SEA LAMPREY CONTROL IN THE GREAT LAKES 2020

ANNUAL REPORT TO
THE GREAT LAKES FISHERY COMMISSION

Jessica Barber
U.S. Fish and Wildlife Service
Marquette, Michigan
United States

Mike Steeves
Fisheries and Oceans Canada
Sault Ste. Marie, Ontario
Canada

Cover: Joe Hodgson (Department) checking the status of a trap on the Koshkawong River, a tributary of Lake Huron. Photo taken by Bruce Morrison (Department).

Report compiled by: Sam Hultberg, U.S.Fish and Wildlife Service, Marquette Biological Station

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Jessica Barber
United States Fish and Wildlife Service
Marquette, Michigan

Mike Steeves
Fisheries and Oceans Canada
Sault Ste. Marie, Ontario

EXECUTIVE SUMMARY

This report summarizes sea lamprey control operations conducted by Fisheries and Oceans Canada and the United States Fish and Wildlife Service in the Great Lakes during 2020, which were consistent with those prescribed in the Great Lakes Sea lamprey Control Plan (2011) to achieve sea lamprey abundance and marking targets. Lampricide treatments were conducted on 25 tributaries and 6 lentic areas. A total of 73 barriers, (47 purpose-built, 26 modified to serve as a sea lamprey barrier) were operated to block sea lamprey migration and serve as an alternative control to the use of lampricides. Larval assessment crews surveyed 84 Great Lakes tributaries and five lentic areas to assess control effectiveness, plan future lampricide treatments, and establish the capacity of streams to produce sea lampreys. Assessment traps were operated in 24 tributaries across the Great Lakes to estimate the index of adult sea lamprey abundance in each Great Lake.

Indices of adult sea lamprey abundance were evaluated relative to fish community objectives for each of the lakes. Indices of adult abundance could not be estimated for Lakes Superior and Michigan due to limitations on trapping operations due to COVID-19 travel restrictions. In Lake Huron, the index of adult abundance was estimated to be 65,280 (95% CI: 59,164 – 71,397), which was greater than the index target of 31,274. In Lake Erie, the index of adult abundance was estimated to be 1,340 (95% CI; 732 – 1,948), which was less than the target of 3,263. In Lake Ontario, the index of adult abundance was estimated to be 4,971 (95% CI; 3,704 – 6,237), which is less than the target of 14,065.

INTRODUCTION

The sea lamprey (*Petromyzon marinus*) is a destructive, invasive species in the Great Lakes that contributed to the collapse of lake trout (*Salvelinus namaycush*) and other native species in the mid-20th century and continues to impede efforts to restore and rehabilitate the fish community. Sea lamprey subsist on the blood and body fluids of large-bodied fish. It is estimated that about half of sea lamprey attacks result in the death of their prey and up to 18 kg (40 lbs) of fish are killed by every sea lamprey that reaches adulthood. The Sea Lamprey Control Program (SLCP) is administered by the Great Lakes Fishery Commission (Commission) and implemented by two control agents: Fisheries and Oceans Canada (Department) and the United States Fish and Wildlife Service (Service). The SLCP is a critical component of fisheries management in the Great Lakes because it facilitates the rehabilitation of important fish stocks by significantly reducing sea lamprey-induced mortality.

As part of *A Joint Strategic Plan for Management of Great Lakes Fisheries,* the lake committees developed fish community objectives for each of the Great Lakes. The fish community objectives include goals for the SLCP that, if achieved, should help establish and maintain self-sustaining stocks of lake trout and other salmonids by minimizing sea lamprey impacts on these stocks. This report outlines the program's efforts in 2020 to meet these goals.

FISH COMMUNITY OBJECTIVES

Each lake committee has identified qualitative goals for sea lamprey control, which are published in lake-specific fish community objectives. During 2004, each lake committee agreed to explicit sea lamprey suppression targets designed to meet their fish community objectives. In lakes Superior, Michigan and Erie, the targets were developed from a five-year period when sea lamprey marking rates resulted in a tolerable annual rate of sea lamprey induced lake trout mortality. A target of adult sea lamprey abundance was calculated for these lakes from the average index of abundance over a five-year period when marking rates were closest to 5 A1-3 marks per 100 lake trout >532 mm. Similarly, a target was developed for Lake Ontario from the estimated average abundance over a five-year period when marking rates were closest to 2 A1 marks per 100 lake trout >431 mm. In Lake Huron, the abundance target and range were calculated as 25% of the estimated average during the five-year period prior to the completion of the fish community objectives (1989–1993).

The annual performance of the SLCP is evaluated by comparing lake-specific adult sea lamprey abundance indexes and lake trout marking rates against established targets. Adult sea lamprey abundance indices are estimated by the Service and Department by tallying mark-recapture estimates from a sub-set of streams within each lake that were selected based on a consistent trapping history and reliable sea lamprey spawning runs. Lake trout marking rates are assessed and collected by member agencies that comprise the lake committees and their technical committees.

Lake Superior

The Lake Superior Committee established the following goal for sea lamprey control in Lake Superior:

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

The adult index target for Lake Superior of 10,421 sea lamprey was calculated from the average abundance estimated for the 5-year period, 1994-1998, when marking rates were closest to 5 marks per 100 lake trout >532 mm (5.2 A1-3 marks per 100 fish >532mm). Due to COVID-19 travel restrictions, trapping operations were limited in 2020 and the index of adult abundance was not calculated. The 3-year moving average of the index was 35,800 and was greater than the target of 10,421. The number of A1-A3 marks on lake trout from spring assessments in 2019 was 5.7 marks per 100 lake trout >532mm. Due to COVID-19 travel restrictions, lake trout marking data was not collected in 2020.

Lake Michigan

The Lake Michigan Committee established the following goal for sea lamprey control in Lake Michigan:

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

Sea lamprey control can have a direct effect on objectives for lake trout and other salmonines:

- *Establish self-sustaining lake trout populations.*

- *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.*

The adult index target for Lake Michigan of 34,982 sea lamprey was calculated from the average abundance estimated for the 5-year period, 1995-1999, when marking rates were closest to 5 marks per 100 lake trout >532 mm (8.9 A1-3 marks per 100 fish >532mm), and multiplied by 5/8.9. Due to COVID-19 travel restrictions, trapping operations did not occur and the index of adult abundance was not calculated. The 3-year moving average of the index was 21,922 and was less than the target of 34,982. The number of A1-A3 marks on lake trout from fall assessments in 2020 was 3.7 marks per 100 lake trout >532mm.

Lake Huron

The Lake Huron Committee established the following specific goals for sea lamprey control in Lake Huron:

- *Reduce sea lamprey abundance to allow the achievement of other fish community objectives.*

- *Obtain a 75% reduction in parasitic-phase sea lampreys by the year 2000 and a 90% reduction by the year 2010 from present levels.*

The sea lamprey objective supports the other fish community objectives, specifically the salmonine objective:

- *Establish a diverse salmonine community that can sustain an annual harvest of 2.4 million kg, with lake trout the dominant species and anadromous (stream-spawning) species also having a prominent place.*

The adult index target for Lake Huron of 31,274 sea lamprey was calculated as 25% of the average abundance estimated during the 5-year period of lowest sea lamprey abundance prior to the publication of the fish community objectives (1989-1993). Unlike the other Great Lakes, this explicit target was not based on observed marking rates that resulted in a tolerable annual lake trout mortality rate. During 2020, the index of adult abundance in Lake Huron was estimated to be 65,280 (*95% CI: 59,164 – 71,397*), which was greater than the index target. The number of A1-A3 marks on lake trout from spring assessments in 2019 was 6.3 marks per 100 lake trout >532mm. Due to COVID-19 travel restrictions, lake trout marking data was not collected in 2020.

Lake Erie

The Lake Erie Committee established the following goal and indicator of success for sea lamprey control in Lake Erie:

- *Suppress abundance of sea lamprey to levels that will not impede achievement of any fish community objective, especially for coldwater species of low abundance.*

- *Reduce sea lamprey abundance to levels specified in the sea lamprey management plan administered by the Commission (Slade 2012).*

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

The adult index target for Lake Erie of 3,263 sea lamprey was calculated from the average abundance estimated for the 5-year period, 1991-1995, when marking rates were closest to 5 marks per 100 lake trout >532 mm (4.4 A1-3 marks per 100 fish >532 mm). During 2020, the index of adult abundance in Lake Erie was estimated to be 1,340 (*95% CI; 732 – 1,948*), which was less than the index target. The number of A1-A3 marks on lake trout from fall assessments in 2020 was 11 marks per 100 lake trout >532mm.

Lake Ontario

The Lake Ontario Committee established the following goal and indicators of success for sea lamprey control in Lake Ontario:

- *Control sea lamprey—suppress abundance of sea lamprey to levels that will not impede achievement of objectives for lake trout and other fish.*

- *Spawning-phase adult sea lamprey abundance in Lake Ontario tributaries below targets identified in the sea lamprey management plan.*

- *Number of A-1 marks on lake trout and other species below targets.*

The Lake Ontario Committee recognized that continued control of sea lamprey is necessary for lake trout rehabilitation and stated a specific objective for sea lamprey:

- *Control sea lampreys so that fresh wounding rates (A1) of lake trout larger than 431 mm is less than 2 marks/100 fish*

This objective is intended to maintain the annual lake trout survival rate of 60% or greater to support a target spawning stock of 0.5 to 1.0 million adults of multiple year classes. Along with sea lamprey control, angler and commercial exploitation will also be controlled so that annual harvest does not exceed 120,000 fish in the near term.

The target for Lake Ontario sea lamprey abundance is calculated using A1 marks exclusively, which have been more consistently recorded on Lake Ontario. The target-marking rate of less than two A1 marks per 100 lake trout was explicitly identified as producing tolerable mortality in the lake trout rehabilitation plan.

The adult index target for Lake Ontario of 14,065 sea lamprey was calculated from the average abundance estimated for the 5-year period, 1993-1997, when marking rates were closest to 2 marks per 100 lake trout >431 mm (1.6 A1 marks per fish >431 mm). During 2020, the index of adult abundance in Lake Ontario was estimated to be 4,971 *(95% CI; 3,704 – 6,237*), which was less than the index target. The number of A1 marks on lake trout from fall assessments in 2020 was 0.6 marks per 100 lake trout >431mm.

LAMPRICIDE CONTROL

Tributaries harboring larval sea lamprey are treated periodically with lampricides to eliminate or reduce larval populations before they recruit to the lake as feeding juveniles. During stream treatments, Department and Service control units administer and analyze several lampricide formulations including TFM or TFM mixed with Bayluscide (70% wettable powder or 20% emulsifiable concentrate). Specialized equipment and techniques are employed to maintain lampricide concentrations at levels that eliminate approximately 93% of resident sea lamprey larvae while minimizing risk to non-target organisms. To control larval populations that inhabit lentic areas and interconnecting waterways, field crews apply a bottom-release formulation of lampricide, Bayluscide 3.2% granular (gB), which is 75% effective on average.

Reporting to the Sea Lamprey Control Board (SLCB), the Lampricide Control Task Force (LCTF) was established by the Commission during December 1995 and charged to improve the efficiency of lampricide control, maximize sea lamprey killed in stream and lentic treatments (while minimizing lampricide use, costs, and impacts on aquatic ecosystems), and define lampricide control options for near and long-term stream selection and target setting. Progress on SLCB charges during 2020 is presented in the LCTF section of this report.

During 2020, lampricide treatments were conducted on 26 tributaries and 6 lentic areas of the Great Lakes (Table 1). The time series of control effort metrics are presented in Figure 1.

Table 1. Summary of lampricide applications in tributaries of the Great Lakes in 2020.

Lake	Number of Streams	Number of Lentic Areas	Discharge (m^3/s)	Distance Treated (km)	TFM (kg) [1,2]	Bayluscide (kg) [1,3]
Superior	10	3	22	69	2,262	129
Michigan	11	2	136	704	26,709	167
Huron	5	1	9	94	1,461	1,502
Erie	0	0	0	0	0	0
Ontario	0	0	0	0	0	0
Total	**26**	**6**	**167**	**867**	**30,432**	**1,798**

[1]Lampricide quantities are reported in kg of active ingredient, [2]Includes solid formulation of TFM, [3]Includes 3.2% granular Bayluscide applied to lentic areas.

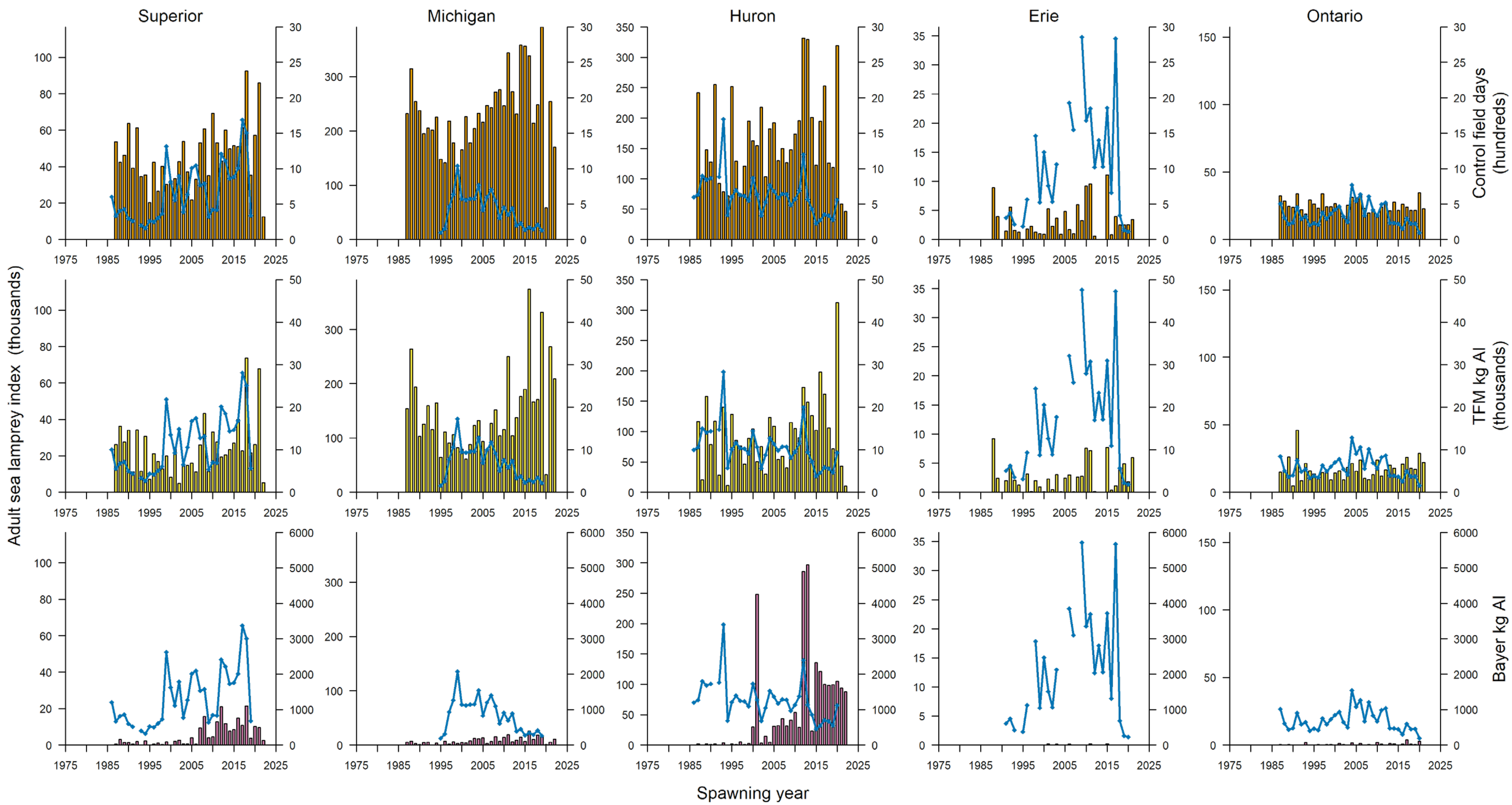

Figure 1. Top Row: Number of control field days (orange bars). Middle Row: TFM used (kg active ingredient, yellow bars). Bottom Row: Bayluscide used (kg active ingredient, purple bars). All rows: Index of adult sea lamprey is shown with blue lines. All metrics plotted against the sea lamprey spawning year. Control metrics are offset by 2 years, e.g., control applied during 2006 is plotted on the 2008 spawning year - the year the treatment effect would first be observed in the adult sea lamprey population.

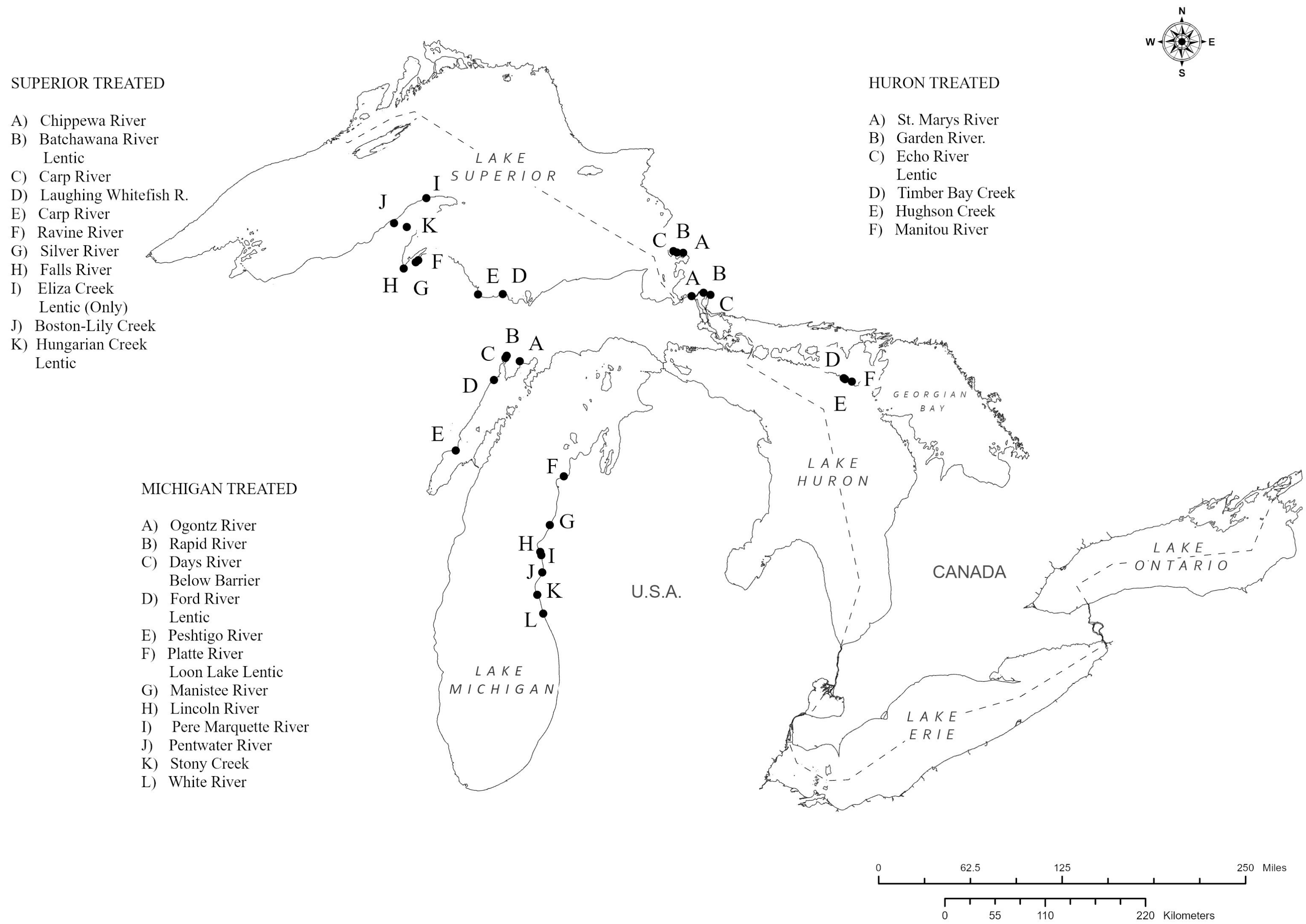

Figure 2. Location of tributaries treated with lampricide in 2020.

Lake Superior

Lake Superior has 1,566 tributaries (833 Canada, 733 U.S.). One hundred sixty-eight tributaries (58 Canada, 110 U.S.) have records of larval sea lamprey production. Of these, 126 tributaries (45 Canada, 81 U.S.) have been treated with lampricides at least once during 2011-2020. Fifty-seven tributaries (20 Canada, 37 U.S.) are treated every 4-6 years. Details on lampricide applications to Lake Superior tributaries and lentic areas during 2020 and tributary locations are found in Table 2 and Figure 2.

- Lampricide treatments were completed in 10 tributaries (3 Canada, 7 U.S.) and in 3 lentic areas (1 Canada, 2 U.S.). Treatments were not attempted in 20 tributaries (13 Canada, 7 U.S.) due to COVID-19 travel restrictions or low water.

- The Michipicoten River was not completed for the third consecutive year. The Pays Plat and Little Pays Plat rivers were not completed for the second consecutive year.

- Hungarian Creek was added to the treatment schedule after larval assessment found numerous large larvae in the system. During treatment, extensive beaver activity and a lengthy estuary were observed and required additional treatment effort. Due to the challenging treatment conditions in the lower river and the number of large larvae recovered in the estuary during treatment, the lentic area was also treated to eliminate the potential for escapement offshore. A small portion of the lentic plot that could not be treated due to the presence of aquatic vegetation is scheduled to be treated in spring 2021.

Table 2. Details on the application of lampricides to tributaries and lentic areas of Lake Superior during 2020 (letter in parentheses corresponds to location of stream in Figure 2).

Tributary	Date	Discharge (m^3/s)	Distance Treated (km)	Liquid TFM (kg)[1]	Solid TFM (kg)[1]	Wettable Powder Bayluscide (kg)[1]	Emulsifiable Concentrate Bayluscide (kg)[1]	Granular Bayluscide (kg)[1]
Canada								
Chippewa R. (A)	Aug-05	2.1	3.0	166.7	---	---	---	---
Batchawana R. (B)	Jul-15	10.7	12.4	844.9	---	---	---	0.3
Lentic	Sep-10	---	---	---	---	---	---	99.2
Carp R. (C)	Aug-10	0.5	8.2	42.6	2.5	---	---	0.4
Total (Canada)		**13.3**	**23.6**	**1,054.2**	**2.5**	**0.0**	**0.00**	**99.9**
United States								
Laughing Whitefish R. (D)	Jul-10	1.1	12.9	185.7	---	---	---	---
Carp R. (E)	Jul-11	4.6	8.9	605.6	---	---	---	---
Ravine R. (F)	Aug-20	0.0	7.2	21.4	0.1	---	---	---
Silver R. (G)	Aug-23	0.7	6.4	99.8	0.4	---	---	---
Falls R. (H)	Aug-19	1.4	0.5	247.6	---	---	---	---
Eliza Cr. (I)								
Lentic	Jul-21	---	---	---	---	---	---	10.4
Boston Lily Cr. (J)	Jul-29	0.3	7.6	35.9	1.1	---	---	---
Hungarian Cr. (K)	Sep-17	0.1	1.9	7.4	---	---	---	---
Lentic	Sep-21	---	---	---	---	---	---	17.8
Total (United States)		**8.2**	**45.4**	**1,203.4**	**1.6**	**0.0**	**0.0**	**28.2**
Total for Lake		**21.5**	**69.0**	**2,257.6**	**4.1**	**0.0**	**0.0**	**128.8**

[1]Lampricide quantities are reported in kg of active ingredient, Stream discharges of <0.05 are recorded as 0.0

Lake Michigan

Lake Michigan has 511 tributaries. One hundred twenty-eight tributaries have records of larval sea lamprey production, and of these, 84 tributaries have been treated with lampricides at least once during 2011-2020. Thirty-three tributaries are treated every 3-5 years. Details on lampricide applications to Lake Michigan tributaries and lentic areas during 2020 and tributary locations are found in Table 3 and Figure 2.

- Lampricide applications were conducted in 11 tributaries and 2 lentic areas. Twenty-eight streams and two lentic areas originally scheduled to be treated were not attempted due to travel restrictions and safety protocols implemented due to COVID-19 travel restrictions.

- The Little Manistee River was not attempted due to low dissolved oxygen measurements in the extensive estuary created by high lake levels.

- The Peshtigo River, deferred in 2019 due to extremely high water levels and inconsistent flow at the WE Energies hydro dam, was successfully treated in 2020.

Table 3. Details on the application of lampricides to tributaries and lentic areas of Lake Michigan during 2020 (letter in parentheses corresponds to location of stream in Figure 2).

Tributary	Date	Discharge (m^3/s)	Distance Treated (km)	Liquid TFM (kg)[1]	Solid TFM (kg)[1]	Wettable Powder Bayluscide (kg)[1]	Emulsifiable Concentrate Bayluscide (kg)[1]	Granular Bayluscide (kg)[1]
Ogontz R. (A)	Sep-16	1.0	18.8	83.2	1.3	---	---	---
Rapid R. (B)	Oct-16	5.4	57.3	1,084.6	0.6	---	---	---
Days R. (C)	Aug-11	0.6	6.8	141.5	---	---	---	---
Ford R. (D)	Aug-05	17.0	185.1	3,793.6	4.9	19.3	---	13.5
Peshtigo R. (E)	Sep-04	21.2	19.3	1,969.5	2.6	---	25.2	---
Platte R. (F)	Sep-14	---	---	---	---	---	---	1.2
Manistee R. (G)	Aug-24	46.7	56.3	7,656.4	4.4	---	93.4	---
Lincoln R. (H)	Jul-10	1.7	21.1	822.9	4.0	---	---	---
Pere Marquette R. (I)	Jul-23	27.3	219.4	5,338.5	1.5	---	14.5	---
Pentwater R. (J)	Sep-17	1.6	26.1	529.8	0.9	---	---	---
Stony Cr. (K)	Sep-20	1.6	5.0	394.1	---	---	---	---
White R. (L)	Sep-04	11.5	88.4	4,872.2	1.5	---	---	---
Total for Lake		**135.6**	**703.6**	**26,686.2**	**21.6**	**19.3**	**133.1**	**14.7**

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

Lake Huron

Lake Huron has 1,761 tributaries (1,334 Canada, 427 U.S.). One hundred twenty-seven tributaries (59 Canada, 68 U.S.) have records of larval sea lamprey production. Of these, 84 tributaries (39 Canada, 45 U.S.) have been treated with lampricide at least once during 2011-2020. Forty-six tributaries (22 Canada, 24 U.S.) are treated every 3-5 years. Details on lampricide applications to Lake Huron tributaries and lentic areas during 2020 and tributary locations are found in Table 4 and Figure 2.

- Lampricide applications were completed in five tributaries (5 Canada, 0 U.S.) and in one lentic area (1 Canada, 0 U.S.). Eleven tributaries (3 Canada, 8 U.S.) and two lentic areas (2 Canada, 0 U.S.) originally scheduled for treatment were deferred due to COVID-19 travel restrictions.

- The Manitou River was treated during 2020, one year in advance of the expected 2021 treatment.

- The Garden River was treated for the first time since 2014. The treatment was a success and large numbers of larvae were reported. Garden River First Nation community members were actively involved during the process.

- Three hundred and five ha of the St. Marys River was treated.

Table 4. Details on the application of lampricides to tributaries and lentic areas of Lake Huron during 2020 (letter in parentheses corresponds to location of stream in Figure 2).

Tributary	Date	Discharge (m^3/s)	Distance Treated (km)	Liquid TFM (kg)[1]	Solid TFM (kg)[1]	Wettable Powder Bayluscide (kg) [1]	Emulsifiable Concentrate Bayluscide (kg) [1]	Granular Bayluscide (kg)[1]
Canada								
St. Marys R. (A)	Jul-21	---	---	---	---	---	---	1,453.7
Garden R. (B)	Jul-21	6.2	73.7	666.7	4.9	---	---	0.6
Echo R. (Bar/Iron) (C)	Aug-31	0.4	10.1	85.9	0.4	---	---	0.1
Lentic	Sep-1	---	---	---	---	---	---	47.1
Timber Bay Cr. (D)	Sep-16	0.2	3.2	42.6	---	---	---	0.1
Hughson. (E)	Sep-17	0.1	5.5	138.4	---	---	---	0.2
Manitou R. (F)	Oct-1	2.3	1.2	521.9	---	---	---	---
Total (Canada)		**9.2**	**93.7**	**1,455.5**	**5.3**	**0.0**	**0.0**	**1,501.8**
Total (United States)		**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Total for Lake		**9.2**	**93.7**	**1,455.5**	**5.3**	**0.0**	**0.0**	**1,501.8**

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

Lake Erie

Lake Erie has 842 tributaries (525 Canada, 317 U.S.). Thirty tributaries (11 Canada, 19 U.S.) have records of larval sea lamprey production. Of these, 18 tributaries (7 Canada, 11 U.S.) have been treated with lampricides at least once during 2011-2020. Six tributaries (2 Canada, 4 U.S.) are treated every 3-5 years. Details on lampricide applications to Lake Erie tributaries and lentic areas during 2020 and tributary locations are found in Table 5 and Figure 2. In addition, larval production has been documented in the St. Clair River, three of its U.S. tributaries, and two tributaries to Lake St. Clair (1 Canada, 1 U.S.).

- No lampricide treatments were conducted in Lake Erie tributaries due to COVID-19 travel restrictions. Four tributaries (2 Canada, 2 U.S.) were originally scheduled for treatment.

Lake Ontario

Lake Ontario has 659 tributaries (405 Canada, 254 U.S.). Sixty-six tributaries (31 Canada, 35 U.S.) have historical records of larval sea lamprey production, and of these, 36 tributaries (18 Canada, 18 U.S.) have been treated with lampricides at least once during 2011-2020. Twenty-nine tributaries (15 Canada, 14 U.S.) are treated on a regular 3-5 year cycle. Details on lampricide applications to Lake Ontario tributaries and lentic areas during 2020 and tributary locations are found in Table 6 and Figure 2.

- No lampricide treatments were conducted in Lake Ontario tributaries due to COVID-19 travel restrictions. Twelve tributaries (6 Canada, 6 U.S.) were originally scheduled for treatment.

ALTERNATIVE CONTROL

The Service and Department continue to coordinate with the Commission and other partners to research and develop alternatives to lampricides to provide a broader spectrum of tactics to control sea lamprey. During 2020, barriers and juvenile trapping were the alternative control methods deployed. Nest destruction was explored as a potential alternative method. Other methods that are currently being investigated include attractants (e.g. pheromones), repellents (e.g. alarm cues), and new trap designs.

Barriers

The sea lamprey barrier program priorities are:

1. Operate and maintain existing sea lamprey barriers that were built or modified by the SLCP.
2. Ensure sea lamprey migration is blocked at important barrier sites not operated or maintained by the SLCP.
3. Construct new structures in streams where they:
    a. Provide control where other options are impossible, excessively expensive, or ineffective.
    b. Provide a cost-effective alternative to lampricide control.
    c. Improve cost-effective control in conjunction with attractant and repellent based control, trapping, and lampricide treatments.
    d. Where structures are compatible with a system’s watershed plan.

Reporting to the SLCB, the Barrier Task Force (BTF) was established by the Commission during April 1991 to coordinate efforts of the Service, Department, and U.S. Army Corps of Engineers (USACE) on the construction, operation, and maintenance of sea lamprey barriers. Progress on SLCB charges during 2020 is presented in the BTF section of this report.

The Commission has invested in 73 barriers in the Great Lakes basin (Figure 3). Of these, 47 were purpose-built as sea lamprey barriers and 26 were constructed for other purposes but have been modified to block sea lamprey migrations.

Data gathered during field visits to assess the status of other dams and structures were recorded in the SLCP's Barrier Inventory and Project Selection System (BIPSS) database and may be used to: 1) select barrier projects; 2) monitor inspection frequency; 3) schedule upstream larval assessments; 4) assess the effects of barrier removal or modifications on sea lamprey populations; or 5) identify structures that are important in controlling sea lamprey.

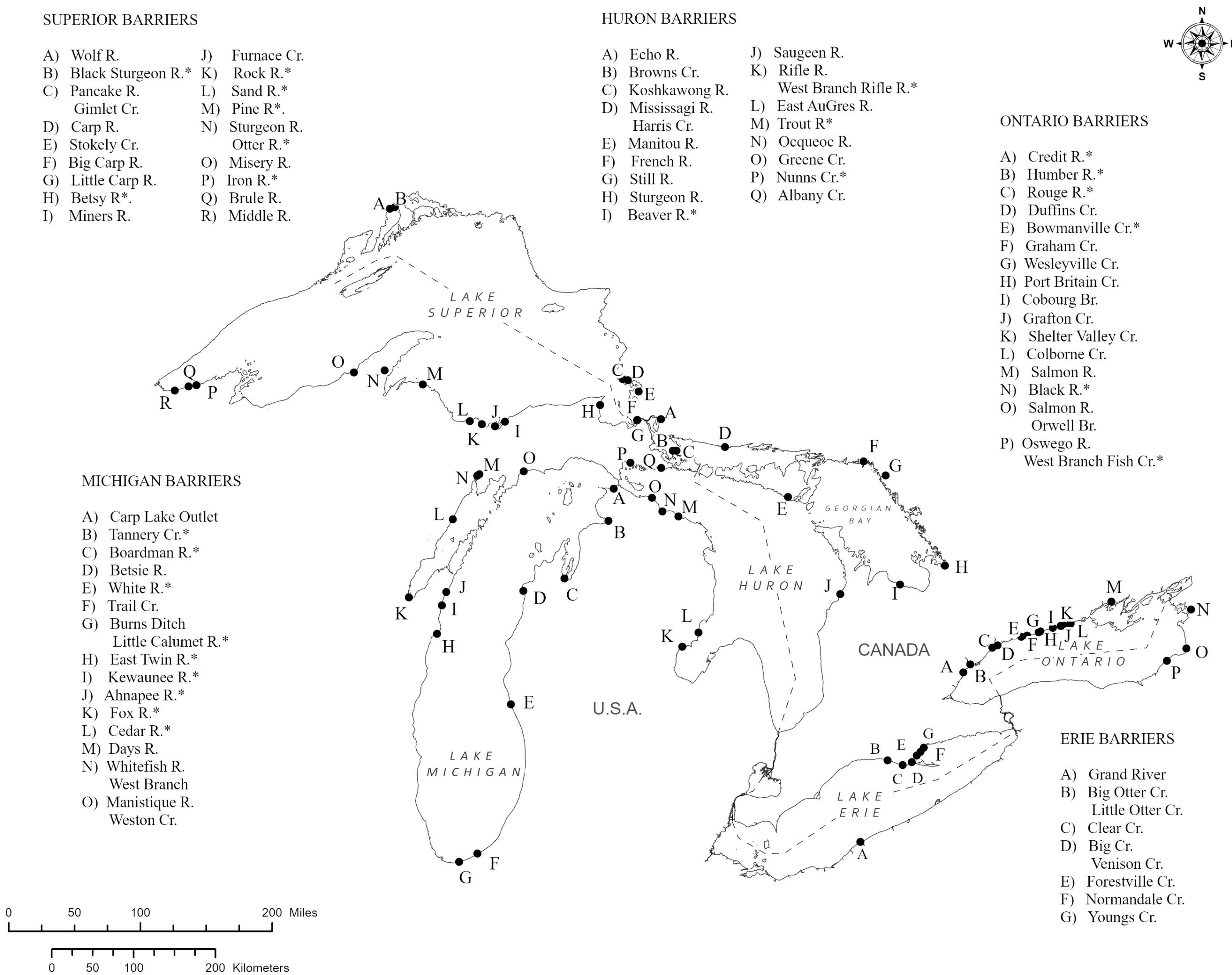

Figure 3. Locations of tributaries with sea lamprey barriers. An asterisk indicates structures that have been modified or constructed by others to prevent the upstream migration of sea lamprey.

Lake Superior

The Commission has invested in 18 barriers on Lake Superior (Figure 3). Of these, 11 were purpose-built as sea lamprey barriers and seven were constructed for other purposes but have been modified to block sea lamprey migrations.

Barrier Inventory and Project Selection System (BIPSS)

- Due to COVID-19 travel restrictions, field crews did not visit structures on Lake Superior tributaries. Consequently, information to evaluate sea lamprey blocking potential and to support the BIPSS was not collected.

Operation and Maintenance

- Routine maintenance, spring start-up, and safety inspections were performed on seven barriers (6 Canada, 1 U.S.).

Ensure Blockage to Sea Lamprey Migration

- Brule River – Portions of the fishway walls were resurfaced with concrete during late 2016 to determine if the patch material would withstand winter conditions. The test patches did not function well, therefore other patching alternatives are being considered. Due to COVID-19 travel restrictions this work was deferred until 2021.

- Black Sturgeon River – The Camp 43 Dam is located within a Provincial Park and Ontario Parks has authority to manage and make decisions regarding the structure. An engineering study was completed in 2010 and determined the structure was below mandatory safety requirements and is at high risk of failure. Due to the high risk of failure, threat to property, public services, and environment, the Ontario Ministry of Environment Conservation and Parks undertook urgent critical repairs of the structure. These were completed in fall, 2020.

- Partner agencies were consulted to ensure blockage at barriers at 9 sites in 4 tributaries during 2020 (Table 5).

New Construction

- Bad River – The USACE completed hydrologic modeling to site a new barrier and trap near the railroad trestle downstream of the Potato River junction. The topography at this location is not conducive for constructing a sea lamprey barrier due to size needed and potential backwater effects. Service personnel attended a public meeting in March 2018 to discuss alternative control technologies including seasonal and velocity barriers. The project was reclassified as a feasibility study until full support from the Tribe for a barrier could be obtained. During the spring of 2020, Service staff met with members of the Bad River Tribal Natural Resources Department to discuss sites that the Tribe would support. The Tribal Council reviewed the list of potential sites considered for feasibility assessments and suggested that the sites be re-evaluated.

- Ontonagon River – The Service continues to work with the U.S. Forest Service to identify a new sea lamprey barrier location in the Ontonagon River system.

Table 5. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Superior tributaries during 2020.

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Au Train R.	Joel Cr.	USFS[1]	Joel Creek culvert	Concur	Ineffective barrier
Brule R.	Greenwood R.	CCSWCD[2]	Powers Lake Rd. culvert	Concur	Ineffective barrier
Brule R.	Greenwood R.	CCSWCD[2]	Powers Lake Rd. culvert #2	Concur	Ineffective barrier
Brule R.	Greenwood R.	CCSWCD[2]	Greenwood River Rd. culvert	Concur	Ineffective barrier
Brule R.	Greenwood R.	CCSWCD[2]	Greenwood River Rd. culvert #2	Concur	Ineffective barrier
Brule R.	Greenwood R.	CCSWCD[2]	Sunfish Lake Rd. culvert	Concur	Ineffective barrier
Ontonagon R.	Trout Cr.	TU[3]	Calderwood Rd. culvert	Concur	Upstream of blocking barrier
Sturgeon R.	Gristmill Cr.	KBIC[4]	Varline Rd. culvert	Concur	Ineffective barrier
Sturgeon R.	Gristmill Cr.	KBIC[4]	Gristmill Rd. culvert	Concur	Ineffective barrier

[1]United States Forest Service, [2]Cook County Soil & Water Conservation District, [3]Trout Unlimited, [4]Keweenaw Bay Indian Community

Lake Michigan

The Commission has invested in 15 barriers on Lake Michigan (Figure 3). Of these, six were purpose-built as sea lamprey control barriers and nine were constructed for other purposes, but have been modified to block sea lamprey migrations.

Barrier Inventory and Project Selection System

Due to COVID-19 travel restrictions, field crews did not visit structures on Lake Michigan tributaries. Consequently, information to evaluate sea lamprey blocking potential and to support the BIPSS was not collected.

Operation and Maintenance

- Routine maintenance, spring start-up, and safety inspections were performed on nine barriers using a new phone check in process.

Ensure Blockage to Sea Lamprey Migration

- Boardman River –The Commission has partnered with the City of Traverse City, Grand Traverse County, Grand Traverse Band of Ottawa and Chippewa Indians, Michigan Department of Natural Resources (MIDNR) and several other State, Federal, academic and NGO partners to develop fish passage technologies on-site to pass desirable fishes while blocking sea lamprey. A selective, bi-directional fish passage experimental research facility (FishPass) is being constructed at the Union Street Dam location. One of the main objectives is to test elective sorting techniques to provide selective passage for desired species and continued blockage of invasive species. The FishPass project continued to move forward with a construction contract issued in 2020. Construction is expected to begin during 2021 and continue through the end of 2022. Larval assessment data collected for the upper

Boardman River is currently being analyzed to determine the sea lamprey production potential for this area should escapement occur.

- Grand River – The City of Grand Rapids along with several citizens groups have proposed removal of the 6th Street Dam on the Grand River to provide more varied use of the downtown rapids area. The current plan calls for removal of the existing structure and the creation of an artificial rapids complex that can be used by kayakers and anglers. The USACE drafted an environmental impact statement that included 14 design alternatives. A completed draft will be available for public review by spring 2021. The Service and Department are engaged in the review of the proposed structure and will continue to participate in various levels of project coordination. Due to COVID-19 travel restrictions, no portable assessment traps or fyke nets were fished in the Grand River during 2020.

- Platte River – Service staff are working with the MIDNR to review weir operation and sediment management practices at the Platte River State Fish Hatchery. A level logger was installed during 2018 to monitor water levels to determine the appropriate number of stop logs needed to maintain an 18" vertical separation between the barrier crest and tail-water during the sea lamprey spawning migration. Data was collected in 2020 and analysis of the data has not been completed.

- Barrier removals/modification – Partner agencies were consulted to ensure blockage at barriers at 37 sites in 11 tributaries (Table 6).

Table 6. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Michigan tributaries during 2020.

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Grand R.	Glass Cr.	BCD[1]	Whitmore Rd. culvert	Concur	Ineffective Barrier
Grand R.	Glass Cr.	BCD[1]	Whitmore Rd. culvert #2	Concur	Ineffective Barrier
Grand R.	Glass Cr.	BCD[1]	M-179 Highway culvert	Concur	Ineffective Barrier
Grand R.	Grand R.	ICD[2]	Wager Dam	Concur	Upstream of Blocking Barrier
Kalamazoo R.	North Br. Kalamazoo R.	CCRD[3]	29 1/2 Mile Rd. culvert	Concur	Upstream of Blocking Barrier
Platte R.	Brundage Cr.	CRA[4]	Stanley Rd. culvert	Concur	Ineffective Barrier
Platte R.	Brundage Cr.	CRA[4]	North Carmean Rd. culvert	Concur	Ineffective Barrier
St. Joseph R	Portage R.	SJCCD[5]	Parkerville Dam	Concur	Upstream of Blocking Barrier
St. Joseph R	Dowagiac R.	CON[6]	Niles Dam (Pucker Street)	Concur	Upstream of Blocking Barrier
Bear R.	Bear R.	TOMWC[7]	Mitchell Dam	Do Not Concur	Lowermost Barrier
Menominee R.	Iron R.	ICWC[8]	Wild Rivers Rd. culvert	Concur	Ineffective Barrier
Menominee R.	Kaine Cr.	TU[9]	Forest Service Rd. 3888 culvert	Concur	Upstream of Blocking Barrier
Oconto R.	McCaslin Cr.	TU[9]	Forest Service Rd. 2123 #1 culvert	Concur	Upstream of Blocking Barrier
Oconto R.	Mosquito Cr.	TU[9]	Forest Service Rd. 2258 culvert	Concur	Upstream of Blocking Barrier

Table 6. *Continued*

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Oconto R.	Snow Falls Cr.	TU[9]	Forest Service Rd. 2330 culvert	Concur	Upstream of Blocking Barrier
Oconto R.	Baldwin Cr.	TU[9]	Forest Service Rd. 2630 culvert	Concur	Upstream of Blocking Barrier
Oconto R.	Round Cr.	TU[9]	Forest Service Rd. 3876 culvert	Concur	Upstream of Blocking Barrier
Oconto R.	Barney Springs Cr.	TU[9]	Forest Service Rd. 2123 #2 culvert	Concur	Upstream of Blocking Barrier
Peshtigo R.	Rock Cr.	TU[9]	Forest Service Rd. 2131 #1 culvert	Concur	Upstream of Blocking Barrier
Peshtigo R.	Armstrong Cr.	TU[9]	Forest Service Rd. 2131 #2 culvert	Concur	Upstream of Blocking Barrier
Peshtigo R.	Hay Cr.	TU[9]	Forest Service Rd. 3877 culvert	Concur	Upstream of Blocking Barrier
Peshtigo R.	Shabadock Cr.	TU[9]	Forest Service Rd. 2695 culvert	Concur	Upstream of Blocking Barrier
Peshtigo R.	Otter Cr.	TU[9]	Forest Service Rd. 3847 culvert	Concur	Upstream of Blocking Barrier
Muskegon R.	Little Cedar Cr.	WMSRDC[10]	Tyler Rd. culvert	Concur	Ineffective Barrier
Muskegon R.	Little Cedar Cr.	WMSRDC[10]	Sweeter Rd. culvert	Concur	Ineffective Barrier
Muskegon R.	Little Cedar Cr.	WMSRDC[10]	Brickyard Rd. culvert	Concur	Ineffective Barrier
Muskegon R.	Little Cedar Cr.	WMSRDC[10]	Michillinda Rd. culvert	Concur	Minimal Upstream Potential
Muskegon R.	Little Cedar Cr.	WMSRDC[10]	Holton Duck Lake Rd. culvert	Concur	Minimal Upstream Potential
Pere Marquette R.	Pere Marquette R.	WMSRDC[10]	Access Rd. culvert	Concur	Minimal Upstream Potential
White R.	Bear Cr.	WMSRDC[10]	128TH Avenue culvert	Concur	Ineffective Barrier
White R.	Cushman Cr.	WMSRDC[10]	Roosevelt Rd. culvert	Concur	Minimal Upstream Potential
White R.	Swinton Cr.	WMSRDC[10]	Baseline Rd. culvert	Concur	Minimal Upstream Potential
White R.	Swinton Cr.	WMSRDC[10]	Buchanan Rd. culvert #2	Concur	Ineffective Barrier
White R.	Swinton Cr.	WMSRDC[10]	East Pierce Rd. culvert	Concur	Ineffective Barrier
White R.	Five Mile Cr.	WMSRDC[10]	Monroe Rd. culvert	Concur	Upstream of Blocking Barrier
White R.	Five Mile Cr.	WMSRDC[10]	Spruce Rd culvert	Concur	Upstream of Blocking Barrier
White R.	Wrights Cr.	WMSRDC[10]	Comstock Avenue culvert	Concur	Upstream of Blocking Barrier

[1]Barry Conservation District, [2]Iona Conservation District, [3]Calhoun County Road Department, [4]Conservation Resource Alliance, [5]St. Joseph County Conservation District, [6]City of Niles, [7]Tip of the Mitt Watershed Council, [8]Iron County Watershed Council, [9]Trout Unlimited, [10]West Michigan Shoreline Regional Development Commission

New Construction

- Manistique River – The USACE is the lead agency administering a project to construct a sea lamprey barrier to replace a deteriorated structure in the Manistique River. Project partners include the Commission, Service, MIDNR, and the City of Manistique. The existing Manistique Paper Inc. Dam was identified as the most feasible site for a new barrier. The final design is being completed for the barrier and permitting will take place after final review. The State is investigating options for securing additional monies to remove the existing dam structure and move the City's waterline. The State of MI and USACE continue to work on acquiring ownership of the dam. The timeline for project completion is 2023.

- Little Manistee River – The Service has been working with MIDNR and USACE staff to improve the blocking capability of the Little Manistee River weir and egg take facility during concurrent facility upgrade work that is being conducted by the State of Michigan. The project would include improvements to the weir structure and construction of permanent traps. The Service continues to provide guidance for placing the permanent trap within the new structure. The Preliminary Restoration Plan is complete for the project. A draft feasibility study was completed and public comments were minimal. The team has incorporated cost savings in the current design by reconfiguring the angle of the spillway. The goal is to award a construction contract in 2021.

- Whitefish River - A section of the metal overhanging lip on the West Branch Whitefish River sea lamprey barrier was replaced to ensure continued sea lamprey blockage.

Lake Huron

The Commission has invested in 17 barriers on Lake Huron (Figure 3). Of these, 13 were purpose built as sea lamprey barriers and 4 were constructed for other purposes, but have been modified to block sea lamprey migrations.

Barrier Inventory and Project Selection System (BIPSS)

- Due to COVID-19 travel restrictions, field crews did not visit structures on Lake Huron tributaries. Consequently, information to evaluate sea lamprey blocking potential and to support the BIPSS was not collected.

Operation and Maintenance

- Routine maintenance, spring start-up, and safety inspections were performed on 13 barriers (5 Canada, 8 U.S.).

- The combination low-head/electrical barrier in the Ocqueoc River was activated February 23, 2020. Due to a wet spring, the barrier was active over five periods: April 1-28, May 28-June 3, June 25-29, July 18-20 and July 24-25. Water level monitoring occurred during the entire sea lamprey spawning migration.

Ensure Blockage to Sea Lamprey Migration

- Cheboygan River – Plans to block adult sea lamprey at the Cheboygan lock and dam complex and to eradicate lampreys from the upper river included:

    1. Control agents and researchers continued discussion with the USACE and the MIDNR regarding alternatives for preventing sea lamprey passage at the Cheboygan River lock. The MIDNR is pursuing a refurbishment of the aging structure and the federal partners are interested in making the lock "lamprey proof". The MIDNR has allocated funding to

update and refurbish the Cheboygan River lock and dam complex. GEI Consultants Inc. (GEI) was awarded the contract and have begun collecting data for the project design. The Service will be involved with the MIDNR and GEI to incorporate sea lamprey control measures into the design.

2. No sterilized male sea lamprey were released upstream of the Cheboygan Dam during 2020 due to COVID-19 travel restrictions. The research project being conducted by the U.S. Geological Survey testing an eradication hypothesis using the Sterile Male Release Technique will resume in 2021.
3. The Lake Kathleen Dam on the Maple River was removed during fall 2018. Currently, there are no plans to mitigate the removal with alternative controls. Due to COVID-19 travel restrictions, annual monitoring to document changes in native and sea lamprey populations throughout the Maple River were not conducted in 2020.

- Nottawasaga River – Reconstruction of Nicolston Dam began during 2017 under the Canadian Federal Infrastructure Initiative. The auxiliary spillway was completed in 2018 and the main spillway construction was completed in February of 2021.

- Partner agencies were consulted to ensure blockage at barriers for 14 sites in four tributaries during 2020 (Table 7).

Table 7. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Huron tributaries during 2020.

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Cheboygan R.	Maple R.	CRA[1]	Robinson Rd. culvert #2	Concur	Ineffective Barrier
Cheboygan R.	Maple R.	CRA[1]	Douglas Lake Rd. culvert	Concur	Ineffective Barrier
Cheboygan R.	Pigeon R.	HP[2]	Sparr Rd. culvert	Concur	Ineffective Barrier
Cheboygan R.	Pigeon R.	HP[2]	Wilkinson Rd. culvert	Concur	Ineffective Barrier
Cheboygan R.	Pigeon R.	HP[2]	White House Trail culvert	Concur	Ineffective Barrier
Cheboygan R.	Pigeon R.	HP[2]	Beckett Rd. culvert	Concur	Ineffective Barrier
Cheboygan R.	Pigeon R.	HP[2]	Ford Lake Rd. culvert	Concur	Ineffective Barrier
Cheboygan R.	Cornwell Cr.	HP[2]	Tin Bridge Rd. culvert	Concur	Minimal Upstream Potential
Munuscong R.	Trib to Munuscong R.	MCRC[3]	Rutledge Rd. culvert	Concur	Minimal Upstream Potential
Munuscong R.	Trib to Munuscong R.	MCRC[3]	Blair Rd. culvert	Concur	Minimal Upstream Potential
Au Sable R.	Hunt Cr.	TU[4]	Hunt Cr. Dam	Concur	Upstream of Blocking Barrier
Au Sable R.	Trib to Au Sable R.	TU[4]	Old Fredric Lumber Mill Dam	Concur	Upstream of Blocking Barrier
Saginaw R.	Shiawassee R.	OCPR[5]	Davisburg Dam	Concur	Upstream of Blocking Barrier
Saginaw R.	Tittabawassee R.	USFWS[6]	Dow Dam	Concur	Fish Passage Modification

[1]Conservation Resource Alliance, [2]Huron Pines, [3]Mackinac County Road Commission, [4]Tround Unlimited, [5]Oakland County Parks and Recreation, [6]United States Fish and Wildlife Service

Experimental barriers

- A next generation low voltage electrical fish barrier was deployed near the mouth of Black Mallard Creek from March to August during 2016-2020 to block adult sea lamprey and eliminate the need for the treatment. The Service will monitor sea lamprey recruitment upstream of the electrical barrier during 2021.

Lake Erie

The Commission has invested in seven purpose-built sea lamprey barriers on Lake Erie (Figure 3).

Barrier Inventory and Project Selection System (BIPSS)

- Due to COVID-19 travel restrictions, field crews did not visit structures on Lake Erie tributaries. Consequently, information to evaluate sea lamprey blocking potential and to support the BIPSS was not collected.

Operation and Maintenance

- Routine maintenance, spring start-up, and safety inspections were performed on seven barriers (7 Canada, 0 U.S.).

Ensure Blockage to Sea Lamprey Migration

- Black River – The MIDNR and Service-Alpena Fish and Wildlife Conservation Office funded a feasibility study for the removal of Wingford Dam. The study was completed in January and it provides three conceptual alternatives including basic dam removal, dam removal with substantial upstream river restoration, and dam removal with targeted restoration and river stabilization. Project partners are currently working to find a mutually beneficial solution to allow selective fish passage while preventing sea lamprey escapement upstream.

- Clinton River – A natural bypass channel reformed around the Yates Mill Dam. The bypass developed in a low-lying area during periods of high flow and has allowed sea lamprey escapement in the past. The MIDNR, Clinton River Watershed Council, the City of Rochester Hills, and the Commission collaborated with Service staff to block the bypass channel and route water through the original channel and over the dam. Construction was completed in 2020.

- Partner agencies were consulted to ensure blockage at barriers for two sites in one tributary (Table 8).

New Construction

- Cattaraugus Creek – The USACE, along with project partners Erie County and New York State Department of Environmental Conservation (NYSDEC) have approved the plan for the Springville Dam Ecosystem Restoration Project. The Project Partnership Agreement was signed in August 2017 between USACE, NYSDEC, and Erie County, and the study team has moved forward with the engineering and design phase of this project. The plan will decrease the existing spillway height from 38 to 13.5 feet to maintain function as a sea lamprey barrier. Requests from the National Historic Registry will be fulfilled by preserving a portion of the original spillway on both banks to show the original structure. A Denil fishway with a seasonal trap and sort operation is also included in the design. The Service has worked closely with the NYSDEC and USACE to design a sea lamprey trap at the entrance of the fishway. Updated cost estimates for the project currently exceed the anticipated budget so the project remains on hold while partners reassess project goals and funding solutions.

- Grand River – The USACE was the lead agency administering a project at the Harpersfield Dam to construct a sea lamprey barrier to replace the deteriorated structure in the Grand River. Project partners included the Commission, Service, Ohio Department of Natural Resources (OHDNR), and Ashtabula County Metro Parks. Construction of the dam was completed in summer 2020.

- Conneaut Creek – The Pennsylvania Fish and Boat Commission and OHDNR have expressed interest in constructing a new barrier on Conneaut Creek in Pennsylvania. The goal of the project is to reduce the amount of stream miles exposed to lampricide application and thus protect sensitive native species. Seven potential barrier sites have been identified as the USACE works to finalize the Federal Interest Determination report. Monthly discussions continue as possible barrier designs are discussed.

Table 8. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Erie tributaries during 2020.

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Huron R.	-	HRWC[1]	Flat Rock Hydro Dam	Do Not Concur	Lowermost Barrier
Huron R.	-	HRWC[1]	Peninsular Paper Dam	Concur	Upstream of Blocking Barrier

[1]Huron River Watershed Council

Lake Ontario

The Commission has invested in 16 barriers on Lake Ontario (Figure 3). Of these, 10 were purpose-built as sea lamprey barriers and 6 were constructed for other purposes, but have been modified to block sea lamprey migrations.

Operation and Maintenance

- Routine maintenance, spring start-up, and safety inspections were performed on 13 barriers (10 Canada, 3 U.S.). Among these, two barriers (1 Canada, 1 U.S.) were seasonally operated.

- The New York State Department of Environmental Conservation completed startup and shutdown of the seasonal barrier at Orwell Brook.

Ensure Blockage to Sea Lamprey Migration

- Partner agencies were consulted to ensure blockage at barriers for one site in one tributaries (Table 9).

Table 9. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Ontario tributaries during 2020.

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Genesee R.	Wiscoy Cr.	WCSWCD[1]	Pike Mills Dam	Concur	Upstream of First Blocker

[1]Wyoming County SWCD

Juvenile Trapping

- Out-migrating juvenile sea lamprey were trapped in four tributaries of Lake Superior using fyke and hoop nets during October through December to mitigate for treatment deferrals or due to geographic efficiency (Table 10).

Table 10. Sea lamprey captures from juvenile trapping in 2020. Catch per unit effort (CPUE) was calculated using lamprey captured per net night.

Lake	River	Field Station	Net Nights	Juvenile Captures	Larval Captures	Juvenile CPUE	Larval CPUE
Superior	Fish Creek	GLFWIC[2]	12			0.000	0.000
Superior	Garlic	MBS[1]	26	21		0.808	0.000
Superior	Marengo	GLFWIC[2]	53	220	5	4.151	0.094
Superior	White	GLFWIC[2]	33			0.000	0.000
Totals			144	241	5	1.674	0.034

[1]Marquette Biological Station, [2]Great Lakes Indian Fish and Wildlife Commission

Supplemental Control

During 2020, the GLFC initiated a long-term study to evaluate supplemental control targeting larval sea lamprey populations in streams that are difficult to control using standard techniques. Supplemental controls are tactics that supplement the two primary sea lamprey control techniques; barriers and lampricides. Supplemental controls primarily focus on the adult and juvenile life stages with the purpose of reducing the reproductive potential of spawning populations within a tributary; these tactics include trapping adults or out-migrating juveniles, release of sterile males, and pheromone communication disruption. The overall goals of the study are to (1) develop, implement, and evaluate an integrated array of sea lamprey control tools focused on reducing reproduction that supplement ongoing barrier and lampricide programs and (2) define stream characteristics where supplemental controls provide the greatest benefit.

- Adult sea lamprey traps were fished in six of the 10 study streams during 2020, including the Cranberry, Traverse, Cheboygan, and Tawas rivers and Black Mallard and Long Lake creeks (Figure 4). The remaining streams were not attempted due to COVID-19 travel restrictions.

- Larval sea lamprey assessment surveys were conducted on eight of the 10 study streams to estimate larval abundance, including the Traverse, Root, Cheboygan, Whitefish, Millecoquins, and Tawas rivers and Black Mallard, Long Lake, and Bellevue creeks (Figure 4). Larvae were collected in all streams surveyed.

- Larval sea lamprey habitat assessment surveys were completed at nearly all reference sites on Bellevue, Bills, and Furlong creeks. This effort was above the standard survey effort based on quantitative larval assessment protocols.

- Juvenile sea lamprey trapping was conducted in eight of the 10 study streams, including the Cranberry, Traverse, Cheboygan, Whitefish, Millecoquins, and Tawas rivers and Black Mallard, and Long Lake creeks (Figure 4). A total of 160 juvenile sea lamprey were captured between October 8 and November 30.

- A geodatabase system was developed for visualizing work assignments and data related to larval sea lamprey assessments. The GIS maps can be accessed and updated by Service, Department, and United States Geological Survey (USGS) field agents.

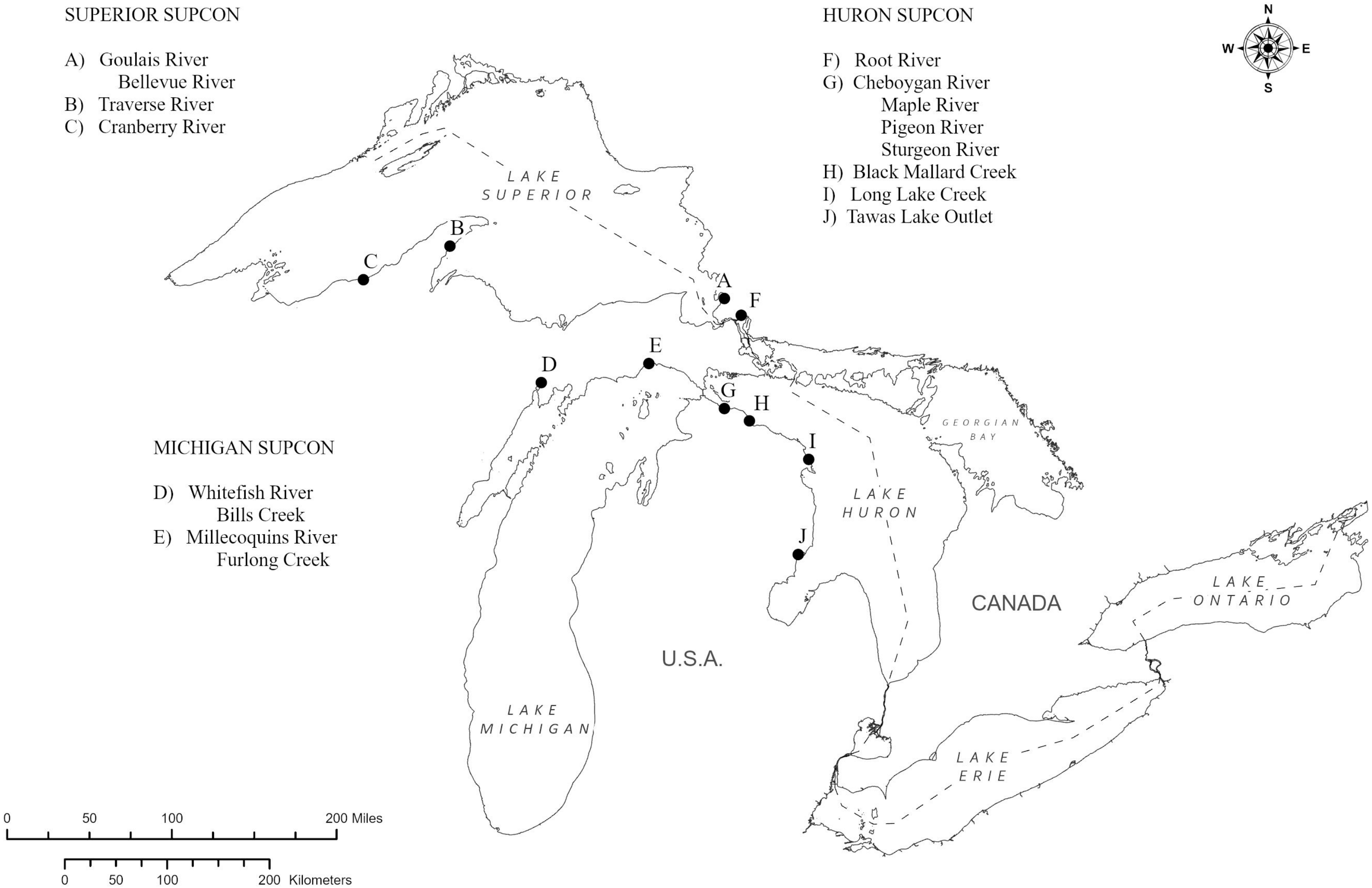

Figure 4. Locations of Supplemental Control evaluation study streams.

Sterile Male Release Technique

The Sterile Male Release Technique (SMRT) was discontinued as an alternative control method in the St. Marys River in 2012 after being implemented during 1997-2011. Monitoring of embryo viability (proportion of embryos that were alive at the time of stage 12 of development) continues to provide insight into the effectiveness of SMRT.

- Due to COVID-19 travel restrictions, nest evaluations were not attempted. In 2019, the mean embryo viability from 12 nests was 75% (Figure 5).

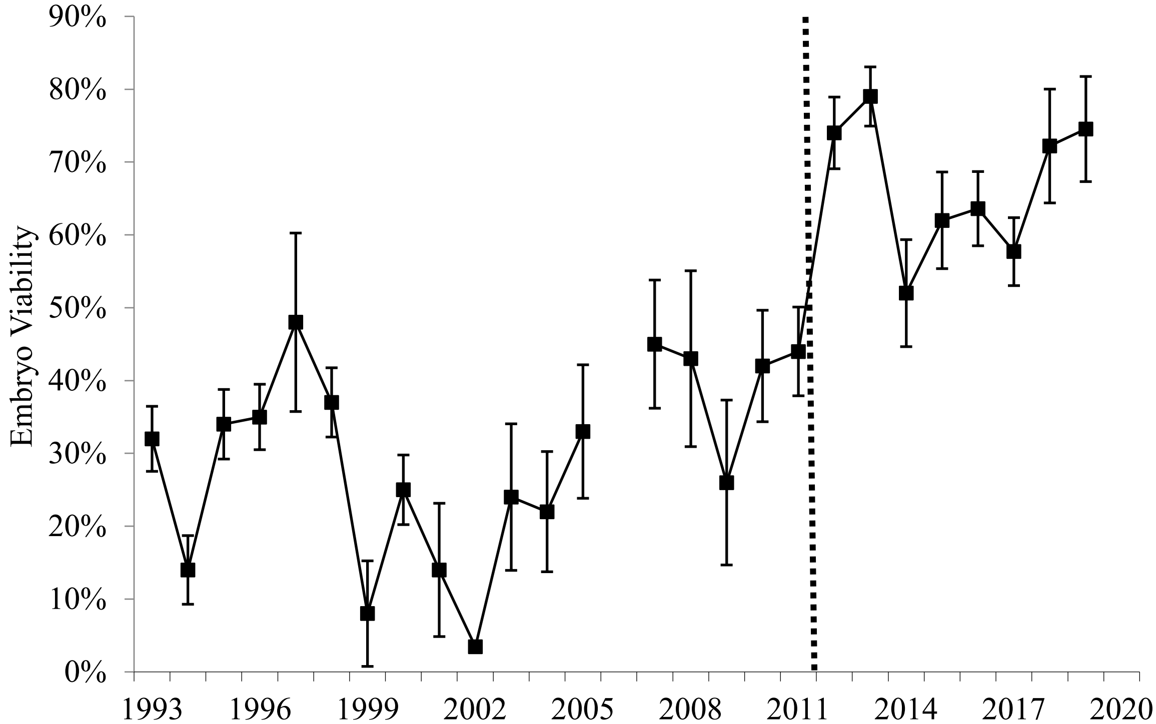

Figure 5. Mean annual embryo viability in the St. Marys River rapids during and after application of the sterile-male release technique (SMRT). The error bars represent SEs (not calculated for 2002 because only one sample was obtained). The vertical dashed line shows when SMRT application was discontinued after 2011.

ASSESSMENT

The SLCP has three assessment metrics:

- Larval assessment, conducted by the Service and Department, determines the abundance and distribution of sea lamprey larvae in streams and lentic areas. These data are used to predict where larvae greater than 100 mm total length will most likely be found by the end of the growing season during the year of sampling. These predictions are used to prioritize lampricide treatments for the following year.

- Juvenile assessment, undertaken by other fishery management agencies, evaluates the lake-specific rate of lake trout marking inflicted by sea lamprey. These time series data are used in conjunction with adult assessment data to assess the effectiveness of the SLCP for each lake. In addition, several indices of relative abundance of feeding juveniles are used in some lakes to monitor sea lamprey populations over time.

- Adult assessment, conducted by the Service and Department, annually estimates an index of adult sea lamprey abundance in each lake. Because this life stage is comprised of individuals that have either survived or avoided exposure to lampricides, the time series of adult abundance indices is the primary metric used to evaluate the effectiveness of the SLCP.

Reporting to the SLCB, the Larval Assessment Task Force (LATF) and the Trapping Task Force (TTF) were established by the Commission in 2012. The LATF is responsible for ranking streams and lentic areas for sea lamprey control options and evaluating the success of lampricide treatments through assessment of residual larvae. The TTF is responsible for optimizing trapping techniques for assessing adult sea lamprey populations and removing adults and juveniles. Task Force progress on SLCB charges during 2020 are presented in the LATF and TTF sections of this report.

Larval Assessment

Tributaries considered for lampricide treatment during 2021 were assessed during 2019 and 2020 to define the distribution and estimate the abundance and size structure of larval sea lamprey populations. Assessments were conducted with backpack electrofishers in waters <0.8 m deep, while waters ≥0.8 m in depth were surveyed with gB or by deep-water electrofishing (DWEF). Additional surveys are used to define the distribution of sea lamprey within a stream, detect new populations, evaluate lampricide treatments, and to establish the sites for lampricide application.

Lake Superior

- Larval assessments were conducted in 84 tributaries (38 Canada, 46 U.S.) and five lentic areas (0 Canada, 5 U.S.). The status of larval sea lamprey populations in historically infested Lake Superior tributaries and lentic areas is presented in Table 11.

- Surveys to estimate larval abundance were conducted in 19 tributaries (5 Canada, 14 U.S.). Offshore surveys to estimate abundance did not occur.

- Surveys to detect the presence of new larval sea lamprey populations were conducted in three tributaries (1 Canada, 2 U.S.). No new populations of larvae were discovered, however sea lamprey distribution expanded beyond historic reaches in Little Beaver Creek and the Gravereat River.

- Post-treatment assessments were conducted in 23 tributaries (11 Canada, 12 U.S.) and one lentic area (1 Canada, 0 U.S) to determine the effectiveness of lampricide treatments conducted during 2019 and 2020.

- Reestablished and residual populations were found in the Two Hearted, Goulais, Batchawana, Pancake, Agawa and Kaministiqua Rivers and Furnace, Havilland, and Unnamed (S-1009) Creeks, however, none of these populations were significant enough to warrant a 2021 treatment.

- Surveys to evaluate barrier effectiveness were conducted in three tributaries. All barriers were found to be effective in limiting sea lamprey infestations.

- Larval assessment surveys were conducted in non-wadable lentic and lotic areas using 16.41 kg active ingredient of 3.2% gB (Table 12).

Table 11. Status of larval sea lamprey in Lake Superior tributaries with a history of sea lamprey production.

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Canada			
East Davignon Cr.	May-72	May-18	May -72
West Davignon Cr.	Jun-14	July-20	June-16
Little Carp R.	May-16	Aug-20	Aug-20
Big Carp R.	Sep-07	Jul-19	Aug-08
Cranberry Cr.	May-17	Aug-20	Aug-20
Goulais R.	Jun-19	Aug-20	Aug-20
Goulais Bay	Oct-16	Jul-18	Jul-18
Boston's Cr.	Never	Aug-20	Aug-20
Horseshoe Cr.	Never	Aug-20	Aug-59
Havilland Cr.	Oct-19	Aug-20	Jun-19
Havilland Bay	Jun-15	Jul-17	Jul-14
Stokely Cr.	Jun-08	Aug-20	Sep-17
Havilland Bay	Aug-11	Aug-20	Jul-09
Tier Cr.	Never	Jul-19	Jun-61
Harmony R.	Jun-14	Aug-20	Aug-20
Batchawana Bay	Aug-14	Aug-17	Aug-17
Sawmill Cr.	Aug-18	Aug-20	Aug-20
Jones Landing Cr.	Never	Aug-20	Jun-66
Tiny Cr.	Never	Aug-20	Aug-19
Chippewa R.	Aug-20	Jul-18	Jul-18
Batchawana Bay	Oct-17	Aug-18	Aug-18
Unamed (S-1009)	Oct-19	Aug-20	Aug-20
Unger Cr.	Jul-10	Aug-20	May-18
Batchawana R.	Jul-20	Aug-20	Aug-20
Batchawana Bay	Aug-18	Jul-19	Jul-19
Digby Cr.	Jun-13	Aug-20	Jul-19
Carp R.	Aug-20	Aug-20	Jul-19
Batchawana Bay	Jul-18	Jul-19	Jul-17
Pancake R.	Jun-19	Aug-20	Aug-20
Pancake Bay	Jun-19	Jul-18	Jul-18
Hibbard Bay Cr.	Never	Aug-20	Never
Westman Cr.	Jun-16	Aug-20	Jul-15
Agawa R.	Jul-19	Jun-18	Jun-18
Agawa Bay	Aug-10	Aug-20	Aug-20
Sand R.	Sep-71	Aug-20	Aug-20
Baldhead R.	Never	Aug-20	Sep-01
Gargantua R.	Sep-18	Oct-18	Jul-15
Old Woman R.	Jul-18	Aug-20	Jul-17
Michipicoten R.	Aug-16	Aug-20	Jul-19
Michipicoten R. (Lower) lentic	Aug-19	Aug-16	Aug-12

Table 11. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Dog R.	Aug-63	Jul-18	Jul-17
White R.	Jul-16	Jul-18	Jul-15
Pic R.	Jul-19	Jul-18	Jul-18
Nama Cr.	Jul-19	Jul-18	Jul-18
Little Pic R.	Jul-16	Jul-19	Jul-19
Prairie R.	Jul-19	Jul-18	Jun-18
Steel R.	Aug-19	Jul-18	Jul-18
Pays Plat R.	Jul-15	Aug-18	Aug-18
Pays Plat Bay	Never	Aug-18	Aug-16
Little Pays Plat Cr.	Jul-15	Aug-18	Aug-18
Gravel R.	Aug-19	Aug-20	Aug-18
Mountain Bay	Sep-18	Aug-17	Aug-17
Little Gravel R.	Jul-18	Aug-20	Aug-19
Mountain Bay	Aug-16	Aug-17	Aug-17
Little Cypress	Aug-14	Aug-20	Aug-17
Cypress Bay	Aug-16	Aug-15	Aug-15
Cypress R.	Jul-18	Aug-20	Aug-20
Cypress Bay	Jul-19	Aug-18	Aug-18
Jackpine R.	Never	Aug-19	Aug-19
Nipigon Bay	Aug-19	Aug-18	Aug-18
Jackfish R.	Oct-16	Aug-18	Jun-18
Nipigon Bay	Never	Aug-14	Aug-05
Nipigon R.			
Upper Nipigon R.	Aug-19	Aug-18	Aug-18
Lake Helen lentic	Aug-19	Aug-18	Aug-18
Lower Nipigon R.	Aug-06	Aug-19	Aug-19
Nipigon R (Lower) lentic	Aug-19	Aug-19	Aug-19
Cash Cr.	Oct-15	Aug-20	Aug-19
Lake Helen lentic	Sep-16	Aug-17	Aug-15
Polly Cr.	Jul-18	Aug-19	Aug-17
Poly Lake lentic	Jul-87	Aug-17	Jul-90
Stillwater Cr.	Aug-19	Aug-19	Jun-18
Nipigon Bay	Sep-18	Aug-19	Aug-19
Big Trout Cr.	Jul-18	Aug-20	Aug-19
Nipigon Bay	Oct-11	Aug-18	Aug-18
Otter Cove Cr.	Aug-19	Aug-19	Aug-19
Black Sturgeon R.	Aug-16	Aug-19	Aug-19
Black Bay	Never	Aug-11	Jul-04
Big Squaw Cr.	Jun-72	Aug-18	Aug-71
Wolf R.	Jul-18	Aug-20	Aug-20
Black Bay	Aug-15	Aug-18	Aug-16
Coldwater Cr.	Jul-18	Aug-20	Aug-20
Black Bay	Aug-19	Aug-18	Aug-18
Pearl R.	Jul-19	Aug-18	Aug-18
D’Arcy Cr.	Jul-19	Aug-20	Aug-18
Black Bay	Jun-17	Aug-17	Aug-16
Blende Cr.	Jun-17	Aug-19	Aug-19
MacKenzie R.	Aug-16	Aug-19	Aug-19
MacKenzie Bay	Aug-19	Aug-18	Aug-18

Table 11. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Wild Goose Cr.	Jul-18	Aug-20	Aug-20
Current River			
Thunder Bay	Sep-18	Aug-19	Aug-19
Neebing-McIntyre FW	Jun-17	Aug-19	Aug-19
Kaministiquia R.	Sep-16	Aug-20	Aug-20
Slate R.	Oct-19	Aug-18	Aug-18
Corbett Cr.	Jul-16	Aug-20	Aug-18
Whitefish R.	Aug-16	Aug-20	Aug-20
Oliver Cr.	Jul-16	Aug-20	Aug-18
Jarvis R.	Jun-17	Aug-19	Aug-19
Cloud R.	Jun-17	Aug-19	Aug-19
Pine R.	Jul-18	Aug-16	Aug-17
Pigeon R.	Jul-18	Aug-19	Aug-17
Pigeon Bay	Aug-10	Aug-15	Aug-15
United States			
Waiska R.	Jul-07	Jul-19	Jun-18
West Branch	Jun-16	Jul-19	Jul-19
Sec. 11SW Cr.	Never	Jun-17	Jun-12
Pendills Cr.	Jul-12	May-18	May-16
Tahquamenon Bay	Never	Jul-17	Jul-12
Grants Cr.	Aug-15	Jul-19	Jul-19
Tahquamenon Bay	Jul-18	Jul-19	Jul-19
Halfaday Cr.	Jul-12	Jul-19	Jul-19
Tahquamenon Bay	Never	Jul-12	Jul-12
Naomikong Cr.	Jul-18	Jul-19	Jun-17
Ankodosh Cr.	Aug-19	July-19	Jul-19
Tahquamenon Bay	Jul-18	Jul-19	Jul-17
Roxbury Cr.	Jul-17	Aug-19	Aug-19
Tahquamenon Bay	Never	Jul-19	Jul-19
Galloway Cr.	Aug-19	Jun-18	Jun-18
Tahquamenon Bay	Never	Jun-13	Jul-88
Tahquamenon R.	Aug-19	Aug-19	Jul-18
Betsy R.	Jul-17	Jul-19	Jul-19
Three Mile Cr.	Jul-18	Jun-19	Aug-17
Little Two Hearted R.	Aug-16	Aug-19	Aug-19
Two Hearted R.	Aug-19	Sep-20	Sep-20
Dead Sucker R.	Aug-13	May-19	May-19
Sucker R.	Jul-18	Sep-20	Aug-20
Grand Marais Harbor	Never	Sep-18	Sep-18
Chipmunk Cr.	Sep-62	May 19	Sep-61
Carpenter Cr.	Aug-15	May-19	Aug-14
West Bay	Aug-19	Sep-20	Sep-20
Sable Cr.	Sep-89	Jul-20	Jul-20
Hurricane R.	Never	Sep-18	Aug-08
Sullivans Cr.	Jul-19	Aug-20	Aug-20
Seven Mile Cr.	Jul-18	Jul-20	Jul-20
Beaver Lake Cr.			
Beaver Lk Outlet	Jul-18	Jul-20	Aug-17
Lowney Cr.	Jul-18	Jul-20	Jul-20

Table 11. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Little Beaver Cr.	Jul-18	Aug-20	Aug-20
Arsenault Creek	Never	Aug-20	Aug-20
Beaver Lake	Never	Aug-17	Jun-19
Little Beaver Lake	Never	Jun-19	Jun-19
Mosquito R.	Jun-73	Sep-18	Oct-72
Miners R.			
Barrier downstream	Jul-16	Jul-19	Sep-18
Barrier upstream	Jul-13	Aug-18	May-12
Miners Lake Lentic	Jun-11	Sep-13	Sep-13
Munising Falls Cr.	Sep-64	Jun-20	Jun-14
Anna R.	Jul-19	Oct-19	May-19
Munising Bay	Jul-19	Sep-19	Sep-19
Tourist Park Cr.	Never	Jul-19	Jul-10
Furnace Cr.			
Lower	Jul-19	Jun-20	Jun-20
Upper	Sep-10	Sep-18	Aug-09
Furnace Bay	Jul-17	Jul-19	Jul-19
Furnace Lake – Near Outlet	Never	Jul-20	May-12
Furnace Lake – Offshore Hanson Cr.	Never	Jul-17	Jul-09
Furnace Lake – Offshore Gongeau Cr.	Never	Jul-17	Jul-09
Five Mile Cr.	Jul-16	Jul-20	Jul-20
Five Mile Cr. Lentic	Never	Jul-16	Jul-16
Au Train R.			
Lower	Jul-19	Jul-20	May-19
Upper	Jul-19	Jul-20	Jul-20
Au Train Lake	Never	Jul-20	Jul-20
Rock R.	Jul-02	Sep-18	Aug-97
Deer Lake Cr.	Aug-70	Sep-17	Aug-78
Laughing Whitefish R.	Jul-20	Jul-20	Jul-20
Sand R.			
Below Dam	Jul-19	Jun-20	Sep-18
Above Dam	Jul-15	Aug-17	Aug-17
Chocolay R.	Jul-19	Jul-20	Jul-20
Carp R.	Jul-20	Jun-20	Jun-20
Carp R. lentic	Jun-15	Oct-19	Jul-19
Dead R.	Jul-19	Sep-19	Jul-19
Presque Isle Harbor	Jul-19	Sep-19	Aug-18
Compeau Cr.	Never	Jul-19	Jun-12
Harlow Cr.	Sep-19	Sep-20	Jul-20
Harlow Lake – offshore Bismark Cr.	Never	Jun-20	Jun-20
Little Garlic R.	May-17	Jul-20	Jul-20
Little Garlic R. lentic	Jun-12	Jul-20	Jul-20
Garlic R.	Jul-18	Aug-20	Aug-20
Garlic R. lentic	Never	Jul-12	Sep-05
Saux Head Lake	Jul-17	Jun-19	Jun-19
Iron R.	Sep-19	Jul-20	Sep-18
Salmon Trout R.	Jul-19	Oct-19	Jun-19
Pine R. (Marquette Co.)	Jun-18	Jun-20	Sep-17
Huron R.	Aug-19	Jul-20	Jul-20
Ravine R.	Aug-20	Jun-20	Sep-19

Table 11. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Huron Bay	Sep-15	Jul-20	Jul-20
Slate R.	Jun-19	Jun-20	Jun-20
Huron Bay	Aug-17	Sep-19	Sep-19
Silver R.	Aug-20	Jun-20	Jun-19
Huron Bay	Aug-17	Sep-19	Sep-17
Falls R.	Aug-20	Jul-20	Jun-06
L'anse Bay	Jun-18	Sep-19	Sep-19
Six Mile Cr.	Sep-18	Jul-19	Jun-17
L'anse Bay	Never	Jun-18	Jun-18
Little Carp R.	May-19	Oct-19	Aug-18
Kelsey Cr.	Never	Jul-20	Aug-16
Sturgeon R.	Oct-18	Jul-20	Jun-20
Pilgrim R.	Aug-62	Sep-20	Sep-20
Trap Rock R.	Jul-19	Sep-20	Sep-20
Torch Lake	Jul-19	Jul-20	Sep-19
McCallum Cr.	Aug-63	May-15	May-94
Traverse River	May-19	Oct-20	Oct-20
Little Gratiot R.	Jun-16	May-19	May-15
Eliza Cr.	Jul-19	Sep-19	Aug-18
Eagle Harbor	Jul-20	Oct-19	Sep-19
Gratiot R.	Sep-18	Sep-20	Sep-20
Smiths Cr.	May-64	Sep-20	May-64
Boston-Lily Cr.	Jul-20	Sept-19	Sep-19
Schlotz Cr.	Jul-16	Sep-20	Sep-20
Salmon Trout R. (Houghton Co.)	Jun-16	Sep-20	Sep-20
Mud Lake Outlet	Sep-18	Sep-20	Sep-20
Hungarian Creek	Sep-20	Jun-20	Jun-20
Torch Lake	Sep-20	Jun-20	Jun-20
Graveraet R.	Sep-18	Sep-20	Sep-20
Elm R.	Aug-16	May-19	Aug-15
Misery R.			
Barrier Downstream	Aug-18	Sep-20	Sep-20
Barrier upstream	Aug-00	Aug-18	Sep-08
East Sleeping R.	May-19	Aug-19	Aug-19
West Sleeping R.	May-19	Aug-19	Aug-19
Firesteel R.	Jun-19	Sep-20	Aug-19
Flintsteel R.	Sep-17	Jul-20	Jul-20
Ontonagon R.	Oct-19	Sep-20	Aug-19
Potato R.	Sep-17	Sep-20	Sep-20
Floodwood R.	Never	Jul-18	Aug-85
Cranberry R. (Ontonagon Co.)	Sep-18	Sep-20	Aug-19
Mineral R.	Sep-17	Sep-19	Jul-18
Mineral R. lentic	Never	Aug-19	Sep-11
Big Iron R.	Never	Aug-19	Jul-15
Little Iron R.	Sep-75	Aug-19	Sep-13
Union R.	May-64	Oct-20	Aug-62
Black R.	Sep-19	Jul-19	Jul-17
Black River Harbor	Sep-19	Jul-19	Jul-19
Montreal R.	Jul-75	Aug-18	Jul-10

Table 11. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Washington Cr.	Jun-80	Jul-12	Sep-82
Bad R.	Sep-17	Sep-19	Sep-19
Fish Cr. (Eileen Twp)	Jun-15	Sep-19	Sep-19
Chequamegon Bay	Never	Aug-15	Aug-06
Sioux R.	Jul-19	Sep-19	Aug-18
Pikes Cr.	May-16	Aug-18	Aug-18
Red Cliff Cr.	Jun-18	Jul-19	Jul-19
Buffalo Bay	Never	Aug-11	Aug-03
Raspberry R.	May-16	Jul-19	Sep-15
Sand R. (Bayfield Co.)	Jul-16	Sep-19	Sep-19
Sand Bay	Aug-10	Aug-15	Aug-15
Cranberry R. (Bayfield Co.)	Jun-17	Aug-18	Sep-16
Iron R.			
Barrier downstream	Aug-16	Aug-19	Aug-19
Barrier upstream	Oct-64	Aug-16	Never
Reefer Cr	Oct-64	Aug-18	Jun-16
Fish Cr. (Orienta Twp)	Oct-64	Sep-16	Aug-63
Brule R.			
Barrier downstream	Jun-18	Aug-19	Aug-19
Barrier upstream	Jun-86	Aug-18	Sep-87
Poplar R.	Jun-18	Aug-19	Jul-19
Middle R.			
Barrier downstream	Jun-17	Jun-19	Sep-16
Barrier upstream	Jun-02	Jul-17	Sep-09
Amnicon R.	Jul-18	Sep-19	Jun-19
Amnicon R. Lentic	Never	Aug-18	Aug-18
Nemadji R.	Sep-18	Jun-19	Jun-19
St. Louis R.	Sep-87	Aug-19	Aug-19
Sucker R. (St. Louis Co.)	Never	Aug-17	Sep-89
Gooseberry R.	Aug-76	Aug-17	May-10
Splitrock R.	Aug-76	Aug-17	Aug-86
Poplar R.	Jun-18	Aug-18	Aug-17
Arrowhead R.	Jun-09	Aug-18	Aug-18

Table 12. Details on application of granular Bayluscide to tributaries and lentic areas of Lake Superior for larval assessment purposes during 2020.

Tributary	Bayluscide (kg)[1]	Area Surveyed (ha)
Canada		
No granular Bayluscide used during 2020		
United States		
Carpenter Creek (Lentic)	1.95	0.41
Furnace Creek (Lentic)	0.98	0.20
Au Train Lake	2.93	0.62
Harlow Lake	1.95	0.41
Little Garlic (Lentic)	1.46	0.31
Iron River	0.49	0.10
Huron River	0.73	0.15
Ravine River (Lentic)	1.95	0.41
Trap Rock River (Lentic)	1.95	0.41
Hungarian Creek (Lentic)	1.95	0.41
Total (United States)	**16.41**	**3.47**
Total for Lake	**16.41**	**3.47**

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

Lake Michigan

- Larval assessments were conducted in 56 tributaries and 8 lentic areas. The status of larval sea lamprey populations in historically infested Lake Michigan tributaries and lentic areas is presented in Table 13.

- Surveys to estimate larval abundance were conducted in five tributaries.

- Surveys to detect the presence of new larval sea lamprey populations were conducted in four tributaries. No new infestations were identified.

- Post-treatment assessments were conducted in 15 tributaries to determine the effectiveness of lampricide treatments conducted during 2019 and 2020.

- Surveys to evaluate barrier effectiveness were conducted in six tributaries. All barriers were found to be effective in limiting sea lamprey infestations.

- Larval assessment surveys were conducted in 15 non-wadable lentic and lotic areas using 15.41kg active ingredient of 3.2% gB (Table 14).

Table 13. Status of larval sea lamprey in Lake Michigan tributaries with a history of sea lamprey production.

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Brevort R.			
Upper	Jun-17	Aug-19	Aug-19
Lower	Jun-17	Aug-19	Aug-19
Brevort Lake	May-12	Jun-19	Jun-19
Paquin Cr.	Jun-19	Sept-18	Sep-18
Paquin Cr. Lentic	Never	Sep-18	Sep-18
Davenport Cr.	Sep-13	Aug-19	Aug-11
Hog Island Cr.	Jun-17	Aug-19	Aug-19
Hog Island Cr. Lentic	Jun-07	Jul-18	Jul-18
Sucker R.	Jun-61	Sep-17	May-07
Black R.	Jun-17	Aug-19	Aug-19
Black R. lentic	Jun-76	Aug-11	Aug-11
Mattix Cr.	Aug-15	Jun-18	Jun-14
Mile Cr.	May-17	Aug-20	Jun-19
Mile Cr. Lentic	Aug-68	Jun-18	Jun-08
Millecoquins R.	Jun-17	Jul-20	Jul-19
Furlong Creek	Sep-19	Jun-20	Jun-20
Millecoquins Lake	Never	Jun-19	Jun-14
Rock R.	Jun-19	Jun-20	Jun-18
Crow R.	Jun-19	Aug-20	Jun-20
Cataract R.	Sep-19	Aug-20	Sep-18
Cataract R. lentic	Never	Jul-19	Jul-19
Pt. Patterson Cr.	Jul-13	Aug-18	Sep-12
Hudson Cr.	Aug-19	Sep-20	Aug-18
Swan Cr.	Jul-13	Aug-20	Jul-19
Seiners Cr.	Aug-17	Aug-20	Jul-19
Milakokia R.	Oct-16	Aug-20	Jul-19
Seul Choix Bay	Never	Jul-19	Jul-80
Bulldog Cr.	Jun-13	Jun-18	Sep-13
Gulliver Lake Outlet	Sep-19	Sep-20	Sep-18
Marblehead Cr.	Jun-19	Jul-20	Jul-20
Manistique R.	Sep-19	Aug-20	Aug-20
Inside Breakwalls	Jun-19	Jul-20	Jul-20
Outside Breakwalls	Jul-18	Jul-20	Jul-20
Southtown Cr.	Jul-13	Jul-19	Aug-12
Thompson Cr.	Never	Aug-20	Jul-19
Johnson Cr.	Jun-13	Jul-19	Sep-12
Deadhorse Cr.	Aug-18	Aug-20	Aug-20
Deadhorse Cr. Lentic	Never	Jul-11	Oct-64
Gierke Cr.	Never	Jul-19	Jun-04
Bursaw Cr.	Aug-17	Jul-20	Jul-19
Bursaw Cr. Lentic	Never	Jul-11	Jul-11
Parent Cr.	Aug-17	Aug-20	Aug-20
Poodle Pete Cr.	Aug-17	Jul-20	Jul-19
Valentine Cr.	Aug-17	Sep-20	Jul-19
Big Bay de Noc	Never	Sep-11	Aug-94
Little Fishdam R.	May-01	Jul-19	Jul-04
Big Fishdam R.	Aug-16	Sep-20	Aug-20

Table 13. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Sturgeon R.	Jul-19	Aug-20	Aug-20
Big Bay de Noc	Never	Aug-19	Aug-15
Ogontz R.	Sep-20	Jun-20	Oct-19
Big Bay de Noc	Sep-14	Aug-17	Jul-15
Squaw Cr.	Aug-17	Jul-20	May-16
Hock Cr.	May-17	Jul-19	May-16
Whitefish R.	May-19	Aug-20	Aug-20
Little Bay de Noc	Jun-83	Aug-18	Jul-11
Rapid R.	Oct-20	Aug-20	Jul-20
Little Bay de Noc	May-15	Aug-18	Jul-16
Tacoosh R.	Oct-14	Jul-19	Jul-14
Days R.			
Barrier downstream	Aug-20	Jun-20	Aug-18
Barrier upstream	Aug-17	Jun-20	Aug-17
Little Bay de Noc	Aug-14	Jun-20	Aug-13
Escanaba R.	Never	Aug-20	Jul-06
Portage Cr.	May-17	Aug-19	Aug-17
Portage Bay	Never	Aug-17	Aug-82
Ford R.	Aug-20	Jun-20	Jun-20
Green Bay	Oct-14	Aug-19	Aug-19
Sunnybrook Cr.	May-71	Aug-19	Sep-90
Bark R.	May-17	Jul-19	Aug-16
Green Bay	Never	Jul-16	Sep-98
Cedar R.	Jun-17	Sep-20	Sep-20
Green Bay	May-10	Aug-19	Jul-16
Sugar Cr.	May-08	Jul-20	Jul-19
Arthur Bay Cr.	Jun-10	Jul-20	Jul-19
Rochereau Cr.	Apr-63	Jul-19	Jul-62
Johnson Cr.	Apr-17	Jul-20	Jul-19
Bailey Cr.	May-19	Jul-19	Jul-19
Green Bay	Never	Aug-18	Aug-18
Beattie Cr.	May-19	Jul-19	Aug-18
Springer Cr.	May-19	Jul-19	Jul-19
Menominee R.	Jul-16	Jun-19	Jun-19
Green Bay	Jul-16	Aug-17	Sep-15
Little R.	Aug-77	Aug-18	Aug-77
Peshtigo R.	Sep-20	Aug-20	Aug-20
Oconto R.	Oct-17	Jul-19	Aug-17
Pensaukee R.	Nov-77	Aug-17	Sep-85
Suamico R.	Never	Aug-17	May-67
Ephraim Cr.	Apr-63	Jun-19	Apr-61
Hibbards Cr.	May-07	Jun-19	Oct-09
Whitefish Bay Cr.	May-16	Jun-19	Jun-15
Shivering Sands Cr.	Apr-12	Jun-19	May-14
Lily Bay Cr.	Apr-63	Jun-18	May-63
Bear Cr.	May-75	Jun-19	May-75
Door Co. 23 Cr.	May-19	Jun-19	Jun-18
Silver Creek	Never	Jul-18	Jul-15

Table 13. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Ahnapee R.	Apr-64	Jun-18	Apr-64
Three Mile Cr.	Apr-17	Jun-19	Jun-19
Kewaunee R.			
Barrier downstream	May-75	Jun-19	May-98
Barrier upstream	May-75	Jul-17	Aug-13
Casco Cr.	May-14	Jun-19	Aug-14
East Twin R.	Apr-17	Jun-19	Jun-19
Fischer Cr.	May-87	Jun-19	May-87
French Farm Cr.	Never	Jul-19	Jun-10
Carp Lake Outlet	Jun-17	Jun-19	May-15
Big Stone Cr.	Sep-13	Jun-19	Aug-10
Big Sucker R.	Sep-13	Jul-19	Sep-13
Wycamp Lake Outlet	Jul-17	Jun-19	Aug-16
Bear R.	Never	Sep-20	Never
Bear R. Lentic	Jun-07	Jun-19	Jun-08
Horton Cr.	Jun-17	Aug-19	Oct-19
Horton Cr. Lentic	Jun-19	Aug-20	Aug-20
Boyne R.	Jul-18	Jun-19	Jun-19
Boyne R. Lentic	Jun-17	Jun-19	Jun-14
Porter Cr.	Sep-13	Jun-19	Jun-19
Porter Cr. Lentic	Sep-13	Sep-20	Sep-20
Jordan R.	Jul-18	Sep-20	Sep-20
Jordan R. Lentic	Jul-18	Jun-19	Jun-14
Monroe Cr.	Aug-13	Jun-19	Jun-13
Loeb Cr.	Aug-13	Jun-19	Aug-11
McGeach Cr.	Oct-99	May-15	Jun-98
Elk Lake Outlet	Jun-17	Jul-20	Jun-16
Yuba Cr.	May-06	Jul-20	Aug-05
Acme Cr.	Aug-63	Aug-18	Jul-73
Mitchell Cr.	Jul-17	Aug-20	Aug-20
Boardman R. (lower)	Aug-15	Aug-20	Jun-14
Boardman R. (mid.)	Aug-15	Aug-20	Sep-14
Boardman R. Lentic	Jun-17	Sep-20	Jun-16
Hospital Creek	Jul-18	Aug-19	Jun-17
Leo Cr.	Never	Aug-19	Jul-95
Leland River Lentic	Never	Jul-19	Jun-13
Good Harbor Cr.	Jul-10	Aug-19	Sep-09
Crystal R.	Apr-19	Aug-19	Sep-18
Platte R. (upper)	May-19	Sep-20	Sep-20
Platte R. (middle)	May-19	Sep-20	Sep-20
Loon Lk. Lentic	May-19	Sep-20	Sep-20
Platte R. (lower)	May-19	Sep-20	Sep-18
Betsie R.	May-19	Sep-20	May-19
Bowen Cr.	Jun-09	Aug-19	Oct-19
Big Manistee R.	Aug-20	Jul-20	Oct-19
Bear Cr.	Aug-19	Jul-20	Jul-20
L. Manistee R.	Jul-18	Jul-20	Jul-20
L. Manistee R. Lentic	Jul-11	Jul-18	Sep-05
Gurney Cr.	Jun-16	Aug-19	Jul-15
Cooper Cr.	Jul-08	Aug-19	Sep-07

Table 13. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Lincoln R.	Jul-20	Sep-20	Sep-20
Pere Marquette R.	Aug-20	Sep-20	Sep-20
Bass Lake Outlet	Aug-78	Jun-18	Aug-75
Pentwater R. (N. Br.)	Sep-20	Jun-20	Jun-18
South Branch	Never	Aug-17	Jun-83
Lambricks Cr.	Sep-84	Aug-17	Sep-84
Stony Cr.	Sep-20	Jul-20	Aug-19
Flower Cr.	Jul-17	Jul-20	May-17
White R.	Sep-20	Jul-20	Jul-20
Duck Cr.	Jul-84	Jul-19	Aug-95
Muskegon R.	Sep-19	Jul-20	Jul-20
Brooks Cr.	Sep-19	Jul-19	Aug-18
Cedar Cr.	Sep-19	Jul-19	Sep-16
Bridgeton Cr.	Sep-19	Jul-19	May-17
Minnie Cr.	Sep-19	Jul-19	Jul-19
Bigelow Cr.	Sep-19	Jul-19	Aug-18
Big Bear Cr.	Aug-70	Jul-19	Aug-70
Mosquito Cr.	Jul-69	Aug-14	Jul-07
Black Cr.	Aug-08	Jul-19	Aug-08
Grand River	Never	Aug-20	Never
Norris Cr.	Jun-17	Jul-19	Sep-16
Lowell Cr	Sep-65	Aug-20	Jun-65
Buck Cr.	Sep-65	Jul-18	Sep-65
Rush Cr.	Sep-65	Jul-18	Sep-62
Sand Cr.	Jun-07	Jul-18	Jun-07
Crockery Cr.	Jun-17	Jul-20	Sep-16
Bass R.	Aug-04	Jul-18	Sep-03
Rogue R.	Sep-09	Aug-20	Sep-08
Pigeon R.	Oct-64	Sep-19	May-62
Pine Cr.	Oct-64	Sep-19	May-62
Gibson Cr.	Jul-84	Sep-19	Jun-83
Kalamazoo R.	Oct-65	Aug-20	Never
Bear Cr.	Apr-19	Aug-19	Aug-19
Sand Cr.	Sep-10	Aug-19	May-17
Mann Cr.	Jul-16	Aug-19	Sep-15
Rabbit R.	Sep-15	Aug-19	Jul-14
Swan Cr.	Jul-13	Aug-19	Aug-19
Allegan 3 Cr.	Sep-65	Sep-19	Jun-62
Allegan 4 Cr.	Oct-78	Sep-19	Sep-19
Allegan 5 Cr.	Sep-15	Sep-19	Jul-14
Black R.			
North Branch	Jun-77	Sep-19	Sep-19
Middle Branch	May-17	Sep-19	Sep-19
South Branch	May-17	Aug-19	May-17
Brandywine Cr.	Aug-85	May-17	Jul-02
Rogers Cr.	May-18	Sep-19	Jun-16
St. Joseph R.	Never	Jul-19	Never
Lemon Cr.	Oct-65	Sep-19	Jun-65

Table 13. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Pipestone Cr.	May-14	Sep-19	Sep-19
Meadow Dr.	Oct-65	Oct-19	Apr-62
Hickory Cr.	Jul-15	Sep-19	Sep-19
Farmers Creek	Never	Sep-19	Oct-19
Paw Paw R.	Sep-17	Sep-19	Sep-19
Blue Cr.	Sep-15	Sep-19	Jun-15
Mill Cr.	Sep-17	Sep-19	Jun-17
Brandywine Cr.	Sep-17	Sep-19	Jul-17
Brush Cr.	Sep-15	Sep-19	Jun-15
Hayden Cr.	Sep-17	Sep-19	Sep-18
Campbell Cr.	Sep-18	Sep-19	Sep-18
Ritter Cr.	Sep-17	Sep-19	Oct-16
Galien R. (N. Br.)	Jun-16	Sep-19	Sep-15
E. Br. & Dowling Cr.	Oct-10	Sep-19	Sep-09
S. Br. & Galina Cr.	Jun-16	Sep-19	Sep-18
Spring Cr.	Jun-16	Sep-19	May-16
S. Br. Spring Cr.	Jun-16	Sep-19	Sep-19
State Cr.	Apr-14	May-19	Sep-13
Trail Cr.	Apr-14	Jul-19	Aug-18
Donns Cr.	May-66	May-19	May-66
Burns Ditch	Jul-99	Sep-17	Oct-98
Salt Creek	May-18	Oct-19	Jun-19

Table 14. Details on application of granular Bayluscide to tributaries and lentic areas of Lake Michigan for larval assessment purposes during 2020.

Tributary	Bayluscide (kg)[1]	Area Surveyed (ha)
Manistique River (Inside Breakwalls)	1.94	0.41
Manistique River (Outside Breakwalls)	1.47	0.31
Manistique River – Indian River	0.98	0.20
Days River (Lentic)	1.94	0.41
Escanaba River	0.98	0.20
Cedar River (Estuary)	0.49	0.10
Cedar River – Walton River	0.44	0.93
Arthur Bay Creek (Lentic)	0.49	0.10
Peshtigo River	1.47	0.31
Horton Creek (Lentic)	1.42	0.30
Porter Creek (Lentic)	0.95	0.20
Boardman River (Lentic)	0.71	0.15
Boardman River (Boardman Lake Lentic)	0.24	0.05
Platte River (Loon Lk. Lentic)	1.18	0.25
Kalamazoo River (Lotic)	0.71	0.15
Total for Lake	**15.41**	**4.07**

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

Lake Huron

- Larval assessments were conducted in 31 tributaries (30 Canada; 0 U.S.). No lentic surveys occurred. The status of larval sea lamprey populations in historically infested Lake Huron tributaries and lentic areas is presented in Table 15.

- Surveys to estimate larval abundance were conducted in 26 tributaries (26 Canada, 0 U.S.) and no lentic areas.

- Surveys to detect the presence of new larval sea lamprey populations were conducted in one tributary (1 Canada, 0 U.S.). No new infestations were identified.

- Post-treatment assessments were conducted in two tributaries (2 Canada, 0 U.S.) No lentic areas were surveyed to determine the effectiveness of lampricide treatments conducted during 2019 and 2020. Munuscong River (Taylor Creek) is scheduled for treatment during 2021 based on the presence of residual sea lamprey.

- Surveys to evaluate barrier effectiveness were conducted in three tributaries (3 Canada, 0 U.S.). All barriers were found to be effective in limiting sea lamprey infestations.

- Monitoring of larval sea lamprey in the St. Marys River did not occur in 2020.

- Larval assessments were conducted in non-wadable lentic and lotic areas using 2.83 kg active ingredient of 3.2% gB (Table 16).

Table 15. Status of larval sea lamprey in Lake Huron tributaries with a history of sea lamprey production.

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Canada			
St. Marys R.	Oct-19	Oct-19	Oct-19
Whitefish Ch.	Jul-16	Nov-19	Nov-19
Root R.	May-16	Jul-20	Jul-20
Garden R.	Jul-20	Sep-20	Sep-20
Maud &Driving Cr.	Jul-20	Aug-20	Jul-14
Echo R.			
Main	Jul-11	Oct-19	Oct-19
Bar & Iron Cr.	Aug-20	Aug-20	Oct-17
Echo Lake	Jun-15[1]	Aug-20	Sep-17
Solar Lake	Jul-87	Jul-06	May-90
Stuart Lake	Jul-80	May-90	May-90
Bar R.	Oct-11	Jul-19	Jul-10
Stoby-Portlock Cr.	Never	July-20	Never
Sucker Creek	May-18	Aug-20	Sep-17
Sucker Cr. (lentic)	Jul-84	Sep-16	Jun-13
Two Tree R.	May-15	Aug-20	Jul-14
Two Tree R. (lentic)	Never	Aug-81	Aug-81
Richardson Cr.	Sep-16	Aug-20	Jul-16
Watson Cr.	May-18	Aug-20	Jul-19
Gordon Cr.	May-18	Aug-20	Jul-19
Gordon Cr. (lentic)	Jul-84	Jul-18	Aug-91
Browns Cr.	May-16	Aug-20	Jul-18
Browns Cr. (lentic)	Aug-87	Jul-18	Aug-91
Koshkawong R.	May-18	Aug-20	Jul-19
Koshkawong R. (lentic)	Never	Jul-17	Aug-91
No Name (H-65)	Jun-13	Aug-20	Jun-15
No Name (H-68)	Jun-19	Aug-20	Jul-18
North Channel	Never	Apr-12	May-95
MacBeth Cr.	Jun-19	Aug-20	Jun-18
Thessalon R.			
Upper	Sept-18	Aug-20	Sep-17
Patten Lake Cr.	Jul-17	Sep-16	Sep-16
Lower	Jul-17	Aug-20	Aug-20
Livingstone Cr.	Jun-13	Sep-20	Sep-20
Mississagi R.	Aug-19	Oct-19	Oct-19
Harris/Bolton Cr.	Aug-19	Sep-20	Sep-20
North Channel	Jul-16	Sep-19	Sep-19
Blind R.	May-84	Jun-19	Jun-05
Lauzon R.	Jun-15	Sep-20	Sep-20
North Channel	Jun-15	Sep-18	Sep-18
Spragge Cr.	Oct-95	May-18	Jun-98
No Name (H-114)	Jun-19	Sep-20	Sep-20
North Channel	Jun-15	Sep-18	Sep-14
Marcellus Cr.	Jun-13	May-17	Sep-11

Table 15. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Serpent R.			
Main	Jun-16	Jun-19	Jun-19
Grassy Cr.	Jun-19	Aug-20	May-18
Spanish R.			
Main	Sep-15	Jun-17	Sep-12
LaCloche Cr.	Oct-18	Sep-19	Sep-17
Birch/Beaudin Cr.	Jun-18	Sep-20	Sep-20
Aux Sables R.	Sep-15	Sep-20	Sep-20
Kagawong R.	Aug-67	May-18	Aug-16
Mudge Bay	Aug-87	Jun-19	Jun-15
Unnamed (H-267)	Apr-17	Sep-20	Sep-20
Silver Cr.	May-17	Sep-20	Sep-20
Sand Cr.	Oct-17	Jul-19	Jul-19
Mindemoya R.	May-17	Sep- 20	Sep-20
Providence Bay	Jul-81	May-12	Jul-88
Timber Bay Cr.	Apr-17	Jun-19	Jun-19
Hughson Cr.	Sep-20	Sep-20	Sep-20
Manitou R.	Sep-20	Sep-19	Sep-17
Michael's Bay	Oct-20	Sep-17	Sep-17
Blue Jay Cr.	Sep-18	Sep-20	Sep-20
Blue Jay Cr. (lentic)	Jun-18	Sep-17	Sep-17
Kaboni Cr.	Oct-78	May-18	Jul-78
Chikanishing R.	Jun-18	Jun-19	May-17
French R. System			
O.V. Channel	Jun-12	Jun-19	Sep-15
Wanapitei R.	Jun-11	Jun-19	Jun-08
Key R. (Nesbit Cr.)	Sep-72	Jun-19	Aug-73
Still R.	Jul-17	Jun-19	May-16
Byng Inlet	Jun-12	Jun-19	Aug-16
Magnetawan R.	Jun-18	Sep-19	Sep-19
Naiscoot R.	May-18	Sep-20	Sep-20
Shebeshekong R.	Never	May-19	Aug-17
Boyne R.	Sep-18	Sep-20	May-18
Georgian Bay	Never	Aug-17	May-16
Musquash R.	Aug-13	Jun-19	Jun-19
Simcoe/Severn System	Never	May-19	May-19
Georgian Bay	Aug-18	May-19	May-19
Sturgeon R.	Apr-12	May-19	Sep-09
Sturgeon Bay	Never	May-14	Jun-99
Hog Cr.	Sep-78	Aug-17	Aug-78
Lafontaine Cr.	Jun-68	May-18	May-67
Nottawasaga R.			
Main	Jun-17	May-19	May-19
Boyne R.	Jun-17	May-19	May-19
Bear Cr.	Jun-13	May-19	April-11
Pine R.	Jun-18	May-19	May-19
Marl Cr.	Apr-13	May-19	May-11
Pretty R.	May-72	May-18	May-72

Table 15. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Silver Cr.	Sep-82	May-18	Sep-82
Bighead R.	Aug-18	Sep-20	Sep-20
Bighead R. (lentic)	Aug-18	Aug-17	Aug-17
Bothwells Cr.	Jun-79	May-18	Aug-83
Sydenham R.	Jun-72	May-18	Jul-71
Sauble R.	Jun-04	May-18	May-18
Saugeen R.	Jun-71	May-17	May-95
Bayfield R.	Jun-70	May-17	Sep-73
United States			
Mission Cr.	Never	May-16	Aug-04
Frechette Cr.	Never	May-16	Jul-81
Ermatinger Cr.	Never	May-16	Jun-12
Charlotte R.	Oct-11	Jun-17	Jun-17
Little Munuscong R.	Jul-16	Jul-19	Jul-19
Big Munuscong R.	Jun-99	May-16	Jul-97
Taylor Cr.	May-19	Aug-19	Aug-19
Gogomain River	Jul-16	Jun-18	Jun-18
Carlton Cr.	Oct-18	Aug-19	Aug-19
Canoe Lake Outlet	May-70	Apr-13	May-69
Caribou Cr.	Oct-19	Aug-19	Aug-19
Caribou Cr. Lentic	May-18	Sep-18	Jul-17
Bear Lake Outlet	Sep-16	Aug-19	Aug-19
Carr Cr.	Jun-13	Aug-19	Jun-15
Joe Straw Cr.	Jun-13	May-19	Oct-12
Saddle Cr.	Never	May-19	May-02
Huron Point Cr.	May-18	Aug-19	Aug-19
Albany Cr.			
Barrier downstream	May-18	Aug-19	Aug-19
Barrier upstream	Sep-01	Aug-15	May-03
Albany Bay	May-18	Sep-18	Jul-16
Trout Cr.	Jul-15	Aug-19	Aug-19
Trout Cr. Lentic	Never	Jul-14	Jul-11
Beavertail Cr.	Jul-18	Aug-19	Jul-17
Prentiss Cr.	Oct-19	Sep-18	May-19
McKay Cr.	May-18	Aug-19	Aug-19
McKay Bay	Never	Sep-18	Jul-11
Flowers Cr.	Jun-13	May-19	May-11
Flowers Bay	Never	Jun-12	Jul-80
Ceville Cr.	Jul-16	May-19	Jul-15
Hessel Cr.	Jul-15	Aug-19	Aug-19
Steeles Cr.	Sep-16	Aug-19	Aug-19
Nunns Cr.			
Barrier downstream	Jul-16	Aug-19	May-14
Barrier upstream	Jul-16	May-19	Jun-15
St. Martin Bay	Never	Aug-14	Aug-87
Pine R.	Jun-18	Aug-19	Sep-18
St. Martin Bay	May-18	Sep-18	Jul-17
McCloud Cr.	Jul-15	Aug-19	Aug-15

Table 15. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
St. Martin Bay	Never	Aug-15	Aug-15
Carp R.	Jul-18	Aug-19	Sep-18
St. Martin Bay	Jul-18	Aug-19	Aug-19
Martineau Cr.	Jul-16	Aug-19	May-17
Horseshoe Bay	Never	Aug-19	Sep-14
Hoban Cr.	Jun-12	May-17	May-11
266-20 Cr.	Aug-76	Jun-18	Sep-94
Beaugrand Cr.	Jun-16	Jun-18	Jul-15
Little Black R.	May-67	May-14	May-07
Cheboygan R.	Oct-83	Jun-19	Jun-19
Cheboygan R. lentic	Never	Jun-19	Aug-93
Laperell Cr.	May-00	Sep-18	Aug-99
Meyers Cr.	Jul-17	Sep-18	Jun-16
Maple R.	Aug-16	Aug-19	Aug-19
Pigeon R.	Sep-16	Sep-19	Sep-19
Little Pigeon R.	Aug-12	Sep-19	Jun-10
Sturgeon R.	Aug-16	Aug-19	Aug-19
Sturgeon R. lentic	Jun-19	Aug-19	Aug-18
Elliot Cr.	Jul-17	Aug-19	Aug-19
Duncan Bay	Never	Aug-16	Jul-12
Greene Cr.			
Barrier downstream	Jul-12	Jun-18	Sep-10
Barrier upstream	Jun-07	Aug-19	Jun-13
Grass Cr.	May-78	Jun-19	Jun-19
Mulligan Cr.	Jun-16	Jul-19	Jun-18
Mulligan Cr. lentic	Never	Aug-16	Aug-16
Grace Cr.	Oct-18	May-19	May-19
Black Mallard Cr. (Lower)	Jun-18	Jul-19	Jul-19
Black Mallard Lake	Never	Jul-12	Jun-10
(Upper)	May-15	Jun-18	Sep-19
Seventeen Cr.	Jul-12	Jun-19	Jul-12
Ocqueoc R.			
Hammond Bay lentic	Never	Sep-12	Sep-86
Barrier upstream	Sep-18	Jun-19	Jun-19
Barrier downstream	Jul-16	Jul-19	Jul-19
Johnny Cr.	Sep-70	Jun-19	Jun-19
Hammond Bay Cr. lentic	Never	Sep-17	Sep-17
Schmidt Cr.			
Lower	Jun-18	Jun-19	Jun-17
Upper	May-08	Jun-17	May-08
Nagels Cr.	Never	Aug-18	Jun-09
Trout R.			
Barrier downstream	Jul-16	Jul-19	Jul-19
Barrier upstream	Oct-07	Jun-19	Jun-07
Swan R.	Jun-10	Jul-17	Jun-10
Grand Lake Outlet	Never	Jun-17	May-03
Middle Lake Outlet	Jun-67	Aug-18	Aug-66
Long Lake Outlet	Jun-16	Jul-19	Jul-19

Table 15. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Squaw Cr.	Jun-13	Aug-18	Oct-11
Devils R.	Oct-14	Aug-18	Aug-13
Thunder Bay	Never	Jun-09	Aug-76
Black R.	Jun-18	Aug-18	Aug-18
Mill Cr.	Never	Aug-18	May-98
Au Sable R.	Aug-18	Jul-19	Jul-19
Au Sable. R lentic	Aug-15	Aug-17	Sep-14
Pine R.	May-87	Sep-19	Sep-94
Tawas Lake Outlet	Jun-15	Jul-19	Jun-14
Cold Cr.	Aug-18	Aug-19	May-17
Sims Cr.	Jul-09	Aug-19	Aug-08
Grays Cr.	Sep-05	May-18	Jul-04
Silver Cr.	Sep-18	Aug-19	Sep-17
East AuGres R.	Jun-18	May-18	Jul-19
East AuGres R. lentic	Never	Aug-15	Jun-86
AuGres R.	Sep-18	Jul-18	Jun-19
Rifle R.	Aug-18	Jul-18	Jul-18
Saginaw R.			
Shiawassee R.	May-18	Jun-19	Jun-19
Cass R.	Jun-18	Jun-19	Jul-18
Flint R.	Never	Jul-19	Jul-14
Armstrong Cr.	May-15	Sep-17	Jul-14
Tittabawassee R.	Jun-18	Sep-19	Sep-19
Chippewa R.	May-18	Jul-20	Jul-20
Chippewa gravel pits	May-18	Jun-20	Jun-20
Pine R.	May-19	Sep-19	Sep-19
Carroll Cr.	May-17	Oct-19	Jul-16
Big Salt R.	Jun-18	Oct-19	Oct-19
Rock Falls Cr.	Never	Jun-19	Jun-69
Cherry Cr.	Never	Jun-16	Jul-77
Mill Cr.	May-85	Jun-19	Jun-12

Table 16. Details on application of granular Bayluscide to tributaries and lentic areas of Lake Huron for larval assessment purposes during 2020.

Tributary	Bayluscide(kg)[1]	Area Surveyed (ha)
Canada		
No granular Bayluscide used during 2020		
United States		
Upper Chippewa R.	2.83	0.60
Total (United States)	**2.83**	**0.60**
Total for Lake	**2.83**	**0.60**

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

Lake Erie

- Due to COVID-19 travel restrictions, larval assessments were not conducted in Lake Erie. The status of larval sea lampreys in historically infested Lake Erie tributaries and lentic areas is presented in Table 17, and is based on assessment effort to 2019.

Table 17. Status of larval sea lamprey in Lake Erie tributaries with a history of sea lamprey production.

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Canada			
East Cr.	Jun-87	May-19	Jun-13
Catfish Cr.	Apr-16	May-19	Apr-15
Bradley Cr.	Apr-16	May-19	Oct-15
Silver Cr.	May-18	May-19	Jun-17
Big Otter Cr.	Jun-17	May-19	May-19
South Otter Cr.	Aug-10	May-19	Aug-09
Clear Cr.	May-91	May-19	May-91
Big Cr.	Jun-17	May-19	May -19
Forestville Cr.	Aug-13	May-19	Jun-13
Normandale Cr.	Jun-87	May-18	Apr-08
Fishers Cr.	Jun-87	May-19	May-04
Young's Cr.	Aug-13	May-19	Jul-12
Ussher's Cr.	Never	Jun-17	Jun-17
United States			
Buffalo R.			
Buffalo Cr.	Apr-19	Jul-19	Jul-18
Cayuga Cr.	Apr-19	Jul-19	Jul-18
Cazenovia Cr.	Apr-19	Jul-19	Jul-18
Big Sister Cr.	Apr-15	Jul-19	Jun-14
Delaware Cr.	Jun-13	Jul-18	Jul-12
Cattaraugus Cr.	Apr-19	Jul-19	Jul-19
Lentic Lake Erie	Never	Jul-17	Aug-12
Halfway Br.	Oct-86	Jul-18	Jul-85
Canadaway Cr.	May-16	Jul-19	May-16
Chautauqua Cr.	Never	Jul-19	Jul-12
Crooked Cr.	Apr-19	Jun-19	Jun-18
Raccoon Cr.	May-15	Aug-19	Aug-19
Conneaut Cr.	Apr-19	Jun-19	Jun-18
Conneaut Harbour	Never	Sep-19	Jul-16
Wheeler Cr.	Never	Jul-19	Oct-87
Grand R.	Apr-17	Jun-19	Jun-19
Fairport Harbour	Never	Sep-19	Jun-87
Chagrin R.	Never	Jul-19	Jul-18
Huron R.	May-18	Aug-19	May-18
Lake St. Clair			
St. Clair R.	Never	Jun-19	Jun-19
Black R.	Never	Jun-19	Jul-07
Pine R.	Apr-88	Sep-19	Jun-16
Belle R.	Never	Sep-19	May-96
Clinton R.	Never	Sep-19	May-17
Paint Cr.	May-15	Sep-19	May-14
Thames R.	Never	May-16	Never

Table 17. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Komoka Cr.	Aug-15	May-19	May-17
Pine R.	Jun-18	Aug-19	Sep-18
St. Martin Bay	May-18	Sep-18	Jul-17

Lake Ontario

- Due to COVID-19 travel restrictions, larval assessments were not conducted in Lake Ontario. The status of larval sea lampreys in historically infested Lake Erie tributaries and lentic areas is presented in Table 18, and is based on assessment effort to 2019.

Table 18. Status of larval sea lamprey in Lake Ontario tributaries with a history of sea lamprey production.

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Canada			
Niagara R.	Never	Jun-17	Jun-14
Ancaster Cr.	May-03	May-19	Jun-15
Grindstone Cr.	Never	Jun-18	Jun-14
Bronte Cr.	Jun-19	Jun-19	Jun-19
Sixteen Mile Cr.	Jun-82	Jun-18	May-05
Credit R.	May-18	Jun-19	Jun-19
Humber R.	Never	Jun-17	Never
Rouge R.	Jun-11	Jun-19	Jun-19
Little Rouge. R.	Jun-15	Jun-19	Aug-14
Petticoat Cr.	Sep-04	Jun-18	Jun-16
Duffins Cr.	Jun-18	Jul-19	Jul-19
Duffins Cr. - lentic	Never	Aug-15	Aug-15
Carruthers Cr.	Sep-76	Jun-18	Jul-78
Lynde Cr.	Jun-15	Jun-19	Jun-19
Oshawa Cr.	Jun-18	Jun-19	Jun-19
Oshawa Cr. - lentic	Never	Jul-13	Oct-81
Farewell Cr.	Jun-15	Jun-19	Jun-19
Bowmanville Cr.	May-17	Jun-19	Jun-19
Wilmot Cr.	Jun-18	Jun-19	Jun-19
Wilmot Cr. - lentic	Never	Aug-11	Aug-11
Graham Cr.	Apr-19	Jul-19	Jun-18
Wesleyville Cr.	Oct-02	Jun-18	May-04
Port Britain Cr.	Apr-19	Jul-19	Jun-18
Gage Cr.	May-71	Jul-19	Apr-71
Cobourg Br.	Oct-96	Jul-18	Jul-18
Covert Cr.	May-19	Jul-19	Jul-19
Grafton Cr.	Jun-17	Ju1-19	Jun-16
Shelter Valley Cr.	Apr-16	Jul-19	Jul-19
Colborne Cr.	Apr-19	Jul-19	Jul-18
Salem Cr.	Apr-18	Jul-19	Jul-19
Proctor Cr.	Apr-18	Jul-19	Jul-19
Smithfield Cr.	Sep-86	Jul-19	May-86
Trent R. (Canal)	Sep-11	Jul-17	Jul-17
Mayhew Cr.	May-19	Jul-19	Jul-18

Table 18. *Continued*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Moira R.	Jun-15	Jul-19	Jul-19
Salmon R.	Jun-16	Jul-19	Jul-19
Napanee R.	Never	Jul-17	Jul-15
United States			
Black R.	Aug-15	Aug-18	Aug-18
Black R. (lentic)	Aug-18	Aug-18	Aug-18
Stony Cr.	Sep-82	Aug-17	May-81
Sandy Cr.	Never	Aug-18	Apr-10
South Sandy Cr.	Jun-17	Aug-19	Aug-19
Skinner Cr.	Apr-05	Aug-19	Apr-06
Lindsey Cr.	Oct-18	Aug-19	Aug-19
Blind Cr.	May-76	Aug-17	Oct-75
Little Sandy Cr.	Oct-18	Aug-19	Aug-19
Little Sandy Cr. (lentic)	Never	Aug-18	Aug-18
Deer Cr.	Apr-04	Aug-18	Sep-06
Salmon R.	Jun-18	Aug-19	Aug-19
Orwell Brook	May-17	Aug-19	Apr-14
Trout Brook	Jun-18	Aug-19	Aug-19
Altmar Cr.	Jun-18	Aug-19	Aug-19
Grindstone Cr.	Apr-18	Aug-19	Aug-19
Snake Cr.	Apr-18	Aug-19	Aug-19
Sage Cr.	May-78	Aug-19	May-88
Little Salmon R.	May-17	Aug-19	Aug-19
Butterfly Cr.	May-72	Jul-19	Jun-70
Catfish Cr.	Apr-18	Aug-19	Aug-19
Oswego R.			
Black Cr.	May-81	Aug-17	Jun-04
Big Bay Cr.	Sep-93	Aug-15	Aug-94
Scriba Cr.	May-19	Aug-18	Aug-18
Fish Cr.	Aug-19	Aug-18	Aug-18
Carpenter Br.	May-94	Jul-16	Apr-94
Putnam Br./ Coldsprings Cr.	May-96	Jul-19	Apr-05
Hall Br.	Never	Aug-15	Aug-77
Crane Br.	Never	Aug-16	Jun-81
Owasco Outlet	Jun-19	Jul-19	Jul-18
Rice Cr.	May-72	Aug-18	Jun-70
Eight Mile Cr.	Apr-18	Aug-19	Aug-19
Nine Mile Cr.	May-17	Jul-19	Jul-19
Sterling Cr.	May-18	Aug-19	Aug-19
Unnamed Cr.	May-19	Aug-19	Aug-19
Blind Sodus Cr.	May-78	Jul-19	May-78
Red Cr.	Apr-18	Jul-19	Aug-17
Wolcott Cr.	May-79	Aug-19	Aug-78
Sodus Cr.	Apr-15	Aug-19	Aug-19
Forest Lawn Cr.	Never	Aug-19	Aug-19
Irondequoit Cr.	Never	Jul-18	Apr-09
Larkin Cr.	Never	Jul-18	May-07
Northrup Cr.	Never	Jul-18	Aug-78
Salmon Cr.	Apr-05	Aug-19	Aug-17

Table 18. *Continued*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Sandy Cr.	Apr-14	Aug-19	Aug-14
Oak Orchard Cr.			
Marsh Cr.	Apr-14	Jul-18	Aug-14
Johnson Cr.	Apr-10	Jul-18	Jun-09
Third Cr.	May-72	Aug-17	Sep-72
First Cr.	May-95	Jul-18	Sep-94

Juvenile Assessment

The juvenile life stage is assessed through the interpretation of marking rates by feeding juvenile sea lamprey on lake trout. Used in conjunction with adult sea lamprey abundance to annually evaluate the performance of the SLCP, marking rates on lake trout are contrasted against the targets set for each lake. Marking rates on lake trout are estimated from fisheries assessments conducted by state, provincial, tribal, and federal fishery management agencies associated with each lake, and are updated when the data become available. These data provide a metric of the mortality inflicted on lake trout on a lake-wide basis. The Commission contracts the Service's Green Bay Fish and Wildlife Conservation Office (GBFWCO) to calculate marking statistics and lake trout abundance estimates to assess the damage caused by sea lamprey.

Lake Superior

- Lake trout marking data for Lake Superior are provided by the MIDNR, Minnesota Department of Natural Resources, (WIDNR), Great Lakes Indian Fish and Wildlife Commission (GLIFWC), Chippewa-Ottawa Resource Authority (CORA), Keweenaw Bay Indian Community (KBIC), Grand Portage Band of Lake Superior Chippewa Indians, and the Ontario Ministry Natural Resources and Forestry (OMNRF), and analyzed by the Service's GBFWCO. Due to COVID-19 travel restrictions, lake trout marking data was not collected in 2020.

- Based on standardized spring assessment data, the marking rate during 2019 was 5.7 A1-A3 marks per 100 lake trout >532mm, which is greater than the target of five marks per 100 fish (Figure 6).

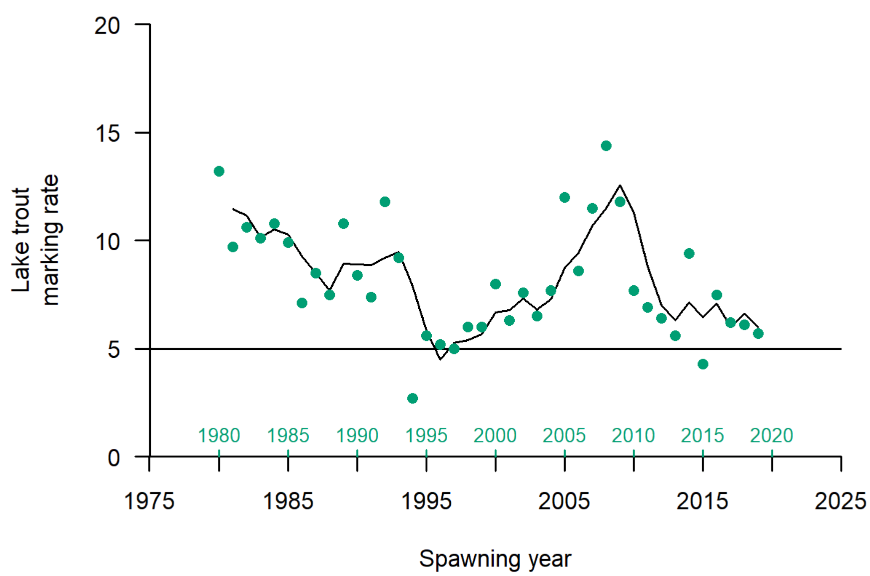

Figure 6. Number of A1-A3 marks per 100 lake trout > 532 mm from standardized assessments plotted against the sea lamprey spawning year, including the three-year moving average (line). The three-year (2017-2019) average marking rate of 5.7 was above the target of five A1-A3 marks per 100 lake trout > 532 mm (horizontal line). A second x-axis shows the year the lake trout were surveyed.

Lake Michigan

- Lake trout marking data for Lake Michigan are provided by MIDNR, WIDNR, Illinois Department of Natural Resources, Indiana Department of Natural Resources, CORA, Service, and the USGS, and analyzed by the Service's GBFWCO.

- Based on standardized fall assessment data, the marking rate during 2020 was 3.5 A1-A3 marks per 100 lake trout >532mm, which is less than the target of five marks per 100 fish (Figure 7).

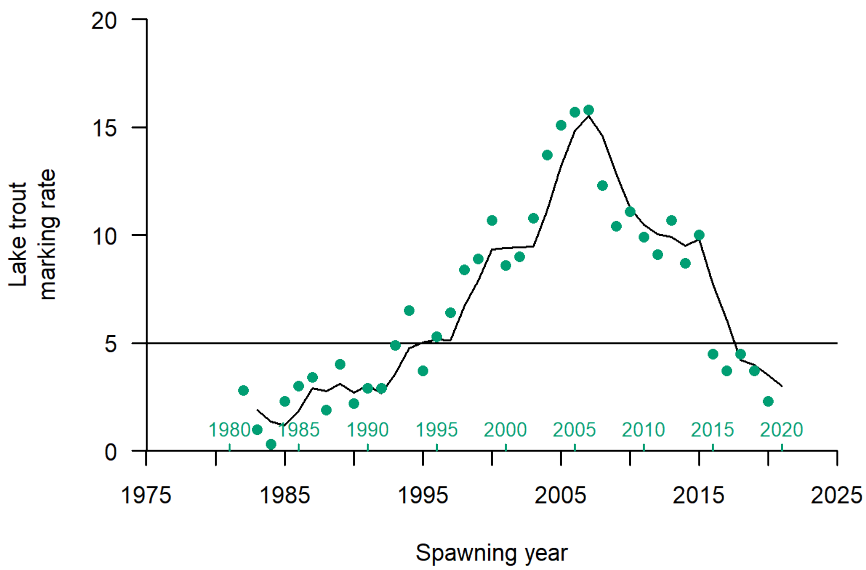

Figure 7. Number of A1-A3 marks per 100 lake trout > 532 mm from standardized assessments during August-November plotted against the sea lamprey spawning year, including the three-year moving average (line). The three-year average marking rate of 3.5 met the target of five A1-A3 marks per 100 lake trout > 532 mm (horizontal line). A second x-axis shows the year the lake trout were surveyed.

Lake Huron

- Lake trout marking data for Lake Huron are provided by the MIDNR, CORA, USGS, and OMNRF. The data is analyzed by the Service's GBFWCO. Due to COVID-19 travel restrictions, lake trout marking data was not collected in 2020.

- Based on standardized spring assessment data, the marking rate during 2019 was 6.3 A1-A3 marks per 100 lake trout >532 mm, which is greater than the target of five marks per 100 fish (Figure 8).

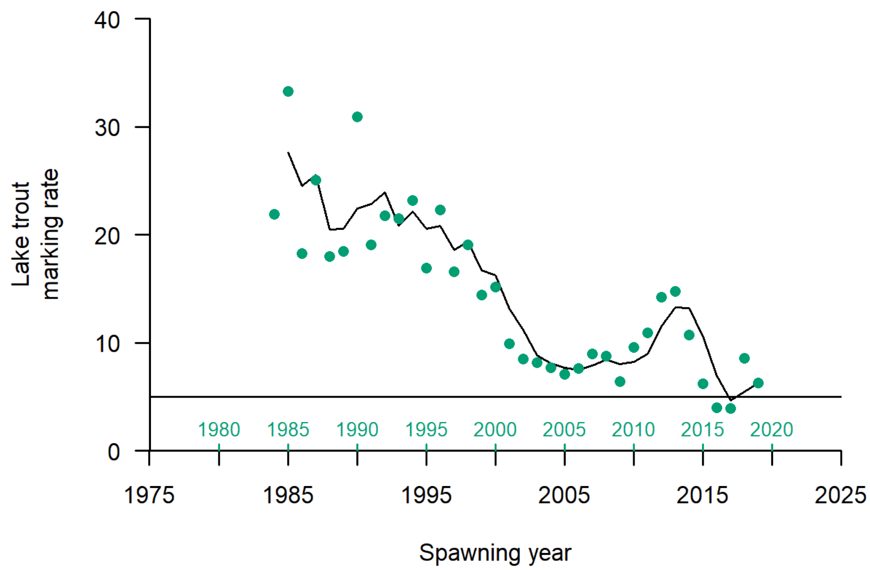

Figure 8. Number of A1-A3 marks per 100 lake trout > 532 mm from standardized assessments plotted against the sea lamprey spawning year, including the three-year moving average (line). The 2020 marking rate and the three year marking rate could not be reported because of the COVID-19 panedemic. During 2019, the 3 year marking rate was 6.3, above the target of five A1-A3 marks per 100 lake trout > 532 mm (horizontal line). A second x-axis shows the year the lake trout were surveyed.

- Canadian commercial fisheries in northern Lake Huron continued to provide parasitic juvenile sea lamprey in 2020, along with associated catch information including date, location, and host species. The total number of sea lamprey captured each year, along with effort data provided by commercial fishers to the OMNRF, is used as an index of juvenile sea lamprey abundance in northern Lake Huron. The effort data for 2020 has not yet been analyzed; the CPUE value for 2019 was slightly higher than 2018 (Figure 9).

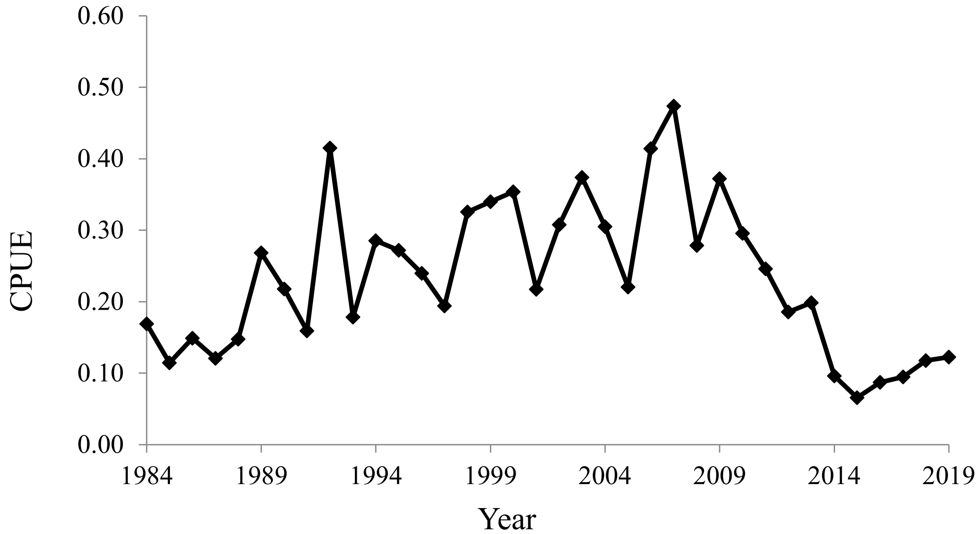

Figure 9. Northern Lake Huron commercial fisheries index showing CPUE (number of parasitic juvenile sea lamprey per km of gillnet per night) for 1984-2019.

- Since 1998, standardized trapping for out-migrating juveniles has been conducted in the St. Marys River as an index of sea lamprey production. Eleven floating fyke nets are deployed each October and November in the Munuscong, Sailor's Encampment, and Middle Neebish channels. The CPUE value for 2019 was lower than the previous 3 years (Figure 10). Due to COVID-19 travel restrictions, data was not collected in 2020.

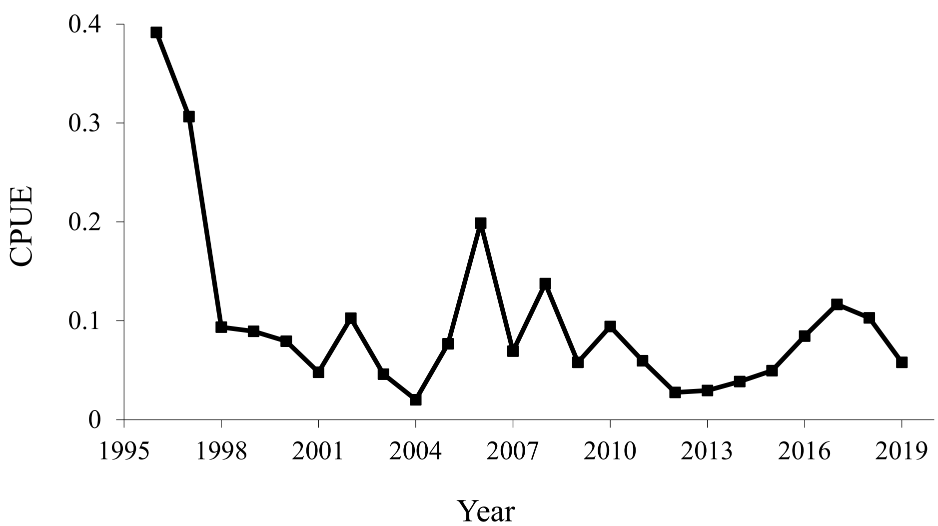

Figure 10. CPUE (number of out-migrating juvenile sea lamprey per net day) of fall fyke netting in the St. Marys River during 1996-2019.

Lake Erie

- Lake trout marking data for Lake Erie are provided by the NYSDEC, the Pennsylvania Fish and Boat Commission, USGS, and OMNRF, and analyzed by the Service's GBFWCO.

- Based on standardized fall assessment data, the marking rate during 2020 was 11 A1-A3 marks per 100 lake trout >532 mm. The marking rate has been greater than the target for the last 16 years (Figure 11).

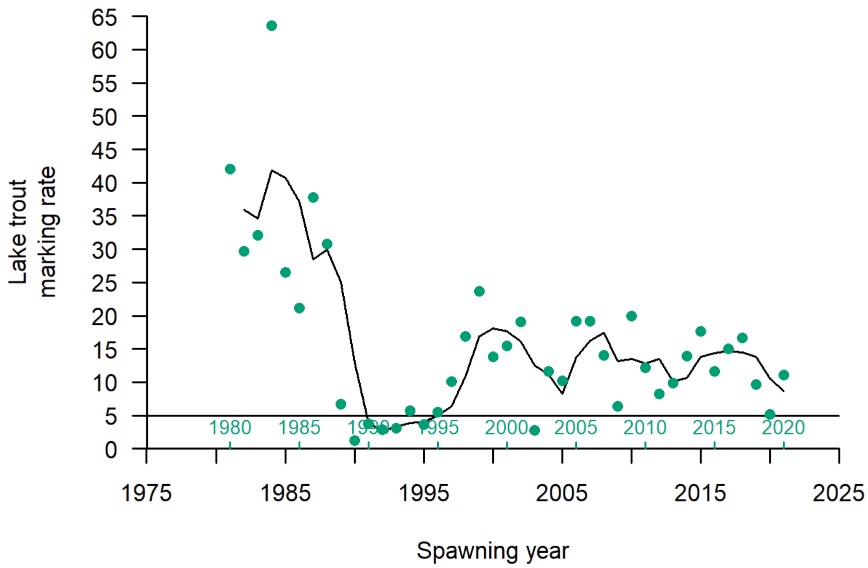

Figure 11. Number of A1-A3 marks per 100 lake trout > 532 mm from standardized assessments plotted against the sea lamprey spawning year, including the three-year moving average (line). The three-year average marking rate of 11 was above the target of five A1-A3 marks per 100 lake trout > 532 mm (horizontal line). A second x-axis shows the year the lake trout were surveyed.

- Due to COVID-19 travel restrictions, out-migrating juvenile sampling in the St. Clair River did not occur in 2020.

Lake Ontario

- Lake trout marking data for Lake Ontario are provided by USGS, OMNRF, and the NYSDEC. The data is analyzed by the Service's GBFWCO.

- Based on standardized fall assessment data, the marking rate during 2020 was 0.57 A1 marks per 100 lake trout >431 mm which is less than the target of 2 A1 marks per 100 lake trout target (Figure 12).

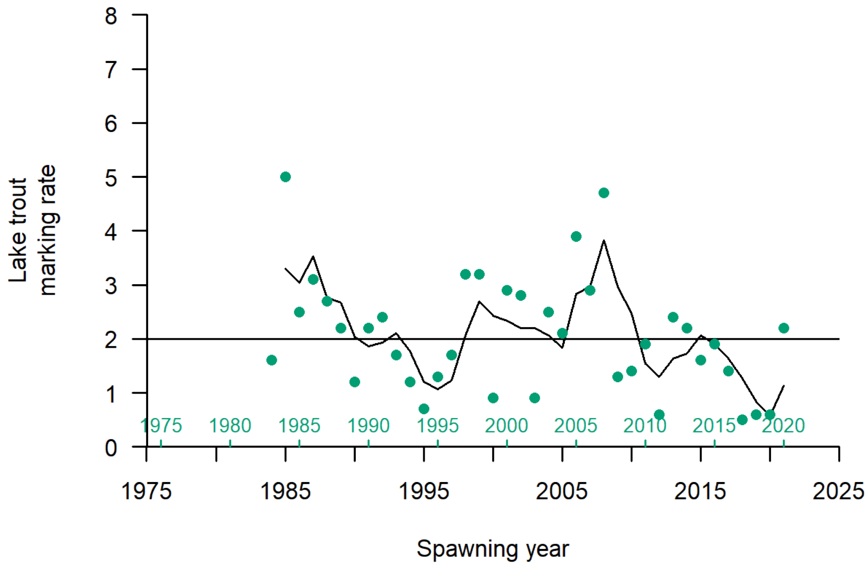

Figure 12. Number of A1 marks per 100 lake trout > 431 mm from standardized assessments plotted against the sea lamprey spawning year, including the three-year moving average (line). The three-year average marking rate of 0.57 met the target of two A1 marks per 100 lake trout > 431 mm (horizontal line). A second x-axis shows the year the lake trout were surveyed.

Adult Assessment

An annual index of adult sea lamprey abundance is derived for each lake by summing individual abundance estimates from traps operated in a specific suite of streams (index streams) during spring and early summer. Abundance estimates are derived using simple Petersen mark-recapture in each index stream. In the absence of a stream-specific estimate due to an insufficient number of marked or recaptured sea lamprey, abundance is estimated using a model based on trap efficiency and dynamics of abundance from other tributaries. The index targets are estimated as the mean of indices during a period within each lake when marking rate was considered acceptable, or the percentage of the mean that would be deemed acceptable.

Lake Superior

- A total of 512 sea lampreys were captured in nine tributaries during 2020, 5 of which were index locations. Due to COVID-19 travel restrictions, some traps were deployed after the peak of the spawning run. Abundance estimates from late set trap sites were not used to produce the lake-wide adult index estimate because they did not represent the majority of the spawning run and could be biased. Adult population estimates based on mark-recapture were obtained from one of the five index locations, the Brule River (Table 19, Figure 23). This single mark-recapture estimate was similar to the 2019 estimate (787 vs. 770).

- The 2020 index of adult sea lamprey abundance was not calculated because only one index stream had a mark-recapture population estimate (Figures 13, 14). Two or more streams with mark-recapture estimates are required to model a lake-wide adult index estimate.

- Adult sea lamprey migrations were assessed in the Middle, Brule, Misery, and Silver rivers through cooperative agreements with GLIFWC.

Table 19. Information regarding adult sea lamprey captured in assessment traps or nets in tributaries of Lake Superior during 2020 (letter in parentheses corresponds to streams in Figure 23).

Tributary	Number Caught	Adult 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
Canada									
Neebing R. (A)	6	---	---	0	---	---	---	---	---
Big Carp R. [3] (B)	4	---	---	0	---	---	---	---	---
Total or Mean (Canada)	**10**	---	---	**0**	---	---	---	---	---
United States									
Betsy R. (D)	36	---	---	0	---	---	---	---	---
Rock R. (E)	124	---	50	62	44	420	408	172	169
Silver R.[3] (F)	2	---	---	0	---	---	---	---	---
Misery R. [3] (G)	77	273	27	20	55	409	409	174	178
Firesteel R. [3] (H)	37	---	---	3	33	502	413	249	229
Brule R. (J)	176	787	21	21	62	463	422	237	184
Middle R. (K)	50	---	---	1	100	199	---	157	---
Total or Mean (U.S.)	**502**	---	---	**107**	**50**	**426**	**410**	**190**	**175**
Total or Mean (for lake)	**512**	---	---	**107**	**50**	**426**	**410**	**190**	**175**

[1] The number of sea lamprey used to determine percent males, mean length, and mean weight, [2] Gender was determined using external characteristics, [3] Not an index location.

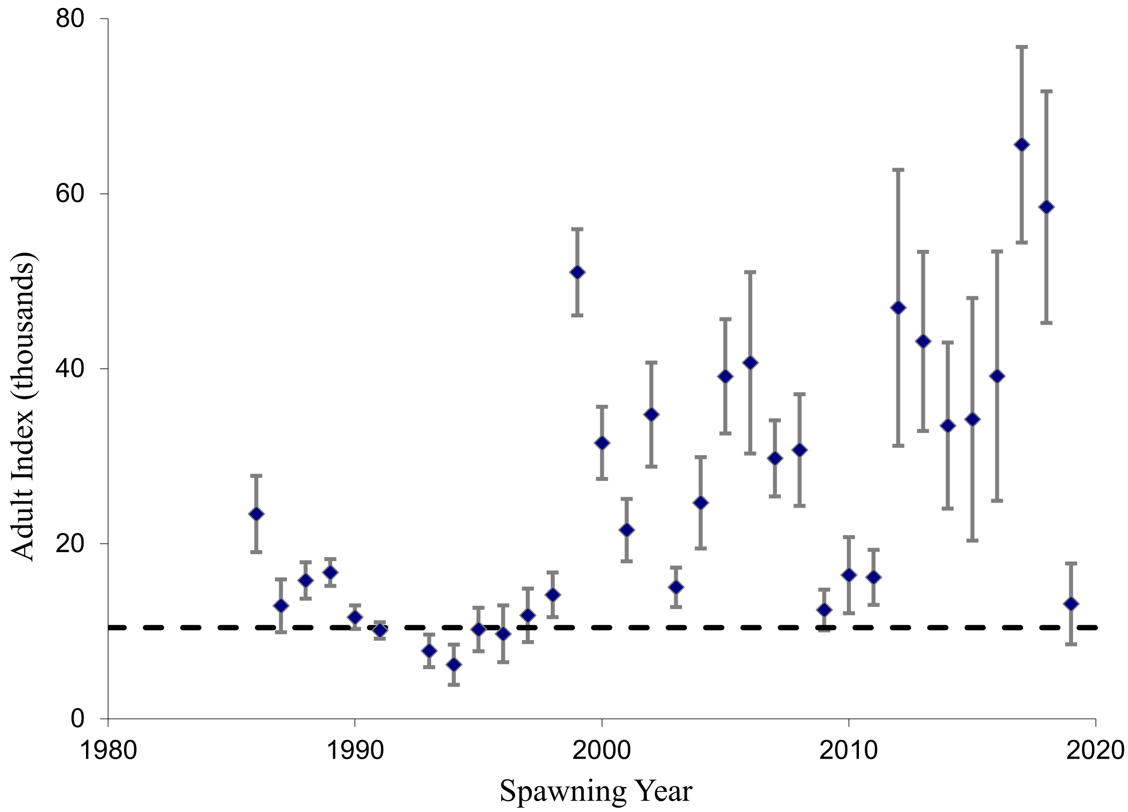

Figure 13. Index estimates with 95% confidence intervals of adult sea lampreys in Lake Superior. The target of 10,421 is represented by the dotted horizontal line. The index target was estimated as the mean of indices during a period with acceptable marking rates (1994-1998).

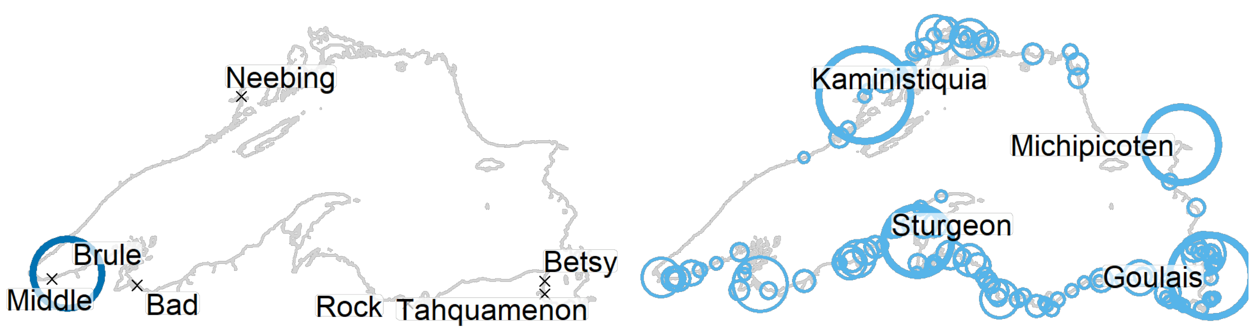

Figure 14. LEFT: Estimated index of adult sea lamprey in Lake Superior during the spring spawning migration, 2020. Circle size corresponds to estimated number of adults from mark-recapture studies (blue) and model predictions (orange). RIGHT: Maximum estimated number of larval sea lamprey in each stream surveyed during 1995-2012. Tributaries composing over half of the lake-wide larval population estimate are identified (Kaministiquia 6,600,000; Goulais 5,000,000; Michipicoten 4,100,000; Sturgeon 3,300,000).

Lake Michigan

- A total of 1,425 sea lampreys were captured at six tributaries during 2020, 4 of which were index locations. Due to COVID-19 travel restrictions, some traps were deployed after the spawning run peak. Abundance estimates from late set trap sites were not used to produce the lake-wide adult index estimate because they did not represent the spawning run. Adult population estimates based on mark-recapture were obtained from one of the four index locations, the Carp Lake Outlet. (Table 20, Figure 23). This single mark-recapture estimate was similar to the 2019 estimate (1,625 vs. 1,532).

- The 2020 index of adult sea lamprey abundance was not calculated because only one index stream had a mark-recapture population estimate (Figures 15, 16). Two or more streams with mark-recapture estimates are required to model a lake-wide adult index estimate. Adult sea lamprey migrations were monitored in the Boardman and Betsie rivers through a cooperative agreement with the Grand Traverse Band of Ottawa and Chippewa Indians.

- Due to COVID-19 travel restriction, adult sea lamprey assessment activities did not occur in the Grand River.

Table 20. Information regarding adult sea lamprey captured in assessment traps or nets in tributaries of Lake Michigan during 2020 (letter in parentheses corresponds to stream in Figure 23).

Tributary	Number Caught	Adult Estimate	Trap Efficiency (%)	Number Sampled[1]	Percent Males[2]	Mean Length (mm)		Mean Weight (g)	
						Males	Females	Males	Females
Carp Lake Outlet (A)	731	1,615	45	37	46	463	453	205	215
Boardman R. [3] (B)	23	---	---	0	---	---	---	---	---
Betsie R. (C)[4]	374	---	29	23	65	465	498	222	276
Big Manistee R. (D)	29	---	---	0	---	---	---	---	---
St. Joseph R.[4] (F)	231	---	7	6	67	485	457	236	244
Trail Cr. [3] (G)	38	---	---	0	---	---	---	---	---
Total or Mean (for lake)	**1,425**	**---**	**---**	**66**	**55**	**466**	**465**	**215**	**233**

[1] The number of sea lamprey used to determine percent males, mean length, and mean weight, [2] Gender was determined by using external characteristics, [3] Not an index location, *Traps set late due to COVID-19 travel restrictions, estimate not used for lake-wide index.

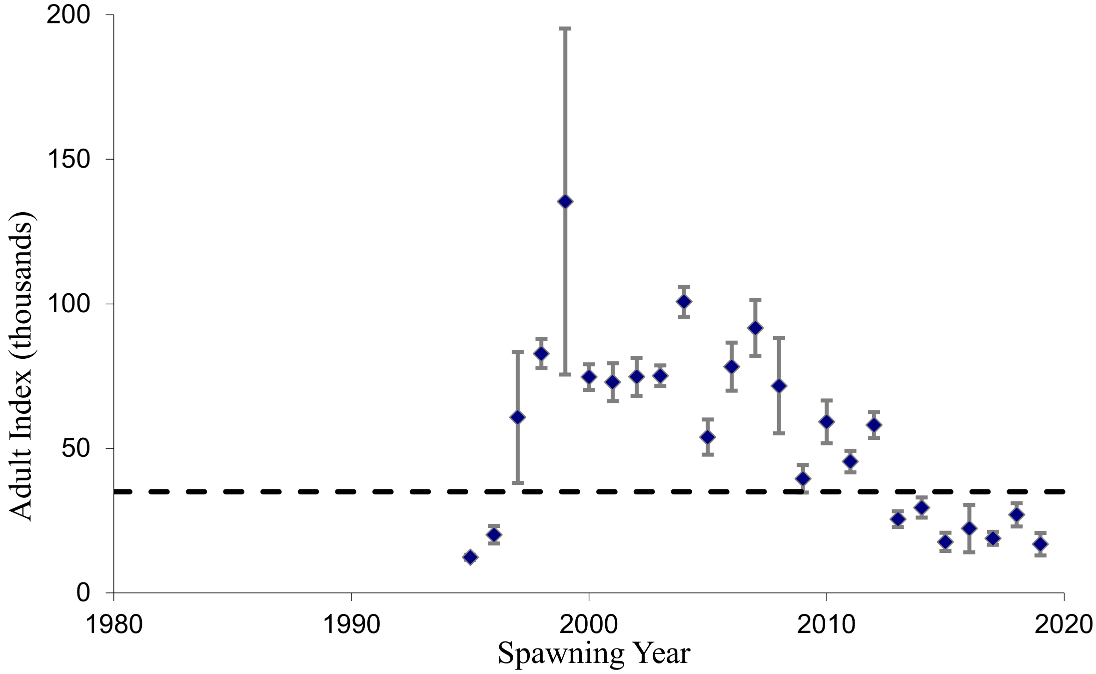

Figure 15. Index estimates with 95% confidence intervals of adult sea lampreys in Lake Michigan. The dotted horizontal line represents the target of 34,982. The index target was estimated as 5/8.9 times the mean of indices (1995-1999).

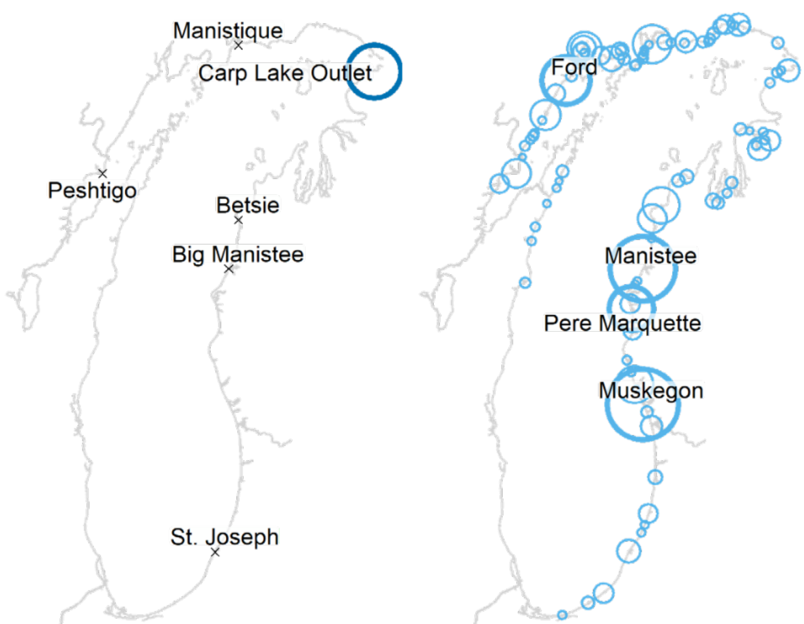

Figure 16. LEFT: Estimated index of adult sea lamprey in Lake Michigan during the spring spawning migration, 2020. Circle size corresponds to estimated number of adults from mark-recapture studies. RIGHT: Maximum estimated number of larval sea lamprey in each stream surveyed during 1995-2012. Tributaries composing over half of the lake-wide larval population estimate are identified (Muskegon 4,500,000; Manistee 3,600,000; Ford 1,800,000; Pere Marquette 1,400,000).

Lake Huron

- A total of 13,598 sea lampreys were trapped in five tributaries during 2020, all of which were index locations. Adult population estimates based on mark-recapture were obtained from three of the five index locations; East Au Gres, Echo, and St Marys rivers were estimated using the relative annual pattern of abundance (Table 21, Figure 23).

- The index of adult sea lamprey abundance was 65,280 *(95% CI: 59,164 – 71,397)*, which was higher than the target of 31,274 (Figures 17 and 18).

- The USACE continued planning for trap improvement projects at the St. Marys, Au Sable, and East Au Gres rivers using Great Lakes and Fishery and Ecosystem Restoration (GLFER) program funding.

Table 21. Information regarding adult sea lamprey captured in assessment traps or nets in tributaries of Lake Huron during 2020 (letter in parentheses corresponds to stream in Figure 23).

Tributary	Number Caught	Adult Estimate	Trap Efficiency (%)	Number Sampled[1]	Percent Males[2]	Mean Length (mm)		Mean Weight (g)	
						Males	Females	Males	Females
Canada									
St. Marys R. (A)	---	---	---	---	---	---	---	---	---
Echo R. (B)	303	4,783	3	---	---	---	---	---	---
Thessalon R. (C)									
Bridgeland Cr.	2,581	4,182	58	117	62	465	462	211	220
Total or Mean (Canada)	**2,884**	---	---	**117**	**62**	**465**	**462**	**211**	**220**
United States									
East Au Gres R. (D)	153	---	1	1	100	490	---	299	---
Ocqueoc R. (E)	5,000	13,319	37	115	50	444	439	195	195
Cheboygan R. (F)	5,561	12,883	47	158	47	454	465	203	224
Total or Mean (U.S.)	**10,714**	---	---	**274**	**49**	**450**	**455**	**200**	**212**
Total or Mean (for Lake)	**13,598**	---	---	**391**	**53**	**463**	**455**	**227**	**213**

[1] The number of sea lamprey used to determine percent males, mean length, and mean weight, [2] Gender was determined using external characteristics.

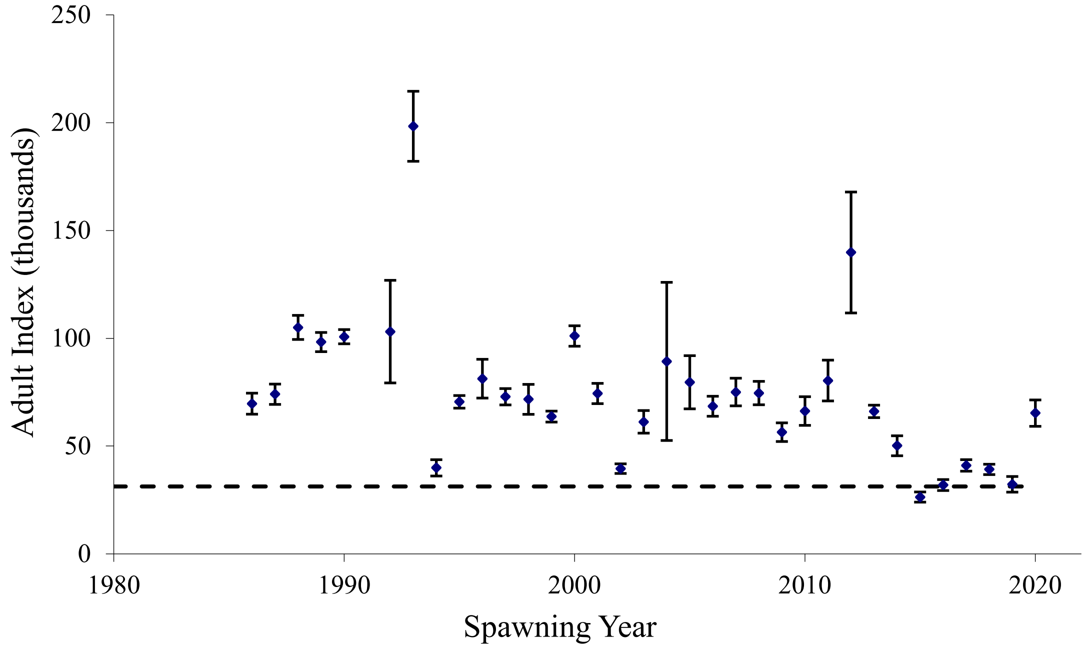

Figure 17. Index estimates with 95% confidence intervals of adult sea lampreys in Lake Huron. The horizontal dotted line represents the index target of 31,274. The index target was estimated as 0.25 times the mean of indices between 1989 and 1993.

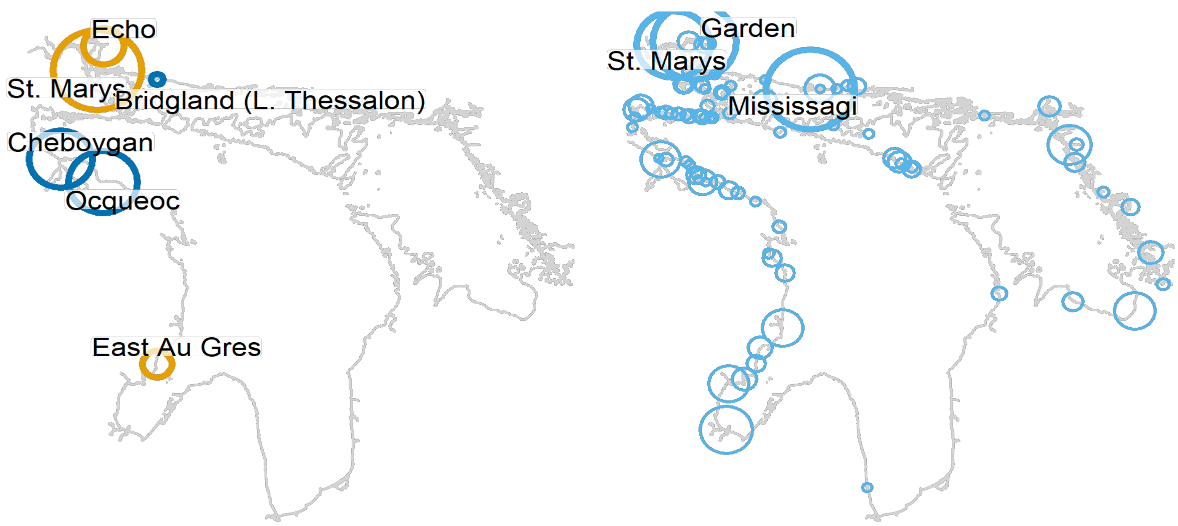

Figure 18. LEFT: Estimated index of adult sea lampreys in Lake Huron during the spring spawning migration, 2020. Circle size corresponds to estimated number of adults from mark-recapture studies. RIGHT: Maximum estimated number of larval sea lampreys in each stream surveyed during 1995-2012. Tributaries composing over half of the lake-wide larval population estimate are identified (Mississagi 8,100,000; Garden 7,000,000; St. Marys 5,200,000).

Lake Erie

- A total of 125 sea lampreys were trapped in five tributaries during 2020, all of which were index locations. Adult population estimates based on mark-recapture were obtained from two of the three locations; Little Otter Creek, Cattaraugus River and Grand River were estimated using the relative annual pattern of abundance (Table 22, Figure 23).

- The index of adult sea lamprey abundance was 1,340 *(95% CI; 732 – 1,948)* in 2020, which was lower than the target of 3,263 (Figures 19, 20).

- The adult sea lamprey migration in Cattaraugus Creek was monitored through a cooperative agreement with the Seneca Nation of Indians.

Table 22. Information regarding adult sea lamprey captured in assessment traps or nets in tributaries of Lake Erie during 2020 (letter in parentheses corresponds to stream in Figure 23).

Tributary	Number Caught	Adult 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
Canada									
Big Otter Cr. (A)									
Little Otter Cr.	2	---	---	---	---	---	---	---	---
Big Cr. (B)	111	333	31	8	75	---	---	248	320
Young's Cr. (C)	12	31	33	4	75	466	480	238	224
Total or Mean (Canada)	**125**	**---**	**---**	**53**	**62**	**503**	**496**	**255**	**240**
United States									
Cattaraugus Cr. (D)	0	**---**	**---**	---	---	---	---	---	---
Grand R. (E)	0	**---**	**---**	**---**	**---**	**---**	---	**---**	---
Total or Mean (U.S.)	**0**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	---
Total or Mean (for Lake)	**125**	**---**	**---**	**53**	**62**	**503**	**496**	**255**	**240**

[1]The number of sea lamprey used to determine percent males, mean length, and mean weight, [2]Gender was determined using external characteristics.

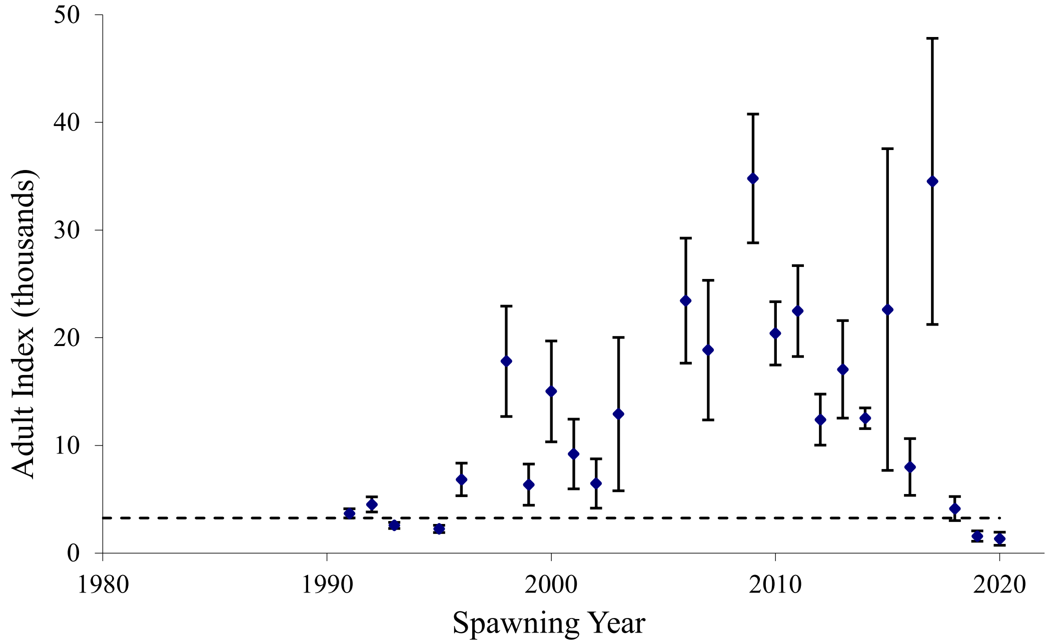

Figure 19. Index estimates with 95% confidence intervals of adult sea lampreys in Lake Erie. The dotted horizontal line represents the index target of 3,263. The index target was estimated as the mean of indices during a period with acceptable marking rate (1991-1995).

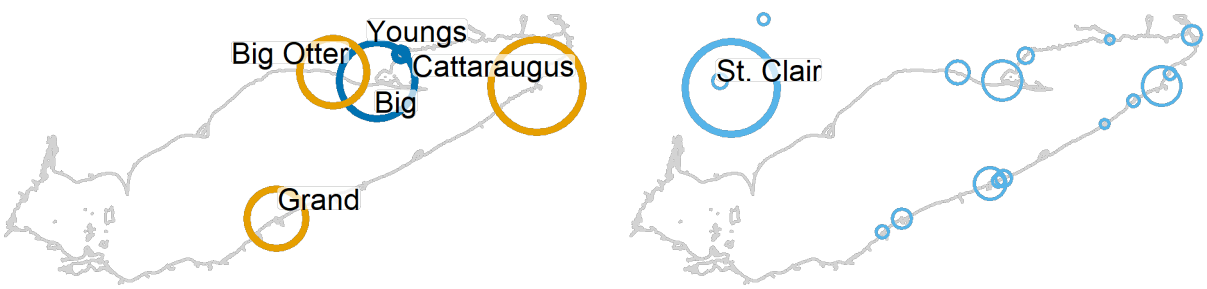

Figure 20. LEFT: Estimated index of adult sea lampreys in Lake Erie during the spring spawning migration 2020. Circle size corresponds to estimated number of adults from mark-recapture studies (blue) and model predictions (orange). RIGHT: Maximum estimated number of larval sea lampreys in each stream surveyed during 1995-2012. Tributaries composing over half of the lake-wide larval population estimate are identified (St. Clair 920,000)

Lake Ontario

- A total of 1,279 sea lampreys were trapped in seven tributaries during 2020, 5 of which were index locations. Adult population estimates based on mark-recapture were obtained from three of the five index locations; Black and Sterling rivers were estimated using the relative annual pattern of abundance (Table 23, Figure 23).

- The index of adult sea lamprey abundance was 4,971 *(95% CI; 3,704 – 6,237)* in 2020, which was lower than the target of 14,065 (Figures 21, 22).

Table 23. Information regarding adult sea lamprey captured in assessment traps or nets in tributaries of Lake Ontario during 2020 (letter in parentheses corresponds to stream in Figure 23).

Tributary	Number Caught	Adult 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
Canada									
Humber R. (A)	850	1,772	47	40	55	469	458	248	229
Duffins Cr. (B)	116	757	13	6	67	532	481	323	292
Bowmanville Cr. (C)	107	270	39	21	67	498	500	277	290
Cobourg Cr.[3] (D)	127	---	---	69	43	470	456	227	213
Salmon R.[3] (E)	---	---	---	---	---	---	---	---	---
Total or Mean (Canada)	**1,200**	---	---	**136**	**58**	**492**	**474**	**269**	**256**
United States									
Black R. (F)	18	---	---	0	---	---	---	---	---
Salmon R.(G)									
Orwell Br.[3]	25	108	20	5	60	496	480	306	333
Sterling Cr. (H)	73	---	3	1	100	491	---	360	---
Total or Mean (U.S.)	**79**	---	---	**6**	**67**	**494**	**480**	**320**	**333**
Total or Mean (for lake)	**1,279**	---	---	**142**	**65**	**493**	**475**	**299**	**271**

[1] The number of sea lamprey used to determine percent males, mean length, and mean weight, [2] Gender was determined using external characteristics, [3] Not an index location.

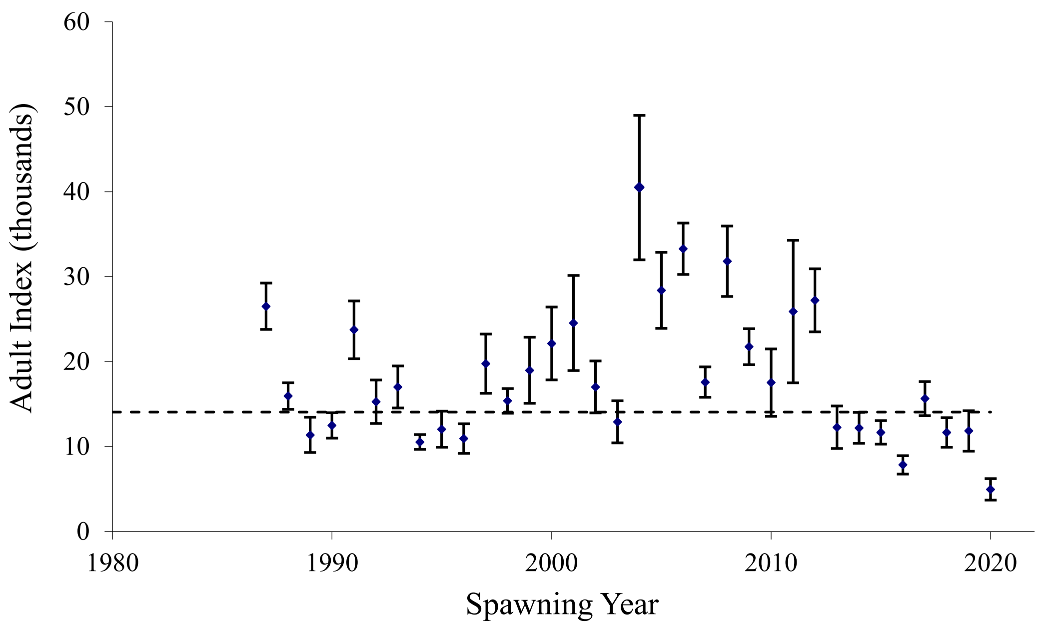

Figure 21. Index estimates with 95% confidence intervals of adult sea lamprey in Lake Ontario. The dotted horizontal line represents the index target of 14,065. The index target was estimated as the mean of indices during a period with acceptable marking rates (1993-1997).

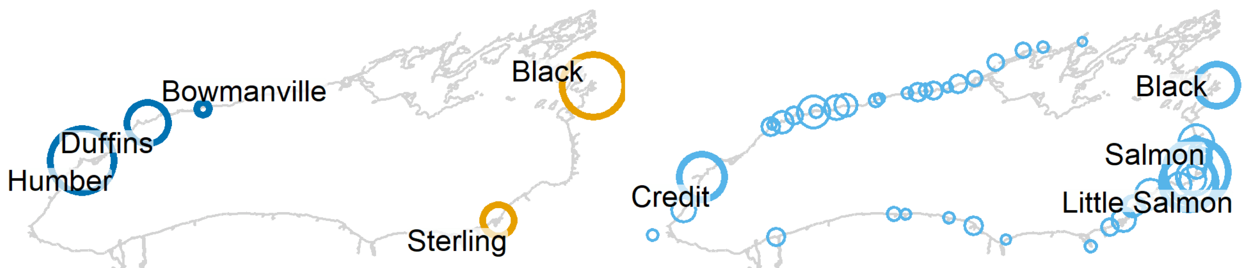

Figure 22. LEFT: Estimated index of adult sea lampreys in Lake Ontario during the spring spawning migration 2020. Circle size corresponds to estimated number of adults from mark-recapture studies. RIGHT: Maximum estimated number of larval sea lampreys in each stream surveyed during 1995-2012. Tributaries composing over half of the lake-wide larval population estimate are identified (Salmon 1,400,000; Little Salmon 970,000; Credit 590,000; Black 470,000).

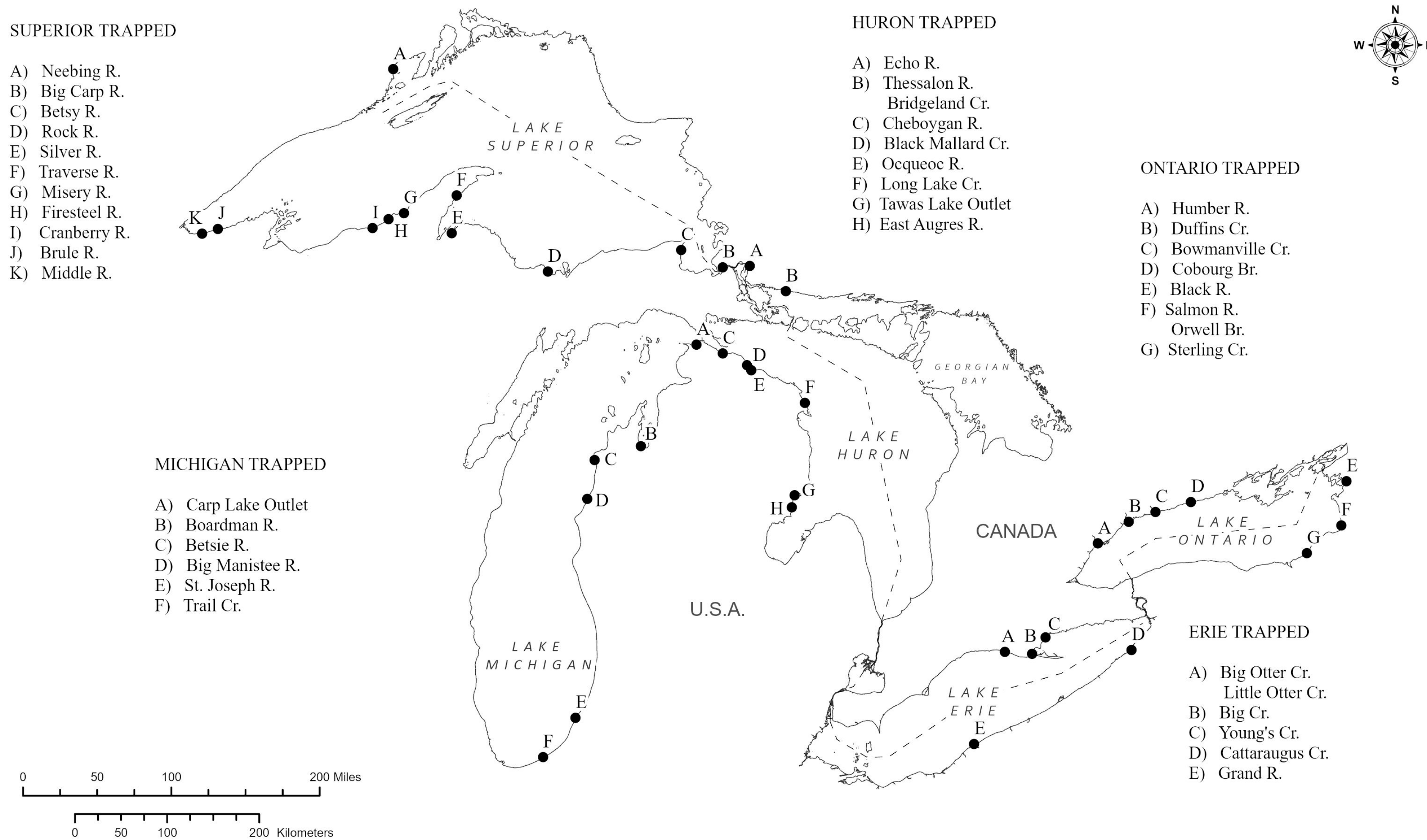

Figure 23. Locations of tributaries where assessment traps were operated during 2020.

RISK MANAGEMENT

Risk management addresses environmental and non-target issues related to the implementation of the SLCP in the United States and Canada. This involves coordination with many federal, provincial, state and tribal agencies, and working with others to minimize risk to non-target organisms.

Species at Risk Act

The goal of the Species at Risk Act (SARA) is to protect endangered or threatened organisms and their habitats. Conducting activities that are prohibited under Sections 32, 33 and 58(1) of SARA require approval from the Department. SARA permits are sought where lampricide applications overlap with the known occurrence and critical habitat of federally listed threatened and endangered species. The Department under section 73 of SARA annually issues permits.

Endangered Species Act

Section 7 of the Endangered Species Act (ESA) requires all U.S. federal agencies consult with the Service's Ecological Services (ES) to ensure that actions that are federally funded, authorized, permitted, or otherwise carried out will not jeopardize the continued existence of any federally listed (endangered, threatened, and candidate) species or adversely modify designated critical habitat.

Annual Reviews

Endangered species reviews are conducted annually with ES to discuss and assess the potential risk of proposed lampricide applications to federally listed species and develop procedures to protect and avoid disturbance.

During 2020, the following ES offices reviewed the effect of scheduled lampricide applications on endangered species within their jurisdiction. Concurrence with proposed conservation measures and determinations of "no effect" or "not likely to adversely affect" was received by:

- East Lansing Ecological Services Field Office
- Twin Cities Ecological Services Field Office

Programmatic Review

Because of the broad scope of the SLCP, consultation under Section 7 of the ESA involves several states, many listed species, and hundreds of streams. In an effort to streamline the consultation process and to add predictability for project planning, an informal, draft, SLCP-wide (programmatic) Section 7 review was prepared in coordination with the East Lansing Field Office and submitted to the Midwest Region ES Program for consideration during 2007. The programmatic review evaluates all SLCP activities, identifies potential impacts to protected species and critical habitats, and specifies conservation measures to eliminate or minimize disturbance. No further action has been taken on the SLCP programmatic Section 7 review due to limited staffing within the ES Program.

State-Listed Species

Annual Reviews

Reviews are annually conducted with state agencies to fulfill regulatory permit requirements, assess the potential risk to state listed (endangered, threatened, and special concern) species, and develop procedures that protect and avoid disturbance for each listed species.

During 2020, the following state regulatory offices reviewed endangered species within their jurisdiction and issued permits to conduct lampricide applications:

- Michigan Department of Natural Resources

- Wisconsin Department of Natural Resources

Studies and Fieldwork

- Big Manistee River – the GBFWCO and MIDNR collected young-of-the-year lake sturgeon before (6 days), during (1 day), and after (2 days) the treatment of the Big Manistee River (August 24). The Risk Management Team (RMT) was not able to participate due to COVID-19 travel restrictions.

Field Protocols

Field protocols are developed annually for field personnel so they can help protect and avoid disturbance to federal and state listed species located near scheduled SLCP activities. The protocols provides information on each species, their known locations, and detailed conservation measures to be followed:

- Protocol to protect and avoid disturbance to federal- and state-listed endangered, threatened, candidate, proposed, or special concern species and critical, or proposed critical habitats in or near Great Lakes streams scheduled for *lampricide treatments* in the United States during 2020.

- Protocol to protect and avoid disturbance to federal- and state-listed endangered, threatened, candidate, proposed, or special concern species and critical or proposed critical habitats in or near Great Lakes streams scheduled for *granular Bayluscide* assessments in the United States during 2020.

A total of 15 federal and state listed species, 1 critical habitat, multiple bat hibernacula, and the de-listed bald eagle (*Haliaeetus leucocephalus*) were highlighted in the 2020 protocols.

National Environmental Policy Act

Title I and Section 102 of the National Environmental Policy Act (NEPA) requires U.S. federal agencies to incorporate environmental considerations in their planning and decision-making, which includes the details of the environmental impact of, and alternatives to, major federal actions significantly affecting the environment. During 2020, NEPA was required for cooperative agreements for the following actions:

Trapping for adult sea lampreys on the following streams:

- Boardman River (Lake Michigan)
- St. Marys River (Lake Huron)

Federal Insecticide, Fungicide and Rodenticide Act

Reports were prepared to comply with the U.S. EPA June 16, 1998 ruling of Section 6(a)(2) of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). This section of FIFRA requires pesticide registrants to report unreasonable adverse effects of their products to the EPA. The Service is the registrant for lampricides and must report unreasonable adverse effects on humans, domestic animals, fish, wildlife, plants, other non-target organisms, water and damage to property. Incident reports are required with the observed mortality of a single federally-listed endangered, threatened or candidate species, and with observed mortalities of greater than 50 non-schooling or 1,000 schooling fish of any non-target species or taxa during a lampricide application (Table 25).

Table 24. Summary of 6(a)(2) reports submitted for incidents of non-target mortality during 2020 TFM treatments.

Lake	Stream	Mortality	Frequency	Comments
Champlain	Winooski River	banded killifish (*Fundulus diaphanous*)	60	pH suppression TL < 6 cm
	LaPlatte River	stonecat (*Noturus flavus*)	83	Sensitive species

TASK FORCE REPORTS

The Commission has four task forces (Lampricide Control, Barrier, Larval Assessment and Trapping). The task forces include agents with expertise in specific program areas, researchers and academics, outside experts, Lake Committee representatives, Commission staff, and other experts as needed. The task forces report to the SLCB, which established their terms of reference and works with them to recommend program direction and funding to the Commission.

The following sections report the purpose, membership, and progress on objectives charged to each task force by the SLCB.

Lampricide Control Task Force

Purpose
Maximize the number of sea lamprey killed in individual streams and lentic areas while minimizing costs and impacts on aquatic ecosystems.

2020 Membership
Lori Criger (Chair), Cheryl Kaye, Chris Gagnon, Benson Solomon, Tim Sullivan, Jenna Tews, Aaron Jubar (Service); Bruce Morrison, Shawn Robertson, Al Rowlinson, Fraser Neave (Department); Jean Adams (USGS/GLFC); Jim Luoma, Mike Boogaard, Karen Slaght (USGS); Michael Wilkie (Wilfred Laurier University); Dale Burkett, Mike Siefkes, Chris Freiburger (Commission Secretariat).

Progress towards goals described in the GLFC Vision:

Goal 1: Suppress sea lamprey populations to target levels.

Strategy 1: Implement lampricide treatment strategies to suppress sea lamprey populations to target levels in each Great Lake.

2020 Outcomes:

1. Due to COVID-19 travel restrictions, approval to conduct treatments was not granted until early July. Additionally, to ensure the safety of Service employees and prevent the spread of COVID-19, no overnight travel was permitted in the United States; only treatments within a 130-mile radius of the SLC stations could be completed. Overnight stays for treatment were permitted in Canada, but border closure, provincial guidelines, local health unit restrictions, and challenging environmental conditions such as insufficient discharge, combined to limit opportunity to deploy treatment beyond lakes Huron and Superior.
2. Where applicable, strategies were employed to reduce the number of sea lamprey that survive treatment and increase the effectiveness of individual stream treatments. Backwaters and isolated areas in target streams that did not otherwise receive lethal doses of lampricide were treated in conjunction with the main application to prevent escapement in these refugia areas. Lampricide concentrations were targeted to be greater than 10% above theoretical values due to some uncertainty with the predictive chart levels. With the exception of outside agency or endangered species constraints,

streams were scheduled for treatment in the optimal time of year to ensure favorable discharge and water chemistries.
3. Service personnel from other program units were deployed to the control units to treat more streams and to augment treatment effort on complex, labor-intensive systems. This was particularly important during 2020 when there was a pandemic-related shortage of temporary staff, and control units could not travel to collaborate on large treatments. Although the Department had planned to assist with lampricide treatments in the U.S., travel restrictions and border closures prevented that from happening.
4. Crews from both the Service and the Department had planned to work together to treat the St. Marys River plots with granular Bayluscide in early July before heavy vegetation became problematic; however, USFWS personnel were not permitted to travel, leaving the Department to complete the treatments without assistance.
5. Due to travel restrictions, the RMT was not able to participate in the partner-led effort to collect young-of-the-year lake sturgeon before/during/after the lampricide treatment in the Manistee River.
6. The partner-led effort to conduct non-target surveys in the Grand River (Ohio) did not occur because the treatment was deferred.

2021 Objectives:

1. Treat all streams listed on the 2021 treatment schedule.
2. Review past treatment results and larval assessment data to direct implementation of strategies to achieve improved efficacy of lampricide treatments scheduled during 2021.
3. Deploy additional personnel from within the program to treat more streams in the spring when larvae are more susceptible and stream discharge and water chemistries are optimal. Additionally, treatment supervisors will request additional personnel to augment treatment effort on complex, labor-intensive systems scheduled in the fall.
4. Develop an optimized schedule jointly between the agents to realize efficiencies in travel and maximize treatment efficacy. Flexibility will be incorporated into the treatment schedule to allow for potential pandemic-related travel restrictions.
5. If international travel is permitted, both spray boats will be employed to increase treatment effectiveness of St. Marys River granular Bayluscide applications and to ensure treatments are completed before aquatic vegetation becomes problematic.
6. Support and provide input into research that investigates sea lamprey sensitivity and effects on non-target organisms with anticipation that it leads to improved control strategies that increase treatment efficacy while minimizing effects on non-target species.
   a. The Service RMT will participate in the partner-led effort to conduct non-target collection during the Grand River (Ohio) treatment.
   b. LCTF will continue to support and provide feedback on research evaluating the effects of lampricide on species of concern (e.g. young lake sturgeon, mussels).

Strategy 3: Measure the effectiveness of lampricide application and account for its variation among streams.

2020 Outcomes:

1. Lampricide analysis and water chemistry data from streams treated in 2020 were/are being reviewed to identify potential areas that did not receive lethal TFM

concentrations. Information was provided to larval assessment to help guide treatment evaluation survey effort and recommend re-treatment.
2. The streamside bioassay scheduled to be conducted by Upper Midwest Environmental Sciences Center (UMESC) personnel prior to the Manistee River treatment was cancelled due to pandemic-related travel restrictions.
3. UMESC personnel, with support from Service, conducted TFM pellet field trials in tributaries to the Ford River in late October. Completion report is forth coming.
4. The LCTF had planned to provide logistical support to Schueller et al. (UMESC) as they conducted research to examine the seasonality effect on sea lamprey and TFM efficacy; however, this study was postponed due to the pandemic.
5. UMESC continues to work with Battelle (UK) to develop a formulation of emulsifiable concentrate that is more environmentally compatible and more suitable for field application.

2021 Objectives:

1. Review past treatment history and larval assessment information for streams scheduled for treatment in 2021 to identify impediments to effectiveness and develop strategies to increase efficacy.
2. Work with other task forces to measure effectiveness of lampricide applications. LCTF will continue to assist Larval Assessment Task Force (LATF) with evaluating the success of prior targeted treatment strategies. Treatment supervisors will review results of treatment evaluation surveys to identify problem areas and improve success of future treatments.
3. Treatment personnel will assist UMESC with field trials that support the development of a more effective TFM bar.
4. The LCTF will provide logistical support to Schueller et al. (UMESC) as they conduct research to examine the seasonality effect on sea lamprey and TFM efficacy.

Goal 2: Increase the effectiveness and efficiency of sea lamprey control to maximize reductions in sea lamprey populations in each Great Lakes.

Strategy 4: Implement integrated strategies for sea lamprey control for each lake and evaluate their effectiveness.

2020 Outcomes:

1. The 2020 targeted treatment strategy was to be focused on sea lamprey producing tributaries to Lake Michigan. However, due to pandemic-related travel restrictions, only two of the 29 streams included in the strategy were successfully treated.
2. Assisted the LATF with developing the 2021 rank list. Special consideration was given to streams not treated due to the pandemic-related travel restrictions, particularly those that were part of the Lake Michigan targeted treatment strategy, and to Lake Huron tributaries included in the 2021 targeted treatment strategy. Treatment supervisors reviewed and calculated treatment costs for all streams considered for treatment.

2021 Objectives:

1. Optimize stream treatment schedules to prioritize Lake Michigan treatments not treated in 2020 and facilitate the implementation of the next the sequential treatment strategy targeting tributaries to Lake Huron.
2. The LCTF will assist LATF with planning for sequential targeted treatment effort in each of the upper Great Lakes. Input will be provided on streams selected for inclusion in the Lake Superior targeted treatment strategy to occur in 2022.

Barrier Task Force

Purpose
The task force was established during April 1991 to coordinate efforts of the Department, the Service, and the USACE on the construction, operation, and maintenance of sea lamprey barriers.

2020 Membership
Matt Symbal (Chair), Pete Hrodey, Kevin Mann, Cheryl Kaye, and Rob Elliott (Service); Bruce Morrison, Tonia Van Kempen, Bhuwani Paudel, and Tom Pratt (Department); Amanda Meyer and Carl Platz (USACE); Gary Whelan (MIDNR); David Gonder (OMNRF); Nicholas Johnson and Ted Castro-Santos (USGS); Dan Zielinski (GLFC); Rob McLaughlin (University of Guelph); Dale Burkett, Michael Siefkes, and Chris Freiburger (Commission Secretariat).

Progress towards goals described in the GLFC Vision:

Goal 1: Suppress sea lamprey populations to target levels.

Strategy 5: Construct and maintain a network of barriers to limit sea lamprey access to spawning habitats.

2020 Outcomes:

1. Planning continued on 18 barrier construction projects to prevent sea lamprey from accessing spawning habitat.
2. Construction of the Grand River (Lake Erie) sea lamprey barrier was completed.
3. Rebuild of Nicholston Dam on the Nottawasaga River (Lake Huron) continued and was completed in February of 2021.
4. Critical repairs were completed on Camp 43 dam on the Black Sturgeon River.
5. Routine maintenance, spring start-up, and safety inspections were completed on 49 barriers (28 Canada, 21 U.S.) to ensure adult sea lampreys do not have access to spawning habitat. Activities were limited due to travel restrictions developed due to COVID-19 travel restrictions.
6. Review of 63 fish passage projects on 21 tributaries was initiated or completed to determine the effect of fish passage and dam or culvert removals to sea lamprey control operations.
7. Completed electrofishing surveys and habitat assessments conducted upstream of Lake Street dam on the Bear River to quantify potential infestation risk. Barrier inspections

to verify historical information at locations not currently represented in the barrier database were not completed due to COVID-19 travel restrictions.

2021 Objectives:

1. Initiate construction of the Manistique River (Lake Michigan) sea lamprey barrier.
2. Initiate construction of the Little Manistee River (Lake Michigan) sea lamprey barrier.
3. Initiate feasibility study for a sea lamprey barrier on Conneaut Creek.
4. Members remain engaged in the analysis and review of options at the 6th Street Dam on the Grand River (Lake Michigan) to assess risk of adult sea lamprey migrating upstream of the proposed structure that will create a white water rapids area in downtown Grand Rapids, MI.
5. Continue working on priority Great Lakes GLFER barrier projects with the USACE: Bad (Lake Superior) and Little Manistee rivers (Lake Michigan) to limit sea lamprey access to spawning habitat.
6. Investigate use of existing surrogate species data and geographic information systems (GIS) data to predict infestation risk upstream of blocking barriers.
7. Deliver barrier program of operation and maintenance to limit sea lamprey access to spawning habitat.

Goal 2: Increase the effectiveness and efficiency of sea lamprey control to further reduce sea lamprey populations in each Great Lake.

Strategy 4: Implement integrated sea lamprey control strategies for each lake and evaluate their effectiveness.

2020 Outcomes:

1. Participated in laboratory experiments to identify alarm cue compounds and to determine the effect of sea lamprey alarm cue on native species. Work to identify the chemical nature of the alarm cue is ongoing and preliminary results indicate that the magnitude of the response to sea lamprey alarm cue in other species seems to be related to how close the species is to sea lamprey, phylogenetically.
2. Several Barrier Task Force (BTF) members and participants are involved with the Supplemental Control Program workgroup. During 2020, the group developed sampling protocols and conducted fieldwork on SUPCON streams to collect baseline data. Trapping of adult sea lampreys occurred on eight streams, while larval population and habitat surveys occurred on 12 streams.
3. The Cheboygan Working Group (CWG) investigated wounding and adult capture reports from the upper Cheboygan River system and confirmed presence of a small adult sea lamprey population through monitoring of fyke nets. One unmarked adult sea lamprey was captured during 2020 in the upper Cheboygan. Sterilized male sea lamprey were not released into Sturgeon, Pigeon, and Maple rivers due to COVID-19 travel restrictions. Larval assessment surveys were completed in these rivers using the SUPCON sampling protocol.
4. Participated in a field experiment in the Black Mallard River to test NEMO as a seasonal barrier to block a natural sea lamprey run with the goal of eliminating the

need for lampricide treatment. The electric field was operated in the Black Mallard River, March through August from 2016-2020. Based on trap catches, it blocked >99% of the adults each year. The electric barrier decreased larval production. In 2018, larval sea lamprey abundance upstream of the barrier was about 50% lower than historical averages, and genetic analysis found that most larvae collected upstream of the barrier were spawned in 2015, a year before the barrier was operated. Larval surveys were conducted in 2019 and 2020. No sea lamprey larvae have been discovered since 2019.

2021 Objectives:

1. Remain involved in barrier research regarding use of chemosensory techniques to block or guide sea lampreys to increase capture of adult sea lamprey at barrier/trap complexes.
2. Participate in research trials to further test alarm cue response and its utility in a push-pull scenario to direct lampreys toward a successful barrier/trap complex or effective treatment location.
3. Provide support to the Supplemental Control Program in identifying assessment and control strategies (SMRT, pheromone, alarm cue, NEMO, etc.) for successfully controlling sea lampreys in streams difficult to treat with lampricide.
4. The Cheboygan Work Group (CWG) will continue to assess the upper Cheboygan River population during 2021 to confirm that adult populations upstream of the Cheboygan Lock and Dam complex are small and to document the system response to the Lake Kathleen Dam removal on the Maple River.

Larval Assessment Task Force

The task force was established in 2012 and combined some objectives from the LATF and the Larval Assessment Work Group (LAWG).

Purpose:
Rank streams and lentic areas for sea lamprey control options and evaluate success of lampricide treatments through assessment of residual larvae.

2020 Membership
Aaron Jubar (Chair), Mike Steeves and Kevin Tallon (Department); Lori Criger, Bob Frank, (Service); Jean Adams and Chris Holbrook (USGS); Travis Brenden (Quantitative Fisheries Center, MSU); Dale Burkett, Chris Freiburger, and Mike Siefkes (Commission Secretariat).

Progress towards goals described in the GLFC Vision:

Goal 1: Suppress sea lamprey populations to target levels.

Strategy 2: Conduct detection and distribution surveys to identify all sources of larval sea lampreys.

2020 Outcomes:

1. Due to COVID-19 travel and fieldwork restrictions, only a fraction of scheduled distribution surveys and detection surveys were conducted.
2. No new sea lamprey producing tributaries were detected. No unexpected sea lamprey infestations were identified in tributaries which were historically infested but that have been negative for >10 years. However, sea lamprey distributions expanded beyond historic reaches in Little Beaver Creek, and the Sturgeon River.

2021 Objectives:

1. Conduct detection surveys as possible given higher priority survey needs. When new infestations are found, rank streams for treatment as larval population and size structure warrants.
2. Conduct larval and habitat assessments in the Tittabawassee River (Saginaw River tributary) to monitor infestation and recruitment following catastrophic dam failures in the system during spring 2020.
3. Prioritize and conduct distribution surveys on all streams scheduled for treatment during 2021, with emphasis on addressing data gaps resulting from the pandemic. Conduct distribution surveys on all streams expected to be treated during 2022.

Strategy 3: Measure the effectiveness of lampricide application and account for its variation among streams.

2020 Outcomes:

1. Within the geographic work boundaries established due to the pandemic, post-treatment assessments were conducted on streams treated during 2019 and early 2020. The presence of large larvae and newly metamorphosed sea lampreys in Hungarian Creek resulted in a recommendation for an urgent treatment in 2020. Hungarian Creek was treated in late September 2020. The presence of residual larvae in portions of the Manistique, Whitefish, and Platte rivers will lead to inclusion of those tributaries for stream ranking for possible treatment in 2021.

2021 Objectives:

1. Continue to conduct post-treatment assessments on all treated streams and rank streams when problematic populations of residual sea lampreys are detected.

Goal 2: Increase the effectiveness and efficiency of Sea Lamprey control to further reduce sea lamprey populations in each Great Lake.

Strategy 3: Improve existing and develop new rapid assessment methods to determine the distribution and relative abundance of larval sea lamprey populations.

2020 Outcomes:

1. Multi-station larval habitat identification training that was planned for spring 2020 was postponed due to pandemic restrictions on regional and international travel. All larval habitat training for staff was conducted within the respective agent offices in Marquette, Ludington and Sault Ste. Marie.

2. To address stream selection issues and other items as directed by the LATF, the LAWG will meet in association with SLAWs meetings or as needed. Since Aaron Jubar moved into the LATF Chair position, the LAWG Chair has been assumed by Bob Frank (MBS).

2021 Objectives:

1. Contingent upon travel bans being lifted, multi-station larval habitat identification and quantification training will be held during early spring 2021
2. Continue to edit larval assessment protocols and operating procedures as necessary.
3. Continue to refine existing field methodologies and work with others to develop new and innovative larval sea lamprey detection techniques (e.g., eDNA).
4. Work with GLFC Communications staff to develop a larval lamprey identification guide, which would serve as an important resource for both new and experienced staff at all agent offices. Volunteers from all offices were identified to work with Commission staff to develop a Technical Assistance Proposal to get the project underway.

Strategy 4: Develop integrated strategies for sea lamprey control for each lake and evaluate their effectiveness.

2020 Outcomes:

1. Year two of the 2019-2021 Targeted Effort treatment strategy was implemented. This basin-wide approach focused on Lake Michigan tributaries in 2020. However, due to pandemic-related travel restrictions and a truncated field season, the majority of Lake Michigan Targeted Effort stream treatments had to be deferred. The 2021 Targeted Effort strategy will include a blend of Lake Michigan streams deferred from 2020 and Lake Huron streams originally slated for 2021.
2. Ranking surveys, distribution surveys, and where required, habitat assessment were conducted for streams identified as candidates for the Targeted Treatment strategy in 2021 throughout most of the Canadian tributaries to Lake Huron. Due to COVID-19 travel restrictions, all of the Marquette jurisdiction tributaries of Lake Huron and most of the Ludington streams were not surveyed in 2020. Where possible, US Control Agents will use recent Lake Huron larval survey data from 2018 and 2019 to plan and guide the 2021 Targeted Treatment strategy.
3. Larval assessment staff from Marquette and Sault Ste. Marie assisted with larval and habitat surveys on streams that are a part of the Supplemental Control (SupCon) research project.

2021 Objectives:

1. Develop the blended Lake Michigan – Lake Huron Targeted Effort stream list for 2021, based on a combination of 2020 (Department) and recent (2018-2019) larval assessment survey data.
2. Continue to work with the Trapping Task Force to identify and target streams for trapping out-migrating juveniles for control. Prior to treatment of Hungarian Creek in

late September, Marquette staff assisted with the collection of 175 transformers which were transported to HBBS for research.

3. Initiate planning for the next Targeted Effort strategy which is expected to begin in 2022, continuing with the process used in 2019 – 2021 Upper Great Lakes rotation strategy. Input from the LATF and LCTF will be combined to propose options for the upcoming Targeted Effort.
4. Continue to work with HBBS and Alternative Control and Evaluation staff to survey and evaluate SupCon project streams.

Trapping Task Force

Purpose

Coordinate optimization of trapping techniques for assessing adult sea lamprey populations and removing adult and transforming sea lampreys from spawning and feeding populations.

2020 Membership

Gale Bravener (Chair) and Mike Steeves (Department), Peter Hrodey, Sean Lewandoski (Service), Jean Adams, Scott Miehls, Kim Fredricks, Alex Haro (USGS); Weiming Li, Michael Wagner (Michigan State University), Heather Dawson (University of Michigan), Rob McLaughlin (University of Guelph), Michael Siefkes, Dale Burkett, Chris Freiburger (Commission Secretariat).

Progress towards goals described in the GLFC Vision:

Goal 1: Suppress sea lamprey populations to target levels.

Strategy 4: Quantify the relationship between the abundance of spawning-phase sea lampreys, lake trout abundance, and wounding rates on lake trout.

2020 Outcomes:

1. Due to COVID-19 travel restrictions, only 24 of 29 index sites were trapped and some were only trapped for part of the season. Mark-recapture population estimates were obtained from 11. Index values were generated for Lakes Huron, Erie, and Ontario. A data analysis protocol is being developed (to complement the trapping protocol). The protocol will document and formalize the methodology used to develop the annual lake wide adult sea lamprey abundance indices and will be updated if methods change in the future.
2. A manuscript describing the new adult sea lamprey index was submitted as part of SLIS III, titled “Quantifying Great Lakes sea lamprey populations using an index of adults.” by Jean V. Adams, Jessica M. Barber, Gale A. Bravener, and Sean A. Lewandoski.
3. Also a manuscript describing development of wounding and abundance targets was submitted as part of SLIS III, titled “A case study of setting threshold suppression targets for sea lamprey in the Great Lakes.” by Ted J. Treska, Mark P. Ebener, Gavin C. Christie, Jean V. Adams, and Michael J. Siefkes.

2021 Objectives:

1. Operate and maintain 39 trap sites throughout the Great Lakes. These include the 29 index streams, for which populations will be estimated using mark-recapture, and another 10 non-index streams.

Strategy 6: Deploy trapping methods to increase capture of spawning-phase and recently metamorphosed sea lampreys.

2020 Objectives:

1. Continue trapping transformers for control in newly discovered or deferred streams to mitigate escapement to the lakes, beginning in October 2020 if warranted.

Status: Approximately 190 transformers were electrofished from Dover River for research prior to treatment in September. Transformer trapping will occur in Garlic River below Saux Head Lake, Bad River system, and Fish Creek. In addition, transformer trapping will occur in 12 of the 13 SupCon streams (Tawas Lake Outlet, Long Lake Outlet, Black Mallard Creek, Pigeon River, Sturgeon River, Maple River, Furlong Creek, Bills Creek, Cranberry River, Traverse River, Belleuve Creek, Root River).

2020 Outcomes:

1. There are several recent and ongoing research projects aimed at improving the capture efficiency of adults and out-migrating juveniles for control purposes. Several projects were delayed due to COVID-19 travel restrictions. Pheromone, alarm cue, and antagonist research was able to continue. No new methods were deployed in 2020.
2. The SLaMSE model was updated to include expert judgement and results are presented in the trapping for control manuscript submitted as part of SLIS III, titled "Where you trap matters: implications for integrated sea lamprey management" by S. Miehls, H.A. Dawson, A. Maguffee, N.S. Johnson, M.L. Jones, and N. Dobiesz. Streams with low adult density, regular producers, and those where lampricide treatments are difficult show promise as possible trapping for control options. The trapping for control workgroup will be discussing next steps, including exploring questions about impact of transformer removal relative to adult trapping.
3. Assessment phase of SupCon underway. Eight of 13 streams were trapped. Due to COVID-19 travel restrictions, five rivers were not trapped. Adult trapping occurred in Cranberry River, Traverse River, Pigeon River, Sturgeon River, Maple River, Black Mallard River, Long Lake Outlett, Tawas Lake Outlet. Larval assessment should be complete by October.

2021 Objectives:

1. Continue trapping transformers for control in newly discovered or deferred streams to mitigate escapement to the lakes.
2. Continue monitoring results from recent and ongoing research projects and be prepared to implement effective new technologies and methods into the sea lamprey control field program when they become available.
3. Continue to evaluate trapping for control options, including trapping adults (and transformers) in streams where TFM is less effective.
4. Continue assisting with SupCon by providing suggestions and advice to core group on study design and deployment options for each study stream.

Goal 2: Increase the effectiveness and efficiency of sea lamprey control to further reduce sea lamprey populations in each Great Lake.

Strategy 1: Increase the capture of sea lampreys by developing cost-effective trapping methods including those based on release of pheromones.

2020 Outcomes:

1. Milt Pheromones – No new milt pheromone components were identified due to COVID-19 restricting Dr. Li's travel from China to MSU for additional compound identification. In the field, three tests involving milt were conducted, 1) milt was added to spermiating male washings (SMW) to determine if the addition of milt makes an already potent pheromone source more attractive, 2) different volumes of milt were added to SMW to determine if females discriminate between differing milt pheromone concentrations, and 3) spermine was tested to determine its behavioral effects on ovulated females. Tests were only conducted on ovulated females this season as hiring restrictions limited our field site use and did not allow for tests on spermiating males. All analyses are currently underway and results should be available for the spring meeting in 2021.

2021 Objectives:

1. Milt Pheromones – Test ceramides C14 and C20 in the field to determine behavioral effects on ovulated females. If travel restrictions are eased, continue fractionation and chemical identification of compounds from milt. Continue testing milt pheromones on spermiating males, which was not accomplished in 2020.

Strategy 2: Evaluate a repellent-based method to deter sea lampreys from spawning areas.

2020 Outcomes:

1. The Wagner lab developed a new high-throughput behavioral assay using individual sea lamprey to increase output during the severely shortened field season. They were able to complete tests of 16 compounds and 4 odor mixtures, 12-33 replicates per odorant/odor, for a total of 351 tests in 9 days. Emily Mensch is currently analyzing the data.
2. Outcome: A planned field experiment was canceled due to COVID-19 travel restrictions. The project team is planning that experiment for 2021. An application has been forwarded to the GLFC to address the funding impacts of a lost year.
3. A laboratory experiment to test the efficacy of two pulsed application schemes (on/off and high/low pulsing) for applying alarm cue was completed at the Hammond Bay Biological Station. Graduate student Mikaela Hanson is currently analyzing data.
4. The Li lab sought to determine if ovulated females (sham or naris-plugged) released downstream of a spawning grounds locate, interact, and spawn with nesting males when antagonist is applied in a 200 m section of the Carp Lake Outlet downstream of the sea lamprey barrier. They applied 1) vehicle (50% methanol) or 2) a mixture of PZS and 3sPZS (each at 6.2 x 10–11 M) with a diffuser bar upstream of the spawning grounds and tracked female movements with visual observations. When a mixture of PZS and 3sPZS was applied, spawning was reduced by 84%, from 37% of released ovulated females in control trials to a mere 6% during antagonist trials. Antagonist application not only reduced spawning but also reduced the proportion of females that swam upstream and found a male occupied nest. A comprehensive analysis of the behavior and water chemistry data is underway, and results will be made available when analyses are completed.

2021 Objectives:

1. A laboratory experiment will be conducted to test combinations of isolated and identified odorants from the sea lamprey alarm cue. The goal is to identify an effective mixture for us as a repellent.
2. A field project will be executed to evaluate movement paths of migrating sub-adult sea lamprey in rivers when exposed to predation risk (alarm cue). This project was delayed due to COVID-19 travel restrictions.
3. Mikaela Hansen will complete the data analysis and publication of results of the 2020 pulsed alarm cue application study in 2021.
4. The Li lab is still in the initial planning stage for 2021 experiments. They will design experiments to continue to assess the efficacy of antagonist in halting reproduction in *in situ* spawning populations.

Strategy 4: Implement integrated sea lamprey control strategies for each lake and evaluate their effectiveness.

2020 Outcomes:

1. Worked with LATF members to identify streams for trapping transformers for control.
2. Evaluated the effects of integrated control strategies that have been implemented (e.g. large-scale treatment strategies) by tracking adult sea lamprey abundance.

2021 Objectives:

1. Continue to work with LATF to identify and target streams for trapping transformers for control.
2. Continue to evaluate the effect of integrated control strategies that have been implemented by developing adult sea lamprey abundance estimates.

COMMUNICATIONS AND OUTREACH

The Great Lakes Fishery Commission (GLFC) and its partners, the Service Marquette Biological Station (MBS) and Ludington Biological Station (LBS), Fisheries and Oceans Canada (DFO), and United States Geological Survey-Hammond Bay Biological Station (USGS), conduct a comprehensive education and outreach program. The following is an update regarding recent outreach and educational activities.

OUTREACH AND EDUCATION EVENTS, 2020:

As part of the outreach and education program to inform the public about the Commission's programs, the health of the Great Lakes, and the importance of the fisheries to the region, the following major shows and events were conducted by the GLFC, USFWS, DFO, and USGS during the 2020 season.

2020 Shows, events, and programs:

Ultimate Fishing Show, Novi, MI—January 9-12 (LBS)
Cleveland Boat Show, Cleveland, OH—January 16-20 (LBS)
Chicagoland Fishing, Travel and Outdoor Expo, Schaumburg, IL—January 23-26 (MBS)
Gwinn Middle School 6th Graders, Gwinn, MI – January 28 (MBS)
Black Lake Sturgeon Shivaree, Black Lake, MI—February 1 (USGS)
Duluth Boat, Sports, Travel show, Duluth, MN—February 12-16 (MBS)
NMU Summer Job Fair, Marquette, MI—February 12 (MBS)
London Boat, Fishing, and Outdoors Show, London, ON—February 21-23 (DFO/USGS)
Wawa Ice Fishing Derby, Wawa, ON—March 7-8 (GLFC)
Sarnia Green Drinks, Sarnia, ON—March 11 (GLFC)
KBOCC Career Fair, Lanse, MI—March 12 (MBS)
Ohio Charter Captains Conference, Huron, OH—March 14 (GLFC)
WLUC TV-6 Interview, Marquette, MI – June 25 (MBS)
Hiawatha Sportsman's Club, Engadine, MI—July 16 (MBS)
Pictured Rocks National Lakeshore, Munising, MI – July 30 (MBS)
Hiawatha National Forest, Manistique, MI – August 20 (MBS)
AFS Annual Meeting Columbus, OH—August 31-Sept 2 (GLFC)
Cheboygan Rotary, Cheboygan, MI—October 21 (USGS)
Upper Midwest Invasive Species Conference, Duluth, MN—November 2-6 (GLFC)

PERMANENT EMPLOYEES OF THE SEA LAMPREY CONTROL PROGRAM

FISHERIES AND OCEANS CANADA

Debbie Ming/Hilary Oakman, Director, Aquatic Invasive Species and Species at Risk

Sea Lamprey Control Centre – Sault Ste. Marie, Ontario Canada
Mike Steeves, Program Manager

Team Leader, Control: Bruce Morrison

Lampricide Control Biologists:
Shawn Robertson: Treatment Supervisor
Alan Rowlinson: Treatment Supervisor
Barry Scotland: Assistant Supervisor
Clint Wilson: A/Assistant Supervisor

Lampricide Application Coordinators:
Peter Grey: Supervisor
Jamie Storozuk: Supervisor

Lampricide Analysis Technicians:

Stefanie Grand	Joe Lachowsky
Jerome Keen	Richard Middaugh

Lampricide Application Technicians:

Zach Allan	Sean Nickle
Justin Colbourne	Troy Pine
Sarah Daniher	Chris Sierzputowski
Kevin Finlayson	Kathy Smith
Paul Kyostia	Kevin Sullivan
Melissa Leonard	Brandon Trotter
Adam Loubert	Ryan Whitaker
Matt McAulay	

Barriers:
Bhuwani Paudel: Barrier Engineering Coordinator (On Assignment)
Joe Hodgson: Barrier Engineering Technician
Chad Hill: Technician

Team Leader, Assessment: Tonia Van Kempen

Assessment Biologists:
Gale Bravener: Adult Supervisor
Fraser Neave: Larval Supervisor (Upper Lakes)
Kevin Tallon: Larval Supervisor (On Assignment)
Sean Morrison: A/Larval Supervisor (Lower Lakes)

Assessment Technicians:

Stephanie Best	Andrea Phippen
Ryan Booth	Trevor Plumley
Jennifer Hallett	Jeff Rantamaki
Agata Kolodziejczyk	Thomas Voigt
Sarah Larden	

Administrative Support:
Lisa Vine: Finance and Administrative Officer
Melanie McCaig: Administrative Clerk
Christine Reid: Field Administrative Clerk

Maintenance:
Brian Greene: Foreman

Environmental Biologist:
Ryan Booth: A/Environmental Supervisor

Environmental Technician:
Nathan Coombs

UNITED STATES FISH AND WILDLIFE SERVICE

Amy McGovern, Aquatic Invasive Species Supervisor, Sea Lamprey Program Manager

Ludington Biological Station – Ludington, Michigan

Scott Grunder, Station Supervisor

Administrative Support:
Danya Sanders
Vacant (CS)

Database Management and IT Support:
Daniel McGarry

Lampricide Control Fish Biologists:
Jenna Tews, Treatment Supervisor
Timothy Sullivan, Treatment Supervisor
Lauren Freitas

Lampricide Control Lead Physical Science Technician:
Barry Shier

Lampricide Control Physical Science Technicians:
Jeffrey Sartor
Kevin Butterfield
Vacant

Lampricide Control Biological Science Technicians:
Bobbie Halchishak (CS)
Paul Seckora (CS)
Ben Molitor (CS)
Chelsey Taylor (CS)
Vacant (CS)
Vacant (CS)

Larval Assessment Fish Biologists:
Aaron Jubar, Larval Assessment Supervisor
David Keffer
Matthew Lipps

Larval Assessment Biological Science Technicians:
John Ewalt
Timothy Granger (CS)
Todd Gerardot
Callie Kopp (CS)
Mark Martin (CS)

Maintenance Worker:
Thomas McVay

Marquette Biological Station – Marquette, Michigan

Jessica Barber, Field Supervisor

Administrative Support:
Tracy Demeny, Administrative Officer
Lisa Dennis
Karla Godin

Database Management and IT Support:
Christopher Roberts, Database and IT Supervisor
Lynn Kanieski (Fish Biologist)
Deborah Larson (Data Transcriber)

Risk Management:
Cheryl Kaye, Risk Management Supervisor
Mary Henson (Fish Biologist)
Chad Andresen (Biological Science Technician)

Chemist:
Benson Solomon

Maintenance Worker:
John Gilkenson

Unit Supervisor (Adult): Pete Hrodey

Fish Biologists:
Matthew Symbal, Barrier and Trapping Supervisor
Samuel Hultberg
Sean Lewandoski
Kevin Mann

Barrier and Trapping Biological Science Technicians:
Kevin Letson
Jason Pynnonen (CS)
Dennis Smith
Nicholas Scripps (CS)
Tiffany Opalka-Myers (CS)

Unit Supervisor (Control, Larval): Shawn Nowicki

Lampricide Control Fish Biologists:
Lori Criger, Treatment Supervisor
Christopher Gagnon, Treatment Supervisor
Jesse Haavisto
Sara Ruiter

Lampricide Control Lead Physical Science Technician:
Jamie Criger

Lampricide Control Physical Science Technicians:
Daniel Kochanski
Justin Oster
Patrick Wick

Lampricide Control Biological Science Technicians:
Ross Gay (CS)
Randy Parker (CS)
Janet McConnell (CS)
Cory Racine (CS)
Kevin Hensiak (CS)
Dan Suhonen (CS)
Vacant (CS)
Vacant (CS)

Larval Assessment Biologists:
Robert Frank, Larval Assessment Supervisor
Rebecca Philipps
Vacant

Larval Assessment Biological Science Technicians:
Nikolas Rewald
Matt Elya (CS)
Mark Bash (CS)
Alex Larson (CS)

(CS) Career Seasonal