# INTEGRATED MANAGEMENT OF SEA LAMPREYS IN LAKE SUPERIOR 2002

Report to
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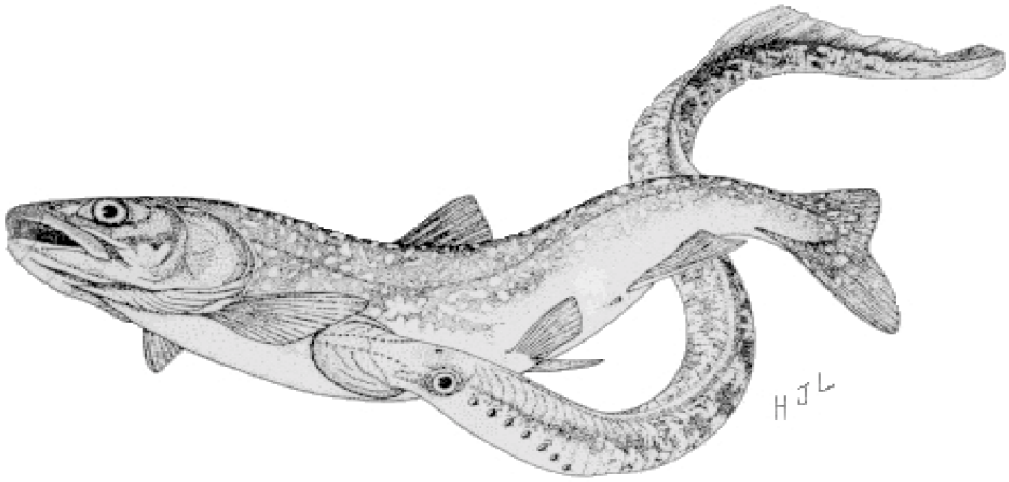

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## INTRODUCTION

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 current target statements and to develop common target formats for each of the lakes. 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. 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 cooperation of state, provincial, and tribal agencies continues to be critical to the success of all aspects of the control program. For example, in collaboration with the State of Michigan the agents employed stream treatment methods that provided the best possible suppression of sea lampreys while protecting critical lake sturgeon populations.

This report presents the actions of the Service and Department in the integrated management of sea lampreys in Lake Superior during 2002. 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, in its "Strategic Vision for the First Decade of the New Millennium," identified milestones that included:

*Accomplish at least 50% of sea lamprey suppression with alternative technologies while reducing TFM use by 20%.*

The pesticide 3-trifluoromethyl-4-nitrophenol (TFM) has been used as a management tool to control larval sea lamprey in the Great Lakes since 1958. In the past decade, the Service and Department have reduced the dependency on TFM through the development and implementation of alternative controls, the refinement of assessment procedures, and improvement of application techniques to more efficiently treat tributaries. The use of TFM has decreased 35% from an annual average of 55,169 kg active ingredient from 1986 through 1990 to an annual average of 35,687 kg active ingredient from 1998 through 2002.

## FISH COMMUNITY OBJECTIVES

In the 2001 Fish Community Objectives, the Lake Superior Committee established the target for sea lamprey management in Lake Superior as:

*Suppress sea lampreys to population levels that cause only insignificant mortality on adult lake trout.*

The management objective for sea lampreys defines 'insignificant mortality' as a level of sea lamprey abundance that accounts for less than 5% of the annual lake trout mortality in Lake Superior. Currently, sea lamprey-induced mortality on lake trout is estimated as 12% of the annual total.

The desired level of sea lamprey abundance is unlikely to be achieved through the increased use of TFM, as all sea lamprey producing tributaries to Lake Superior are currently being treated. A cost-benefit analysis indicates that an increase in the number of stream treatments will result in a relatively small decline in lake-wide lamprey abundance.

Instead, efforts are being directed towards an increase in assessment and control of lentic populations, an increase in number of lamprey barriers, and investment in new technologies such as pheromone-based control. These additional methods will be combined with continued TFM treatment to further suppress sea lamprey populations in Lake Superior.

## TRIBUTARY INFORMATION

- Lake Superior has 1,566 (733 U.S., 833 Canada) tributaries.
- 139 (92 U.S., 47 Canada) tributaries have historical records of production of sea lamprey larvae.
- 68 (39 U.S., 29 Canada) tributaries have been treated with lampricides at least once during 1993-2002.
- Of these, 52 (32 U.S., 20 Canada) tributaries are treated on a regular 3-5 year cycle.

## LAMPRICIDE CONTROL

Lampricide treatments are systematically scheduled for tributaries harboring larval sea lampreys to eliminate or reduce the populations of larvae before they recruit to the lake as parasitic adults. Service and Department treatment units administer and monitor doses of the lampricide TFM, sometimes augmented with Bayluscide 70% Wettable Powder, 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 non target organisms.

The following statements highlight the lampricide control program for Lake Superior during 2002. Table 1 provides details on the application of lampricides to tributaries treated during 2002 and Fig. 1 shows the locations of the tributaries.

- Treatments with TFM were completed in 14 tributaries (11 U.S., 3 Canada).

- Treatment effectiveness studies were conducted in 2 U.S. tributaries.

- The interim protocol for application of lampricides to streams with populations of young-of-year lake sturgeon was followed during treatment of the Tahquamenon River. The protocol limits the concentrations of TFM and Bayluscide 70% Wettable Powder to 1.2 times minimum lethal concentration (MC: concentration required to kill99.9% of sea lampreys in a 12-hour treatment) to protect young-of-year lake sturgeon.

- Rainfall during treatment of the Firesteel River tripled stream discharge and made maintenance of effective lampricide concentrations difficult. Some troutperch and longnose dace were killed in the west branch of the river and a 6(a)2 report was filed with the Environmental Protection Agency (EPA).

- Rainfall during treatment of the Rock River increased stream discharge significantly. Maintenance of effective lampricide concentrations was difficult, however, the high discharge allowed coverage of areas normally hard to reach and treat effectively.

- Wet weather during the spring and fall also produced higher-than-normal stream discharge during treatments of the Silver, Traverse, and Trap Rock rivers. This resulted in greater-than-normal use of TFM in these treatments.

- Great numbers of transformed larvae were observed during treatment of the Chocolay and Kaministiquia rivers. In addition, significant numbers of large (>120 mm) larvae were observed during treatments of the Sucker, Little Garlic, Trap Rock, and Traverse rivers, and Harlow Creek. These observations support the quantitative assessment projection for these tributaries.

- Treatments of all Canadian tributaries were considered successful with the exception of the Pays Plat River. Heavy rains reduced treatment effectiveness in about 40% of the total treatment distance.

**Table 1. Details on the application of lampricides to tributaries of Lake Superior, 2002**
(Number in parentheses corresponds to location of stream in Fig. 1.)

| Stream | Date | Flow ($m^3/s$) | TFM (kg)[1,2] | Bayluscide (kg)[1] | Distance treated (km) |
|---|---|---|---|---|---|
| **United States** | | | | | |
| Middle R. (14) | Jun 8 | 0.3 | 90.8 | 0 | 37.0 |
| Firesteel R. (13) | Jun 21 | 3.5 | 418.5 | 0 | 57.9 |
| Harlow Cr. (8) | Jul 3 | 0.7 | 75.8 | 0 | 11.3 |
| Rock R. (6) | Jul 8 | 1.4 | 213.0 | 0 | 24.1 |
| L. Garlic R. (9) | Aug 29 | 0.1 | 22.5 | 0 | 8.0 |
| Chocolay R. (7) | Sep 1 | 3.5 | 410.3 | 1.6 | 40.2 |
| Tahquamenon R. (4) | Sep 13 | 9.1 | 612.8 | 8.9 | 9.7 |
| Sucker R. - lower (5) | Sep 16 | 1.7 | 216.8 | 0 | 9.7 |
| Silver R. (10) | Oct 10 | 5.4 | 248.3 | 0 | 8.0 |
| Traverse R. (12) | Oct 11 | 0.5 | 11.3 | 0 | 4.8 |
| Trap Rock R. (11) | Oct 14 | 1.1 | 198.0 | 0 | 14.5 |
| Total | | 27.3 | 2,518.1 | 10.5 | 225.2 |
| **Canada** | | | | | |
| Goulais R. (3) | Jun 20 | 7.1 | 845.6 | 0 | 105.0 |
| Kaministiquia R. (1) | Aug 9 | 31.0 | 2,687.1 | 22.0 | 70.4 |
| Pays Plat R. (2) | Aug 17 | 5.3 | 261.0 | 0 | 8.6 |
| Total | | 43.4 | 3,793.7 | 22.0 | 184.0 |
| **Grand Total** | | **70.7** | **6,311.8** | **32.5** | **409.2** |

[1]Lampricide quantities are in kg of active ingredient.

[2]Includes a total of 5.33 TFM bars (1.0 kg of active ingredient) applied in 2 streams

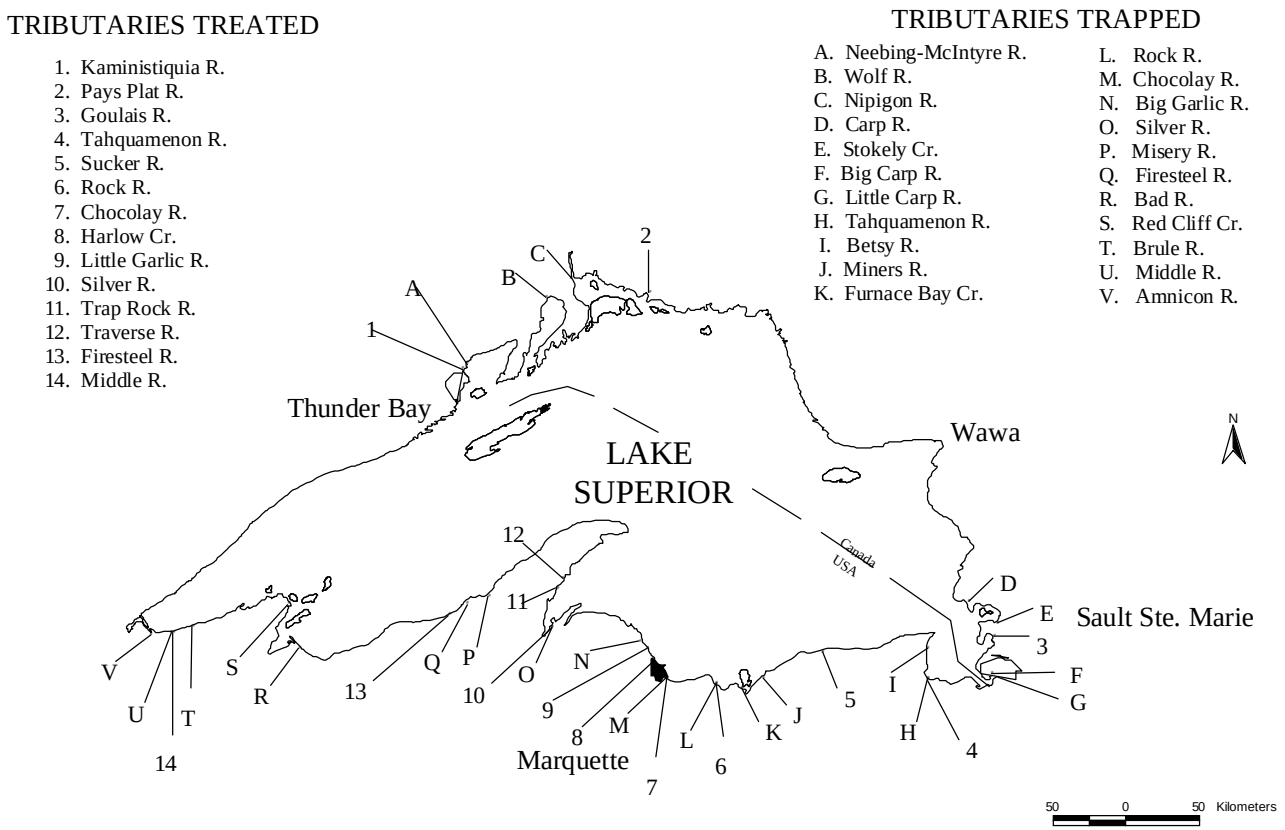


Fig. 1. Locations of Lake Superior tributaries treated with lampricides (Numbers, Table 1) and tributaries where assessment traps were operated during 2002 (Letters, Table 3).

## ALTERNATIVE CONTROL

### Sterile Male Release Technique

Research into the sterile male release technique (technique) in sea lamprey control began during 1971. The technique was experimentally implemented in Lake Superior and in the St. Marys River during 1991-1996. The technique was refocused for exclusive use in the St. Marys River after 1996.

Male sea lampreys are captured during their spawning migrations in 20 tributaries to lakes Superior, Michigan, Huron, and Ontario, and the St. Marys River and transported to the sterilization facility (facility) at the Hammond Bay Biological Station. At the facility sea lampreys are sterilized with the chemosterilant bisazir, decontaminated, and released into the St. Marys River. Laboratory and field studies have shown that treated male sea lampreys are sterile, and sexually competitive, and that the numbers of eggs hatched in nests are reduced.

- A total of 2,408 spawning-phase male sea lampreys were transported to the sterilization facility during May 21-June 26 from trapping operations on the Rock (266), Misery (96), Brule (175), and Middle (1,871) rivers.

### Barriers

In its *Strategic Vision for the First Decade of the New Millennium*, the Commission committed to implementing an integrated control program that relying on alternative control methods to achieve 50 percent of lamprey suppression. Barriers are currently the only proven alternative control method. Presently, there are 16 barriers on Lake Superior tributaries (Fig. 2).

The sea lamprey management program benefits substantially from a number of dams built and operated for other purposes. A Geographic Information System (GIS) inventory of these “de-facto” barriers has been initiated. This will be a useful tool in identifying dams of value to sea lamprey management and tracking a growing number of barrier mitigation proposals that have potentially serious consequences to the Great Lakes fishery. The inventory is complete or nearing completion for Michigan, and Wisconsin.

- Little Carp River - Construction of the barrier was completed in March. Revisions to the final site and access road were completed in June.

- Big Carp River - Technical support and engineering support were provided for the first year of the fishway performance and telemetry study. The study is being conducted by the Great Lakes Laboratory for Fishery and Aquatic Sciences.

- Pine River - An all-purpose exotic species barrier was constructed by the Huron Mountain Club. Sea lamprey barrier staff provided technical support.

- Misery River - The barrier is now functioning to block sea lampreys. A perpetual easement for additional crest height was secured with the assistance of the Michigan Department of Natural Resources.

- Sheppard Creek (Goulais River) - The remote barrier is in poor condition and no longer blocks sea lampreys. The decommissioning of this structure was recommended.

- Furnace Creek - Construction of the barrier was deferred due to withdrawal of State funds from the Clean Michigan Initiative. The Alger County Soil Conservation District was to use the funds for purchasing real estate, engineering and permitting. Funding may be restored during 2003.

- Stokely Creek - A structural engineering inspection at the barrier revealed numerous perforations of the sheet piling and significant corrosion between the water line and the crest. Deflection of the barrier was temporarily stabilized by infilling the tailrace with large rip-rap, however, corrosion must be addressed. Alternatives include repair, replacement, or decommissioning.

- Wolf River - A retroactive application under the Navigable Waters Protection Act was submitted for the sea lamprey barrier.

- In an effort to provide three additional miles of habitat for coaster brook trout, a cooperative project among the Service-Ashland Fishery Resources Office, the Minnesota Department of Transportation, and Grand Portage Tribe resulted in construction of a fish passage in a culvert in Grand Portage Creek. Sea lampreys have not previously reproduced downstream of the culvert.

TRIBUTARIES WITH BARRIERS

1. McIntyre R.
2. Wolf R.
3. Black Sturgeon R.
4. Gimlet Cr. (Pancake R.)
5. Carp R.
6. Stokely Cr.
7. Sheppard Cr. (Goulais R.)
8. Big Carp R.
9. Little Carp R.
10. Betsy R.
11. Miners R.
12. Pine R.
13. Misery R.
14. Iron R.
15. Brule R.
16. Middle R.

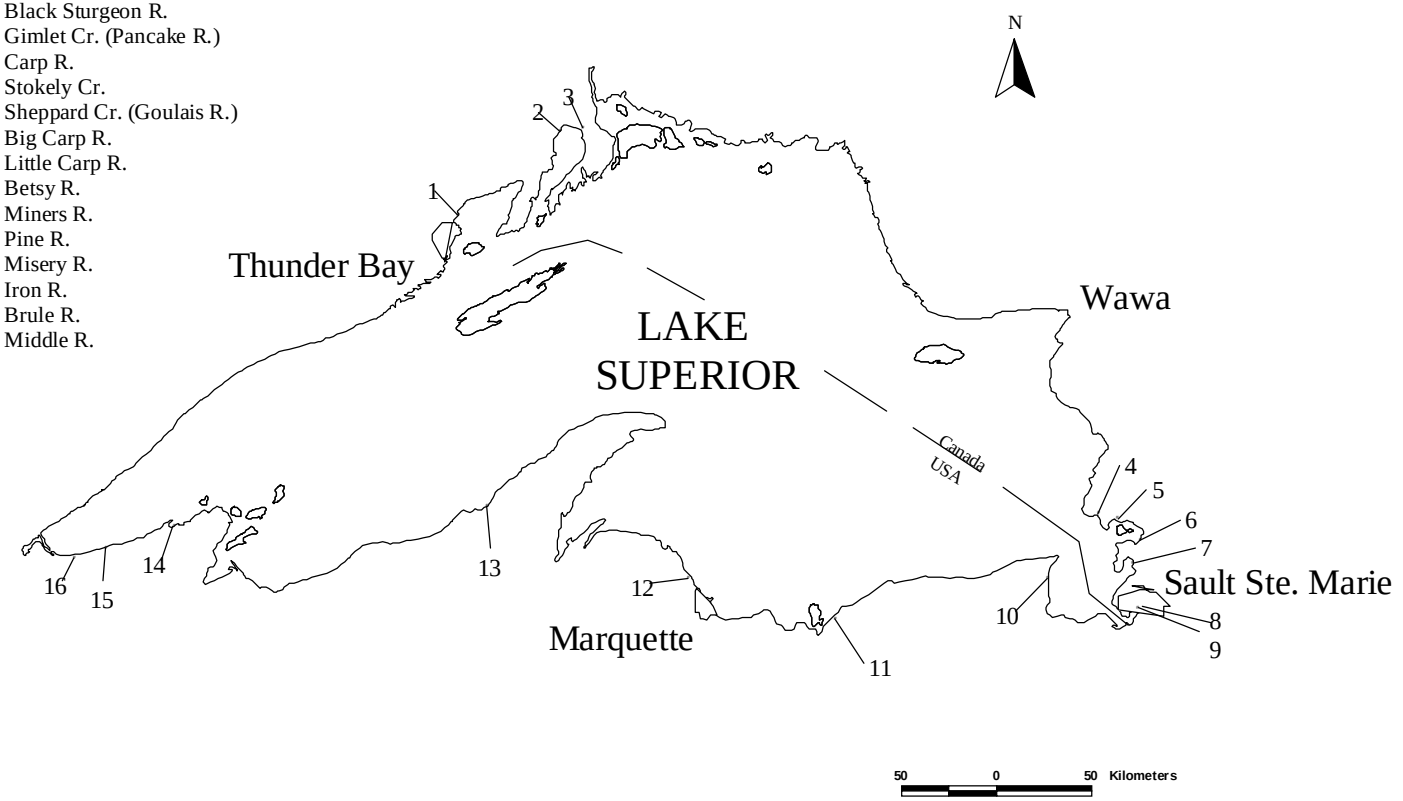


Fig. 2. Locations of Lake Superior tributaries with sea lamprey barriers.

## ASSESSMENT

### Larval

Tributaries to the Great Lakes are systematically assessed for abundance and distribution of sea lamprey larvae. Quantitative estimates of the number of metamorphosing lampreys that will leave individual tributaries the following year are used to prioritize streams for lampricide treatment. Qualitative sampling is used to define the distribution of sea lampreys within a stream and to establish the sites for lampricide application.

Tributaries considered for lampricide treatment during 2003 were assessed during 2002 to estimate larval density and amount of suitable larval habitat. Assessments were conducted with backpack electrofishers in waters <1m deep. Waters >1m in depth were surveyed with deepwater electrofishers or the Bayluscide 3.2% Granular Sea Lamprey Larvicide. Survey plots were randomly selected in each tributary, catches of larvae were adjusted for gear efficiency, and lengths were standardized to the end of the growing season. Populations of larvae in each tributary were estimated by multiplying the mean density of larvae (number per $m^2$) by an estimated area of suitable habitat ($m^2$). The probable number of larvae that would metamorphose into parasitic sea lampreys during 2003 was developed from historical relations of the proportion of metamorphosed sea lampreys to larval sea lampreys collected during previous lampricide applications. After the data was processed, tributaries were ranked for treatment during 2003 based on an estimated cost per kill of metamorphosed sea lampreys

- Assessments of populations of sea lamprey larvae were conducted in 113 tributaries (37 U.S., 76 Canada) and offshore of 6 tributaries (3 U.S., 3 Canada). The status of larval sea lamprey populations in streams treated during the last 10 years is presented in Table 2.

- Populations were estimated in 38 tributaries (20 U.S., 18 Canada; Table 2).

- Post-treatment quantitative assessments were conducted in 2 U.S. tributaries to determine the effectiveness of lampricide treatments during 2002.

- 51 non-producing tributaries were assessed along the Canadian shoreline of Lake Superior. No sea lamprey producers were found.

- Efforts were made to pinpoint the source of increased wounding in Thunder and Nipigon bays. The Kaministiquia River was the likely source in Thunder Bay. Treatment of the river in August 2002 produced numerous metamorphosing larvae. The source of the wounding in Nipigon Bay is believed to be the Nipigon River system which includes Helen Lake.

**Table 2. Status of Lake Superior tributaries that have been treated for sea lamprey larvae during 1993-2002, and sea lamprey population estimates for tributaries surveyed during 2002.**

| Tributary | Last Treated | Last Surveyed | Residuals Found | Oldest Reestablished Year Class | Estimate of 2002 Larval Population | 2003 Metamorphosing Estimate | On 2003 Treatment Schedule |
|---|---|---|---|---|---|---|---|
| **United States** | | | | | | | |
| Waiska R. | Sep-01 | 2002 | Yes | 2001 | - | - | No |
| Grants Cr. | Jul-63 | 2002 | No | 1999 | 1,344 | 0 | No |
| Ankodosh Cr. | Jul-73 | 2002 | No | 1999 | 1,801 | 0 | No |
| Roxbury Cr.[1] | Never | 2002 | No | 1999 | 1,903 | 0 | No |
| Tahquamenon R. - Upper Pools | Sep-02 | 2000 | - | - | - | - | No |
| Dead Sucker R. | Jul-75 | 2002 | - | 1998 | - | - | No |
| Betsy R. | Jul-00 | 2000 | - | - | - | - | No |
| Little Two Hearted R. | Jul-00 | 2000 | - | - | - | - | No |
| Two Hearted R. | Sep-99 | 1998 | - | - | - | - | No |
| Sucker R. (Alger) - Lower | Sep-02 | 2001 | - | - | - | - | No |
| Chipmunk Cr. | May-98 | 2000 | No | None | - | - | No |
| Carpenter Cr. | May-98 | 2000 | Yes | 1998 | - | - | No |
| Sullivans Cr.[1] | Jul-87 | 2002 | - | 1999 | 2,024 | 0 | No |
| Miners R. | Jun-98 | 2002 | No | 1999 | 4,492 | 2 | No |
| Furnace Cr.[2] | Aug-93 | 2001 | - | 1998 | - | - | No |
| Five Mile Cr. | Oct-98 | 2001 | No | 1999 | - | - | No |
| Au Train R. (Lower R.) | Aug-97 | 2001 | - | 1998 | - | - | No |
| Au Train R. (Upper R. & Tribs.)[2] | Sep-01 | 2000 | - | - | - | - | No |
| Rock R. | Jul-02 | 2001 | - | - | - | - | No |
| Laughing Whitefish R. | Jun-98 | 2002 | No | 1999 | 1,353 | 31 | No |
| Chocolay R.[3] | Sep-02 | 2002 | Yes | - | - | - | No |
| Carp R. | Jul-01 | 2002 | Yes | 2001 | 30,940 | 945 | Yes |
| Dead R.[1] | Sep-84 | 2002 | - | 1998 | 137,935 | 376 | Yes |
| Harlow Cr. | Jul-02 | 2002 | - | - | 866 | 92 | No |
| Little Garlic R.[3] | Aug-02 | 2002 | - | - | - | - | No |
| Big Garlic R. | Aug-00 | 2002 | Yes | 2000 | 61,904 | 2,837 | Yes |
| Iron R. | Jul-01 | 2000 | - | - | - | - | No |
| Salmon Trout R. (Marquette) | Jul-00 | 2001 | Yes | None | - | - | No |
| Pine R.[1] | Oct-87 | 2002 | - | 1998 | 7,582 | 0 | No |
| Huron R. | Jul-01 | 2001 | - | - | - | - | No |
| Ravine R.[2] | Sep-98 | 2002 | Yes | 1998 | 18,789 | 62 | Yes |
| Silver R.[2,4] | Oct-02 | 2001 | - | - | - | - | Yes |
| Falls R. | Sep-97 | 2002 | - | 1999 | - | - | No |
| Sturgeon R. | Aug-01 | 2002 | Yes | 2001 | 245 | 0 | No |
| Trap Rock R. | Oct-02 | 2001 | - | - | - | - | No |
| Traverse R. - Upper | Oct-02 | 2001 | - | - | - | - | No |
| Eliza Cr. | Oct-77 | 2002 | - | 1999 | 4,618 | 16 | No |
| Big Gratiot R. | Jun-84 | 2002 | - | 1999 | 26,887 | 72 | No |
| Salmon Trout R. (Houghton) | Aug-92 | 2002 | - | 1999 | - | - | No |
| Misery R. | Sep-00 | 2002 | Yes | 2000 | 4,648 | 3 | No |
| East Sleeping R. | Oct-99 | 2001 | Yes | 1999 | - | - | No |
| Firesteel R. | Jun-02 | 2002 | - | - | 3,031 | 497 | No |

**Table 2. continued**

| Tributary | Last Treated | Last Surveyed | Residuals Found | Oldest Reestablished Year Class | Estimate of 2002 Larval Population | 2003 Metamorphosing Estimate | On 2003 Treatment Schedule |
|---|---|---|---|---|---|---|---|
| Ontonagon R. | May-01 | 2002 | Yes | 2001 | - | - | No |
| Potato R. | Jun-01 | 2001 | - | - | - | - | No |
| Cranberry R. | Jun-01 | 2001 | Yes | 2001 | 4,232 | 0 | No |
| Bad R. | Sep-01 | 2002 | Yes | 2001 | 72,339 | 3,798 | Yes[5] |
| Red Cliff Cr. | Jun-01 | 2001 | Yes | 2001 | - | - | No |
| Brule R. | Jun-01 | 2001 | - | - | - | - | No |
| Poplar R. | Oct-96 | 2002 | - | 1999 | 48,997 | 1,831 | Yes |
| Middle R. | Jun-02 | 2001 | - | - | - | - | No |
| Amnicon R. | Jun-01 | 2001 | - | - | - | - | No |
| Nemadji- South Fork & Net R. | May-90 | 2001 | - | 1999 | - | - | No |
| Nemadji- Black R. | Sep-00 | 2001 | Yes | 1999 | - | - | No |
| **Canada** | | | | | | | |
| Little Carp R. | Sep-01 | 2001 | - | - | - | - | No |
| Big Carp R. | Sep-01 | 2002 | Yes | None | 8,356 | 99 | No |
| Goulais R. | Jul-02 | 2002 | Yes | None | - | - | No |
| Stokely Cr. | Sep-00 | 2002 | Yes | None | 4,475 | 63 | No |
| Chippewa R.[2] | Jul-98 | 2002 | No | 1999 | 5,401 | 129 | No |
| Batchawana R.[2] | Oct-98 | 2002 | Yes | 1999 | 503,411 | 727 | Yes |
| Carp R. | Sep-00 | 2002 | Yes | 2001 | 10,284 | 1,296 | Yes |
| Pancake R. | Jul-98 | 2002 | Yes | 1999 | 69,149 | 88 | No |
| Agawa R. | Jul-01 | 2001 | - | - | - | - | No |
| Gargantua R. | Aug-99 | 2001 | Yes | 2000 | - | - | No |
| Michipicoten R.[6] | Aug-99 | 2002 | Yes | 2000 | - | - | No |
| White R. [1] | Sep-88 | 2002 | No | 1999 | 22,153 | 16 | No |
| Pic R. | Sep-97 | 2001 | No | 1998 | - | - | No |
| Little Pic R. | Sep-94 | 2001 | Yes | 1995 | - | - | No |
| Prairie R. | Jul-94 | 2002 | - | 1998 | - | - | No |
| Steel R. | Jul-01 | 2000 | - | - | - | - | No |
| Pays Plat R. | Aug-02 | 2001 | - | - | - | - | No |
| Little Pays Plat R. | Never | 2002 | No | 1998 | 4,123 | 3 | No |
| Gravel R.[2] | Aug-98 | 2002 | Yes | 1999 | 138,480 | 33 | No |
| Mountain Bay-Gravel R. | Jul-00 | 2002 | - | - | - | - | No |
| Little Gravel R.[2] | Jul-95 | 2002 | No | 1995 | 68,397 | 941 | Yes |
| Cypress R. | Aug-99 | 2002 | Yes | 2000 | 30,272 | 414 | Yes |
| Jackfish R. | Jul-00 | 2002 | - | - | - | - | No |
| Nipigon R. | | | | | | | |
| Upper[2] | Sep-99 | 2002 | Yes | None | 191,470 | 1,388 | Yes |
| Cash Cr. | Jul-96 | 2002 | No | 1996 | 184,151 | 457 | Yes |
| Stillwater Cr. | Jul-96 | 2002 | No | 1996 | 596 | 21 | No |
| Black Sturgeon R. | Aug-99 | 2000 | Yes | None | - | - | No |
| Wolf R. | | | | | | | |
| Above Barrier | Sep-00 | 2002 | Yes | None | 11,972 | 1,492 | Yes |
| Below Barrier | Sep-00 | 2001 | Yes | 2001 | - | - | Yes |

**Table 2. continued**

| Tributary | Last Treated | Last Surveyed | Residuals Found | Oldest Reestablished Year Class | Estimate of 2002 Larval Population | 2003 Metamorphosing Estimate | On 2003 Treatment Schedule |
|---|---|---|---|---|---|---|---|
| Pearl R. | Jul-91 | 2000 | - | 1999 | - | - | No |
| McIntyre R. | Aug-97 | 2002 | Yes | 1998 | 2,134 | 43 | No |
| Neebing R. | Jul-94 | 2002 | No | None | - | - | No |
| Kaministikquia R. | Aug-02 | 2002 | Yes | - | - | - | No |
| Cloud R. | Jul-94 | 2002 | No | 1998 | 988 | 194 | No |
| Pigeon R. | Aug-99 | 2002 | Yes | None | 2,828 | 0 | No |

[1]Not treated during the past 10 years, but quantitative larval surveys were conducted during 2000-2002.
[2]Stream has a known lentic population.
[3]Quantitative assessment conducted prior to treatment during 2002.
[4]Lentic population was assessed during 2002.
[5]Upper Marengo River only.
[6]Assessed as part of sampling efficiency study during 2002.

**Spawning-phase**

The long-term effectiveness of the control program has been measured by the annual estimation of the lake-wide abundance of spawning-phase sea lampreys. Traps and nets were used to capture migrating spawning-phase sea lampreys during the spring and early summer. Lakewide abundance has been estimated since 1986 from a combination of mark-recapture estimates in streams with traps and model-predicted estimates in streams without traps.

- 7,799 sea lampreys were trapped in 21 tributaries during 2002 (Table 3, Fig. 1).

- The estimated population of spawning-phase sea lampreys for 2002 was 110,391 (42,806 western U.S. and 67,585 eastern U.S. and Canada; $r^2$=0.54).

- No significant trend (Fig. 3) was detected from a linear regression of spawner abundance during 1983-2002 (p=0.618). Lake Superior estimates (1983-2002) were recalculated with additional data that accounted for sea lampreys introduced in seven tributaries for research studies from 1983-2002.

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

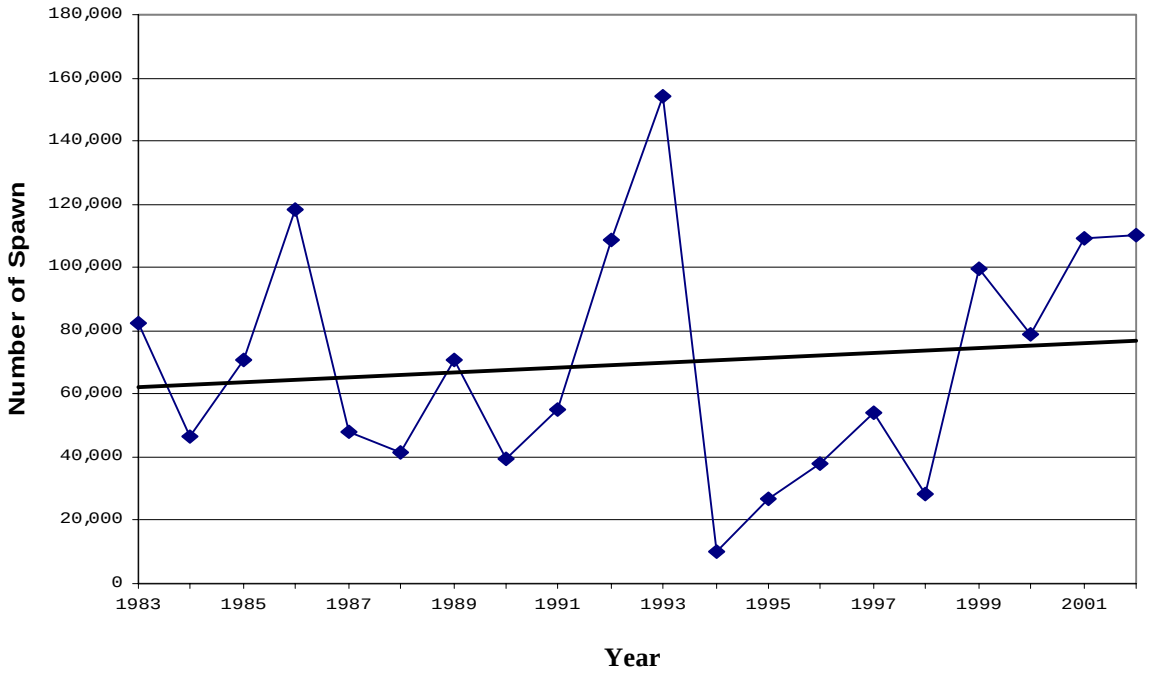


Fig. 3. Trendline of the linear regression of spawner abundance for Lake Superior, 1983-2002.

**Table 3. 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, 2002.** (Letters in parentheses corresponds to location of stream in Fig. 1.)

| Stream | Number caught | Spawner estimate | Trap efficiency | Number sampled[1] | Percent males | Mean Length (mm) Males | Mean Length (mm) Females | Mean Weight (g) Males | Mean Weight (g) Females |
|---|---|---|---|---|---|---|---|---|---|
| **United States** | | | | | | | | | |
| Tahquamenon R. (H) | 411 | 6,025 | 7 | 20 | 60 | 434 | 424 | 175 | 174 |
| Betsy R. (I) | 599 | 8,943 | 7 | 41 | 68 | 441 | 427 | 168 | 190 |
| Miners R. (J) | 39 | --- | --- | 0 | --- | --- | --- | --- | --- |
| Furnace Bay Cr. (K) | 30 | 68 | 44 | 9 | 56 | 428 | 451 | 186 | 225 |
| Rock R. (L) | 828 | 1,367 | 61 | 91 | 45 | 437 | 435 | 194 | 199 |
| Chocolay R. (M) | 277 | 2,825 | 10 | 18 | 64 | 454 | 442 | 214 | 200 |
| Big Garlic R. (N) | 64 | 424 | 15 | 4 | 50 | 435 | 490 | 230 | 285 |
| Silver R. (O) | 7 | --- | --- | 0 | --- | --- | --- | --- | --- |
| Misery R. (P) | 463 | 602 | 77 | 107 | --- | 401 | 417 | 148 | 161 |
| Firesteel R. (Q) | 90 | 212 | 42 | 21 | --- | 448 | 453 | 186 | 226 |
| Bad R. (R) | 1,039 | 13,678 | 8 | 233 | 52 | 416 | --- | 413 | --- |
| Red Cliff Cr. (S) | 7 | 24 | 29 | 1 | 100 | 390 | --- | 134 | --- |
| Brule R. (T) | 490 | 1,114 | 44 | 38 | 50 | 433 | 439 | 203 | 218 |
| Middle R. (U) | 2,624 | 3,327 | 79 | 325 | 49 | 419 | 419 | 171 | 189 |
| Amnicon R. (V) | 30 | 552 | 5 | 1 | 38 | 374 | --- | 132 | --- |
| **Total or Mean (South Shore)** | **6,998** | **39,161** | | **909** | **52** | **426** | **423** | **185** | **188** |
| **Canada** | | | | | | | | | |
| Neebing-McIntyre Floodway | | | | | | | | | |
| Neebing R. (A) | 108 | 204 | 53 | 0 | 61 | --- | --- | --- | --- |
| McIntyre R. (A) | 119 | 226 | 53 | 0 | 61 | --- | --- | --- | --- |
| Wolf R. (B) | 269 | 430 | 62 | 0 | 59 | --- | --- | --- | --- |
| Nipigon R. (C) | 1 | --- | --- | 0 | --- | --- | --- | --- | --- |
| Carp R. (D) | 238 | 619 | 38 | 0 | --- | --- | --- | --- | --- |
| Stokely Cr. (E) | 46 | 91 | 51 | 0 | --- | --- | --- | --- | --- |
| Big Carp R. (F) | 16 | --- | --- | 0 | 40 | --- | --- | --- | --- |
| Little Carp R. (G) | 4 | --- | --- | 0 | 100 | --- | --- | --- | --- |
| **Total or Mean (North Shore)** | **801** | **1,570** | | **0** | **59** | **---** | **---** | **---** | **---** |
| **Total or Mean (for lake)** | **7,799** | **40,731** | | **909** | **53** | **426** | **423** | **185** | **188** |

[1] The number of sea lampreys from which all length and weight measurements were determined.

**Parasitic-Phase**

The Michigan Department of Natural Resources provided data on the frequency of parasitic-phase sea lampreys attached to fish caught by sport charter boats during 2002.

- 19 sea lampreys attached to lake trout were collected from 2 management districts.
- Lampreys were attached at a rate of 0.45 per 100 lake trout (n = 4,230).
- The recapture of spawning-phase sea lampreys that were released as metamorphosing juveniles during 2000 was completed. Of 1,501 metamorphosing lampreys marked with coded wire tags and released, 11 (0.73%) were recaptured as spawning adults during 2002. A total of 6,343 (5,542 U.S.; 801 Canada) spawning-phase sea lampreys were scanned for coded wire tags in 16 (9 U.S.; 7 Canada) Lake Superior streams during 2002. The estimated abundance of 794,000 (491,000- 1,736,000) is a measure of the 2001 parasitic cohort.
- A total of 1,192 metamorphosing sea lampreys were marked with coded wire tags and released into Lake Superior tributaries during September and October, 2002. (Brule River-184, Misery River-228, AuTrain River-152, Two Hearted River-123, Chippewa River-102, Michipicoten River-102, Nipigon River-101, Wolf River-101, and McIntyre River-99). Recapture of these sea lampreys as spawning-phase adults will take place in 2004.

**Table 4. Lake-wide population estimates including 95% confidence intervals (CI) of metamorphosing, and spawning-phase sea lampreys in Lake Superior during 2000-2002.**

| Spawning year | Estimate of metamorphosing lampreys (thousands) | | | Estimate of spawning-phase lampreys (thousands) |
|---|---|---|---|---|
| | Population | Lower CI | Upper CI | |
| Lake Superior | | | | |
| 2000 | 564 | 419 | 846 | 79 |
| 2001 | 361 | 284 | 494 | 109 |
| 2002 | 794 | 491 | 1,736 | 110 |