal (South)	113.35	12,379	12,632	Subtotal (South)	371.58	4,143
(w/traps)	96.31	12,379	10,733			
(w/o traps)	17.05		1,899			
Primary Lake Total	2,477.94	70,144	213,006	Secondary Lake Total	612.64	22,080

TOTAL LAKE HURON POPULATION ESTIMATE: 235,086

[1]Primary streams are streams with consistent and significant larval production that are treated on a regular cycle ($\leq$ once every five years).
[2]Secondary streams are streams with significant but sporadic larval production that are treated on an irregular cycle (> once every five years).
[3]Population estimates were calculated from stratified multiple mark/recapture studies. A linear regression estimates populations for all streams by relation of mean stream discharge to the number of adult lampreys entering 13 tributaries.
[4]The St. Marys River annually receives a substantial number of spawning sea lampreys, but does not meet the criteria of a primary stream (the river is not treated). The estimate of spawners in the river is in addition to the regression estimate.

Lake Erie

- 396 sea lampreys were trapped in 4 of 5 tributaries during 1998 (Table 20, Fig. 9).
- Current trap catch of spawning lampreys is less than the catch prior to the start of lampricide control (started during 1986 and showed effect in spawner population during 1989), but is greater than 10% of pretreatment catch (Fig. 9).
- When the management plan for sea lampreys in Lake Erie was developed (prior to the implementation of stream treatments during 1986), the target level of less than 5% wounding on lake trout was for fish of 533-633mm. During 1998, there were 0 wounds per 100 lake trout of 533-633 mm. Lake trout that were 634-734 mm had 23 wounds per 100 fish, and those >734 mm had 39 wounds per 100 fish.

Table 20. Stream, number caught, estimated spawner population, trap efficiency, number sampled, percent males, and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Erie, 1998. (Number in parentheses corresponds to location of stream in Fig. 9).

Stream	Number Caught	Spawner Estimate	Trap Efficiency	Number Sampled[1]	Percent Males[2]	Mean Length (mm) Males	Mean Length (mm) Females	Mean Length (g) Males	Mean Length (g) Females
United States									
Cattaraugus Cr. (6)	209	2,862	7	12	67	486	475	280	233
Conneaut Cr. (7)	0	-	-	-	-	-	-	-	-
Grand R. (8)	152	1,978	6	6	83	508	490	291	278
Total or Mean (U.S.)	**361**	**4,840**		**18**	**72**	**494**	**478**	**284**	**242**
Canada									
Big Cr. (53)	7	-	-	0	-	-	-	-	-
Young's Cr. (54)	28	-	-	0	-	-	-	-	-
Total or Mean (Canada)	**35**			**0**					
Total or Mean (for lake)	**396**	**4,840**		**18**	**72**	**494**	**478**	**284**	**242**

[1]The number of lampreys from which all length and weight measurements were determined.
[2]Percent males generally are determined from internal body examination of the number sampled.

Lake Ontario

- 7,996 sea lampreys were trapped at 15 sites in 14 tributaries during 1998 (Table 21, Fig. 9).
- A study of the contribution of Fish Creek to the parasitic lamprey population of Lake Ontario began during the fall of 1996 with the release of 686 coded wire tagged transformers (482 released in Fish Creek and 204 released in Little Salmon River) and was completed during spring 1998. A total of 7,046 spawning-phase adult sea lampreys were checked for the tags. None released in Fish Creek were recovered and only one released in the Little Salmon River was recovered.
- Lamprey populations in Lake Ontario have remained relatively stable during 1986-1998 (Fig. 6).

Table 21. Stream, number caught, estimated spawner population, trap efficiency, percent males and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Ontario, 1998. (Number in parentheses corresponds to location of stream in Fig. 9).

Stream	Number Caught	Spawner Estimate	Trap Efficiency	Number Sampled[1]	Percent Males[2]	Mean Length (mm) Males	Mean Length (mm) Females	Mean Weight(g) Males	Mean Weight(g) Females
United States									
Black R. (1)	303	1,324	19	44	57	473	473	265	287
Grindstone Cr. (2)	43	-	-	1	100	350	-	134	-
Little Salmon R. (3)	8	-	-	-	-	-	-	-	-
Fish Cr. (4)	0	-	-	-	-	-	-	-	-
Sterling Cr. (5)	111	709	25	11	64	458	505	244	268
Sterling Valley Cr. (5)	159	992	39	22	45	483	508	260	311
Total or Mean (U.S.)	**624**	**3,025**		**78**	**55**	**470**	**488**	**257**	**293**
Canada									
Humber R. (55)	3,500	6,688	52	301	49	460	454	224	234
Duffins Cr. (56)	2,414	3,171	76	257	52	479	479	249	256
Bowmanville Cr. (57)	604	1,909	32	296	49	469	462	242	238
Graham Cr. (58)	91	145	63	37	43	469	479	224	251
Port Britain Cr. (59)	70	-	-	12	17	502	441	315	231
Cobourg Br. (60)	232	282	82	43	49	451	462	224	238
Grafton Cr. (61)	31	40	77	0	-	-	-	-	-
Shelter Valley Br. (62)	261	352	74	63	59	488	486	237	250
Salmon R. (63)	169	297	57	0	-	-	-	-	-
Total or Mean (Canada)	**7,372**	**12,884**		**1,009**	**50**	**470**	**465**	**237**	**242**
Total or Mean (for Lake)	**7,996**	**15,909**		**1,087**	**50**	**470**	**475**	**238**	**256**

[1]The number of lampreys from which all length and weight measurements were determined.
[2]Percent males generally are determined from internal body examination of the number sampled.

Parasitic-Phase

Lake Superior

The Michigan Department of Natural Resources provided data on the frequency of parasitic-phase sea lampreys attached to fish caught by sport charterboats during 1998.

- 19 sea lampreys attached to lake trout were collected from 8 management districts.

- Lampreys were attached at a rate of 0.5 per 100 lake trout (n = 4,008) and 0.0 per 100 chinook salmon (n = 120).

Lake Michigan

The Michigan and Wisconsin Departments of Natural Resources provided data on the frequency of parasitic-phase sea lampreys attached to fish caught by sport charterboats during 1998.

- 602 sea lampreys were collected from 13 management districts; 454 sea lampreys were attached to lake trout and 148 were attached to chinook salmon.

- Lampreys were attached at a rate of 0.9 per 100 lake trout (*n* = 52,954) and 0.3 per 100 chinook salmon (*n* = 52,087).

Lake Huron

The Michigan Department of Natural Resources provided data on the frequency of parasitic-phase sea lampreys attached to fish caught by sport charterboats during 1998. Personnel from the Sea Lamprey Control Centre, Hammond Bay Biological Station, and Marquette Biological Station, in cooperation with the Inter-Tribal Fisheries and Assessment Program of the Chippewa/Ottawa Treaty Fishery Management Authority, collected parasitic-phase sea lampreys from nine commercial fisheries.

- 3,464 sea lampreys (U.S.: sport-750, commercial-587, Black Mallard River transformer net-1; Canada: commercial-2,126) were collected from 12 management districts (6 U. S.; 6 Canada) during 1998. This is an increase from the 2,158 collected during 1997.

- 175 of the sea lampreys captured in the sport fishery were attached to lake trout and 568 were attached to chinook salmon.

- Lampreys were attached at a rate of 2.1 per 100 lake trout (*n* = 8,424) and 5.2 per 100 chinook salmon (*n* = 10,834).

RISK ASSESSMENT

Priority projects included environmental risk management for permits from regulatory agencies, assessments of populations of lake sturgeons, and the conclusion of toxicity tests on mussels.

<u>Permits</u>

Issues concerning environmental risk management were addressed for regulatory agency permit requirements for the following: agreements and Certificates of Approval from the Michigan Department of Environmental Quality (January 16, March 12, May 7, and June 12), letter of authorization from the Wisconsin Department of Natural Resources (January 27), letter of permission from the Red Cliff Band of Lake Superior Chippewas (March 31), letter of authorization from the Indiana Department of Natural Resources (April 16), letter of authorization from the Pennsylvania Fish and Boat Commission (May 10), letter of concurrence for the Informal Section 7 Endangered Species Act Consultation on the Sea Lamprey Control Action Effects on the Hungerford's Crawling Water Beetle from the Service East Lansing Field Office (May 29), and Memorandum of Stipulations Between the Service and Bad River Band of Lake Superior Tribe of Chippewa Indians (July 21).

<u>Lake Sturgeon</u>

During 1982, the lake sturgeon was being considered for threatened or endangered status in the United States and was listed in the Federal Notices of Review Register as a category 2 (C2) candidate species. The C2 classification was removed within the Service during 1995 and for the public during 1996. The lake sturgeon now has no formal Federal designation. During 1998, the lake sturgeon was listed as State endangered in Illinois, Indiana, Ohio, and Pennsylvania, threatened in Michigan and New York, and special concern species in Minnesota and Wisconsin.

Streams where lake sturgeons recently have been documented include the Bad, Ontonagon, and Sturgeon rivers (Lake Superior) and Manistee, Millecoquins, Oconto, and Peshtigo rivers (Lake Michigan), and during 1998 the Michigan Department of Natural Resources expressed concern for the impact of lampricide treatments to suspected populations of lake sturgeons in the Manistee, Sturgeon, and Whitefish rivers (Lake Michigan) and Au Sable River (Lake Huron). Assessments by dip and fyke nets during and immediately after treatment of these 4 rivers found no lake sturgeons. The assessments were completed to fulfill requirements specified in the 1998 certification of approval issued for lampricide treatments by the Michigan Department of Environmental Quality.

During 1997-1998, the Service conducted surveys of the Bad and Sturgeon rivers (Lake Superior) and Oconto and Peshtigo rivers (Lake Michigan) to determine if lake sturgeons were present during July and August. Adult fish enter the rivers in the spring, but previous information hypothesized that all lake sturgeons had left the rivers prior to July and migrated into the Great Lakes. Partnerships were established to assess young-of-the-year (YOY) lake sturgeon in the Bad and Peshtigo rivers during May and in the Bad, Sturgeon, Oconto, and Peshtigo rivers during July and August. A total of 28 YOY lake sturgeon (28, range 10-22 mm) were collected by drift net and were released alive back into the Bad (12) and Peshtigo (16) rivers during May 1-20, and 52 YOY lake sturgeons (range, 82-229 mm) were collected by dip nets and backpack electrofishing gear, seine, and bottom trawl and were released alive back into the Bad (6), Sturgeon (17), and Peshtigo (29) rivers during July 1-August 26 (Fig. 10). No lake sturgeons were observed in the Oconto River and no adults were observed in any rivers during July and August.

Partners who participated in the lake sturgeon assessments included the Great Lakes Fishery Commission, Service Fisheries Resources Offices (Ashland and Green Bay, Wisconsin, and Alpena, Michigan), U.S. Geological Survey-Biological Resources Division (Lake Superior Biological Station, Hammond Bay Biological Station, and Upper Midwest Environmental Sciences Center), the Keweenaw Bay Indian Community Biological Services Department, Bad River Band of Lake Superior Tribe of Chippewa Indians Natural Resources Department, Great Lakes Indian Fish and Wildlife Commission, Department of Biological Sciences of Michigan Technological University, and the Michigan, Minnesota, and Wisconsin Departments of Natural Resources.

Mussels

A 3-year (1996-1998) cooperative project titled "Field Evaluation of Acute and Sublethal Effects of Lampricides 3-trifluoromethyl-4-nitrophenol (TFM) and Bayluscide on Freshwater Unionid Mussels" was concluded during 1998. Partners included the Upper Midwest Environmental Sciences Center, Bad River Band of Lake Superior Tribe of Chippewa Indians Natural Resources Department, and Marquette Biological Station. Detailed progress reports of this project are included in the annual report of the Upper Midwest Environmental Sciences Center.

Flow-through toxicity tests using lampricides (TFM and the combination of TFM and 1% Bayluscide) were conducted to determine the effect of simulated lampricide stream treatments on adult and juvenile mussels of Atlantic Elliptio (*Elliptio complanata*) and Floater (*Pygnadon cataracta*). Tests were conducted on mussel populations in the Bad River to address one of the stipulations in the Memorandum of Stipulations Between the Service and Bad River Band of Lake Superior Tribe of Chippewa Indians. Immediately after the toxicity tests acute mortality was <1% at the anticipated treatment levels for the Bad River and behavioral responses of mussels were minimal at typical treatment concentrations. Post-exposure evaluations after 2 weeks showed no additional mortality. Examination of treated and control groups of mussels held in cages in the Bad River for one year showed similar survival between treated and control groups for similar ages and species. In summary, these tests show that lampricides applied to streams in the Great Lakes to kill sea lampreys have little short- or long-term effect on these two species of mussels.

Growth of YOY Lake Sturgeon in 1998

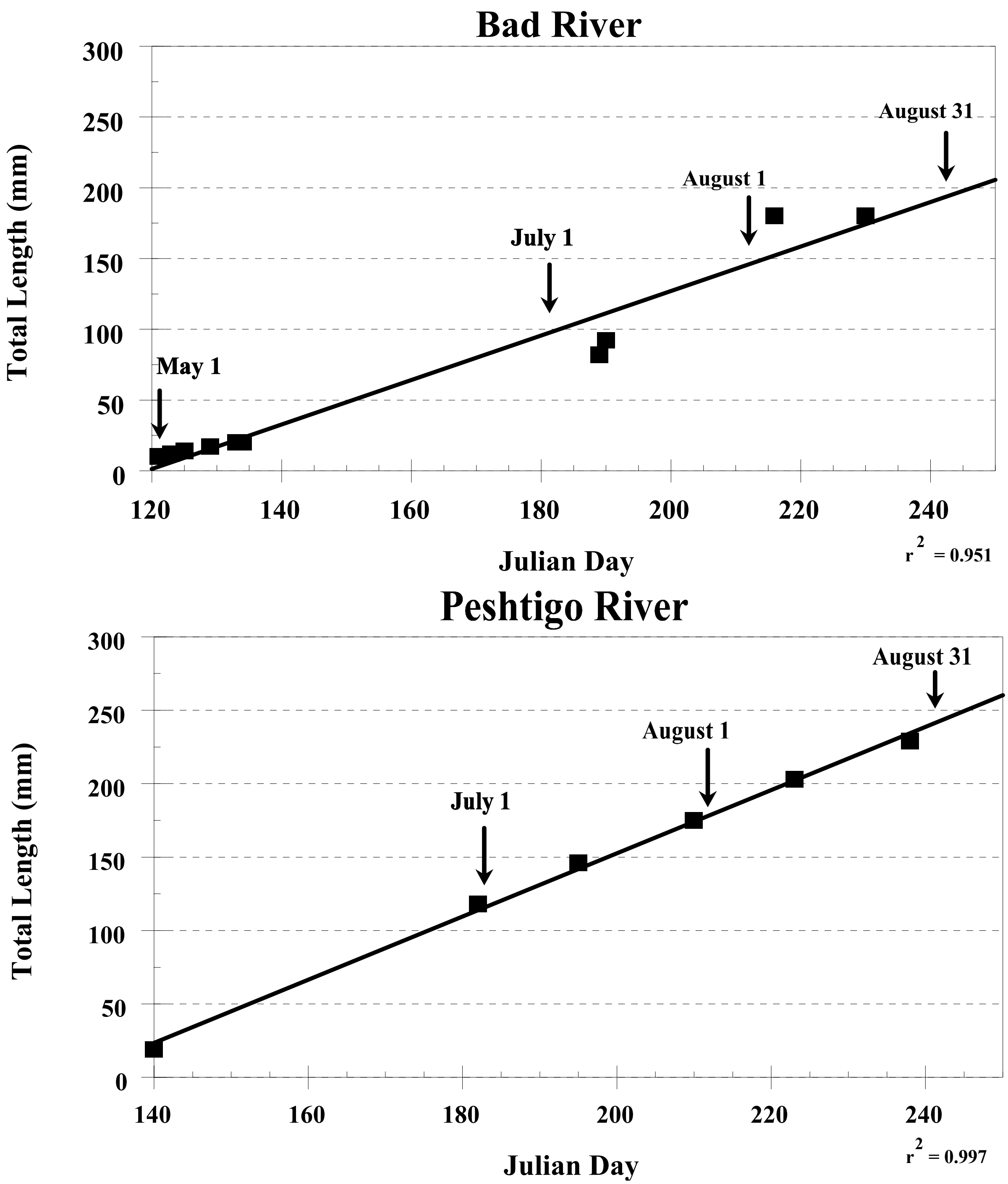

Fig. 10. Growth of young-of-the-year (YOY) lake sturgeon in the Bad and Peshtigo Rivers from May 1 to August 26, 1998.

TASK FORCE REPORTS

The Commission through its Sea Lamprey Integration Committee has established Task Forces to recommend direction and coordinate actions in several focus areas: St. Marys River Control, Sterile Male Release Technique, Barriers, Assessment, and Lampricide Control. The progress and major actions of the Task Forces for 1998 are outlined below.

ST. MARYS RIVER CONTROL TASK FORCE

- Task Force (SMRCTF) established during January 1992

- Purpose of Task Force: The SMRCTF presented a revised 'terms of reference' at the February 1998 Sea Lamprey Integration Committee (SLIC) meeting. The following summarizes the revised purpose and charges as approved by SLIC.

- Coordinate the adaptive implementation of the St. Marys River integrated sea lamprey control strategy that initially includes a combination of trapping, sterile male release, and granular Bayluscide applications, but later maintains the required level of suppression without further use of lampricides. This coordination task will last, at least, through the year 2003, when the decision of whether to apply a second round of granular Bayluscide will have been made. Major charges include the following:

    - Coordinate the St. Marys River actions of the other SLIC Task Forces and review their progress in delivering the St. Marys River control strategy and assessment plan.

    - Evaluate the success of the control strategy and use an adaptive-management approach to recommend the most cost-effective approach to continuing control with the least possible reliance on lampricides.

    - Provide information on near- and long-term control actions, effects, and assessment needs to the Lake Huron Technical Committee for inclusion in Sea Lamprey Management Plans and Economic Injury Level target-setting exercises.

    - With input from the other SLIC Task Forces, develop detailed near-term plans for larval assessment, adult assessment/trapping, sterile male release, lampricide operations, and lampricide supplies.

    - Establish research priorities to support the most effective, efficient control possible for the St. Marys River and review and recommend external and internal research projects for relevance against priorities.

- Members are Larry Schleen (chair) and Douglas Cuddy, Department of Fisheries and Oceans Canada; Dennis Lavis, John Heinrich, and Terry Morse, U.S. Fish and Wildlife Service; Roger Bergstedt, U.S. Geological Survey-Biological Resources Division; James Johnson (Lake Huron Technical Committee representative), Michigan Department of Natural Resources; Richard Fleming (outside expert), Forestry Canada; and Gavin Christie and Robert Young, Commission Secretariat.

- Meetings held during February 25-26 and September 8-9.

- Progress on the charge during 1998:

During 1998 the agents began to implement the recommended control options in the St. Marys River which include treatment of high larval density areas with granular Bayluscide, trapping of spawners, and release of sterile males. As well, the St. Marys River long-term assessment plan (SMRAP) was formulated and reviewed by a panel of outside experts. The SMRAP and the recommendations of the review panel are discussed in the Assessment Task Force report on pages 69-70.

1. The enhanced sterile male release program continued, with 16,743 sterile males released, giving a theoretical sterile:untreated male ratio of 2.2:1.

2. Trap catches of spawners was about average, with capture of an estimated 37% of 20,235 adult lampreys.

3. The granular Bayluscide treatment of known larval concentrations was initiated with 82.2 ha (in U.S. waters, Lake Nicolet) being targeted by a contracted aerial (helicopter) pesticide application firm. The application operation ran smoothly and utilized a joint Service/Department crew. Treatment evaluation surveys indicated an average of 76% reduction of larvae in the treated plots. Nontarget effects were minimal.

4. A portion of the north channel section of the river was sampled with deepwater electrofishing gear to verify the current distribution and density map. The distribution of larvae remained relatively unchanged and density showed a general decrease.

5. Continued sampling of the established larval index sites showed a continuation of variability in catch.

6. Distribution surveys in the river upstream of the compensating works produced no sea lamprey larvae.

7. A total of 36 recently metamorphosed sea lampreys were collected in fyke nets attached to navigation buoys, and 33 were marked with coded wire tags and released.
8. A total of 15 transforming larvae were collected with electrofishers in the rapids area and were aged using statoliths. Assigned ages were either 4+ or 5+.

1999 Program Recommendations:

The SMRCTF recommended to the Commission the following courses of action for 1999 for the St. Marys River:

- Application of granular Bayluscide to approximately 781.9 ha. However a number of issues must be resolved, including approval from Health Canada for aerial application of granular Bayluscide in Canadian waters and permission from the Ministry of Environment for an outside (U.S.) pesticide application firm to operate in Canada.

- Continuation of adult sea lamprey trap modifications and operating procedures at the GLP and COE trap sites in an attempt to improve trapping efficiency to 50%.

- Release of up to 23,000 sterile males in an attempt to achieve a 3:1 ratio of sterile:untreated males.

- Continuation of the adaptive St. Marys River Assessment Plan, including further larval map validation and sampling of select index sites prior to and following Bayluscide treatment.

STERILE MALE RELEASE TECHNIQUE TASK FORCE

- Task Force established during April 1984

- Purpose of Task Force:

  - Continue to refine the long-term strategy for application of sterile male release in an integrated program of sea lamprey control.

  - Coordinate the current large-scale research program into the effectiveness of the sterile male release technique in Lake Superior and the St. Marys River and include operational and research studies to test all required hypotheses.

- Members are John Heinrich (chair), Michael Twohey, and Dennis Lavis, U.S. Fish and Wildlife Service; Rod McDonald and Douglas Cuddy, Department of Fisheries and Oceans Canada; Gavin Christie and Robert Young, Great Lakes Fishery Commission Secretariat; Gerald McKibben (outside expert), U.S. Department of Agriculture (retired); Charles Bronte (lake technical committee representative) and Roger Bergstedt, U.S. Geological Survey-Biological Resources Division.

- Meetings held during March 3-4 and September 15-16.

- Progress on charges:

  In 1995 the Commission forwarded to the Sterile Male Release Technique Task Force a list of specific charges organized in three planning groups: Strategic Long-term, Tactical/Operational, and Research. Progress on the charges is described below.

Strategic Long-term Integrated Management of Sea Lamprey (IMSL) Planning

- The Sterile Male Release Technique Task Force reviewed the sequential hypotheses that describe the series of events that must occur in a successful sterile male release program. The research hypotheses addressing the long-term success of the technique are:

  1. Male sea lampreys are successfully sterilized.
  2. Sterilized males reach the spawning grounds and construct nests at the expected ratio of sterilized to resident males.
  3. Sterilized males attract females to nests and mate normally.
  4. Sterility persists through mating and percent survival of embryos at hatch is reduced in individual nests.
  5. Percent survival of embryos at hatch is reduced in individual streams.
  6. The abundance of year classes of burrowed larvae (after leaving the nest) is reduced in individual streams.
  7. Reductions in abundance of larvae persist through the larval life stage and result in reductions in the number of metamorphosing sea lampreys in individual streams.
  8. The number of parasitic-phase sea lampreys in the lake is reduced.
  9. Damage to fish in the lake is reduced.

- Tests of hypothesis 6 continued in the third year of the 4-year study protocol *Long-term evaluation of sterile-male release for control of sea lampreys in the Great Lakes* (long-term evaluation), by Roger Bergstedt.

- The Task Force continues to work with the Barrier, Assessment, and St. Marys River Control Task Forces to refine understanding of the stock recruitment relation and its effects on release strategies.

- The combination of sterile male release, trapping, and granular Bayluscide spot treatments has been identified as the most cost effective control option for the St. Marys River. This option offers the potential to reduce larval populations in the river by 97%.

- The Task Force has identified an optimum ratio of 4:1 sterile male lampreys to resident male lampreys in the St. Marys River to assure achievement of targeted reductions. This would require the acquisition of an additional 10,000 male lampreys from sources outside the St. Marys River.

- The Task Force is working with the Assessment and St. Marys River Control Task Forces to assess enhanced sterile male release in the St. Marys River.

- A long-range plan of operational activities through FY 2001 is detailed in Table 21.

Tactical/Operational Planning

- A barrier was completed on Grindstone Creek which will provide an average of 500 additional lampreys for sterilization.

- The experimental Carp River weir will be removed. Costs to proceed with development of a permanent weir have been determined to be excessive in light of the diminishing number of lampreys that are projected to be available.

- The Task Force continued to investigate the use of Atlantic origin lampreys for sterilization and release to supplement the technique in the Great Lakes.

- The Task Force continued to investigate the use of female lampreys for sterilization and release in Great Lakes tributaries. Sterile female lampreys have the potential for use in tributaries that do not receive sterilized male lampreys.

- The sterilization facility continued to meet the Michigan Department of Environmental Quality permit requirements for the discharge of effluent. Bisazir was not detected in water effluent during the field season.

- The Task Force recommended an operational budget for FY 1999 and FY 2001. The Commission approved the FY 1999 operational budget.

- Operational requirements for the technique were projected through FY 2001 in a long-range plan of operational activities (Table 21).

Research Planning

- Areas were identified in which hypotheses for evaluation studies may be developed. Research priorities remain in the following broad areas, and development of research continues.

    - Continuation of examination into H6 through H9, all of which involve the effect of compensatory mechanisms in sea lampreys.

- Examination of sources, processes, and methods that add to the existing supply of lampreys for use in the technique.

- Examinations to improve safety and effectiveness of the current industrial technique.

- The current research study described in the *Long-term evaluation* is testing hypothesis 6. The Task Force is developing a proposal to modify and extend the *Long-term evaluation* to test hypothesis 7 in the 8 existing study streams.

- The Task Force worked closely with the Assessment, Barrier, and St. Marys River Control task forces to understand compensatory mechanisms. The current *Long-term evaluation* tests for density dependant responses with the following parameters: spawner run allocation, reproduction and larval recruitment, and year class survival and growth. The Task Force continues to participate in the Jones et al. study on compensatory mechanisms.

- Substantial progress is being made in internal and external research. Research recommendations through FY 2001 are listed in the long-range plan (Table 21).

- The early sterilization and release of about 13,000 non-resident males from lakes Superior, Huron, Michigan, and Ontario into the St. Marys River was successful. The early released non-resident sterile males appeared in traps throughout the trapping season and appeared on nests as often as the later released and resident sterile males.

- The Task Force cooperated with the following research during 1998:

    - *Compensatory mechanisms in Great Lakes lamprey populations*, Dr. Jones et al.

    - *Effects of lamprey GnRH-I and III analogs on reproductive process and behavior of male sea lampreys,* Dr. Sower.

    - *Studies on reproductive functions of male sea lamprey in relation to potential targets for population control*, Dr. Dabrowski et al.

    - *Determining the sources and complete chemical composition of the lamprey larval pheromone, and assessing the merit of measuring one of its principle components in river waters*, Dr. Sorenson.

    - *A putative male sea lamprey pheromone: its function, identity, and potential application in sea lamprey control*, Dr. Li.

- The Task Force worked to advance the following:

    - *Experimental examinations of factors affecting polygyny and ployandry of sea lampreys (<u>Petromyzon marinus</u>) as a means of optimizing sterile female releases* by Li et al. which will commence during FY 1999.

- A study of the phenotypic expression of growth in juvenile sea lampreys of Atlantic and Great Lakes origins when held and fed in fresh water is scheduled to occur during FY 1999.

- In conjunction with the Fish Health Committee, a disease profile of Atlantic origin lampreys was developed to define a disease screening program for the eventual importation and sterilization of these animals. Preliminary disease screening will begin during 1999.

Table 21. A long-range plan of operational activities in the Sterile Male Release Program through FY 2001.

Activity	FY 99	FY 00	FY 01
Operations Trap 15 streams/sterilize 25,000 males	X	X	X
Release in St. Marys R.	X	X	X
Analysis of bisazir in water	X	X	X
Sterile female release			facility increase
Atlantics - east coast trap study		X	
Atlantics - facility increase and new injector			X
Purchase bisazir			X
Assessment Release in Big Carp River	X		
Nest success Big Carp River	X		
Continue long-term evaluation, larval	X	Big Carp	
Assess metamorphosis (H7)	propose	X	X
Assess spawners U.S. and Canada	X	X	X
Assess year class strength in stream	X	X	X
St. Marys River assessment plan	X	X	X
Internal research Atlantics - disease screen	X	X	X
Atlantics - genetic assessment	X	X	
Atlantics - field trial		X	
Female lampreys - verify early sterility			X
External and Collaborative Research Lamprey pheromone - Li	X	X	
Spawning behavior - high female ratio and density - Li	X	X	X
Spawning behavior - high male ratio and density - Scribner	X	X	X
Lamprey pheromone - Sorenson	X	X	
Sperm studies - Dabrowski	X		
Compensatory mechanisms studies - Jones et al.	X	X	X

SEA LAMPREY BARRIER TASK FORCE

- Task Force established during April 1991.

- Purpose of Task Force:

  - Refine the long-term strategy for the application of barriers in an integrated program of sea lamprey control which includes the decision model, resulting rank-order list of projects, and rules for the order in which to build the priority barriers.

  - Evaluate barrier program for achieving potential targets set for sea lamprey suppression on all lakes, for meeting targets for reducing the amount of lampricides used in the sea lamprey program, and for effectiveness relative to lampricide control.

  - Coordinate the implementation of an accelerated program of barrier construction including developing detailed plans and accurate cost estimates, meeting all environmental assessment requirements, and supporting the Commission decision process.

  - Establish research priorities and recommend research direction into barrier technology, efficacy, and ecosystem impacts.

- Members are Dennis Lavis (chair) and Ellie Koon, U.S. Fish and Wildlife Service; Tom McAuley and Andrew Hallett, Department of Fisheries and Oceans Canada; Bill Swink, U.S. Geological Survey-Biological Resources Division, Hammond Bay Biological Station; John Schrouder, Michigan Department of Natural Resources; Les Weigum, U.S. Army Corps of Engineers; Dr. David Noakes, University of Guelph; Dr. Dan Hayes, Michigan State University; and Robert Young and Gavin Christie, Great Lakes Fishery Commission Secretariat.

- Meetings held during March 2-3 and September 29.

Activities of the Task Force:

- Began transition of the barrier program from a developmental process to a fully integrated and operational part of the sea lamprey control program by developing operating protocols working with the Sea Lamprey Barrier Transition and Program Management Teams.

- Developed drafts and submitted final, approved reports to the United States and Canada on behalf of the Commission to seek opinions of the legal responsibilities and long-term liabilities of the barrier program.

- Provided to the Sea Lamprey Integration Committee draft criteria for the environmental acceptability of sea lamprey barriers for review and comment before incorporating into barrier transition protocol, submitting for peer review, and forwarding to the Commission for approval.

- Began revising the policy statement, “Role of Barriers in an Integrated Sea Lamprey Control Program” and “Guidelines for the Sea Lamprey Barrier Program” to more accurately reflect expected changes to the Commission Vision and products of the Barrier Transition project.

- Continued to focus research direction into the combination fixed-crest and electrical barrier, biological impacts of barriers, and compensatory mechanisms in Great Lakes sea lamprey populations.

- Provided overview of the construction program during 1998 (see pages 23-26).

- Developed and recommended a barrier program budget of $318,100 for fiscal year 1999 with no additional construction projects scheduled. The barrier program is undergoing a refocus toward a proposed $2 million annual construction program beginning in fiscal year 2000. Most of 1999 will be devoted to protocol development and life cycle planning.

ASSESSMENT TASK FORCE

- Task Force established during April 1996.

- Charges:

  - Develop strategic and long-term IMSL plans for projecting transformer production, developing summary databases, reviewing and improving key life history parameters, developing a habitat inventory, estimating efficacy of control options, evaluating the uncertainty in assessment parameters, and evaluating the role of trapping as a control strategy.

  - Create tactical and operational plans for developing cost-effective protocols for assessment, co-ordinating training among agents to ensure standardization of techniques, and modifying current sampling protocols.

  - Establish internal and external research priorities, review research titles for relevance against priorities, and recommend research approaches.

- Members are Douglas Cuddy (chair) and Paul Sullivan, Department of Fisheries and Oceans Canada; Michael Fodale, John Heinrich, Katherine Mullett, and Jeffrey Slade, U.S. Fish and Wildlife Service; Bill Swink and Jean Adams, U.S. Geological Survey- Biological Resources Division; Bill Mattes, lake technical committee representative, Great Lakes Indian Fish and Wildlife Commission; Mike Jones, Michigan State University; and Gavin Christie and Robert Young, Great Lakes Fishery Commission.

- Meetings were held during March 5-6 and September 16-17.

- Progress on charges:

  - Developed projections of transformer production and submitted TFM treatment recommendations for the 1999 field season to the Program Integration Working Group.

  - Completed review of the St. Marys River Assessment Plan (SMRAP) by external review panel and implemented some of the recommendations during the 1998 St. Marys Assessment strategy. Plans to measure the efficacy of the proposed 1999 Bayluscide treatment and enhanced sterile male release are being developed.

  - In cooperation with the Secretariat and IMSL contractor, developed the Empiric Stream Treatment Ranking Model (ESTR). ESTR uses larval assessment catch and habitat data, stream specific growth and transformation models along with treatment cost and resources available to estimate transformer production and rank streams for lampricide treatment.

- Implemented several recommendations of the adult assessment review panel including redistribution of trapping effort from small to large streams, estimation of the parasitic population in Lake Huron by marking and releasing parasitic lampreys (n = 775) into the lake, and estimation of the transformer population in Lake Superior by marking and releasing transformers into 9 tributary streams (n = 1,038).

- Completed a pilot telemetry study to investigate spawning sea lamprey movement in the Spanish River (Lake Huron).

- Conducted joint Service and Department training in habitat classification.

- Updated and prioritized a list of 23 proposed research topics.

LAMPRICIDE CONTROL TASK FORCE

- Task Force established during December 1995.

- Purposes of Task Force:

  - Improve the efficiency of lampricide control to maximize the numbers of sea lampreys killed in stream and lentic area treatments while minimizing lampricide use, costs, and impacts on stream and lake ecosystems

  - Define lampricide control options for near and long-term stream selection and target setting

- Members are Terry Morse (Chair), Dorance Brege, David Johnson, Dennis Lavis, and Alex Gonzalez, U.S. Fish and Wildlife Service; Larry Schleen, Brian Stephens, and Wayne Westman, Department of Fisheries and Oceans Canada; Robert Young, Great Lakes Fishery Commission Secretariat; and Terry Bills and Ronald Scholefield, U.S. Geological Survey-Biological Resources Division.

- Meetings held on February 24-25 and September 10.

- Progress on lampricide savings options during 1998:

  - Control agents continue to implement the options for reducing the annual use of lampricide. The options continue to contribute toward achieving the Commission's vision of a 50% reduction of lampricide use by 2000.

  - The use of Bayluscide 70% wettable powder was restricted until late summer in Canada by legal questions and in the United States by low stream discharge and concerns for nontarget species. The use of Bayluscide was deferred during treatment of the AuSable River to protect young-of-the-year lake sturgeon. The deferral increased the use of TFM by nearly 3,100 kg active ingredient, valued at approximately $200,000.

  - Treatment of the Manistee River (Lake Michigan) was conducted by Service personnel from the Ludington and Marquette Biological Stations, and Department personnel from the Sea Lamprey Control Centre. The combined effort saved an estimated $245,000 in lampricide. The Whitefish River (Lake Michigan) was treated in a single 10-day trip by personnel from the Marquette and Ludington Biological Stations. This effort saved nearly $7,000 in lampricide.

- Tactical/operational Planning

  - The international effort to develop a manual of unified procedures for chemical control of sea lampreys is nearing completion. Final review of the manual, "Standard operating procedures for application of lampricides in the Great Lakes Fishery Commission integrated management of sea lamprey (Petromyzon marinus) control program" will begin during April 1999.

  - Protocols for the handling and storage of lampricide standards have been developed. The function of the protocols (now in review) is to assure the validity of the standards on which all analyses of lampricides are based.

  - Liability issues prevented Service treatment personnel from working in Canada during 1998. Information was provided to a Canadian insurance underwriter who developed an estimate of cost for a policy covering liability of Service personnel who work in Canada.

- Research:

  - Research projects and proposals for 1999-2001 were reviewed and prioritized. A study on the toxicity of lampricides to lake sturgeon was identified as a critical need. The first phase of the study was completed in 1998 and additional work is scheduled for 1999.

  - A study on storage stability of standards used in a new method of analysis for TFM was identified as a high priority internal research need.

OUTREACH 1998

Activity or event	Number of Occurrences U.S.	Number of Occurrences Canada	Staff Days U.S.	Staff Days Canada
School presentations	36	14	29	4
Sports shows	6	6	43	66
Youth fishing	1	1	3	2
Civic groups	6	2	5	8
Media interviews	30	11	2	3
Media mailings/Electronic mail	774	353	18	12
Station public display	4	2	31	6
Miscellaneous	20	24	13	13
Total	877	413	144	114
Combined	1,290		258	

PERMANENT EMPLOYEES OF THE SEA LAMPREY MANAGEMENT PROGRAM

U.S. Fish and Wildlife Service

Gerald T. Klar, Field Supervisor
Marquette Biological Station

Control Supervisor: Terry J. Morse

Chemist: David Johnson

Biologist:
- Dorance Brege, Treatment Supervisor
- Darrian Davis
- Joseph Genovese

Lead Physical Science Technician:
- Robert Wootke

Physical Science Technician:
- Timothy Peiffer
- Michael St. Ours
- Kelley Stanley

Administration Supervisor: Nadine Seeke
- Mary Jo Buckett
- Steven Dagenais
- Pauline Hogan
- Gloria Hoog
- Betty L'Huillier

Assessment Supervisor: John W. Heinrich

Biologist:
- Michael Fodale, Larval Supervisor
- Katherine Mullett, Adult Supervisor
- Michael Twohey, Sterile Male Supervisor
- John Weisser, Risk Assessment Supervisor
- Mary Henson
- Cheryl Kaye
- Dale Ollila

Biological Science Technician:
- Gregg Baldwin
- Gregory Klingler
- Kyle Krysiak
- Geraldine Larson
- Mark McNeill
- Deborah Winkler
- Michelle Zastrow

ADP Supervisor: Larry Carmack
- Robert Kahl
- Deborah Larson

Ludington Biological Station
Dennis S. Lavis, Station Supervisor

Barrier Coordinator: Ellie Koon

Biologist:
- Alex Gonzalez, Treatment Supervisor
- Kathy Hahka

Lead Physical Science Technician:
- Jeffrey Sartor

Physical Science Technician:
- Kevin Butterfield
- Tim Sullivan

Computer Assistant: Barry Matthews

Biologist:
- Jeffrey Slade, Larval Supervisor
- Sidney Morkert

Biological Science Technician:
- David Keffer
- Lois Mishler

Administration Support:
- Robert Anderson
- Linda Krupinski
- Tana Reimer

Department of Fisheries and Oceans
Sea Lamprey Control Centre - Sault Ste. Marie, Ontario Canada

Control Supervisor: Larry P. Schleen

Biologist:
- R. Wayne Westman, Treatment Supervisor

Technicians:
- Ed Achtemichuk
- Jamie Smith
- Randy Stewart

Finance & Administration: Jackie Bassett

Accounts Clerk: Lisa Vine

Administrative Support:
- Tina Berry*
- Christine Youngson
- John Graham*

Assessment Supervisor: Douglas W. Cuddy

Biologist:
- Rod McDonald, Adult Assessment Supervisor
- Brian Stephens, Larval Assessment Supervisor
- Jerry Weise, Quantitative Assessment Supervisor
- Paul Sullivan, Lower Lakes Assessment Supervisor

Technicians:
- Robert Bouchard
- Mike MacKenna
- Mike Steeves*

Barrier Coordinator: Tom McAuley

Barrier Assistant, Andrew Hallett*

Property & Contract Manager: David Haight

Storeperson: William Green

Maintenance Supervisor: Dave Reid
- Maintenance Assistant, Brian Greene*

*Continuing GLFC