SEA LAMPREY CONTROL IN THE GREAT LAKES 2021

ANNUAL REPORT TO THE GREAT LAKES FISHERY COMMISSION

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Cover: Sabrina Butler (U.S Fish & Wildlife Service) checking the application rate during a lampricide treatment on Long Lake Creek, a tributary of Lake Huron.
Photo credit: Andrea Miehls (GLFC).

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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 2021, 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 71 tributaries and 9 lentic areas. Operation of 73 barriers, (47 purpose-built, 26 modified to serve as a sea lamprey barrier) to block sea lamprey migration and serve as an alternative control to the use of lampricides. Larval assessment crews surveyed 479 Great Lakes tributaries and 78 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 39 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. In Lake Superior, the index of adult abundance was estimated to be 27,174 (95% CI: 23,920 – 30,427), which was greater than the index targets of 10,421. In Lake Michigan, the index of adult abundance was estimated to be 15,507 (95% CI: 14,621 – 16,394), which was less than the target of 34,982. In Lake Huron, the index of adult abundance was estimated to be 39,128 (95% CI: 36,725 – 41,531), which was greater than the target of 31,274. In Lake Erie, the index of adult abundance was estimated to be 449 (95% CI; 405 – 492), which was less than the target of 3,263. In Lake Ontario, the index of adult abundance was estimated to be 5,187 (95% CI; 4,732 – 5,642), 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 2021 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 indices 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). The 2021 index of adult abundance for Lake Superior was 27,174 (*95% CI: 23,920 – 30,427*), which was greater than the index target. 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. The spring 2021 assessment data is currently being compiled.

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. The 2021 index of adult abundance for Lake Michigan was 15,507 (*95% CI: 14,621 – 16,394*), which was less than the target. The number of A1-A3 marks on lake trout from fall assessments in 2019 was 2.3 marks per 100 lake trout >532mm. Due to COVID-19 travel restrictions, lake trout marking data was not collected in 2020. The fall 2021 assessment data is currently being compiled.

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. The 2021 index of adult abundance in Lake Huron was estimated to be 39,128 (*95% CI: 36,725 – 41,531*), 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. The spring 2021 assessment data is currently being compiled.

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.*

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). The 2021 index of adult abundance in Lake Erie was estimated to be 449 (*95% CI; 405 – 492*), 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. The fall 2021 assessment data is currently being compiled.

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). The 2021 index of adult abundance in Lake Ontario was estimated to be 5,187 *(95% CI; 4,732 – 5,642*), which was less than the index target. The number of A1 marks on lake trout from fall assessments in 2020 was 2.2 marks per 100 lake trout >431mm. The fall 2021 assessment data is currently being compiled.

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 2021 is presented in the LCTF section of this report.

During 2021, lampricide treatments were conducted on 71 tributaries and 9 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 2021.

Lake	Number of Streams	Number of Lentic Areas	Discharge (m^3/s)	Distance Treated (km)	TFM (kg) [1,2]	Bayluscide (kg) [1,3]
Superior	16	7	47	488	7,845	206
Michigan	20	1	54	577	13,306	25
Huron	22	1	79	822	20,903	1,671
Erie	2	0	12	221	4,241	1
Ontario	11	0	32	232	4,327	1
Total	**71**	**9**	**224**	**2,340**	**50,622**	**1,904**

[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.

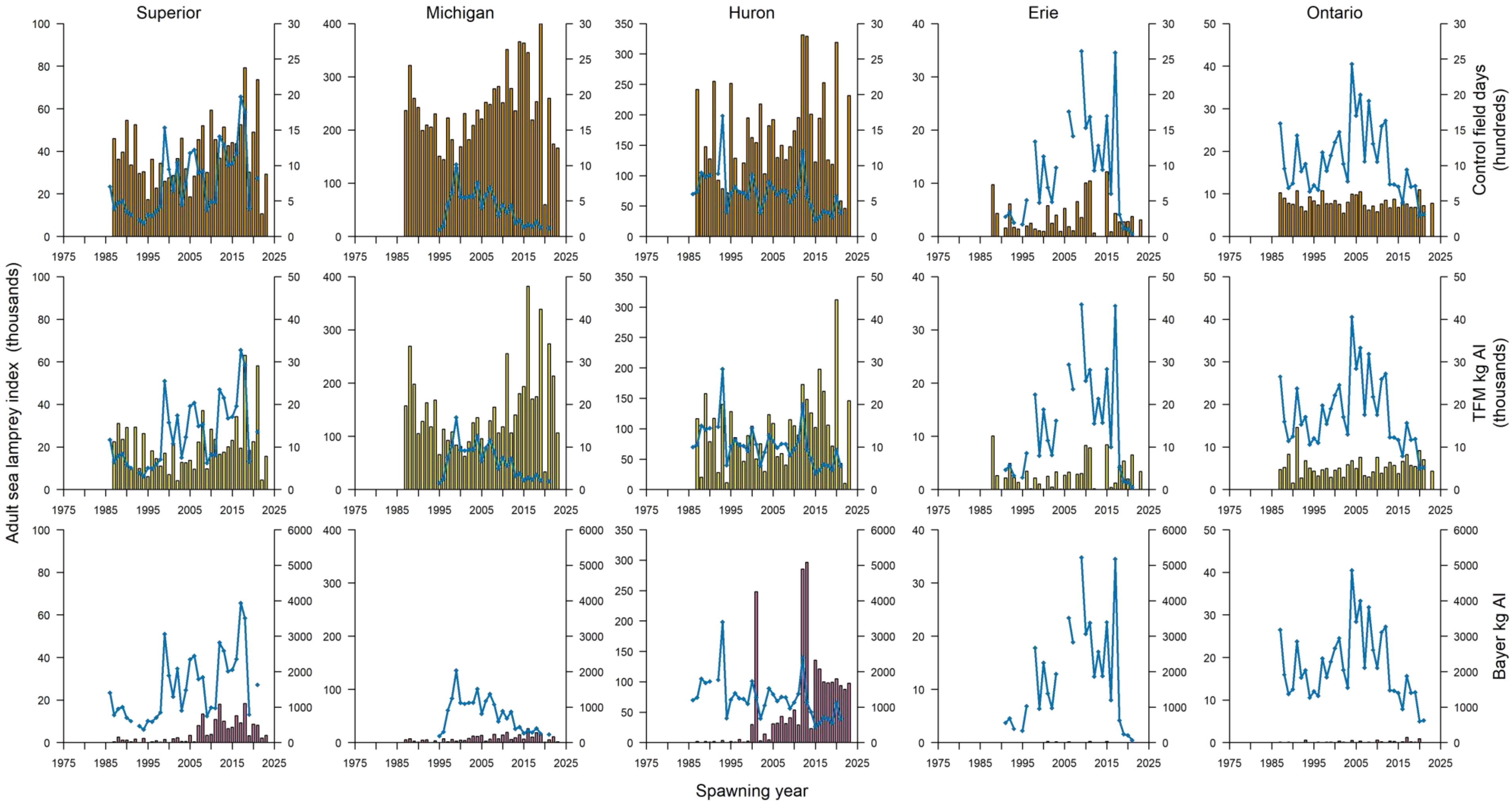

Figure 1. Top Row: Number of control field days (orange bars). Middle Row: TFM used (kg active ingredient, yellow bars). Bottom Row: Bayluscide used (kg active ingredient, purple bars). All rows: Index of adult sea lamprey is shown with blue lines. All metrics plotted against the sea lamprey spawning 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.

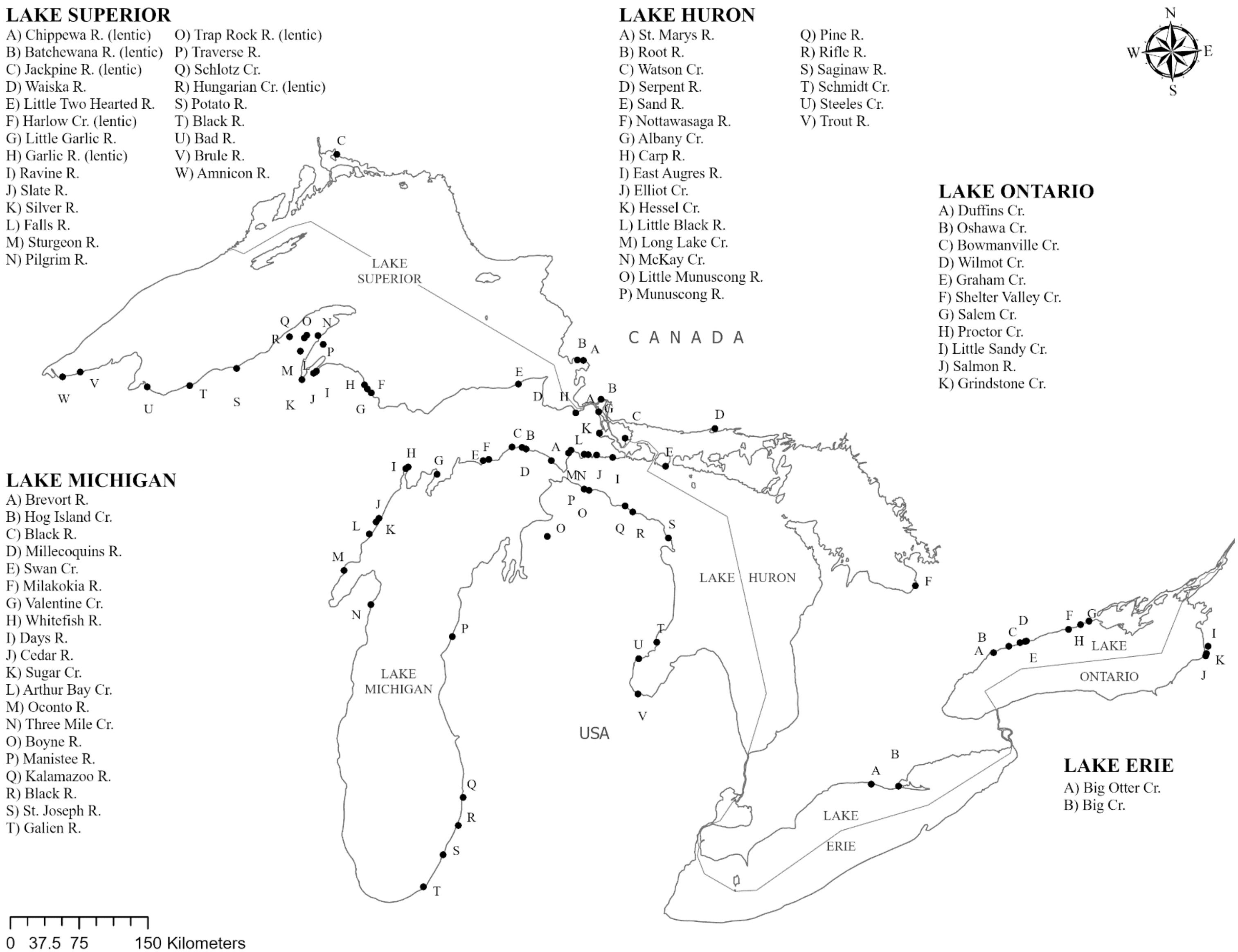

Figure 2. Location of tributaries treated with lampricides during 2021.

Lake Superior

Lake Superior has 1,566 tributaries (833 Canada, 733 U.S.). One hundred sixty-nine tributaries (58 Canada, 111 U.S.) have records of larval sea lamprey production. Of these, 127 tributaries (45 Canada, 82 U.S.) have been treated with lampricides at least once during 2012-2021. Fifty-eight tributaries (20 Canada, 38 U.S.) are treated every 4-6 years. Details on lampricide applications to Lake Superior tributaries and lentic areas during 2021 and tributary locations are found in Table 2 and Figure 2, respectively.

- Lampricide treatments were completed in 16 tributaries (0 Canada, 16 U.S.) and in 7 lentic areas (3 Canada, 4 U.S.;Table 1). COVID-19 travel restrictions or insufficient discharge precluded planned treatments in 13 tributaries (12 Canada, 1 U.S.).

- The Jackpine River estuary was treated with granular Bayluscide after surveys detected a large population of juvenile sea lampreys.

- The Batchawana River lentic treatment was added to the schedule after numerous large sea lamprey larvae were collected during assessment surveys.

- The Michipicoten River, Pays Plat River, Little Pays Plat River, Jackfish River, McIntyre Floodway, Cloud River, and Jarvis River treatments were deferred in 2021 but have been rescheduled for treatment in 2022.

- The Pilgrim River (Houghton County) was treated for the first time since 1962.

- The Service cooperated with Nick Johnson (USGS-Hammond Bay Biological Station) to conduct Supplemental Sea Lamprey Control (SUPCON) surveys during lampricide treatments in the Traverse and Potato rivers. High densities of large sea lamprey larvae and juveniles were collected in both streams.

- The Bad River, deferred during 2020 due to COVID-19 travel restrictions, was treated during September and October. High densities of both larval and metamorphosed sea lampreys were observed throughout the system.

Table 2. Details on the application of lampricides to tributaries and lentic areas of Lake Superior during 2021 (letter in parentheses corresponds to location of stream in Figure 2). Lampricide quantities are reported as kg of active ingredient.

Tributary	Date	Discharge (m^3/s)	Distance Treated (km)	Liquid TFM (kg)	Solid TFM (kg)	Wettable Powder Bayluscide (kg)	Emulsifiable Concentrate Bayluscide (kg)	Granular Bayluscide (kg)
<u>Canada</u>								
Chippewa R. (A)								
Lentic	Jul-28	---	---	---	---	---	---	75.3
Batchawana R. (B)								
Lentic	Sep-1	---	---	---	---	---	---	106.5
Jackpine R. (C)								
Lentic	Sep-12	---	---	---	---	---	---	1.6
Total (Canada)		**---**	**---**	**---**	**---**	**---**	**---**	**183.4**
<u>United States</u>								
Waiska R. (D)								
West Br.	Jul-10	1.4	23.0	240.6	0.9	---	---	---
Little Two Hearted R. (E)	Jul-26	0.9	36.7	92.3	2.1	---	---	---
Harlow Cr. (F)								
Lentic	May-25	---	---	---	---	---	---	0.7
Little Garlic R. (G)	Sep-08	0.1	7.7	26.4	1.7	---	---	---
Garlic R. (H)								
Lentic	May-20	---	---	---	---	---	---	4.8
Ravine R. (I)	May-27	0.1	1.4	2.9	0.2	---	---	---
Slate R. (J)	Aug-25	0.0[1]	1.0	6.6	---	---	---	---
Silver R. (K)	Aug-24	0.2	6.4	44.0	0.4	---	---	---
Falls R. (L)	Aug-24	0.6	0.5	178.0	---	---	---	---
Sturgeon R. (M)	Aug-21	7.7	91.7	938.0	1.1	---	9.3	---
Pilgrim R. (N)	Aug-20	0.3	5.8	58.7	---	---	---	---
Trap Rock R. (O)								
Lentic	Jun-02	---	---	---	---	---	---	2.0
Traverse R. (P)	May-28	0.4	13.8	38.1	0.5			
Schlotz Cr. (Q)	Oct-05	0.3	3.4	45.4	1.3	---	---	---
Hungarian Cr. (R)								
Lentic	Jun-01	---	---	---	---	---	---	5.4
Potato R. (S)	Jun-25	0.5	30.1	93.4	1.7	---	---	---
Black R. (T)	Sep-22	3.4	1.1	483.3	---	---	---	---

Table 2. *Continued*

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]
Bad R. (U)	Sep-17	23.9	238.0	4,611.5	3.6	---	---	---
Brule R. (V)	Jun-25	5.4	9.7	736.5	---	---	---	---
Amnicon R. (W)	Jun-27	2.2	17.9	235.1	0.4	---	---	---
Total (United States)		**47.4**	**488.2**	**7,830.8**	**13.9**	**0.0**	**9.3**	**12.9**
Total for Lake		**47.4**	**488.2**	**7,830.8**	**13.9**	**0.0**	**9.3**	**196.3**

[1]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, 86 tributaries have been treated with lampricides at least once during 2012-2021. Thirty-four tributaries are treated every 3-5 years. Details on lampricide applications to Lake Michigan tributaries and lentic areas during 2021 and tributary locations are found in Table 3 and Figure 2, respectively.

- Lampricide applications were conducted in 20 tributaries and 1 lentic area (Table 1).

- Farmers Creek (St. Joseph River) was successfully treated for the first time.

- The Cedar River lampricide treatment was complicated by low stream discharge, elevated water temperatures, pH suppression, and an atypical estuary due to high lake levels. Surveys to evaluate treatment effectiveness suggest the treatment was successful at removing larval sea lampreys. A 6(a)2 adverse incident report was submitted to the EPA for non-target mortality of mudpuppies throughout the estuary.

- An ongoing drawdown upstream of Stiles Dam and low stream discharge contributed to atypical water chemistries during the Oconto River lampricide treatment making it difficult to determine appropriate concentrations of lampricide. Post-treatment surveys are scheduled during 2022 to evaluate treatment effectiveness. Additionally, the tributary Kelly Brook, was not treated due to low stream discharge and a strong diurnal pH cycle.

- The lentic area offshore of Silver Creek, tributary to Brevort Lake, was treated for the first time since 1982.

Table 3. Details on the application of lampricides to tributaries and lentic areas of Lake Michigan during 2021 (letter in parentheses corresponds to location of stream in Figure 2). Lampricide quantities are reported as kg of active ingredient.

Tributary	Date	Discharge (m^3/s)	Distance Treated (km)	Liquid TFM (kg)	Solid TFM (kg)	Wettable Powder Bayluscide (kg)	Emulsifiable Concentrate Bayluscide (kg)	Granular Bayluscide (kg)
Brevort R. (A)	May-28	1.8	32.7	344.7	0.9	---	---	---
Silver Cr. Lentic	Jun-3	---	---	---	---	---	---	2.5
Hog Island Cr. (B)	May-17	0.5	10.6	61.4	0.6	---	---	---
Black R. (C)	May-14	0.6	29.5	227.8	0.4	---	---	---
Millecoquins R. (D)	Jul-23	4.5	34.1	979.0	1.3	---	---	---
Swan Cr. (E)	Sep-16	0.0[1]	1.1	3.6	---	---	---	---
Milakokia R. (F)	Sep-18	1.3	21.6	605.8	0.2	---	---	---
Valentine Cr. (G)	May-19	0.1	3.7	10.3	0.1	---	---	---
Whitefish R. (H)								
Haymeadow Cr.	May-04	1.7	7.7	168.5	1.1	---	---	---
Days R. (I)	Sep-02	0.2	6.8	88.6	0.4	---	---	---
Cedar R. (J)	May-14	6.2	96.6	1,867.7	3.8	---	---	---
Sugar Cr. (K)	May-05	0.3	1.6	28.6	---	---	---	---
Arthur Bay Cr. (L)	May-13	0.1	1.0	5.9	0.2	---	---	---
Oconto R. (M)	Sep-04	13.6	42.5	2,415.4	---	16.9	5.2	---
Three Mile Cr. (N)	Apr-30	0.1	5.1	54.2	0.9	---	---	---
Boyne R. (O)	Aug-19	2.7	6.4	810.9	8.5	---	---	---
Manistee R. (P)								
Little Manistee R.	June-29	6.1	22.9	1,329.9	15.1	---	---	---
Kalamazoo R. (Q)								
Swan Cr.	Jun-24	1.4	6.3	210.7	0.9	---	---	---
Black R. (Van Buren) (R)	Jul-7	2.7	23.0	419.9	---	---	---	---
St. Joseph R. (S)								
Hickory Cr.	May-1	1.0	21.4	273.0	---	---	---	---
Pipestone Cr.	May-3	1.0	24.3	370.3	---	---	---	---
Farmers Cr.	May-5	0.2	5.5	67.5	---	---	---	---
Paw Paw R.	Sep-3	6.8	137.8	2,542.7	---	---	---	---
Galien R. (T)	Aug-21	0.6	29.9	382.9	2.5	---	---	---
Total for Lake		**53.5**	**576.6**	**13,269.3**	**36.9**	**16.9**	**5.2**	**2.5**

[1]Stream Discharge of <0.05 are recorded as 0.0.

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, 85 tributaries (39 Canada, 46 U.S.) have been treated with lampricide at least once during 2012-2021. Forty-five tributaries (22 Canada, 23 U.S.) are treated every 3-5 years. Details on lampricide applications to Lake Huron tributaries and lentic areas during 2021 and tributary locations are found in Table 4 and Figure 2.

- Lampricide applications were completed in 22 tributaries (6 Canada, 16 U.S.), 1 lentic area (0 Canada, 1 U.S.) and 341 ha (178 ha Canada, 163 ha U.S.) of the St. Marys River (Table 1).

- The Pine River (Saginaw River) was deferred due to unseasonably low water levels.

- The Ocqueoc River was deferred due to an abundance of spawning salmon.

- The Pigeon River (Cheboygan River) was deferred due to instream habitat restoration at the former site of Song of the Morning Dam. The project created turbid conditions throughout the planned treatment area.

- The Little Black River was treated for the first time since 1967.

- Due to COVID-19 related international travel restrictions, crucial assistance from DFO during the Rifle River treatment was not possible. The entire distribution was successfully treated with increased effort from LBS and MBS.

- Most of Section 21SW Tributary (tributary to Taylor Creek, Munuscong River) was not treated due to denial of stream access by a private landowner.

- During the Nottawasaga River treatment, the Pine River, Boyne River and a short section of the main river were treated successfully before the treatment was washed out by heavy rainfall. The main river has been rescheduled for treatment in 2022.

- Livingstone Creek was deferred due to low water.

- Bighead River, Naiscoot River and the tributary to Beaudin Creek (Spanish River) were deferred due to travel restrictions based on the high levels of COVID-19 infection in the area.

- Bayluscide treatment of the Mississagi River delta was not completed due to First Nation concerns.

Table 4. Details on the application of lampricides to tributaries and lentic areas of Lake Huron during 2021 (letter in parentheses corresponds to location of stream in Figure 2). Lampricide quantities are reported as kg of active ingredient.

Tributary	Date	Discharge (m^3/s)	Distance Treated (km)	Liquid TFM (kg)	Solid TFM (kg)	Wettable Powder Bayluscide (kg)	Emulsifiable Concentrate Bayluscide (kg)	Granular Bayluscide (kg)
<u>Canada</u>								
St. Marys R. (A)	Jun-21	---	---	---	---	---	---	1609.9
Whitefish Ch.	Jun-3	0.4	0.7	33.0	---	---	---	0.1
Root R. (B)	Oct-5	3.2	21.9	218.4	2.5	---	---	4.7
Crystal Cr.	May-19	0.4	3.7	16.4	---	---	---	0.1
Watson Cr. (C)	May-27	0.1	1.6	4.8	---	---	---	0.1
Serpent R. (D)	Jun-22	7.9	7.6	353.9	0.4	---	---	0.1
Sand Cr. (E)	Jun-22	0.1	4.8	44.5	---	---	---	0.1
Nottawasaga R.(F)	Jul-12	5.3	13.2	785.9	0.4	---	8.4	0.1
Pine R.	Jul-10	3.1	42.8	1,020.6	0.2	---	---	0.1
Total (Canada)		**20.5**	**96.3**	**2,477.5**	**3.5**	**---**	**8.4**	**1,615.3**
<u>United States</u>								
L. Munuscong R. (G)	Oct-16	1.1	21.1	176.2	5.3	---	---	---
Munuscong R. (H)								
Taylor Cr.	May-02	1.1	9.7	257.7	1.3	---	---	---
Albany Cr. (I)	May-04	1.1	1.0	92.3	0.2	---	---	---
McKay Cr. (J)	Apr-30	1.1	7.6	168.9	0.9	---	---	---
Hessel Cr. (K)	Sep-22	0.1	1.6	27.8	0.9	---	---	---
Steeles Cr. (L)	Sep-21	0.1	1.4	35.8	---	---	---	---
Pine R. (M)	Jun-10	5.5	159.0	1,387.4	13.5	---	---	---
Carp R. (N)	Jul-09	3.1	112.7	884.4	5.9	---	---	---
Little Black R. (O)	Oct-1	0.3	2.3	93.3	---	---	---	---
Elliot Cr. (P)	Oct-3	0.2	4.3	63.8	---	---	---	---
Schmidt Cr. (Q)	Sept-30	0.3	0.6	59.3	---	---	---	---
Trout R. (R)	Oct-2	0.4	1.9	89.2	---	---	---	---
Long Lake Cr. (S)	Aug-19	0.4	3.9	114.1	---	---	---	---
East AuGres R. (T)	May-26	1.3	25.3	405.0	---	---	---	---
Rifle R. (U)	Aug-7	17.0	144.0	4,813.7	12.1	---	20.5	---
Saginaw R. (V)								
Shiawassee R.	May-29	7.1	108.5	3,567.8	---	---	---	---
Chippewa R.	Jun-11	18.1	120.7	6,145.4	---	---	---	---

Table 4. *Continued*

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]
Lentic	Jun-15	---	---	---	---	---	---	26.3
Total (United States)		**58.3**	**725.6**	**18,382.1**	**40.1**	**---**	**20.5**	**26.3**
Total for Lake		**78.8**	**821.9**	**20,859.6**	**43.6**	**---**	**28.9**	**1,641.6**

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 2012-2021. Seven tributaries (2 Canada, 5 U.S.) are treated every 3-5 years. Details on lampricide applications to Lake Erie tributaries and lentic areas during 2021 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.).

- Lampricide applications were completed in 2 Canadian tributaries (Table 1).

- Due to COVID-19 related staff safety concerns, treatment of the Grand River, Conneaut and Racoon creeks was deferred until 2022.

- Big Creek (including Venison Creek) and Big Otter Creek were treated in 2021. Larval sea lamprey abundance was low in Big Creek while Big Otter Creek had moderate abundance with numerous juvenile sea lamprey observed.

Table 5. Details on the application of lampricides to tributaries and lentic areas of Lake Erie during 2021 (letter in parentheses corresponds to location of stream in Figure 2). Lampricide quantities are reported as kg of active ingredient.

Tributary	Date	Discharge (m^3/s)	Distance Treated (km)	Liquid TFM (kg)	Solid TFM (kg)	Wettable Powder Bayluscide (kg)	Emulsifiable Concentrate Bayluscide (kg)	Granular Bayluscide (kg)
Canada								
Big Otter Cr. (A)	Sept-10	3.2	97.9	1,397.2	3.3	---	---	0.8
Big Cr. (B)	July-19	7.5	102.0	2,379.7	2.1	---	---	0.5
Venison Cr.	Sept-15	1.0	21.1	458.7	---	---	---	---
Total (Canada)		**11.7**	**221.0**	**4,235.6**	**5.4**	**---**	**---**	**1.3**
United States								
Total (United States)		**---**	**---**	**---**	**---**	**---**	**---**	**---**
Total for Lake		**11.7**	**221.0**	**4,235.6**	**5.4**	**---**	**---**	**1.3**

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 2012-2021. 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 2021 and tributary locations are found in Table 6 and Figure 2.

- Lampricide applications were completed in 11 tributaries (8 Canada, 3 U.S.;Table 1).

- The Credit River treatment was deferred due to significant numbers of rainbow trout in the river. This is the second consecutive year that the Credit River has been deferred and treatment is planned during 2022.

- Service staff from the Lake Champlain Unit along with New York State Department of Environmental Conservation were able to treat three rivers in New York State; Salmon River (including the Trout Brook tributary), Grindstone Creek and Little Sandy Creek. High densities of sea lamprey larvae were noted in all treatments.

- Treatment of Black River, South Sandy Creek, Lindsey Creek, Snake Creek, Little Salmon River, Catfish Creek, Ninemile Creek and Sterling Creek were deferred and all are planned for 2022 (see Table 1).

- Graham Creek was added to the list of streams to be treated after larval assessment surveys were completed. Surveys indicated that lamprey had breached the barrier as a result of high lake levels.

- Shelter Valley was scheduled to be treated in September but due to large numbers of Chinook salmon present it was delayed until mid-October. Larval sea lamprey abundance was moderate with high number of lampreys observed in isolated locations.

- Urfe and Ganatsekiagon creeks, tributaries to Duffins Creek, had insufficient discharge for treatment in August when Duffins Creek was treated. They were treated in mid-October with low larval sea lamprey abundance in the tributaries.

Table 6. Details on the application of lampricides to tributaries of Lake Ontario during 2021 (letter in parentheses corresponds to location of stream in Figure 2). Lampricide quantities are reported as kg of active ingredient.

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								
Duffins Cr. (A)	Aug-8	2.2	44.4	802.9	0.6	---	---	0.1
Oshawa Cr. (B)	Aug-10	0.7	21.7	278.1	---	---	---	0.1
Bowmanville Cr. (C)	Aug-12	1.1	14.0	444.1	---	---	---	0.1
Wilmot Cr. (D)	Aug-14	0.5	20.7	224.7	0.8	---	---	0.1
Graham Cr. (E)	Aug-16	0.2	17.4	131.1	---	---	---	0.1
Shelter Valley Cr. (F)	Oct-14	0.7	17.1	493.8	---	---	---	0.4
Salem Cr. (G)	Aug-6	0.1	2.2	42.2	---	---	---	0.1
Proctor Cr. (H)	Aug-6	0.1	4.1	26.0	---	---	---	---
Total (Canada)		**5.6**	**141.6**	**2,442.9**	**1.4**	---	---	**1.0**
United States								
Little Sandy Cr. (I)	Jul-16	1.4	13.3	105.5	0.2	---	---	---
Salmon R. (J)	Aug-30	22.6	32.6	1,528.3	2.3	---	---	---
Trout Br.	Jul-13	1.3	22.6	136.1	3.3	---	---	---
Grindstone Cr. (K)	Aug-28	0.7	21.5	107.2	0.2	---	---	---
Total (United States)		**26.0**	**90.0**	**1,877.1**	**6.0**	---	---	---
Total for Lake		**31.6**	**231.6**	**4,320.0**	**7.4**	---	---	**1.0**

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 2021, 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 2021 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.

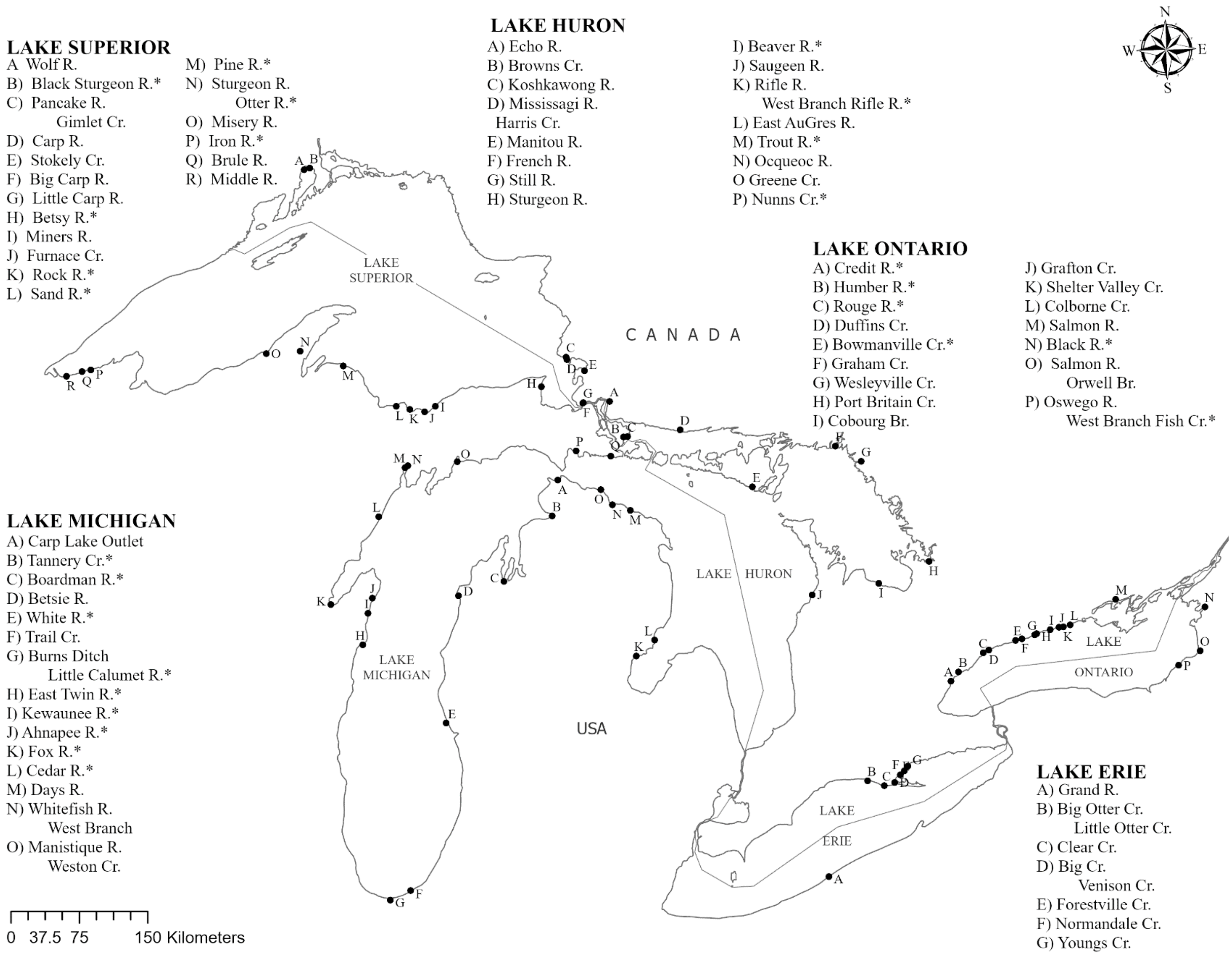

Figure 3. Locations of tributaries with sea lamprey barriers. An asterisk indicates structures that have been modified or constructed by others to prevent the upstream migration of sea lamprey**.**

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 7 were constructed for other purposes but have been modified to block sea lamprey migrations.

Barrier Inventory and Project Selection System (BIPSS)

Barrier inspections are scheduled on a four-year rotation. Lake Superior inspections will be completed during 2023 and the data will be used to evaluate sea lamprey blocking potential and update the BIPSS.

Operation and Maintenance

- Routine maintenance, spring start-up, and safety inspections were performed on 8 barriers (6 Canada, 2 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. The Service and the Commission are working with the Wisconsin Department of Natural Resources (WIDNR) to fund repairs for the fishway and barrier lip. This work will begin in 2022.

- Partner agencies were consulted to ensure blockage at barriers at 9 sites in 6 streams during 2021 (Table 7).

Table 7. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Superior tributaries during 2021.

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Chocolay R.	Cedar Cr.	MCCD[1]	Cherry Cr. Rd. culvert	Concur	Ineffective barrier
Compeau Cr.	Compeau Cr.	EGLE[2]	Compeau Cr. Rd. culvert	Concur	Ineffective barrier
Compeau Cr.	Compeau Cr.	EGLE[2]	County Rd. HD culvert	Concur	Ineffective barrier
Iron R.	Yellow Dog R.	YDWP[3]	Yellow Dog culvert	Concur	Upstream of blocking barrier
Ontonagon R.	Trib. to Two Mile Cr.	MIDNR[4]	Beaton Lake Dam	Concur	Upstream of blocking barrier
Ontonagon R.	Ontonagon R.	VO[5]	Ontonagon Dam	Concur	Ineffective barrier
Ontonagon R.	E. Br. Ontonagon R.	TU[6]	Lower Dam	Conditional	Seasonal requirements
Tahquamenon R.	Creek Number Eight	TU[6]	Creek Number Eight culvert	Concur	Ineffective barrier
Sucker R.	Sucker R.	GLFC[7]	H-58 culvert	Concur	Ineffective barrier

[1]Marquette County Conservation District, [2]Michigan Department of Environment, Great Lakes, and Energy, [3]Yellow Dog Watershed Preserve, [4]Michigan Department of Natural Resources, [5]Village of Ontonagon, [6]Trout Unlimited, [7]Great Lakes Fishery Commission

New Construction

- Bad River – A feasibility study is required to determine the best location for a sea lamprey barrier. To date only the Potato River junction has been investigated for a barrier; however, the topography at this location is not suitable due to the barrier size needed and potential backwater effects. The Service continues to work with the Mashkiiziibii (Bad River) Natural Resources Department, to identify potential sites that the Tribe would support. The Tribal Council reviewed the list of potential sites considered for feasibility assessments during a 2020 meeting and suggested that the sites be re-evaluated. Progress on this project has slowed due to the COVID-19 pandemic.

- Ontonagon River – Service staff continued to work with the U.S. Forest Service to identify a new sea lamprey barrier location in the Ontonagon River system. The Lower Dam site will continue to be operated as a seasonal barrier to block sea lamprey migration until a new location is identified, or the dam is completely removed.

- Neebing River - Preliminary engineering to support the installation of a permanent sea lamprey trap at the existing Neebing River barrier, Thunder Bay, was initiated in 2021.

Lake Michigan

The Commission has invested in 15 barriers on Lake Michigan (Figure 3). Of these, 6 were purpose-built as sea lamprey control barriers and 9 were constructed for other purposes, but have been modified to block sea lamprey migrations.

Barrier Inventory and Project Selection System

Barrier inspections are scheduled on a four-year rotation. Lake Michigan inspections will be completed during 2023 and the data will be used to evaluate sea lamprey blocking potential and update the BIPSS.

Operation and Maintenance

- Routine maintenance, spring start-up, and safety inspections were performed on 1 barrier.

Ensure Blockage to Sea Lamprey Migration

- Boardman River –The Commission and its partners are working to develop fish passage technologies to pass desirable fishes while blocking sea lamprey. A selective, bi-directional fish passage experimental research facility (FishPass) is planned for construction at the Union Street Dam. The FishPass Project is on hold pending the outcome of litigation. Currently, assessment projects have been ongoing including those associated with image recognition software, fish movement, as well as energy and nutrient dynamics. An operation and maintenance plan has been drafted and reviewed.

- Grand River – Work continued on the 6th Street Dam project targeting removal of the existing dam, construction of an adjustable barrier to block sea lamprey migration, and creating an artificial rapids complex for recreational use. The USACE has drafted an environmental impact statement that included 14 design alternatives for consideration. Progress has slowed for this project as permitting issues in the downstream reach are being addressed. A completed EIS draft will be available for public review after the downstream reach issues are resolved.

- Barrier removals/modification – Partner agencies were consulted to ensure blockage at barriers at 30 sites in 19 streams (Table 8).

Table 8. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Michigan tributaries during 2021.

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Black R.	Black R.	MC[1]	Celery Flats Water Control Structure	Concur	Low chance of infestation
Grand R.	Trib. to Thornapple R.	BCD[2]	Glass Cr. Culvert	Concur	Upstream of blocking barrier
Grand R.	Trib. to Crockery Cr.	MCD[3]	Patterson Park Dam	Concur	Ineffective barrier
Jordan R.	Jordan R.	CRA[4]	Jordan R. Rd. culvert #1	Concur	Ineffective barrier
Jordan R.	Jordan R.	CRA[4]	Jordan R. Rd. culvert #2	Concur	Ineffective barrier
Jordan R.	Deer Cr.	CRA[4]	Fuller Rd. culvert	Concur	Ineffective barrier
Boardman R.	N. Br. Boardman R.	CRA[4]	Broomhead Rd. culvert	Concur	Upstream of blocking barrier
Pere Marquette R.	Baldwin R.	CRA[4]	Baldwin Trout Hatchery Dam	Conditional	Seasonal requirements
Stony Cr.	Stony Cr.	CRA[4]	Marshville Dam	Concur	Ineffective barrier
Manistique R.	Cold Cr.	CLMCD[5]	Spring Cr. Trout Pond Dam	Concur	Minimal upstream potential
Menominee R.	Michigamme R.	MRBA[6]	Republic Dam	Concur	Upstream of blocking barrier
Kalamazoo R.	N. Br. Kalamazoo R.	CCRD[7]	Minges Br. Culvert	Concur	Upstream of blocking barrier
Kalamazoo R.	S. Br. Kalamazoo R.	CA[8]	Albion Dam	Concur	Feasibility study
Kalamazoo R.	Kalamazoo R.	CPL[9]	Plainwell Dam #2	Concur	Ineffective barrier
Kalamazoo R.	Portage Cr.	CPO[10]	Red Mill Dam	Concur	Upstream of blocking barrier
Kalamazoo R.	Bear Cr.	MDOT[11]	M-40 culvert	Concur	Ineffective barrier
Kalamazoo R.	Swan Cr.	MIDNR[12]	Swan Cr. Dam	Conditional	Seasonal requirements
Muskegon R.	Denton Cr.	MIDNR[12]	Denton Cr. Flood Control Dam	Concur	Upstream of blocking barrier
Muskegon R.	Backus Cr.	MIDNR[12]	Little Mud Lake Dam	Concur	Upstream of blocking barrier
Muskegon R.	Buckhorn Cr.	MRWA[13]	Buckhorn Cr. Dam	Concur	Upstream of blocking barrier
Muskegon R.	Little Muskegon R.	MRWA[13]	Altona Dam	Concur	Upstream of blocking barrier
Portage Lake Outlet	Portage Lake Outlet	VO[14]	M-22 culvert	Concur	Ineffective barrier

Table 8. *Continued*

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Sheboygan R.	Sheboygan R.	SC[15]	Sheboygan Marsh Dam	Concur	Upstream of blocking barrier
St. Joseph R.	Sherman Mill Cr.	SJCRC[16]	Shimmel Rd.culvert	Concur	Upstream of blocking barrier
Manistee R.	Big Cannon Cr.	TU[17]	North Gillow Rd. culvert	Concur	Upstream of blocking barrier
Sturgeon R.	Mormon Cr.	TU[17]	Mormon Cr. Culvert	Concur	Ineffective barrier
Whitefish R.	Chippeny Cr.	TU[17]	Forest Service Rd. 2428 culvert	Concur	Ineffective barrier
White R.	Swinton Cr.	WMSRDC[18]	144th Avenue culvert	Concur	Minimal upstream potential
Wycamp Cr.	Wycamp Cr.	LTBBOI[19]	North Lake Shore Dr. culvert	Concur	Ineffective barrier
Five Mile Cr.	Five Mile Cr.	LTBBOI[19]	Lower Shore Dr. culvert	Concur	Ineffective barrier

[1]Muskegon County, [2]Barry Conservation District, [3]Muskegon Conservation District, [4]Conservation Resource Alliance, [5]Chippewa Luce Mackinac Conservation District, [6]Mishigamme River Basin Authority, [7]Calhoun County Road Department, [8]City of Albion, [9]City of Plainwell, [10]City of Portage, [11]Michigan Department of Transportation, [12]Michigan Department of Natural Resources, [13]Muskegon River Watershed Assembly, [14]Village of Onekama, [15]Sheboygan County, [16]St. Joseph County Road Commission, [17]Trout Unlimited, [18]West Michigan Shoreline Regional Development Commission, [19]Little Traverse Bay Band of Odawa Indians

New Construction

- Manistique River – The USACE continues to work with the Commission and its partners to construct a sea lamprey barrier in the Manistique River. 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 of Manistique water supply line. The State of Michigan and USACE continue to work on acquiring ownership of the dam. Construction is scheduled to start in 2025.

- Little Manistee River – The Service has been working with the Michigan Department of Natural Resources (MIDNR) and USACE staff to improve the blocking capability of the Little Manistee River weir and egg take facility through the construction of a new spillway and permanent sea lamprey trap. The Service continues to provide guidance for placing the permanent trap within the new structure, as well as operation of weir stop logs with the goal to prevent sea lamprey escapement. The USACE continues to update their flow models based on new survey data. This information will be used to determine the best project design and operation. The goal is to award a construction contract in 2022, with construction slated for 2023.

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

- Pere Marquette River - The Service continues to work with the Village of Baldwin, MIDNR and Conservation Resource Alliance on identifying options for replacing the failing Baldwin River Hatchery Dam with a sea lamprey barrier. Seasonal fish passage options are under consideration.

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)

Barrier inspections are scheduled on a four-year rotation. Field crews inspected 32 structures in Lake Huron during 2021 and the data will be used to evaluate sea lamprey blocking potential and update the BIPSS.

Operation and Maintenance

- Routine maintenance, spring start-up, and safety inspections were performed on 9 barriers (5 Canada, 4 U.S.).

- The combination low-head/electrical barrier in the Ocqueoc River was activated April 28, through May 8, 2021. The electrical barrier operated continually during this time. The electric field remained off the remainder of the year due to drought conditions. Installation of a new cellular modem and water level sensor occurred in 2021. The installation of a new battery backup system is planned for 2022.

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:

    - The Service continues to work with GEI Consultants Inc. (GEI), the MIDNR, and others to identify alternatives for preventing sea lamprey passage at the Cheboygan River lock. The MIDNR is pursuing the refurbishment of the aging structure and the federal partners are interested in making the lock "lamprey proof." GEI is currently investigating the use of anti-suction material on the surfaces of the lock. Construction for this project is expected to begin in 2022.
    - The Lake Kathleen Dam on the Maple River was removed during fall 2018. Annual monitoring to document changes in native and sea lamprey populations throughout the Maple River continued during 2021. Larval sea lamprey were detected upstream of the Lake Kathleen Dam site in the West Branch of the Maple River at the US-31 highway crossing. The Service will continue to monitor this population during the 2022 field season.
    - Additional information can be found in the Supplemental Control section, p36.

- Partner agencies were consulted to ensure blockage at barriers for 14 sites in 5 tributaries during 2021 (Table 9).

Table 9. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Huron tributaries during 2021.

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Cheboygan R.	Pigeon R.	Huron Pines	Wilkinson Rd. culvert	Concur	Ineffective barrier
Cheboygan R.	Pigeon R.	Huron Pines	Johnson Crossing Rd. culvert	Concur	Ineffective barrier
Cheboygan R.	Pigeon R.	Huron Pines	Sparr Rd. culvert	Concur	Upstream of blocking barrier
Cheboygan R.	Pigeon R.	Huron Pines	Sparr Rd. culvert #2	Concur	Ineffective barrier
Cheboygan R.	Pigeon R.	Huron Pines	Whitehouse Rd. culvert	Concur	Ineffective barrier
Cheboygan R.	Cornwall Cr.	Huron Pines	Cornwall Creek Dam	Concur	Repair
Cheboygan R.	Maple R.	CRA[1]	Robinson Rd. culvert	Concur	Ineffective barrier
Cheboygan R.	Maple R.	CRA[1]	Douglas Lake Rd. culvert	Concur	Ineffective barrier
Cheboygan R.	Van Cr.	CRA[1]	Pet-Mack Trail culvert	Concur	Ineffective barrier
Thunder Bay R.	Comstock Cr.	TU[2]	Comstock Creek culvert #1	Concur	Upstream of blocking barrier
Thunder Bay R.	Comstock Cr.	TU[2]	Comstock Creek culvert #2	Concur	Upstream of blocking barrier
Thunder Bay R.	Comstock Cr.	TU[2]	Comstock Creek culvert #3	Concur	Upstream of blocking barrier
Au Sable R.	E. Branch Au Sable R.	TU[2]	Au Sable Hatchery Ponds Dam	Concur	Fish passage modification
Au Sable R.	Chub Cr.	RNR[3]	Ram Nek Ranch Dam	Concur	Upstream of blocking barrier
Saginaw R.	Shiawassee R.	OC[4]	Davisburg Dam	Concur	Upstream of blocking barrier
Saginaw R.	Flint R.	GCPR[5]	Hamilton Dam	Concur	Low chance of infestation
Saginaw R.	Swartz Cr.	FRWC[6]	Swartz Creek Dam	Concur	Ineffective barrier
Saginaw R.	Shiawassee R.	FSR[7]	Unnamed Dam	Concur	Ineffective barrier
Saginaw R.	Tittabawassee R.	Huron Pines	Kreckman Dam	Concur	Ineffective barrier
Trout R.	Trout R.	Huron Pines	Trout Creek Dam	Concur	Seasonal requirements

[1]Conservation Resource Alliance, [2]Trout Unlimited, [3]Ram Nek Ranch, [4]Oakland County, [5]Genesee County Parks and Recreation, [6]Flint River Watershed Coalition, [7]Friends of the Shiawassee River

Lake Erie

The Commission has invested in 7 purpose-built sea lamprey barriers on Lake Erie (Figure 3).

Barrier Inventory and Project Selection System (BIPSS)

Barrier inspections are scheduled on a four-year rotation. Field crews inspected 109 structures in Lake Erie during 2021 and the data will be used to evaluate sea lamprey blocking potential and update the BIPSS.

Operation and Maintenance

- Routine maintenance, spring start-up, and safety inspections were performed on eight barriers (7 Canada, 1 U.S.).

Ensure Blockage to Sea Lamprey Migration

- Black River – The MIDNR and Service-Alpena Fish and Wildlife Conservation Office completed a feasibility study in 2019 for the removal of Wingford Dam. Project partners are currently working to find a mutually beneficial solution to allow fish passage while preventing sea lamprey escapement. Larval assessment data collected for the upper Black River is currently being analyzed to determine the sea lamprey production potential for this area should escapement occur.

- Clinton River – The Service and its partners continue efforts to block a natural bypass around the Yates Mill dam. The bypass developed in a low-lying area during periods of high flow and has allowed sea lamprey escapement. Steel sheet-pile was installed during 2020 at the upstream entrance of the bypass channel to divert flow back through the main channel. Not long after, an extreme flood event washed out this work and re-opened the bypass channel. Remediation is underway to close the channel and repair the damage. The Commission contracted with an engineering firm to conduct a geomorphic survey. Results of the survey will guide the Service in determining the best method to close the bypass channel.

- Partner agencies were consulted to ensure blockage at barriers for 4 sites in 4 tributaries (Table 10).

Table 10. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Erie tributaries during 2021.

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Clinton R.	Trib. to Trout Cr.	CRWC[1]	Bald Mountain Pond Dam	Concur	Upstream of blocking barrier
Huron R.	Huron R.	HRWC[2]	Peninsular Paper Dam	Concur	Upstream of blocking barrier
River Raisin	River Raisin	NE[3] RRWC[4]	Brooklyn Dam	Concur	Upstream of blocking barrier
River Rouge	Trib. to Johnson Drain	MIDNR[5]	Maybury Fish Pond Dam	Concur	Ineffective barrier

[1]Clinton River Watershed Council, [2]Huron River Watershed Council, [3]Niswander Environmental Council, [4]River Raisin Watershed Council, [5]Michigan Department of Natural Resources

New Construction

- Cattaraugus Creek – In 2017, the USACE, along with project partners Erie County and NYSDEC approved the plan for the Springville Dam Ecosystem Restoration Project. 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. In an effort to re-initiate the project, USACE and NYSDEC have pursued a Value Engineering Design Review to reduce costs and identify additional paths toward project completion.

- Grand River – The USACE completed the Harpersfield Dam project in 2020 by replacing the deteriorating structure in the Grand River. After completion, the new structure developed a nappe vibration under certain water flow rates. The USACE is pursuing alternatives to remediate the nappe vibration.

- Conneaut Creek **–** The Pennsylvania Fish and Boat Commission (PAFBC) and Ohio Department of Natural Resources 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. The USACE received a positive Federal Interest Determination report and is considering multiple barrier design criteria to include in a Feasibility Study. Monthly virtual meetings are held as the project moves forward.

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 11 barriers (10 Canada, 1 U.S.). Among these, two barriers (1 Canada, 1 U.S.) were seasonally operated.

- The NYSDEC completed startup and shutdown of the seasonal barrier at Orwell Brook in 2021. Travel restrictions implemented during the COVID-19 pandemic excluded DFO and the Service from attending to this barrier.

Ensure Blockage to Sea Lamprey Migration

- Partner agencies were consulted to ensure blockage at 1 site in 1 tributary (Table 11).

Table 11. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Ontario tributaries during 2021.

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Tonawanda Cr.	Crow Cr.	BNW[1]	Krotz Road culvert	Concur	Ineffective barrier

[1]Buffalo Niagara Waterkeeper

Juvenile Trapping For Control

Out-migrating juvenile sea lamprey were trapped in 8 tributaries of Lake Superior, 2 tributaries of Lake Michigan, and 7 tributaries of Lake Huron using fyke nets, hoop nets, and screw traps from September through December to mitigate for treatment deferrals or due to proximity to program headquarters (Table 12).

- Out-migrating juvenile sea lamprey that may have escaped the 2021 lampricide treatment were trapped in the Marengo and Bad rivers through a cooperative agreement with the Great Lakes Indian Fish and Wildlife Commission (GLIFWC).

Table 12. Sea lamprey catch from juvenile trapping during 2021. Catch per unit effort (CPUE) was calculated as live juvenile lamprey per net, per night.

Lake	Stream	Field Station	Traps Operated	Total Net-Nights	Juveniles	Post-mortem Juveniles	Post-mortem Larvae	CPUE
Superior	Bellevue Cr.	DFO[1]	2	72	---	---	---	0.000
Superior	Bad R.	GLIFWC[2]	2	68	---	---	---	0.000
Superior	Lower Marengo R.*	GLIFWC[2]	3	105	1	---	---	0.010
Superior	Upper Marengo R.*	GLIFWC[2]	1	41	---	44	229	0.000
Superior	Cranberry R.	KBIC[3]	4	224	13	---	---	0.058
Superior	Little Carp R.	KBIC[3]	5	200	---	---	---	0.000
Superior	Potato R.	KBIC[3]	4	184	1	---	---	0.005
Superior	Traverse R.	KBIC[3]	4	216	5	---	---	0.023
Michigan	Bills Cr.	USFWS[4]	4	232	3	---	---	0.013
Michigan	Furlong Cr. Fyke Nets	USFWS[4]	4	232	85	---	---	0.366
Michigan	Furlong Cr. Drift Nets	USGS[5]/USFWS[4]	9	252	13	---	---	0.052
Michigan	Furlong Cr. Lighted Traps	USGS[5]/USFWS[4]	2	56	3	---	---	0.054
Huron	Root R.*	DFO[1]	2	98	19	95	---	0.194
Huron	Black Mallard Cr.	USGS[5]	3	132	---	---	---	0.000
Huron	Long Lake Outlet	USGS[5]	5	50	---	---	---	0.000
Huron	Maple R.	USGS[5]	7	287	7	---	---	0.024
Huron	Munuscong R.	USGS[5]	2	92	40	---	---	0.435
Huron	Pigeon R.	USGS[5]	3	113	57	---	---	0.504
Huron	Silver Cr.	USGS[5]	3	135	---	---	---	0.000
Huron	Sturgeon R.	USGS[5]	3	129	4	---	---	0.031
	Totals		**72**	**2,918**	**251**	**139**	**229**	**0.086**

* Streams treated with lampricide in 2021**,** [1] Fisheries and Oceans Canada, [2] Great Lakes Indian Fish and Wildlife Commission, [3] Keweenaw Bay Indian Community, [4] U.S. Fish and Wildlife Service, [5] U.S. Geological Survey

Supplemental Control

Supplemental controls are tactics that supplement the two primary sea lamprey control strategies – lampricides and sea lamprey barriers - by reducing reproduction or capturing transformed sea lamprey. During 2020, the Commission initiated a long-term study to evaluate supplemental control on up to 12 streams where lampricide treatments are challenging or barriers were recently removed (Figure 4).

In 2020 and 2021, supplemental controls were deployed in four streams:

- Black Mallard River: A seasonal electric sea lamprey barrier has been operated since 2016. In 2020 and 2021, enhanced trapping of adult sea lamprey also occurred downstream of the electrical barrier. Larval recruitment has not been documented upstream of the seasonal barrier since 2017.

- Pigeon, Sturgeon, Maple Rivers (Cheboygan River Watershed): Sterile male release occurred in 2017, 2018, and 2019. The sterilization facility was not operated in 2020 due to COVID-19 travel restrictions. Sterile males were released in 2021 (~ 2,000 males). These rivers were last treated with lampricide in 2016.

    - In the Maple River, evidence of the 2020-year class upstream of the former Lake Kathleen Dam was documented; other year classes were not found.

    - In the Sturgeon River, larval sea lamprey populations remain low in 2021 with only six larvae captured in 26 surveys.

    - In the Pigeon River, multiple year-classes of larvae are present. The 2020-year class was found upstream of the former Song of the Morning impoundment. The Pigeon River is scheduled for lampricide treatment in 2022.

Baseline data prior to supplemental control deployment were collected in eight streams:

- Crews surveyed all life stages of sea lamprey in the Cranberry River, Traverse River, Bills Creek (tributary to Whitefish River), Furlong Creek (tributary to the Millecoquins River), Bellevue Creek (tributary to the Goulais River), Root River, Long Lake Outlet, and Tawas Lake Outlet (Table 13). Supplemental controls are slated to begin in these rivers in 2024 or 2025.

- A novel aspect of this work is the application of close-kin mark-recapture to characterize changes in recruitment and larval growth and survival when supplemental controls are applied. Pedigree analysis is being used to estimate the number of effective spawners and to track known-age larval family groups over multiple years as they grow, drift downstream, and die of natural or control program-induced mortality (trapping or lampricide). Detailed descriptions of sea lamprey population demographics have been hampered in the past work by an inability to reliably age large larvae and juveniles.

Figure 4. Location of streams where supplemental sea lamprey controls are likely to be tested and evaluated in an adaptive management framework. These streams regularly produce larval sea lamprey, are wadable, near cooperator field offices, and are places where larval production is difficult to control using barriers or lampricides. Furlong Creek is a tributary to the Millecoquins River. Bills Creek is a tributary to the Whitefish River. Bellevue Creek is a tributary to the Goulais River.

Table 13. Streams where habitat, larval sea lamprey, and juvenile sea lamprey were assessed during 2020 and 2021 to describe effectiveness of ongoing supplemental controls (streams in Bold) or collect baseline conditions before application of additional supplemental controls.

Lake	Stream	2020 Adult Abundance Estimate	2021 Adult Abundance Estimate	# Larval surveys 2020 & 2021	Larvae Captured	Juveniles Trapped 2020	Juveniles Trapped 2021	Last Lampricide Treatment	Next Expected Lampricide Treatment
Superior	Bellevue	NA*	< 10	32	19	NA*	0	Jul-19	Sep-24
Superior	Cranberry	22	194	15	247	2	13	Sep-18	Sep-22
Superior	Traverse	149	153	20	2100	78	5	May-21	May-24
Michigan	Furlong	NA*	40	32	22	75	101	Sep-19	May-22
Michigan	Bills	NA*	50	32	333	3	3	May-19	Apr-22
Huron	Root	NA*	NA*	30	790	NA*	19	Sep-21	Sep-25
Huron	Tawas Lake	< 10	< 10	40	283	0	0	Sep-18	Aug-22
Huron	Long Lake	310	37	28	865	0	0	Aug-21	Aug-25
Huron	**Black Mallard**	102	51	20	3	0	0	May-19	To be determined
Huron	**Sturgeon**	< 10	< 10	40	8	0	4	Aug-16	To be determined
Huron	**Pigeon**	< 10	35	70	438	1	57	Aug-16	Aug-22
Huron	**Maple**	< 10	<10	40	41	0	7	Sep-16	To be determined

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 stage 12 of development) continues to provide insight into the effectiveness of SMRT.

- In 2021, the mean embryo viability from 7 nests was 65% (Figure 5).

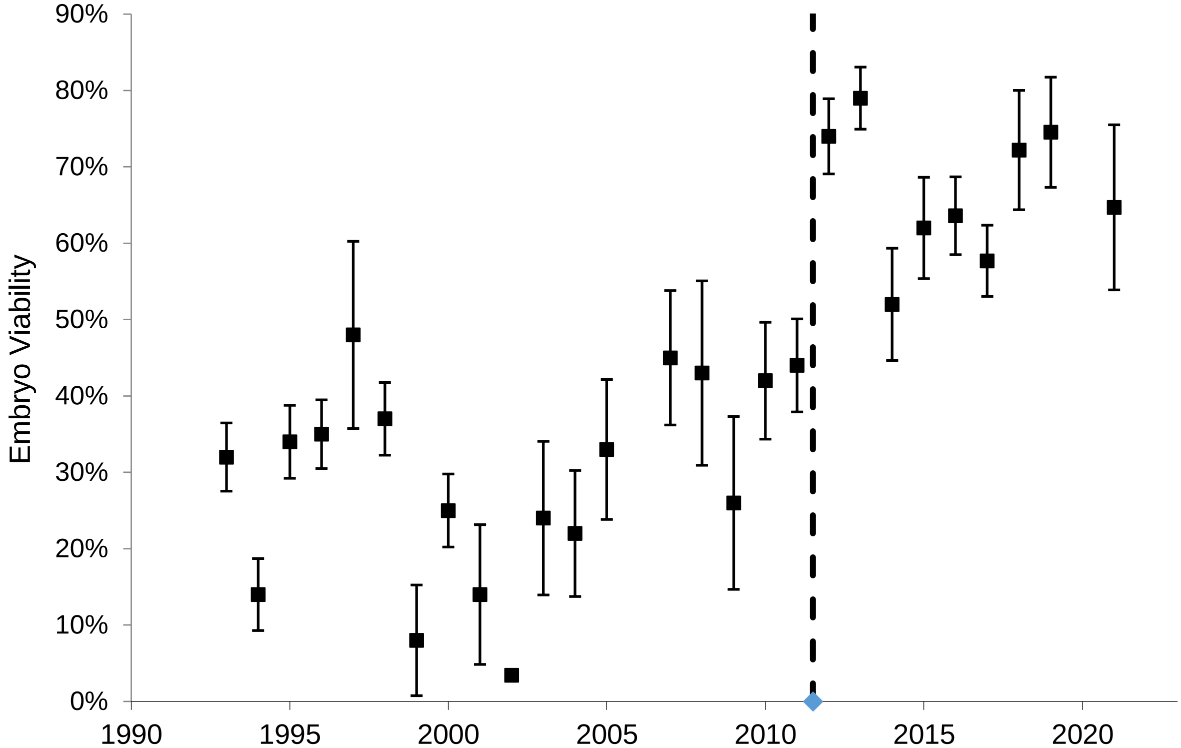

Figure 5. Mean annual embryo viability in the St. Marys River rapids during and after application of the sterile-male release technique (SMRT). The error bars represent SEs (not calculated for 2002 because only one sample was obtained). The vertical dashed line shows when SMRT application was discontinued 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 2021 are presented in the LATF and TTF sections of this report.

Larval Assessment

Tributaries considered for lampricide treatment during 2022 were assessed during 2020 and 2021 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 136 tributaries (45 Canada, 91 U.S.) and 42 lentic areas (18 Canada, 24 U.S.). The status of larval sea lamprey populations in historically infested Lake Superior tributaries and lentic areas is presented in Table 14.

- Surveys to estimate larval sea lamprey abundance were conducted in 36 tributaries (18 Canada, 18 U.S.) and 12 lentic areas (12 Canada, 0 U.S.)

- Surveys to detect the presence of new larval sea lamprey populations were conducted in 33 tributaries (18 Canada, 15 U.S.). Two new populations of larvae were discovered (0 Canada, 2 U.S.) in the Pike and Knife rivers in Minnesota.

- Post-treatment assessments were conducted in 14 tributaries (7 Canada, 7 U.S.) and 10 lentic areas (7 Canada, 3 U.S) to determine the effectiveness of lampricide treatments conducted during 2020 and 2021. Batchawana River (lentic) was re-treated in 2021, and Chippewa River and Hungarian Creek are scheduled for treatment in 2022 based on residual populations following the most recent treatment.

- Surveys to evaluate barrier effectiveness were conducted in Brule River (U.S.) and Kaministiquia River (O'Connor Creek, Canada). Both barriers were found to be effective in limiting sea lamprey infestations.

- Larval assessment surveys were conducted in non-wadable lentic and lotic areas using 78.79 kg active ingredient of 2.7% gB (30.76 kg Canada, 48.03 kg U.S.) (Table 15).

Table 14. 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	Jun-21	May -72
West Davignon Cr.	Jun-14	Jul-20	Jun-16
Little Carp R.	May-16	Jun-21	Jun-21
Big Carp R.	Sep-07	Jul-19	Aug-08
Cranberry Cr.	May-17	Jul-21	Jul-21
Goulais R.	Jun-19	Aug-21	Aug-21
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	Jun-21	Jun-21
Stokely Cr.	Jun-08	Aug-20	Sep-17
Havilland Bay	Aug-11	Jun-21	Jun-21
Tier Cr.	Never	Jul-19	Jun-61
Harmony R.	Jun-14	Oct-21	Oct-21
Batchawana Bay	Aug-14	Jul-21	Jul-21
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-21	Jul-21
Batchawana Bay	Oct-17	Aug-18	Aug-18
Unnamed (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	Sep-21	Jul-21
Digby Cr.	Jun-13	Jul-21	Jul-19
Carp R.	Aug-20	Aug-20	Jul-19
Batchawana Bay	Jul-18	Jul-19	Jul-17
Pancake R.	Jun-19	Oct-21	Oct-21
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	Aug-21	Aug-21
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	Aug-21	Aug-21
Old Woman R.	Jul-18	Aug-20	Jul-17
Michipicoten R.	Aug-16	Aug-20	Jul-19
Michipicoten R. (Lower) lentic	Aug-19	Aug-21	Aug-21
Dog R.	Aug-63	Jul-18	Jul-17
White R.	Jul-16	Jul-18	Jul-15
Pic R.	Jul-19	Aug-21	Jul-18
Nama Cr.	Jul-19	Jul-18	Jul-18

Table 14. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Little Pic R.	Jul-16	Aug-21	Aug-21
Prairie R.	Jul-19	Aug-21	Aug-21
Steel R.	Aug-19	Aug-21	Aug-21
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-21	Aug-21
Little Gravel R.	Jul-18	Aug-20	Aug-19
Mountain Bay	Aug-16	Aug-21	Aug-21
Little Cypress R.	Aug-14	Aug-20	Aug-17
Cypress Bay	Aug-16	Aug-15	Aug-15
Cypress R.	Jul-18	Aug-21	Aug-21
Cypress Bay	Jul-19	Sep-21	Aug-18
Jackpine R.	Never	Aug-21	Aug-21
Nipigon Bay	Aug-19	Sep-21	Aug-18
Nipigon Bay (Mini-Treat plot)	Sept-21	Sep-21	Sep-21
Jackfish R.	Oct-16	Aug-18	Jun-18
Nipigon Bay	Never	Aug-14	Aug-05
Nipigon R.			
Upper Nipigon R.	Aug-19	Aug-21	Aug-21
Lake Helen lentic	Aug-19	Sep-21	Sep-21
Lower Nipigon R.	Aug-06	Aug-19	Aug-19
Nipigon R (Lower) lentic	Aug-19	Sep-21	Sep-21
Cash Cr.	Oct-15	Sep-21	Sep-21
Lake Helen lentic	Sep-16	Sep-21	Sep-21
Polly Cr.	Jul-18	Aug-19	Aug-17
Polly Lake lentic	Jul-87	Aug-17	Jul-90
Stillwater Cr.	Aug-19	Sep-21	Sep-21
Nipigon Bay	Sep-18	Aug-19	Aug-19
Big Trout Cr.	Jul-18	Sep-21	Sep-21
Nipigon Bay	Oct-11	Aug-18	Aug-18
Otter Cove Cr.	Aug-19	Aug-19	Aug-19
Black Sturgeon R.	Aug-16	Aug-21	Aug-19
Black Bay	Never	Aug-21	Jul-04
Valley Cr.	Jun-72	Aug-18	Aug-71
Wolf R.	Jul-18	Aug-21	Aug-21
Black Bay	Aug-15	Aug-21	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	Sep-21	Sep-21
MacKenzie R.	Aug-16	Sep-21	Sep-21
MacKenzie Bay	Aug-19	Sep-21	Sep-21
Wild Goose Cr.	Jul-18	Aug-20	Aug-20
Current R.			
Thunder Bay	Sep-18	Sep-21	Sep-21
Neebing-McIntyre FW	Jun-17	Aug-19	Aug-19

Table 14. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Kaministiquia R.	Sep-19	Sep-21	Sep-21
Slate R.	Oct-19	Sep-21	Sep-21
Corbett Cr.	Jul-16	Sep-21	Sep-21
Whitefish R.	Aug-16	Sep-21	Sep-21
Oliver Cr.	Jul-16	Sep-21	Sep-21
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	Sep-21	Sep-21
Pigeon Bay	Aug-10	Sep-21	Sep-21
United States			
Waiska R.	Jul-07	Jul-19	Jun-18
West Branch	Jul-21	May-21	May-21
Sec. 11SW Cr.	Never	Jun-21	Jun-21
Pendills Cr.	Jul-12	May-21	May-21
Tahquamenon Bay	Never	Jul-17	Jul-12
Grants Cr.	Aug-15	Aug-21	Aug-21
Tahquamenon Bay	Jul-18	Jul-19	Jul-19
Halfaday Cr.	Jul-12	Aug-21	Aug-21
Tahquamenon Bay	Never	Jul-12	Jul-12
Mill Creek (Chippewa)	Never	Aug-21	Aug-21
Naomikong Cr.	Jul-18	Oct-21	Oct-21
Ankodosh Cr.	Aug-19	Oct-21	Jun-21
Tahquamenon Bay	Jul-18	Sep-21	Sep-21
Roxbury Cr.	Jul-17	Aug-21	Aug-21
Tahquamenon Bay	Never	Jul-19	Jul-19
Galloway Cr.	Aug-19	Aug-21	Aug-21
Tahquamenon Bay	Never	Aug-21	Aug-21
Tahquamenon R.	Aug-19	Aug-21	Aug-21
Betsy R.	Jul-17	Oct-21	Oct-21
Three Mile Cr.	Jul-18	Aug-21	Aug-21
Little Two Hearted R.	Jul-21	Jul-21	May-21
Two Hearted R.	Aug-19	Sep-20	Sep-20
Dead Sucker R.	Aug-13	Aug-21	May-19
Sucker R.	Jul-18	Jul-21	Jul-21
Grand Marais Harbor	Never	Sep-18	Sep-18
Chipmunk Cr.	Sep-62	Jun-21	Sep-61
Carpenter Cr.	Aug-15	Jun-21	Jun-21
West Bay	Aug-19	Sep-20	Sep-20
Sable Cr.	Sep-89	Jul-20	Jul-20
Hurricane R.	Never	Jun-21	Aug-08
Sullivans Cr.	Jul-19	Aug-20	Aug-20
Seven Mile Cr.	Jul-18	Jul-21	Jul-21
Beaver Lake Cr.			
Beaver Lk Outlet	Jul-18	Jul-21	Aug-17
Lowney Cr.	Jul-18	Jun-21	Jun-21
Little Beaver Cr.	Jul-18	Jul-21	Jul-21
Arsenault Cr.	Never	Aug-20	Aug-20
Beaver Lake	Never	Jun-21	Jun-21

Table 14. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Little Beaver Lake	Never	Jun-21	Jun-21
Mosquito R.	Jun-73	Sep-18	Oct-72
Miners R.			
Barrier downstream	Jul-16	Jul-19	Jun-21
Barrier upstream	Jul-13	Jun-21	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-21	Oct-21
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	Jun-21	Jun-21
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	Oct-21	Oct-21
Upper	Jul-19	Oct-21	Oct-21
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	Sep-21	Sep-21
Carp R. lentic	Jun-15	Jun-21	Jun-21
Dead R.	Jul-19	Jun-21	Jun-21
Presque Isle Harbor	Jul-19	Jun-21	Jun-21
Compeau Cr.	Never	Jul-19	Jun-12
Harlow Cr.	Sep-19	Sep-21	Sep-21
Harlow Lake – offshore Bismark Cr.	May-21	Jun-20	Jun-20
Little Garlic R.	Sep-21	Sep-21	Jul-20
Little Garlic R. lentic	Jun-12	Jul-20	Jul-20
Garlic R.	Jul-18	Sep-21	Sep-21
Garlic R. lentic	Never	Jul-12	Sep-05
Saux Head Lake	May-21	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.	May-21	May-21	Sep-19
Huron Bay	Sep-15	Jul-20	Jul-20
Slate R.	Aug-21	Aug-21	Jun-20
Huron Bay	Aug-17	Oct-21	Oct-21

Table 14. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Silver R.	Aug-21	Aug-21	Jun-19
Huron Bay	Aug-17	Sep-19	Sep-17
Falls R.	Aug-21	Aug-21	Jun-06
L'anse Bay	Jun-18	Jun-21	Jun-21
Six Mile Cr.	Sep-18	Jul-19	Jun-17
L'anse Bay	Never	Jun-18	Jun-18
Little Carp R.	May-19	Oct-21	Jun-21
Kelsey Cr.	Never	Jul-20	Aug-16
Sturgeon R.	Aug-21	Aug-21	May-21
Pilgrim R.	Aug-21	Aug-21	Sep-20
Trap Rock R.	Jul-19	Sep-21	Sep-21
Torch Lake	Jun-21	Jul-20	Sep-19
McCallum Cr.	Aug-63	Sep-21	May-94
Traverse R.	May-21	May-21	Oct-20
Little Gratiot R.	Jun-16	May-19	May-15
Eliza Cr.	Jul-19	Sep-21	Sep-21
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	Sep-21	Sep-21
Schlotz Cr.	Oct-21	Oct-21	Sep-20
Salmon Trout R. (Houghton Co.)	Jun-16	Sep-20	Sep-20
Mud Lake Outlet	Sep-18	Sep-20	Sep-20
Hungarian Cr.	Sep-20	Sep-21	Sep-21
Torch Lake	Jun-21	Sep-21	Sep-21
Graveraet R.	Sep-18	Sep-21	Sep-21
Elm R.	Aug-16	Aug-21	Aug-21
Misery R.			
Barrier downstream	Aug-18	Aug-21	Aug-21
Barrier upstream	Aug-00	Aug-18	Sep-08
East Sleeping R.	May-19	Oct-21	Oct-21
West Sleeping R.	May-19	Aug-21	Aug-21
Firesteel R.	Jun-19	Sep-20	Aug-19
Flintsteel R.	Sep-17	Aug-21	Aug-21
Ontonagon R.	Oct-19	Aug-21	Aug-21
Potato R.	Jun-21	May-21	Sep-20
Floodwood R.	Never	Jul-18	Aug-85
Cranberry R. (Ontonagon Co.)	Sep-18	Sep-21	Sep-21
Mineral R.	Sep-17	Oct-21	Oct-21
Mineral R. lentic	Never	Aug-19	Sep-11
Big Iron R.	Never	Aug-19	Jul-15
Little Iron R.	Sep-75	Oct-21	Oct-21
Union R.	May-64	Oct-20	Aug-62
Black R.	Sep-21	Sep-21	Jul-17
Black River Harbor	Sep-19	Jul-19	Jul-19
Montreal R.	Jul-75	Aug-18	Jul-10
Washington Cr.	Jun-80	Jul-12	Sep-82
Bad R.	Sep-21	Jul-21	Jun-21
Fish Cr. (Eileen Twp)	Jun-15	Jul-21	Jul-21

Table 14. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
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-21	Jul-21
Buffalo Bay	Never	Aug-11	Aug-03
Raspberry R.	May-16	Jul-19	Sep-15
Sand R. (Bayfield Co.)	Jul-16	Jul-21	Jul-21
Sand Bay	Aug-10	Jul-21	Aug-15
Cranberry R. (Bayfield Co.)	Jun-17	Jun-21	Sep-16
Iron R.			
Barrier downstream	Aug-16	Jul-21	Jul-21
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	Jun-21	Aug-19
Barrier upstream	Jun-86	Aug-18	Sep-87
Poplar R.	Jun-18	Aug-21	Jul-21
Middle R.			
Barrier downstream	Jun-21	Aug-21	Aug-21
Barrier upstream	Jun-02	Jul-17	Sep-09
Amnicon R.	Jun-21	Sep-19	Jun-19
Amnicon R. Lentic	Never	Aug-18	Aug-18
Nemadji R.	Sep-18	Aug-21	Aug-21
St. Louis R.	Sep-87	Aug-19	Aug-19
Sucker R. (St. Louis Co.)	Never	Aug-17	Sep-89
Knife R. Lentic	Never	Aug-21	Aug-21
Gooseberry R.	Aug-76	Aug-17	May-10
Splitrock R.	Aug-76	Aug-21	Aug-21
Poplar R.	Jun-18	Aug-21	Aug-21
Arrowhead R.	Jun-09	Aug-21	Aug-21

Table 15. Details on application of granular Bayluscide to tributaries and lentic areas of Lake Superior for larval assessment purposes during 2021.

Tributary	Bayluscide (kg)[1]	Area Surveyed (ha)
Canada		
Havilland Creek (Lentic)	0.71	0.15
Stokely Creek (Lentic)	0.71	0.15
Harmony River (Lentic)	0.95	0.20
Chippewa River	0.71	0.15
Batchawana River (Lentic)	1.42	0.30
Michipicoten River (Lentic)	1.42	0.30
Pic River	0.71	0.15
Little Pic River	1.42	0.30
Gravel River (Lentic)	2.13	0.45
Little Gravel River (Lentic)	0.71	0.15
Cypress River (Lentic)	0.71	0.15
Jackpine River (Lentic)	0.47	0.10
Nipigon River (Upper)	0.71	0.15
Nipigon River (Lake Helen - Lentic)	0.71	0.15
Nipigon River (Cash Creek – Lentic)	0.95	0.20
Nipigon River (Lower and Lentic)	3.78	0.80
Nipigon River (Stillwater Creek)	0.24	0.05
Black Sturgeon River	1.18	0.25
Black Sturgeon River (Lentic)	0.95	0.20
Wolf River	0.47	0.10
Wolf River (Lentic)	0.95	0.20
MacKenzie River (Lentic)	0.95	0.20
Current River (Lentic)	1.42	0.30
Kaministiquia River (Lower Lentic)	4.25	0.90
Pigeon River	0.71	0.15
Pigeon River (Lentic)	1.42	0.30
Total (Canada)	**30.76**	**6.50**
United States		
Ankodosh Creek (Lentic)	3.43	0.73
Galloway Creek (Lentic)	2.91	0.62
Tahquamenon River	1.96	0.41
Betsy River (Lentic)	0.73	0.16
Beaver Lake Creek (Lowney Creek – Lentic)	1.96	0.41
Beaver Lake Creek (Lowney Creek)	0.31	0.06
Beaver Lake Creek (Little Beaver Creek - Lentic)	1.96	0.41
Furnace Creek (Lentic)	2.45	0.52
File Mile Creek (Alger)- (Lentic)	0.25	0.05
Au Train River	0.98	0.21
Carp River (Marquette) – (Lentic)	1.55	0.31
Dead River (Lentic)	1.96	0.41
Dead River	1.47	0.31
Slate River (Lentic)	1.96	0.41
Silver River (Baraga)-(Lentic)	2.45	0.52
Falls River (Lentic)	1.47	0.31
Trap Rock River (Lentic)	0.98	0.21

Table 15. *Continued.*

Tributary	Bayluscide (kg)[1]	Area Surveyed (ha)
Eliza Creek (Lentic)	1.47	0.31
Hungarian Creek (Lentic)	1.47	0.31
Misery River (Lentic)	0.49	0.10
Misery River	0.98	0.21
East Sleeping River (Lentic)	0.49	0.10
West Sleeping River (Lentic)	0.49	0.10
Ontonagon River	1.47	0.31
Black River (Lentic)	1.96	0.41
Black River	1.47	0.31
Bad River (Marengo Lake)	1.47	0.31
Fish Creek (Eileen Twp.)	1.96	0.41
Sioux River (Lentic)	0.98	0.21
Sioux River	0.49	0.10
Iron River (Bayfield)	1.46	0.31
Nemadji River	0.64	0.14
Knife River (Lentic)	1.96	0.41
Total (United States)	**48.03**	**10.14**
Total for Lake	**78.79**	**16.64**

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

Lake Michigan

- Larval assessments were conducted in 130 tributaries and 11 lentic areas. The status of larval sea lamprey populations in historically infested Lake Michigan tributaries and lentic areas is presented in Table 16.

- Surveys to estimate larval sea lamprey abundance were conducted in six tributaries.

- Surveys to detect the presence of new larval sea lamprey populations were conducted in 59 tributaries. No new infestations were identified.

- Post-treatment assessments were conducted in 22 tributaries to determine the effectiveness of lampricide treatments conducted during 2020 and 2021. No streams were scheduled for treatment based on residual larval populations.

- Surveys to evaluate barrier effectiveness were conducted in Whitefish Bay Creek, Kalamazoo River (Swan Creek), and Cedar, Ahnapee, East Twin, Carp Lake, Boardman, Platte, and Grand rivers. All barriers were found to be effective in limiting sea lamprey infestations.

- Larval assessment surveys were conducted in 12 non-wadable lentic and lotic areas using 18.79 kg active ingredient of 2.7% gB (Table 17).

Table 16. 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	May-21	Jul-21	Jul-21
Lower	May-21	Sep-21	Aug-19
Brevort Lake	May-21	Jun-19	Jun-19
Paquin Cr.	Jun-19	Apr-21	Sep-18
Paquin Cr. Lentic	Never	Sep-18	Sep-18
Davenport Cr.	Sep-13	Aug-19	Aug-11
Hog Island Cr.	May-21	Jul-21	Aug-19
Hog Island Cr. Lentic	Jun-07	Jul-21	Jul-18
Sucker R.	Jun-61	Jul-21	Jul-21
Black R.	May-21	Sep-21	Apr-21
Black R. lentic	Jun-76	Aug-11	Aug-11
Mattix Cr.	Aug-15	Sep-21	Jun-14
Mile Cr.	May-17	Aug-20	Jun-19
Mile Cr. Lentic	Aug-68	Jun-18	Jun-08
Millecoquins R.	Jul-21	Oct-21	Jul-19
Furlong Cr.	Sep-19	Oct-21	Oct-21
Millecoquins Lake	Never	Jun-19	Jun-14
Rock R.	Jun-19	Jun-20	Jun-18
Crow R.	Jun-19	Oct-21	Jun-21
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.	Sep-21	Aug-20	Jul-19
Seiners Cr.	Aug-17	Sep-21	Sep-21
Milakokia R.	Sep-21	Aug-20	Jul-19
Seul Choix Bay	Never	Jul-19	Jul-80
Bulldog Cr.	Jun-13	Aug-21	Sep-13
Gulliver Lake Outlet	Sep-19	Sep-20	Sep-18
Marblehead Cr.	Jun-19	Jul-20	Jul-20
Manistique R.	Sep-19	Oct-21	Oct-21
Inside Breakwalls	Jun-19	Aug-21	Aug-21
Outside Breakwalls	Jul-18	Aug-21	Aug-21
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	May-21	Aug-20
Deadhorse Cr. Lentic	Never	Jul-11	Oct-64
Gierke Cr.	Never	Jul-19	Jun-04
Bursaw Cr.	Aug-17	Aug-21	Aug-21
Bursaw Cr. Lentic	Never	Jul-11	Jul-11
Parent Cr.	Aug-17	Aug-20	Aug-20
Poodle Pete Cr.	Aug-17	Aug-21	Aug-21
Valentine Cr.	May-21	Sep-21	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	Aug-21	Aug-21

Table 16. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Sturgeon R.	Jul-19	Oct-21	Oct-21
Big Bay de Noc	Never	Aug-19	Aug-15
Ogontz R.	Sep-20	Sep-21	Sep-21
Big Bay de Noc	Sep-14	Aug-17	Jul-15
M 117 Cr.	Aug-17	Jul-20	May-16
Hock Cr.	May-17	Jun-21	May-16
Whitefish R.	May-19	Oct-21	Oct-21
Haymeadow Creek	May-21	Sep-21	Sep-21
Little Bay de Noc	Jun-83	Aug-18	Jul-11
Rapid R.	Oct-20	May-21	May-21
Little Bay de Noc	May-15	Aug-18	Jul-16
Tacoosh R.	Oct-14	Jun-21	Jul-14
Days R.			
Barrier downstream	Sep-21	May-21	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	May-21	May-21
Portage Bay	Never	Aug-17	Aug-82
Ford R.	Aug-20	May-21	May-21
Green Bay	Oct-14	Jun-21	Aug-19
Sunnybrook Cr.	May-71	Oct-21	May-21
Bark R.	May-17	May-21	May-21
Green Bay	Never	Jul-16	Sep-98
Cedar R.	May-21	Oct-21	Sep-20
Green Bay	May-10	Aug-19	Jul-16
Sugar Cr.	May-21	Sep-21	Sep-21
Arthur Bay Cr.	May-21	Sep-21	Sep-21
Rochereau Cr.	Apr-63	Jul-19	Jul-62
Johnson Cr.	Apr-17	Jul-20	Jul-19
Bailey Cr.	May-19	Oct-21	Sep-21
Green Bay	Never	Aug-18	Aug-18
Beattie Cr.	May-19	May-21	May-21
Springer Cr.	May-19	Oct-21	Oct-21
Menominee R.	Jul-16	May-21	Jun-19
Green Bay	Jul-16	Aug-17	Sep-15
Little R.	Aug-77	May-21	Aug-77
Peshtigo R.	Sep-20	Sep-21	Sep-21
Oconto R.	Sep-21	Jun-21	Jun-21
Pensaukee R.	Nov-77	May-21	Sep-85
Suamico R.	Never	May-21	May-67
Ephraim Cr.	Apr-63	Jun-19	Apr-61
Hibbards Cr.	May-07	Jun-19	Oct-09
Whitefish Bay Cr.	May-16	Aug-21	Jun-15
Shivering Sands Cr.	Apr-12	Aug-21	May-14
Lily Bay Cr.	Apr-63	Aug-21	May-63
Bear Cr.	May-75	Jun-19	May-75
Door Co. 23 Cr.	May-19	Jun-19	Jun-18
Silver Cr.	Never	Aug-21	Jul-15

Table 16. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Ahnapee R.	Apr-64	Jun-18	Apr-64
Three Mile Cr.	Apr-21	Aug-21	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	Aug-21	Jun-19
Fischer Cr.	May-87	Jun-19	May-87
French Farm Cr.	Never	Oct-21	Jun-10
Carp Lake Outlet	Jun-17	Oct-21	Oct-21
Big Stone Cr.	Sep-13	Oct-21	Aug-10
Big Sucker R.	Sep-13	Oct-21	Sep-13
Wycamp Lake Outlet	Jul-17	Oct-21	Aug-16
Bear R.	Never	Sep-20	Never
Bear R. Lentic	Jun-07	Jun-19	Jun-08
Horton Cr.	Jun-17	Oct-21	Oct-21
Horton Cr. Lentic	Jun-19	Aug-21	Aug-21
Boyne R.	Aug-21	May-21	May-21
Boyne R. Lentic	Jun-17	Jun-19	Jun-14
Porter Cr.	Sep-13	Oct-21	Oct-21
Porter Cr. Lentic	Sep-13	Aug-21	Aug-21
Jordan R.	Jul-18	Oct-21	Oct-21
Jordan R. Lentic	Jul-18	Aug-21	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	Sep-21	Aug-20
Boardman R. (lower)	Aug-15	Sep-21	Jun-14
Boardman R. (middle)	Aug-15	Sep-21	Sep-14
Boardman R. Lentic	Jun-17	Sep-20	Jun-16
Hospital Cr.	Jul-18	Sep-21	Jun-17
Leo Cr.	Never	Aug-19	Jul-95
Leland River Lentic	Never	Jul-19	Jun-13
Good Harbor Cr.	Jul-10	Sep-21	Sep-09
Crystal R.	Apr-19	Sep-21	Sep-18
Platte R. (upper)	May-19	Sep-21	Sep-21
Platte R. (middle)	May-19	Sep-21	Sep-20
Loon Lk. Lentic	May-19	Sep-21	Sep-21
Platte R. (lower)	May-19	Sep-21	Sep-18
Betsie R.	May-19	Nov-21	Nov-21
Bowen Cr.	Jun-09	Aug-19	Oct-19
Big Manistee R.	Aug-20	Jul-21	Oct-19
Bear Cr.	Aug-19	Oct-21	Jul-20
L. Manistee R.	Jun-21	Nov-21	Jul-20
L. Manistee R. Lentic	Jul-11	Jul-21	Sep-05
Gurney Cr.	Jun-16	Aug-19	Jul-15
Cooper Cr.	Jul-08	Aug-19	Sep-07

Table 16. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Lincoln R.	Jul-20	Sep-20	Sep-20
Pere Marquette R.	Aug-20	Jul-21	Jul-21
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	Sep-21	Sep-21
Duck Cr.	Jul-84	Jul-19	Aug-95
Muskegon R.	Sep-19	Sep-21	Sep-21
Brooks Cr.	Sep-19	Sep-21	Sep-21
Cedar Cr.	Sep-19	Sep-21	Sep-21
Bridgeton Cr.	Sep-19	Sep-21	Sep-21
Minnie Cr.	Sep-19	Sep-21	Sep-21
Bigelow Cr.	Sep-19	Sep-21	Sep-21
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 R.	Never	Sep-21	Never
Norris Cr.	Jun-17	Jul-19	Sep-16
Lowell Cr	Sep-65	Aug-21	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	Jun-21	Sep-16
Bass R.	Aug-04	Jun-21	Sep-03
Rogue R.	Sep-09	Aug-21	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	Oct-21	May-17
Mann Cr.	Jul-16	Aug-19	Sep-15
Rabbit R.	Sep-15	Aug-19	Jul-14
Swan Cr.	Jun-21	Oct-21	Oct-21
Allegan 3 Cr.	Sep-65	Sep-19	Jun-62
Allegan 4 Cr.	Oct-78	Jul-21	Sep-19
Allegan 5 Cr.	Sep-15	Oct-21	Jul-14
Black R.			
North Branch	Jun-77	May-21	May-21
Middle Branch	Jul-21	May-21	May-21
South Branch	May-17	May-21	May-21
Brandywine Cr.	Aug-85	Jul-21	Jul-21
Rogers Cr.	May-18	Sep-19	Jun-16
St. Joseph R.	Never	Jul-19	Never
Lemon Cr.	Oct-65	Sep-19	Jun-65

Table 16. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Pipestone Cr.	May-21	Jul-21	Jul-21
Meadow Dr.	Oct-65	Oct-19	Apr-62
Hickory Cr.	May-21	Jul-21	Sep-19
Farmers Cr.	May-21	Jul-21	May-19
Paw Paw R.	Sep-21	Jul-21	Jul-21
Blue Cr.	Sep-15	Jul-21	Jun-15
Mill Cr.	Sep-21	Jul-21	Jul-21
Brandywine Cr.	Sep-17	Jul-21	Jul-17
Brush Cr.	Sep-15	Jul-21	Jun-15
Hayden Cr.	Sep-21	Jul-21	Jul-21
Campbell Cr.	Sep-18	Jul-21	Sep-18
Ritter Cr.	Sep-17	Jul-21	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.	Aug-21	Sep-19	Sep-18
Spring Cr.	Aug-21	Sep-19	May-16
S. Br. Spring Cr.	Aug-21	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	Oct-21	Oct-21
Salt Cr.	May-18	Oct-19	Jun-19

Table 17. Details on application of granular Bayluscide to tributaries and lentic areas of Lake Michigan for larval assessment purposes during 2021.

Tributary	Bayluscide (kg)[1]	Area Surveyed (ha)
Cut River (Lentic)	1.47	0.31
Hog Island Creek (Lentic)	1.47	0.31
Manistique River (Inside Breakwalls)	2.44	0.52
Manistique River (Outside Breakwalls)	2.44	0.52
Ford River (Lentic)	1.47	0.31
Peshtigo River	0.49	0.10
Horton Creek (Lentic)	1.90	0.40
Porter Creek (Lentic)	0.95	0.20
Jordan River (Lentic)	1.42	0.30
Platte River (Loon Lk. Lentic)	2.37	0.50
Manistee Lake (Lentic)	1.42	0.30
St. Joseph River (Lotic)	0.95	0.20
Total for Lake	**18.79**	**3.97**

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

Lake Huron

- Larval assessments were conducted in 124 tributaries (43 Canada, 81 U.S.) and 25 lentic areas (12 Canada, 13 U.S.)The status of larval sea lamprey populations in historically infested Lake Huron tributaries and lentic areas is presented in Table 18.

- Surveys to estimate larval sea lamprey abundance were conducted in 30 tributaries (16 Canada, 14 U.S.) and 2 lentic areas (2 Canada, 0 U.S.).

- Surveys to detect the presence of new larval sea lamprey populations were conducted in 45 tributaries (18 Canada, 27 U.S.) and 2 lentic areas (1 Canada, 1 U.S.). No new infestations were identified.

- Post-treatment assessments were conducted in 12 tributaries (5 Canada, 7 U.S.) and 2 lentic areas (1 Canada, 1 U.S.) to determine the effectiveness of lampricide treatments conducted during 2020 and 2021. No streams were scheduled for treatment based on residual larval populations.

- Surveys to evaluate barrier effectiveness were conducted in Brown's Creek (Canada), and Ocqueoc, Trout, East Augres, Cass, and Tittabawassee rivers (U.S.). Larvae were found upstream of the East Au Gres River sea lamprey barrier, and upstream of Caro Dam on the Cass River (Saginaw River tributary).

- Larval assessments were conducted in non-wadable lentic and lotic areas using 40.41 kg active ingredient of 2.7% gB (13.03 kg Canada, 27.38 kg U.S.) (Table 19).

Table 18. 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 Channel	Jun-21	Nov-19	Nov-19
Root R.	Sep-21	Jul-20	Jul-20
Garden R.	Jul-20	Aug-21	Aug-21
Maud & Driving Cr.	Jul-20	Aug-21	Jul-14
Echo R.			
Main	Jul-11	Oct-19	Oct-19
Bar & Iron Cr.	Aug-20	Oct-21	Oct-17
Echo Lake	Jun-15[1]	Sep-21	Sep-17
Solar Lake	Jul-87	Jul-06	May-90
Stuart Lake	Jul-80	May-90	May-90
Bar R.	Oct-11	Jul-21	Jul-10
Stoby-Portlock Cr.	Never	July-20	Never
Sucker Cr.	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-21	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	Jun-21	Jun-21
Browns Cr. (lentic)	Aug-87	Jul-18	Aug-91
Koshkawong R.	May-18	Jun-21	Jun-21
Koshkawong R. (lentic)	Never	Jul-17	Aug-91
No Name (H-65)	Jun-13	Jul-21	Jul-21
No Name (H-68)	Jun-19	Jun-21	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	Jul-21	Jul-21
North Channel	Jun-15	Sep-18	Sep-18
Spragge Cr.	Oct-95	May-18	Jun-98
No Name (H-114)	Jun-19	Jul-21	Jul-21
North Channel	Jun-15	Sep-18	Sep-14
Marcellus Cr.	Jun-13	May-17	Sep-11

Table 18. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Serpent R.			
Main	Jun-21	Jun-19	Jun-19
Grassy Cr.	Jun-19	Aug-20	May-18
Spanish R.			
Main	Sep-15	Jul-21	Sep-12
LaCloche Cr.	Oct-18	Jul-21	Sep-17
Birch/Beaudin Cr.	Jun-18	Sep-20	Sep-20
Aux Sables R.	Sep-15	Jul-21	Sep-20
Kagawong R.	Aug-67	Jul-21	Aug-16
Mudge Bay	Aug-87	Jun-19	Jun-15
Unnamed (H-267)	Apr-17	Sep-20	Sep-20
Silver Cr.	May-17	Jul-21	Jul-21
Sand Cr.	Jun-21	Jul-19	Jul-19
Mindemoya R.	May-17	Jul-21	Sep-20
Providence Bay	Jul-81	May-12	Jul-88
Timber Bay Cr.	Apr-17	Jul-21	Jul-21
Hughson Cr.	Sep-20	Jul-21	Jul-21
Manitou R.	Sep-20	Jul-21	Jul-21
Michael's Bay	Oct-20	Jul-21	Sep-17
Blue Jay Cr.	Sep-18	Jul-21	Jul-21
Blue Jay Cr. (lentic)	Jun-18	Jul-21	Sep-17
Kaboni Cr.	Oct-78	May-18	Jul-78
Chikanishing R.	Jun-18	Jun-21	Jun-21
French R. System			
O.V. Channel	Jun-12	Jun-19	Sep-15
Wanapitei R.	Jun-11	Jun-21	Jun-08
Key R. (Nesbit Cr.)	Sep-72	Jun-21	Aug-73
Still R.	Jul-17	Jun-21	May-16
Byng Inlet	Jun-12	Jun-21	Jun-21
Magnetawan R.	Jun-18	Jun-21	Jun-21
Naiscoot R.	May-18	Sep-20	Sep-20
Shebeshekong R.	Never	June-21	Aug-17
Boyne R.	Sep-18	June-21	May-18
Georgian Bay	Never	Aug-17	May-16
Musquash R.	Aug-13	Jun-21	Jun-21
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	Jul-21	Oct-21	O
Boyne R.	Jul-21	May-19	May-19
Bear Cr.	Jun-13	May-19	April-11
Pine R.	Jul-21	May-19	May-19
Marl Cr.	Apr-13	May-19	May-11
Pretty R.	May-72	May-18	May-72

Table 18. *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-21	May-21
Frechette Cr.	Never	Sep-21	Jul-81
Ermatinger Cr.	Never	Sep-21	Jun-12
Charlotte R.	Oct-11	Sep-21	Jun-17
Little Munuscong R.	Oct-21	Sep-21	Sep-21
Big Munuscong R.	Jun-99	Oct-21	Sep-21
Taylor Cr.	May-21	Sep-21	Sep-21
Gogomain R.	Jul-16	Sep-21	Jun-18
Carlton Cr.	Oct-18	Sep-21	Aug-19
Canoe Lake Outlet	May-70	Apr-13	May-69
Caribou Cr.	Oct-19	Jul-21	Jul-21
Caribou Cr. Lentic	May-18	Jul-21	Jul-21
Bear Lake Outlet	Sep-16	Jul-21	Jul-21
Carr Cr.	Jun-13	May-21	Jun-15
Joe Straw Cr.	Jun-13	May-21	May-21
Saddle Cr.	Never	Jul-21	May-02
Huron Point Cr.	May-18	Jul-21	Jul-21
Albany Cr.			
Barrier downstream	May-21	Jul-21	Jul-21
Barrier upstream	Sep-01	Aug-15	May-03
Albany Bay	May-18	Jul-21	Jul-21
Trout Cr.	Jul-15	May-21	Aug-19
Trout Cr. Lentic	Never	Jul-14	Jul-11
Beavertail Cr.	Jul-18	Jul-21	Jul-21
Prentiss Cr.	Oct-19	Sep-21	Sep-21
McKay Cr.	May-21	Jul-21	Apr-21
McKay Bay	Never	Sep-18	Jul-11
Flowers Cr.	Jun-13	May-21	May-11
Flowers Bay	Never	Jun-12	Jul-80
Ceville Cr.	Jul-16	May-21	Jul-15
Hessel Cr.	Sep-21	Aug-19	Aug-19
Steeles Cr.	Sep-21	Aug-19	Aug-19
Nunns Cr.			
Barrier downstream	Jul-16	May-21	May-14
Barrier upstream	Jul-16	May-19	Jun-15
St. Martin Bay	Never	Aug-14	Aug-87
Pine R.	Oct-21	Sep-21	May-21
St. Martin Bay	Sep-16	Jul-21	Jul-17
McCloud Cr.	Jul-15	May-21	May-17

Table 18. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
St. Martin Bay	Never	Aug-15	Aug-15
Carp R.	Jul-21	May-21	May-21
St. Martin Bay	Jul-18	Jul-21	Aug-19
Martineau Cr.	Jul-16	May-21	May-17
Horseshoe Bay	Never	Aug-19	Sep-14
Hoban Cr.	Jun-12	Jul-21	May-11
266-20 Cr.	Aug-76	Jun-18	Sep-94
Beaugrand Cr.	Jun-16	Jun-18	Jul-15
Little Black R.	Oct-21	May-14	May-07
Cheboygan R.	Oct-83	May-21	May-21
Cheboygan R. lentic	Never	Jun-19	Aug-93
Laperell Cr.	May-00	May-21	May-21
Meyers Cr.	Jul-17	Sep-21	Sep-21
Maple R.	Aug-16	Aug-21	Aug-21
Pigeon R.	Sep-16	Oct-21	Oct-21
Little Pigeon R.	Aug-12	Sep-19	Jun-10
Sturgeon R.	Aug-16	Sep-21	Aug-19
Sturgeon R. lentic	Jun-19	Aug-19	Aug-18
Elliot Cr.	Oct-21	Aug-19	Aug-19
Duncan Bay	Never	Aug-16	Jul-12
Greene Cr.			
Barrier downstream	Jul-12	Aug-21	Aug-21
Barrier upstream	Jun-07	Aug-21	Jun-13
Grass Cr.	May-78	May-21	May-21
Mulligan Cr.	Jun-16	May-21	Jun-18
Mulligan Cr. lentic	Never	Aug-21	Aug-16
Grace Cr.	Oct-18	May-21	May-19
Black Mallard Cr. (Lower)	Jun-18	Aug-21	Jul-19
Black Mallard Lake	Never	Jul-12	Jun-10
(Upper)	May-15	Aug-21	Aug-21
Seventeen Cr.	Jul-12	May-21	Jul-12
Ocqueoc R.			
Hammond Bay lentic	Never	Aug-21	Aug-21
Barrier upstream	Sep-18	Aug-21	Jun-19
Barrier downstream	Jul-16	Aug-21	Aug-21
Johnny Cr.	Sep-70	May-21	Jun-19
Hammond Bay Cr. lentic	Never	Sep-17	Sep-17
Schmidt Cr.			
Lower	Sep-21	Jul-21	Jul-21
Upper	May-08	Jul-21	May-08
Nagels Cr.	Never	Jul-21	Jun-09
Trout R.			
Barrier downstream	Oct-21	Sep-21	Sep-21
Barrier upstream	Oct-07	May-21	Jun-07
Swan R.	Jun-10	Sep-21	Sep-21
Grand Lake Outlet	Never	Jul-21	May-03
Middle Lake Outlet	Jun-67	Jul-21	Aug-66
Long Lake Outlet	Aug-21	Jul-21	Jul-21

Table 18. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Cranberry Cr.	Jun-13	Sep-21	Oct-11
Devils R.	Oct-14	Sep-21	Aug-13
Thunder Bay	Never	Jun-21	Aug-76
Black R.	Jun-18	Sep-21	Sep-21
Mill Cr.	Never	Sep-21	May-98
Au Sable R.	Aug-18	Sep-21	Sep-21
Au Sable. R lentic	Aug-15	Sep-21	Sep-14
Pine R.	May-87	Sep-19	Sep-94
Tawas Lake Outlet	Jun-15	Jul-21	Jun-14
Cold Cr.	Aug-18	Jul-21	May-17
Sims Cr.	Jul-09	Jul-21	Aug-08
Grays Cr.	Sep-05	Jul-21	Jul-04
Silver Cr.	Sep-18	Jul-21	Jul-21
East AuGres R.	May-21	Oct-21	Oct-21
East AuGres R. lentic	Never	Aug-15	Jun-86
AuGres R.	Sep-18	Jul-21	Jun-19
Rifle R.	Aug-21	Oct-21	Oct-21
Saginaw R.			
Shiawassee R.	May-21	Jun-19	Jun-19
Cass R.	Jun-18	Sep-21	Sep-21
Flint R.	Never	Jul-19	Jul-14
Armstrong Cr.	May-15	Sep-21	Jul-14
Tittabawassee R.	Jun-18	Aug-21	Sep-19
Sanford Dam upstream	Never	Sep-21	Sep-21
Chippewa R.	Jun-21	Aug-21	Aug-21
Chippewa gravel pits	Jun-21	Jun-21	Jun-21
Pine R.	May-19	Aug-21	Aug-21
Carroll Cr.	May-17	Jun-21	Jun-21
Big Salt R.	Jun-18	Oct-21	Oct-21
Rock Falls Cr.	Never	Jun-19	Jun-69
Cherry Cr.	Never	Jun-16	Jul-77
Mill Cr.	May-85	Jun-19	Jun-12

Table 19. Details on application of granular Bayluscide to tributaries and lentic areas of Lake Huron for larval assessment purposes during 2021.

Tributary	Bayluscide(kg)[1]	Area Surveyed (ha)
<u>Canada</u>		
Echo Lake	0.71	0.15
Spanish River	1.42	0.30
Spanish River (Lentic)	0.95	0.20
Whitefish River	0.71	0.15
Little Current (Lentic)	0.95	0.20
Manitou River (Lentic)	0.95	0.20
Blue Jay Creek (Lentic)	0.95	0.20
French River (Wanapitei River)	1.42	0.30
Key River (Main + Lentic)	0.47	0.10
Still River	0.71	0.15
Still River (Lentic)	0.71	0.15
Magnetawan River (Lentic)	1.42	0.30
Musquash River	0.95	0.20
Nottawasaga River	0.71	0.15
Total (Canada)	**13.03**	**2.75**
<u>United States</u>		
Munuscong R.	2.20	0.46
Gogomain R.	0.86	0.18
Caribou Creek (Lentic)	1.96	0.41
Bear Lake Outlet (Lentic)	1.47	0.31
Huron Point Creek (Lentic)	1.47	0.31
Albany Creek (Lentic)	1.96	0.41
Prentiss Creek (Lentic)	1.47	0.31
Pine River (Lentic)	1.96	0.41
Carp River (Lentic)	1.47	0.31
Cheboygan River (Below Locks)	1.19	0.25
Cheboygan River (Mullet Lake – Pigeon River Lentic)	0.95	0.20
Mulligan Creek (Lentic)	0.47	0.10
Black Mallard Creek (Lentic)	0.24	0.05
Ocqueoc River (Lentic)	1.19	0.25
Ocqueoc River (Ocqueoc Lake Inlet)	0.47	0.10
Long Lake Creek (Devils Lake Inlet)	0.95	0.20
Thunder Bay River (Lentic)	1.42	0.30
Thunder Bay River (Lotic)	0.95	0.20
Devils River (Lentic)	1.42	0.30
Au Sable River (Lentic)	0.47	0.10
Saginaw River (Chippewa River Gravel Pits)	2.84	0.60
Total (United States)	**27.38**	**5.76**
Total for Lake	**40.41**	**8.51**

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

Lake Erie

- Larval assessments were conducted in 31 tributaries (12 Canada, 19 U.S.). The status of larval sea lamprey in historically infested Lake Erie tributaries and lentic areas is presented in Table 20.

- No surveys to estimate larval sea lamprey abundance were conducted.

- Surveys to detect the presence of new larval sea lamprey populations were conducted in 8 tributaries (6 Canada, 2 U.S.). No new sea lamprey infestations were detected.

- Surveys to evaluate barrier effectiveness were conducted in Big Creek, Normandale Creek, and Grand River (Canada), and Buffalo, Chagrin, Huron, and Clinton rivers (U.S.). All barriers were found to be effective in limiting sea lamprey infestations.

- Larval assessment surveys were conducted in non-wadable lotic areas including the St. Clair and Detroit rivers using 3.8 kg active ingredient of 2.7% gB (0 kg Canada, 3.8 U.S.;Table 21).

Table 20. 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	Jul-21	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	Jul-21	May -19
Forestville Cr.	Aug-13	May-19	Jun-13
Normandale Cr.	Jun-87	Jul-21	Apr-08
Fishers Cr.	Jun-87	May-19	May-04
Young's Cr.	Aug-13	Aug-21	Jul-12
Ussher's Cr.	Never	Jul-21	Jun-17
United States			
Buffalo R.			
Buffalo Cr.	Apr-19	Jul-21	Jul-18
Cayuga Cr.	Apr-19	Jul-21	Jul-18
Cazenovia Cr.	Apr-19	Jul-21	Jul-18
Big Sister Cr.	Apr-15	Jul-21	Jun-14
Delaware Cr.	Jun-13	Jul-21	Jul-12
Cattaraugus Cr.	Apr-19	Jul-21	Jul-21
Lentic Lake Erie	Never	Jul-17	Aug-12
Halfway Br.	Oct-86	Jul-21	Jul-85
Canadaway Cr.	May-16	Jul-21	May-16
Chautauqua Cr.	Never	Jul-21	Jul-12
Crooked Cr.	Apr-19	Jul-21	Jun-18
Raccoon Cr.	May-15	Jul-21	Jul-21
Conneaut Cr.	Apr-19	Jul-21	Jul-21

Table 20. *Continued.*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
Conneaut Harbour	Never	Sep-19	Jul-16
Wheeler Cr.	Never	Jul-19	Oct-87
Grand R.	Apr-17	Sep-21	Sep-21
Fairport Harbour	Never	Sep-19	Jun-87
Chagrin R.	Never	Sep-21	Sep-21
Huron R.	May-18	Sep-21	May-18
Lake St. Clair			
St. Clair R.	Never	Jun-21	Jun-21
Black R.	Never	Sep-21	Jul-07
Pine R.	Apr-88	Sep-19	Jun-16
Belle R.	Never	May-21	May-96
Clinton R.	Never	May-21	May-17
Paint Cr.	May-15	May-21	May-14
Thames R.	Never	May-16	Never
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

Table 21. Details on application of granular Bayluscide to tributaries and lentic areas of Lake Erie for larval assessment purposes during 2021.

Tributary	Bayluscide(kg)[1]	Area Surveyed (ha)
Canada		
No granular Bayluscide used during 2021		
United States		
St. Clair River	1.42	0.3
Detroit River	2.38	0.5
Total (United States)		
Total for Lake	**3.8**	**0.8**

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

Lake Ontario

- Larval assessments were conducted in 58 tributaries (43 Canada, 15 U.S.). The status of larval sea lamprey in historically infested Lake Ontario tributaries and lentic areas is presented in Table 22.

- Surveys to estimate larval sea lamprey abundance were conducted in 17 tributaries (12 Canada, 5 U.S.)

- Surveys to detect new larval sea lamprey populations were conducted in 23 Canadian tributaries. No new sea lamprey infestations were identified.

- Surveys to evaluate barrier effectiveness were conducted in Cobourg Brook and Bronte Creek (Canada) and Salmon River (Spring Brook) and Oswego River (Scriba Creek; U.S.). Due to high spring lake levels in recent years, a purpose-built barrier on Shelter Valley Creek was inundated and adult sea lamprey were able to spawn further upstream. Shelter Valley Creek was treated in October 2021.

- Larval assessment surveys were conducted in non-wadable lentic areas in Canada using 2.13 kg active ingredient of 2.7% gB (Table 23).

Table 22. 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	Jul-21	Jun-14
Bronte Cr.	Jun-19	Oct-21	Oct-21
Sixteen Mile Cr.	Jun-82	-Jul-21	May-05
Credit R.	May-18	Oct-21	Oct-21
Humber R.	Never	Aug-21	Never
Rouge R.	Jun-11	Jul-21	Jun-19
Little Rouge. R.	Jun-15	Jul-21	Aug-14
Petticoat Cr.	Sep-04	Jul-21	Jun-16
Duffins Cr.	Jun-18	Jul-19	Jul-19
Duffins Cr. - lentic	Never	Aug-15	Aug-15
Carruthers Cr.	Sep-76	Jul-21	Jul-78
Lynde Cr.	Jun-15	Oct-21	Oct-21
Oshawa Cr.	Jun-18	Jun-19	Jun-19
Oshawa Cr. - lentic	Never	Jul-13	Oct-81
Farewell Cr.	Jun-15	Aug-21	Aug-21
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-21	Jul-21
Wesleyville Cr.	Oct-02	Jun-21	May-04
Port Britain Cr.	Apr-19	Jun-21	Jun-21
Gage Cr.	May-71	Jul-19	Apr-71
Cobourg Br.	Oct-96	Jun-21	Jul-18
Covert Cr.	May-19	Jun-21	Jun-21
Grafton Cr.	Jun-17	Ju1-19	Jun-16
Shelter Valley Cr.	Apr-16	Sept-21	Sept-21
Colborne Cr.	Apr-19	Jun-21	Jun-21
Salem Cr.	Apr-18	Jul-19	Jul-19
Proctor Cr.	Apr-18	Aug-21	Aug-21
Smithfield Cr.	Sep-86	Jul-19	May-86
Trent R. (Canal)	Sep-11	Sep-21	Sep-21
Mayhew Cr.	May-19	Jun-21	Jun-21
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

Table 22. *Continued*

Tributary	Last Treated	Last Surveyed	Last Survey Showing Infestation
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-21	Aug-21
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-21	Jun-04
Big Bay Cr.	Sep-93	Aug-21	Aug-94
Scriba Cr.	May-19	Aug-21	Aug-21
Fish Cr.	Aug-19	Aug-21	Aug-21
Carpenter Br.	May-94	Aug-21	Apr-94
Putnam Br.			
Coldsprings Cr.	May-96	Aug-21	Apr-05
Hall Br.	Never	Aug-21	Aug-77
Crane Br.	Never	Aug-21	Jun-81
Owasco Outlet	Jun-19	Jul-19	Jul-18
Rice Cr.	May-72	Aug-18	Jun-70
Eight Mile Cr.	Apr-18	Aug-21	Aug-21
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	Aug-21	Aug-17
Wolcott Cr.	May-79	Aug-19	Aug-78
Sodus Cr.	Apr-15	Aug-21	Aug-19
Forest Lawn Cr.	Never	Aug-21	Aug-21
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
Sandy Cr.	Apr-14	Aug-19	Aug-14
Oak Orchard Cr.			
Marsh Cr.	Apr-14	Aug-21	Aug-14
Johnson Cr.	Apr-10	Jul-18	Jun-09
Third Cr.	May-72	Aug-21	Sep-72
First Cr.	May-95	Jul-18	Sep-94

Table 23. Details on application of granular Bayluscide to tributaries and lentic areas of Lake Ontario for larval assessment purposes during 2021.

Tributary	Bayluscide(kg)[1]	Area Surveyed (ha)
Canada		
Humber R.	0.71	0.15
Trent R.	1.42	0.3
Total (Canada)		
United States		
No granular Bayluscide used during 2021		
Total for Lake	**2.13**	**0.45**

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

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, GLIFWC, Chippewa-Ottawa Resource Authority (CORA), Keweenaw Bay Indian Community (KBIC), Grand Portage Band of Lake Superior Chippewa Indians, and the Ontario Ministry of Northern Development, Mines, Natural Resources, and Forestry (NDMNRF), and analyzed by the Service's GBFWCO. Due to COVID-19 travel restrictions, lake trout marking data was not collected in 2020. Spring assessment data from 2021 is currently being analyzed.

- The MIDNR provided data on the frequency of juvenile sea lamprey attached to fishes caught by sport charter fishers.

    - 107 juvenile Sea Lamprey were collected from 8 management districts: all were attached to Lake Trout. Attachment rates during 2021 were 2.2 per 100 Lake Trout (n=4,871) and 0 per 100 Chinook Salmon (n=46), which was greater than the 0.7 attachment rate on Lake Trout and equal to the attachment rate for Chinook Salmon during 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).

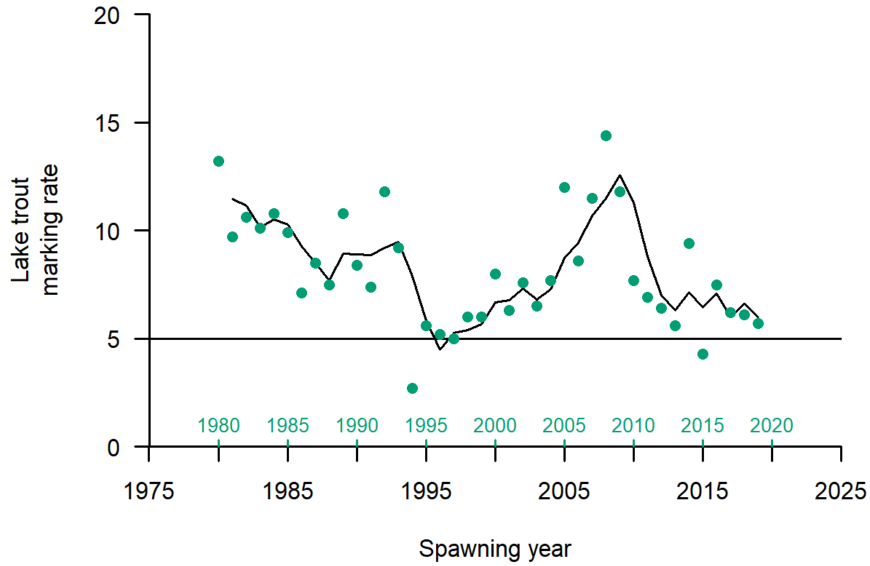

Figure 6. Number of A1-A3 marks per 100 lake trout > 532 mm from standardized assessments on Lake Superior plotted against the sea lamprey spawning year, including the three-year moving average (line). The three-year (2017-2019) average marking rate of 6.0 was above the target of five A1-A3 marks per 100 lake trout > 532 mm (horizontal line). A second x-axis shows the year the lake trout were sampled.

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.

- The MIDNR and WIDNR provided data on the frequency of juvenile Sea Lamprey attached to fish caught by sport charter fishers.

    - 403 juvenile Sea Lamprey were collected from 14 management districts: 206 were attached to Lake Trout and 197 were attached to Chinook Salmon. Attachment rates during 2021 were 0.27 per 100 Lake Trout (n=75,287) and 0.33 per 100 Chinook Salmon (n=59,215), which was greater than the attachment rate on Lake Trout and Chinook Salmon during 2020 (0.18 and 0.30 respectively).

- Based on standardized fall assessment data, the marking rate during 2019 was 2.3 A1-A3 marks per 100 lake trout >532mm, which is less than the target of five marks per 100 fish (Figure 7). Fall assessment data from 2021 is currently being analyzed.

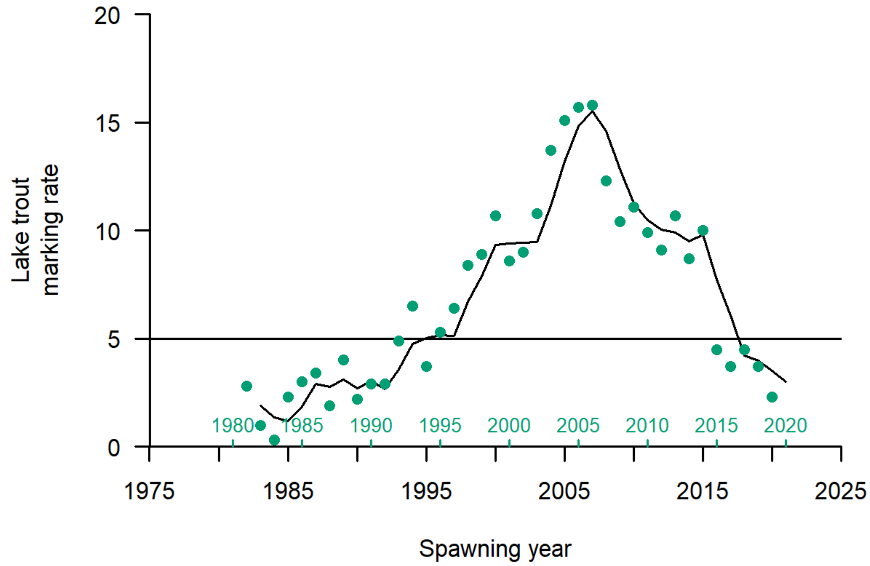

Figure 7. Number of A1-A3 marks per 100 lake trout > 532 mm from standardized assessments on Lake Michigan during August-November plotted against the sea lamprey spawning year, including the three-year moving average (line). The three-year (2017-2019) average marking rate of 3.5 met the target of five A1-A3 marks per 100 lake trout > 532 mm (horizontal line). A second x-axis shows the year the lake trout were sampled.

Lake Huron

- Lake trout marking data for Lake Huron are provided by the MIDNR, CORA, USGS, and NDMNRF. The data is analyzed by the Service's GBFWCO. Due to COVID-19 travel restrictions, lake trout marking data was not collected in 2020. Spring assessment data from 2021 is currently being analyzed.

- The MIDNR provided data on the frequency of juvenile Sea Lamprey attached to fishes caught by sport charter fishers.

323 juvenile Sea Lamprey were collected from 6 management districts: 315 were attached to Lake Trout and 8 were attached to Chinook Salmon. Attachment rates during 2021 were 3 per 100 Lake Trout (n=10,351) and 2.5 per 100 Chinook Salmon (n=316). The 2021 attachment rates on Lake Trout were greater than the 2020 rates of 1.6 per 100 Lake Trout and fewer on Chinook Salmon (7.4 per 100 Chinook Salmon).

- 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).

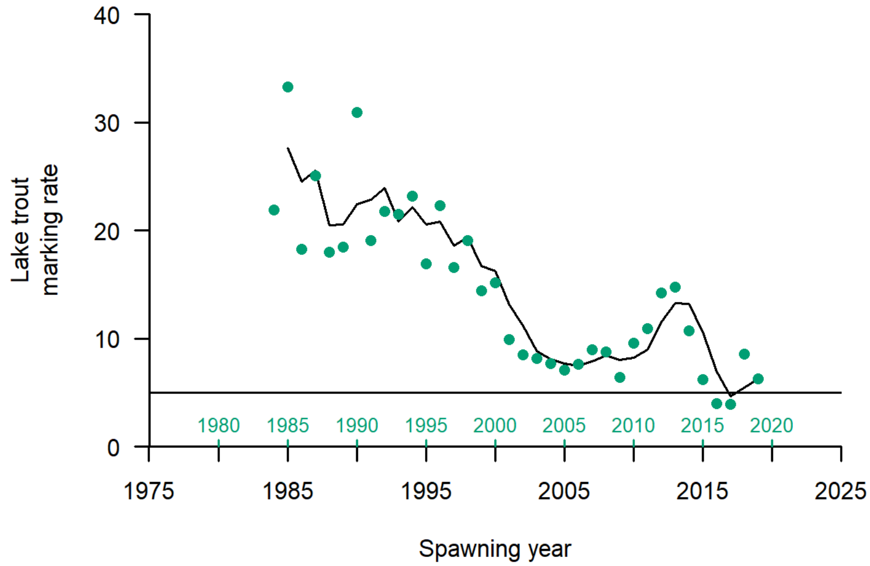

Figure 8. Number of A1-A3 marks per 100 lake trout > 532 mm from standardized assessments on Lake Huron plotted against the sea lamprey spawning year, including the three-year moving average (line). The three-year (2017-2019) average marking rate of 6.3 was above the target of five A1-A3 marks per 100 lake trout > 532 mm (horizontal line). A second x-axis shows the year the lake trout were sampled.

- Canadian commercial fisheries in northern Lake Huron continued to provide parasitic juvenile sea lamprey in 2021, 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 NDMNRF, is used as an index of juvenile sea lamprey abundance in northern Lake Huron. The effort data from 2021 has yet to be analyzed (Figure 9).

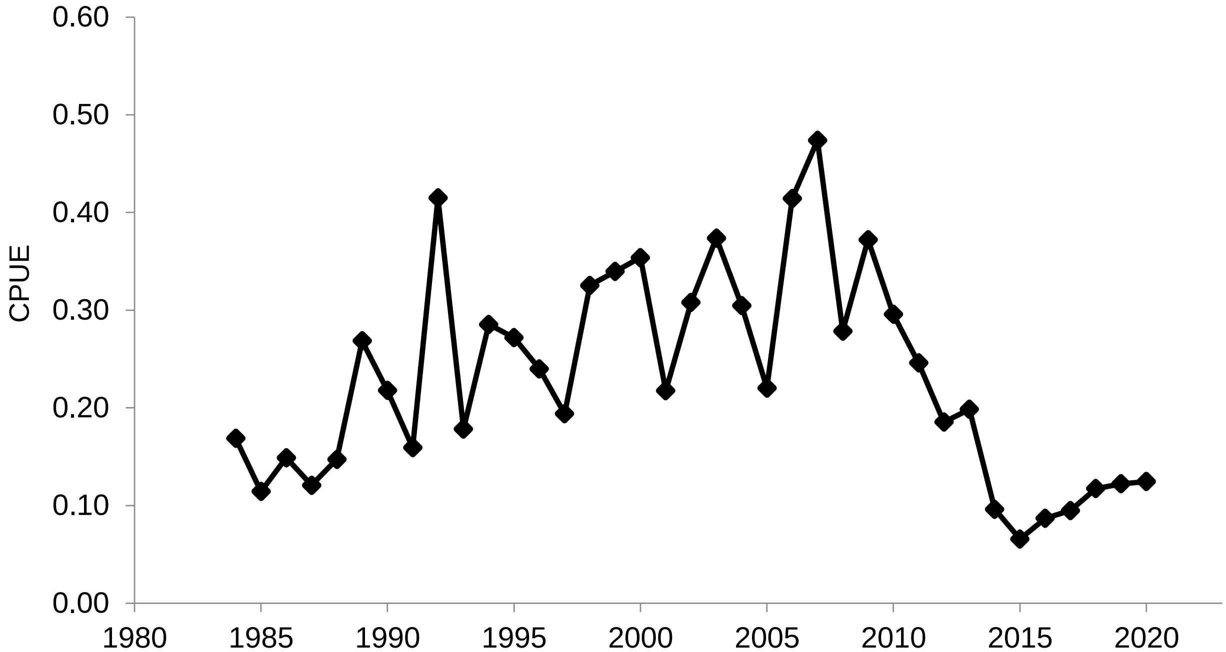

Figure 9. Northern Lake Huron commercial fisheries index showing CPUE (number of parasitic juvenile sea lamprey per km of gillnet per night) for 1984-2020.

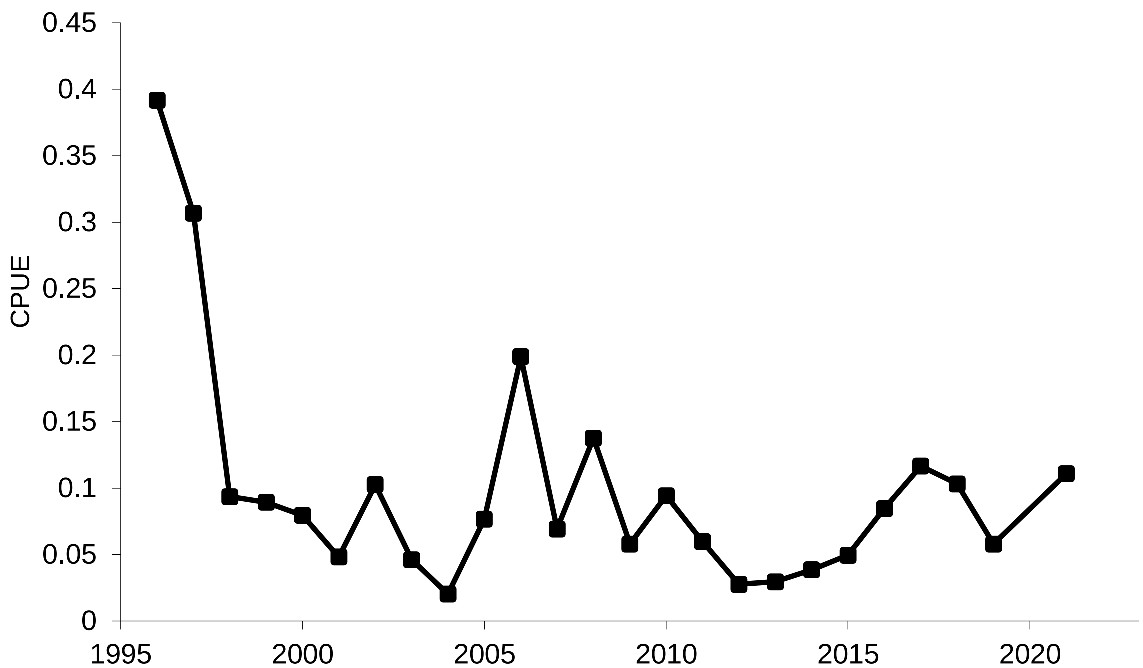

Figure 10. CPUE (number of out-migrating juvenile sea lamprey per net day) of fall fyke netting in the St. Marys River during 1996-2021.

- 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. Thirty eight out-migrating juveniles were caught during 2021. The CPUE value for 2021 was the highest it's been since 2017 (Figure 10).

Lake Erie

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

- Based on standardized fall assessment data, the marking rate during 2020 was 11.1 A1-A3 marks per 100 lake trout >532 mm. The marking rate has been greater than the target for the last 16 years. Fall assessment data from 2021 is currently being analyzed. (Figure 11).

- Out-migrating juvenile sampling in the St. Clair River did not occur during 2021 due to COVID restrictions.

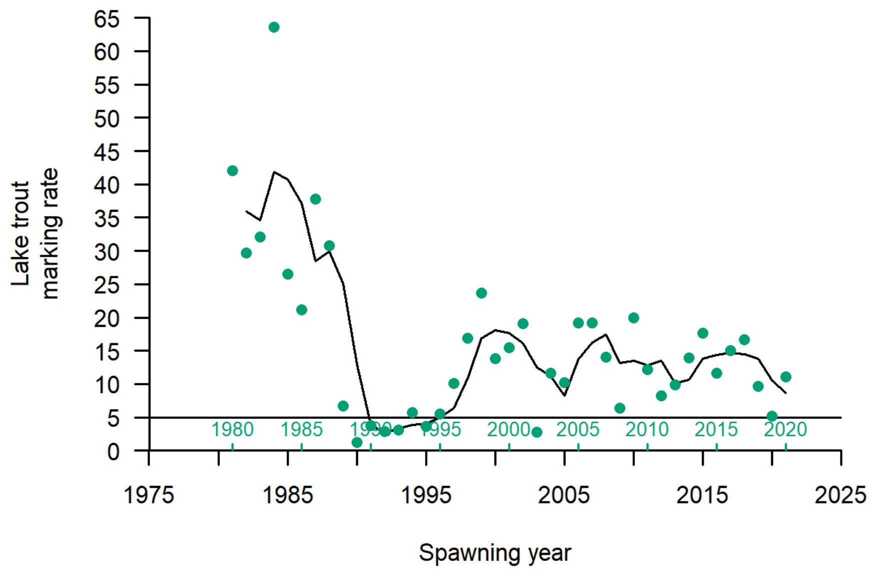

Figure 11. Number of A1-A3 marks per 100 lake trout > 532 mm from standardized assessments on Lake Erie plotted against the sea lamprey spawning year, including the three-year moving average (line). The three-year average marking rate of 8.7 was above the target of five A1-A3 marks per 100 lake trout > 532 mm (horizontal line). A second x-axis shows the year the lake trout were sampled.

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.

- NYSDEC provided data on the frequency of juvenile Sea Lamprey attached to fish caught by sport charter fishers during April 15 – September 30, 2021.

    - 2,982 juvenile Sea Lampreys were observed by anglers. Sea Lampreys were attached to Chinook Salmon (72.4%), Rainbow Trout (4.3%), Brown Trout (15.5%), and Lake Trout (5.2%). Attachment rates were 1.96 per 100 trout and salmon in the west region, 1.19 in the west central region, 3.89 in the east central region, and 1.14 in the east region. In comparison to 2019, attachment rates were greater in all regions except the west central region (0.99, 1.48, 1.14 and 1.07 respectively). Data was not available for 2020 because of restrictions due to the COVID-19 pandemic.

- Based on standardized fall assessment data, the marking rate during 2020 was 2.2 A1 marks per 100 lake trout >431 mm which is greater than the target of 2 A1 marks per 100 lake trout target. Fall assessment data from 2021 is currently being analyzed. (Figure 12).

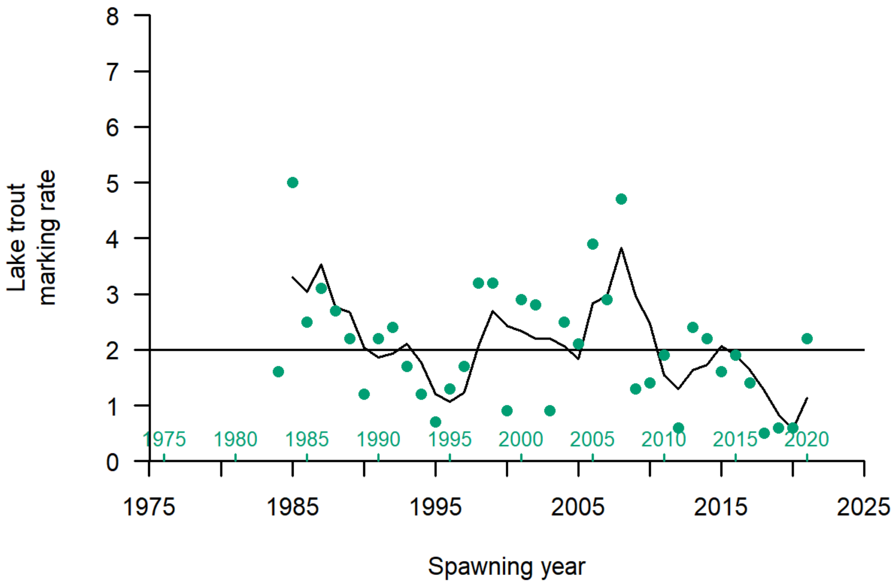

Figure 12. Number of A1 marks per 100 lake trout > 431 mm from standardized assessments on Lake Ontario plotted against the sea lamprey spawning year, including the three-year moving average (line). The three-year average marking rate of 1.1 met the target of two A1 marks per 100 lake trout > 431 mm (horizontal line). A second x-axis shows the year the lake trout were surveyed.

Adult Assessment

Traps to intercept adult sea lamprey during the spawning migration are operated throughout the Great Lakes basin (Figure 13), to remove sea lamprey from rivers, facilitate passage of native fish, and generate mark-recapture estimates of sea lamprey spawning run abundance. An annual lake-wide index of adult sea lamprey abundance is derived by summing individual abundance estimates from traps operated in a specific suite of streams (index streams) during spring and early summer. Stream-specific abundance estimates are derived using Petersen mark-recapture methods. In the absence of a stream-specific estimate due to an insufficient number of marked or recaptured sea lamprey, abundance for that stream and year 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.

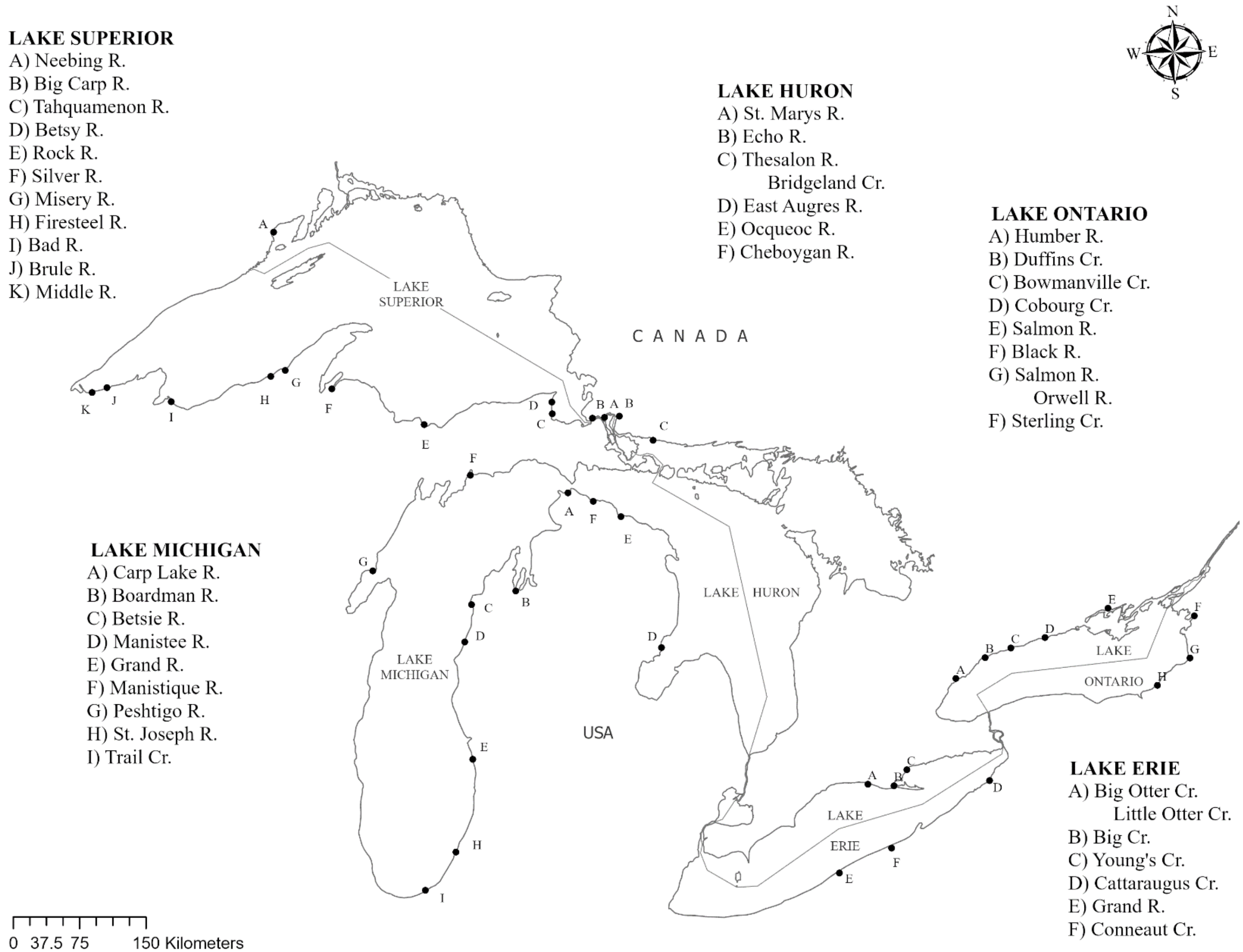

Figure 13. Locations of tributaries where assessment traps were operated during 2021.

Lake Superior

- 2,933 sea lamprey were captured in 11 tributaries during 2021 (Table 24, Figure 13), 7 of which were index locations. Adult population estimates based on mark-recapture were obtained from 6 of the 7 index streams. The Neebing River population estimate was modeled due to insufficient recaptures of marked sea lamprey.

- The index of adult sea lamprey abundance was 27,173 *(95% CI; 23,920 – 30,427)*, which was higher than the target of 10,421 (Figure 14).

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

- A barrier integrated permanent trap is expected to replace the portable traps on the Neebing River for the 2023 trapping season to improve trapping efficiency.

Table 24. Information regarding adult sea lamprey captured in assessment traps or nets in tributaries of Lake Superior during 2021 (letter in parentheses corresponds to streams in Figure 13).

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.[4] (A)	6	---	---	1	0	---	423	---	174
Big Carp R. [3] (B)	1	---	---	1	0	---	499	---	267
Total or Mean (Canada)	**7**	---	---	**2**	**0**	---	**461**	---	**221**
United States									
Bad R. (C)	719	11,725	6	10	40	423	438	211	201
Betsy R. (D)	193	1,178	16	28	46	433	446	200	223
Rock R. (E)	205	285	72	78	37	416	417	158	174
Silver R.[3] (F)	0	---	---	---	---	---	---	---	---
Misery R. [3] (G)	31	56	52	15	40	410	429	176	200
Firesteel R. [3] (H)	49	307	12	6	17	447	495	210	273
Brule R. (J)	1,033	8,593	12	21	43	421	443	222	234
Middle R. (K)	54	270	17	7	100	437	---	240	---
Taquamenon R.	642	4,971	13	38	66	453	464	220	228
Total or Mean (U.S.)	**2,926**	---		**246**	**47**	**432**	**437**	**200**	**205**
Total or Mean (for lake)	**2,933**	---	---	**246**	**47**	**432**	**437**	**200**	**205**

[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, [4] Not used for the lake-wide index

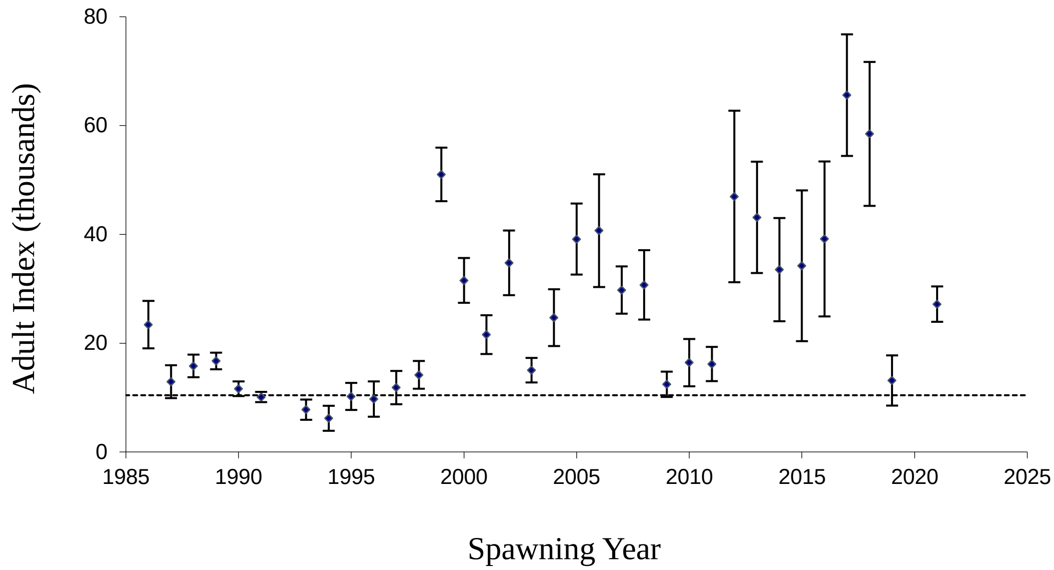

Figure 14. Index estimates with 95% confidence intervals of adult sea lampreys in Lake Superior. The target of 10,421 is represented by the dotted horizontal line. The index target was estimated as the mean of indices during a period with acceptable marking rates (1994-1998).

Lake Michigan

- 6,964 sea lampreys were captured in 9 tributaries during 2021 (Table 25, Figure 13), 6 of which were index locations. Adult population estimates based on mark-recapture data were obtained from 5 of 6 index streams. Recapture of marked lamprey in the St. Joseph River were too low to calculate a mark/recapture estimate. The population estimate for this stream was modeled to generate the lake-wide estimates.

- The index of adult sea lamprey abundance was 15,507 *(95% CI; 14,621 – 16,394)*, which was lower than the target of 34,982 (Figure 15)

- Adult assessment traps and fyke nets set on the Grand River captured 61 sea lamprey resulting in a stream-wide population estimate of 721 lamprey. All lamprey were captured at the 6th Street Dam trap location.

- 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.

Table 25. Information regarding adult sea lamprey captured in assessment traps or nets in tributaries of Lake Michigan during 2021 (letter in parentheses corresponds to stream in Figure 13).

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
Carp Lake Outlet (A)	914	1,167	78	82	52	476	466	232	233
Boardman R. [3] (B)	66	---	29	18	50	397	353	347	420
Betsie R. (C)	314	769	40	28	57	484	495	264	286
Big Manistee R. (D)	193	2,880	6	12	83	493	475	279	229
Grand R.(E)[3]	61	721	7	4	75	527	493	330	283
Manistique R.(F)	3,688	7,701	48	168	47	502	490	271	272
Peshtigo R. (G)	1,535	2,213	69	115	47	500	498	271	277
St. Joseph R.[4] (H)	43	---	4	1	100	473	---	240	---
Trail Cr. [3] (I)	150	---	---	0	---	---	---	---	---
Total or Mean (for lake)	**6,964**	**---**	**---**	**428**	**50**	**490**	**482**	**267**	**273**

[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, [4] Not used for the lake-wide index

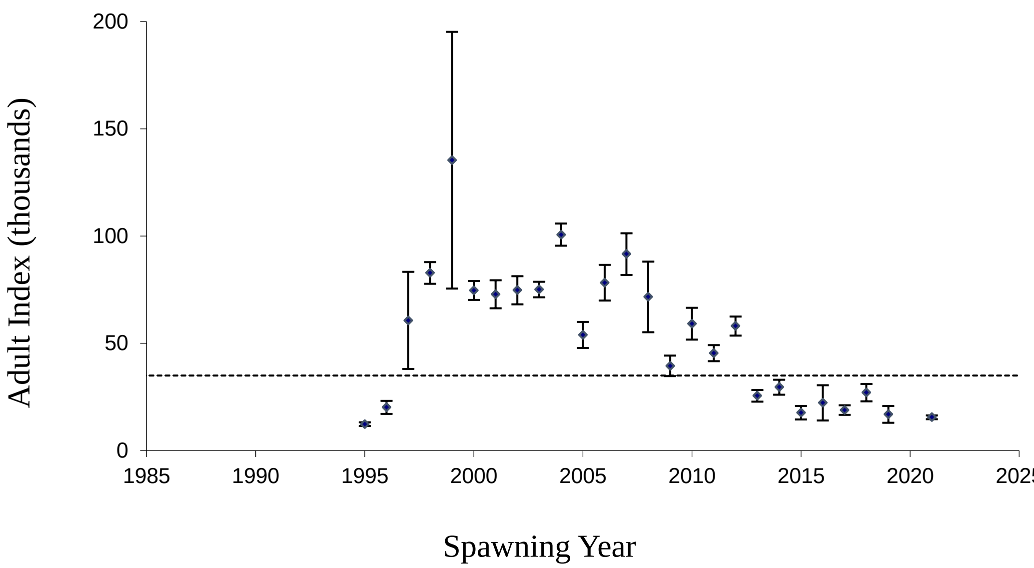

Figure 15. Index estimates with 95% confidence intervals of adult sea lampreys in Lake Michigan. The dotted horizontal line represents the target of 34,982. The index target was estimated as 5/8.9 times the mean of indices (1995-1999).

Lake Huron

- 13,877 sea lampreys were trapped in 6 tributaries during 2021, all of which were index locations (Table 26, Figure 13). Population estimates were generated for all 6 index streams using mark-recapture data.

- The index of adult sea lamprey abundance was 39,128 *(95% CI: 36,725 – 41,531)*, which was higher than the target of 31,274 (Figure 16).

- The Service, MIDNR, and USACE will be moving forward on Great Lakes Fishery and Ecosystem Restoration (GLFER) funded construction projects including permanent sea lamprey traps on the Au Sable and East Au Gres rivers. Construction will begin in 2022.

Table 26. Information regarding adult sea lamprey captured in assessment traps or nets in tributaries of Lake Huron during 2021 (letter in parentheses corresponds to stream in Figure 13).

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									
St. Marys R. (A)	1,861	5,831	32	61	61	488	485	266	265
Echo R. (B)	935	7,020	13	0	---	---	---	---	---
Thessalon R. (C)									
Bridgeland Cr.	2,137	3,077	69	137	45	465	468	220	235
Total or Mean (Canada)	**4,933**	---	---	**198**	**49**	**474**	**472**	**238**	**242**
United States									
East Au Gres R. (D)	285	4,418	6	7	71	488	430	256	164
Ocqueoc R. (E)	2,565	9,753	26	60	32	455	461	208	231
Cheboygan R. (F)	6,094	9,029	67	309	48	476	477	233	243
St. Marys R. (A)	(see Canada)	(see Canada)	(see Canada)	5	0	---	497	---	288
Total or Mean (U.S.)	**8,944**	---	---	**381**	**49**	**473**	**475**	**229**	**242**
Total or Mean (for Lake)	**13,877**	---	---	**579**	**49**	**473**	**474**	**232**	**242**

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

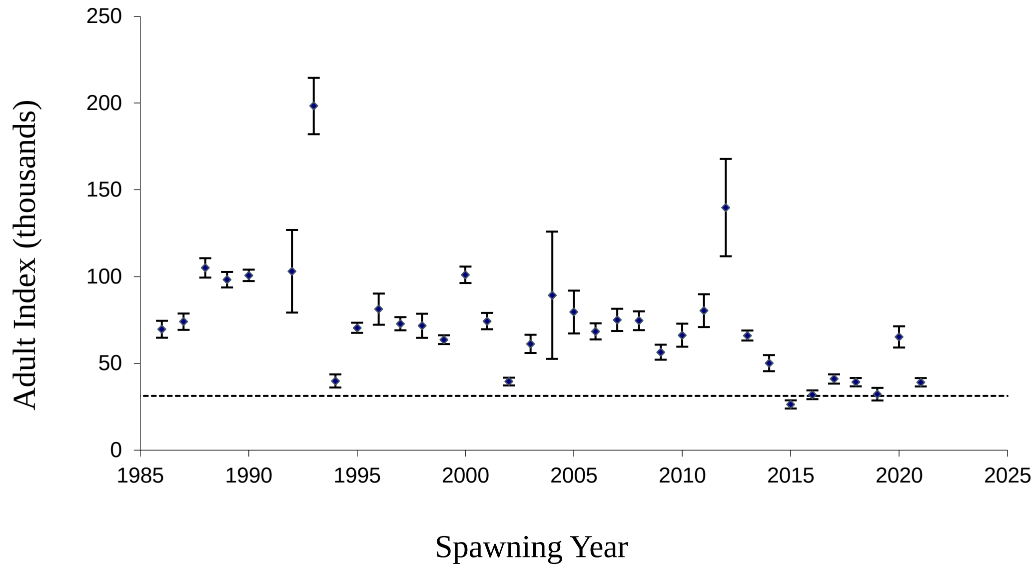

Figure 16. Index estimates with 95% confidence intervals of adult sea lampreys in Lake Huron. The horizontal dotted line represents the index target of 31,274. The index target was estimated as 0.25 times the mean of indices between 1989 and 1993.

Lake Erie

- 117 sea lampreys were trapped in 5 tributaries during 2021, all of which were index locations (Table 27, Figure 13). Adult population estimates based on mark-recapture were obtained from 2 of 5 index streams. Population estimates were modeled for the Cattaraugus, Big Otter, and Young's creeks (Figure 17).

- The index of adult sea lamprey abundance was 449 *(95% CI; 405-492)* in 2019, which was lower than the target of 3,263 (Figures 18,19).

- Fyke nets and portable traps were set during 2021 in Conneaut Creek with assistance from the PAFBC to assess adult sea lamprey migration. No sea lamprey were captured during the trapping run. The Service and PAFBC staff plan to conduct these trapping efforts again in 2022.

- Construction of the barrier-integrated traps on the Grand River in Ohio was completed in 2020. The traps were used for the first time in 2021 and trap efficiency was 40%. Before construction of these traps, the average trapping efficiency was 3.5% since 2015. During the 2021 trapping season, the pipes for the attractant water flow to the traps became clogged, likely effecting the trapping efficiency.

- The adult sea lamprey migration in Cattaraugus Creek was monitored through a cooperative agreement with the Seneca Nation of Indians. Trapping efficiencies have been declining over the past several years. Service staff plan to investigate and assist in trapping efforts during 2022.

Table 27. Information regarding adult sea lamprey captured in assessment traps or nets in tributaries of Lake Erie during 2021 (letter in parentheses corresponds to stream in Figure 13).

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.[4]	9	---	---	1	0	---	457	---	197
Big Cr. (B)	67	149	45	8	63	500	479	261	275
Young's Cr. (C)[4]	12	---	---	2	100	485	---	235	---
Total or Mean (Canada)	**88**	**---**	**---**	**11**	**64**	**496**	**474**	**253**	**256**
United States									
Cattaraugus Cr.[4] (D)	4	---	---	0	---	---	---	---	---
Grand R. (E)	25	58	40	10	60	504	490	289	281
Conneaut Cr.[3](F)	0	---	---	0	---	---	---	---	---
Total or Mean (U.S.)	**29**	**---**	**---**	**10**	**60**	**504**	**490**	**289**	281
Total or Mean (for Lake)	**117**	**---**	**---**	**21**	**62**	**499**	**482**	**270**	**268**

[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, [4]Not used for the lake-wide index

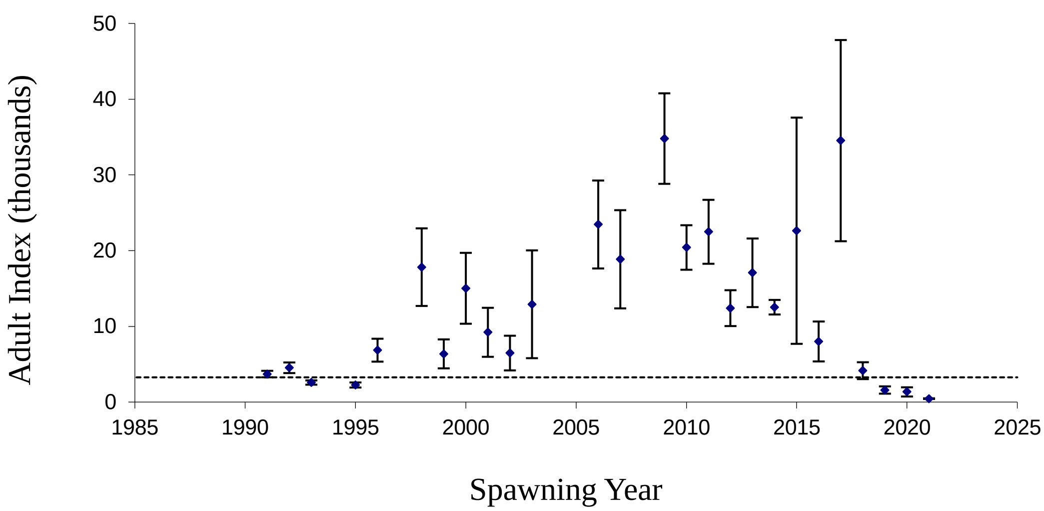

Figure 17. Index estimates with 95% confidence intervals of adult sea lampreys in Lake Erie. The dotted horizontal line represents the index target of 3,263. The index target was estimated as the mean of indices during a period with acceptable marking rate (1991-1995).

Lake Ontario

- 1,704 sea lampreys were trapped in 8 tributaries during 2021, 5 of which were index locations (Table 28, Figure 13). Adult population estimates based on mark-recapture were obtained from 4 of the 5 index locations. Population estimates were modeled for Sterling Creek due to insufficient captures of marked sea lamprey.

- The index of adult sea lamprey abundance was 5,187 *(95% CI; 4,732-5,642)* in 2020, which was lower than the target of 14,065 (Figure 18).

- The two-year fish passage study on Cobourg Brook is now complete following postponement of the 2020 field season due to COVID-19 travel restrictions. McLaughin et al., University of Guelph, are currently analyzing the data to determine if altering lighting and/or discharge in the fishway can increase the efficiency of passively sorting sea lamprey from non-target fish.

Table 28. Information regarding adult sea lamprey captured in assessment traps or nets in tributaries of Lake Ontario during 2021 (letter in parentheses corresponds to stream in Figure 13).

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
<u>Canada</u>									
Humber R. (A)	789	1,636	48	37	51	503	498	300	295
Duffins Cr. (B)	164	597	27	21	57	520	518	315	303
Bowmanville Cr. (C)	69	177	39	15	67	499	515	275	303
Cobourg Cr.[3] (D)	76	125	61	46	39	472	459	253	244
Salmon R.[3] (E)	0	---	---	---	---	---	---	---	---
Total or Mean (Canada)	**1,098**	---	---	**119**	**50**	**496**	**484**	**284**	**273**
<u>United States</u>									
Black R. (F)	494	2,340	20	42	60	486	466	271	238
Salmon R.(G)									
Orwell Br.[3]	90	---	40	25	60	500	477	331	286
Sterling Cr.[4] (H)	22	---	---	---	---	---	---	---	---
Total or Mean (U.S.)	**606**	---	---	**67**	**60**	**491**	**470**	**293**	**256**
Total or Mean (for lake)	**1,704**	---	---	**186**	**53**	**494**	**479**	**288**	**268**

[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, [4] Not used for the lake-wide index

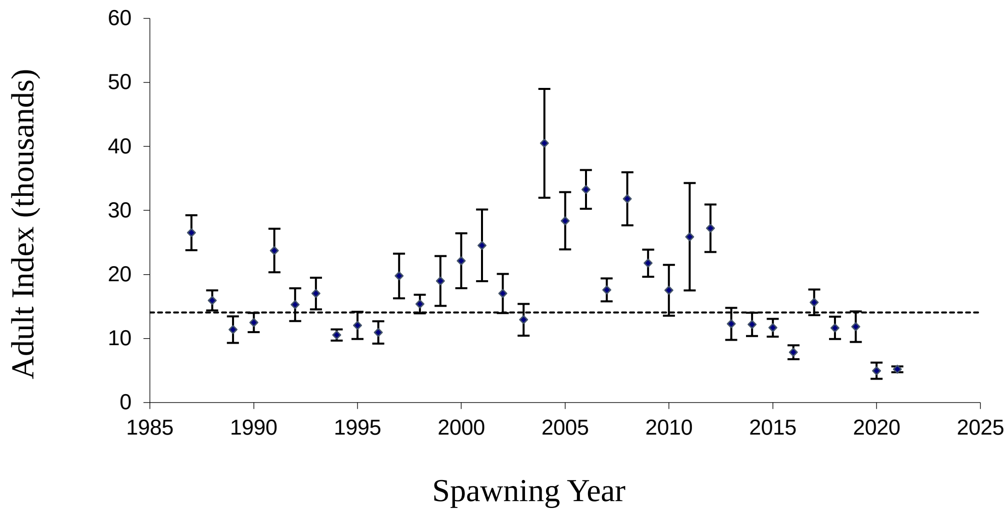

Figure 18. Index estimates with 95% confidence intervals of adult sea lamprey in Lake Ontario. The dotted horizontal line represents the index target of 14,065. The index target was estimated as the mean of indices during a period with acceptable marking rates (1993-1997).

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, tribal and First Nation agencies, and working with others to minimize risk to non-target organisms.

Species at Risk Act (Canada)

Section 73 of the Species at Risk Act (SARA) enables the competent minister to issue permits to for activities that may affect threatened or endangered species, provided that a) alternatives have been considered, b) all feasible measures have been taken to minimize the impact on the species or its critical habitat, and c) the activity will not jeopardize the survival or recovery of the species. During 2021, the SLCP sought and was issued a permit for lampricide applications in 10 waterbodies that overlapped with the known occurrence of the following Species at Risk:

- Black Redhorse (*Moxostoma duquesnei*), Threatened
- Channel Darter (*Percina copelandi*), Endangered
- Eastern Sand Darter (*Ammocrypta pellucida*), Threatened
- Lake Chubsucker (*Erimyzon sucetta*), Endangered
- Northern Madtom (*Noturus stigmosus*), Endangered
- Pugnose Shiner (*Notropis anogenus*), Endangered
- Redside Dace (*Clinostomus elongatus*), Endangered
- Hickorynut (*Obovaria olivaria*), Endangered

Monitoring for sick or dead individuals was conducted immediately after lampricide applications; none of the Species at Risk listed were observed.

Endangered Species Act (U.S.)

Section 7 of the Endangered Species Act requires that 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 (threatened, endangered, 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 2021, the following ES offices reviewed the effect of scheduled lampricide applications on listed 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
- Bloomington Ecological Services Field Office
- Ohio Ecological Services Field Office
- Pennsylvania Department of Conservation and Natural Resources
- New York 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 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.

<u>State-Listed Species</u>

Annual Reviews

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

During 2021, the following state regulatory offices reviewed listed species within their jurisdiction and issued permits to conduct lampricide applications:

- Michigan Department of Natural Resources
- Wisconsin Department of Natural Resources
- Minnesota Department of Natural Resources
- Indiana Department of Natural Resources
- Ohio Department of Environmental Protection
- Pennsylvania Department of Environmental Protection
- New York Department of Environmental Protection

Studies and Fieldwork

Non-target Surveys

Grand River: The Risk Management Team (U.S.) assisted the Ludington Biological Station's Larval Assessment Team and the Service's ES East Lansing Field Office to delineate freshwater mussel and larval sea lamprey habitat in the Grand River. This work identified potential areas that may be considered for surveys using granular Bayluscide and strategies to avoid and minimize risk to federal and state listed freshwater mussels to the maximum extent practical.

Garden River: The Environmental Team (Canada), in conjunction with Garden River First Nation, began a multi-year aquatic ecosystem study on Garden, Root and Echo rivers (northern Lake Huron). The study involves collecting historical information as well as current baseline conditions, including physical (e.g. water chemistry, water temperature) and biological (e.g. fish composition and distribution) data. The study will continue beyond the next planned lampricide treatment of the Garden River.

Barrier monitoring: The Environmental Team (Canada), conducted fish community sampling upstream and downstream of existing purpose-built low-head barriers on Lake Ontario (6 streams) and Lake Huron (4 streams). The purpose of this periodic sampling is to track long-term changes in fish community composition around low-head barriers.

Field Protocols

Field protocols are developed annually for staff 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 2021.

- 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 2021.

The protocols for 2021 identified 57 federal and state listed species, 3 critical habitats, multiple bat hibernacula, and the de-listed bald eagle (*Haliaeetus leucocephalus*).

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 2021, NEPA was required for cooperative agreements for the following actions:

Trapping for adult sea lampreys on the following streams:

- Bad River (Lake Superior)
- Cattaraugus Creek (Lake Erie)
- Cranberry River (Lake Superior)
- Boardman River (Lake Michigan)
- St. Marys River (Lake Huron)

Lampricide treatment for larval sea lampreys on the following streams:

- Bad River (Lake Superior)

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 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 threatened, endangered, 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 29).

Table 29. Summary of 6(a)(2) reports submitted for incidents of non-target mortality during 2021 TFM treatments.

Lake	Stream	Species	Number	Comments
Michigan	Cedar River	Mudpuppy (*Necturus maculosus*)	58 30	Dead Sick Sensitive species
	Valentine Creek	Blacknose dace (*Rhinichthys atratulus*)	73	Spawning
	Boyne River	Burrowing mayfly (*Hexagenia limbata*)	250	Sensitive species
	Oconto River	Logperch (*Percina caprodes*)	53	Sensitive species
	Milakokia River	Burrowing mayfly	1,500	Sensitive species
Huron	Trout River	Chinook salmon (*Oncorhynchus tshawytscha*)	69	Spawning
	Rifle River	Stonecats (*Noturus flavus*)	88	pH suppression Sensitive species
	Shiawassee River	Stonecats	131	pH suppression 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.

2021 Membership
Lori Criger (Chair), Cheryl Kaye, Chris Gagnon, Benson Solomon, Tim Sullivan, Jenna Tews, Aaron Jubar (Service); Bruce Morrison, Shawn Robertson, Al Rowlinson (Department), Jean Adams (USGS/Commission); 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 Commission 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.

2021 Outcomes:

1. Due to the pandemic, Department staff were not permitted to conduct field work until mid-June. Service personnel began field work as scheduled in mid-April. Despite setbacks from the pandemic, crews were able to safely and successfully treat the majority of streams on the treatment schedule. Special thanks to staff from the Lake Champlain field office and the NYSDEC for their cooperation and willingness to successfully treat three U.S. tributaries to Lake Ontario.
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 the larval assessment and ACE units were deployed to the control units as needed to augment treatment effort on complex, labor-intensive systems. This was particularly important during the Rifle River treatment when the Department could not assist due to pandemic-related travel restrictions.
4. Crews from the Service and the Department had planned to work together to treat the St. Marys River plots with granular Bayluscide in early July; however, due to pandemic-related border closures, the crews were required to work independently. Although nearly all plots were treated, some efficiency was lost by not collaborating.
5. Treatment staff provided logistical support to Schueller et al. (UMESC) as they conducted research to examine TFM efficacy and seasonality effects on sea lamprey larvae in three study streams (Ocqueoc, Trout, and Sucker rivers).
6. The partner-led effort to conduct non-target surveys in the Grand River (Ohio) did not occur because the treatment was deferred.

2022 Objectives:

1. Develop a treatment schedule jointly between the agents that incorporates efficiencies in travel and maximizes treatment efficacy. Flexibility will be incorporated into the treatment schedule to allow for potential pandemic-related travel restrictions.
2. Treat all streams listed on the 2022 treatment schedule.
3. Review past treatment results and larval assessment data to direct implementation of strategies to improve efficacy of lampricide treatments scheduled during 2022.
4. 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 most favorable. Additionally, treatment supervisors will request additional personnel to augment treatment effort on complex, labor-intensive systems scheduled in the fall.
5. If international travel is permitted, crews from the Service and the Department will collaborate to treat high-density larval plots in the St. Marys River with granular Bayluscide when conditions are optimal.
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 collections during the Grand River (Ohio) treatment.
    b. LCTF will support the Service RMT as they examine the risk of lampricide treatments to the round hickorynut.
    c. Treatment staff will continue support to Schueller et al. as they conduct the second year of research examining TFM efficacy and seasonality effects on sea lamprey larvae.
    d. LCTF will consider and provide feedback on external research evaluating the effects of lampricide on species of concern as well as lampricide efficacy.

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

2021 Outcomes:

1. Lampricide analysis and water chemistry data from streams treated in 2021 was 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. USFWS personnel provided logistical support to UMESC as they conducted TFM bar field trials in three tributaries to the Rifle River. Completion report is pending.
3. 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.
4. LCTF continues to support and provide input to UMESC as they work with Battelle (UK) to develop a formulation of liquid Bayluscide that would eliminate tubing degradation and clogging and increase applicator safety by eliminating NMP, a potential carcinogen..

2022 Objectives:

1. Review past treatment history and larval assessment information for streams scheduled for treatment in 2022 to identify impediments to effectiveness and develop strategies to increase efficacy.
2. The LCTF will work with other task forces to measure effectiveness of lampricide applications.
   i. LCTF will continue to assist Larval Assessment Task Force (LATF) with evaluating the success of prior targeted treatment strategies.
   ii. Treatment supervisors will review results of treatment evaluation surveys to identify problem areas and improve success of future treatments.
3. 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.
4. Collaborate with UMESC to conduct bioassays on select systems where there is concern that lampricide concentrations may not be effective late in the season due to elevated water temperatures and/or seasonality effects. The Muskegon River is a probable candidate for 2022.

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

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

2021 Outcomes:

1. The 2021 targeted treatment strategy was focused on Lake Michigan tributaries deferred in 2020 as well as Lake Huron tributaries on cycle for treatment. Twenty-nine of 33 streams included in the targeted treatment strategy were successfully treated.

2. Assisted the LATF with developing the 2022 rank list. Special consideration was given to streams deferred in 2020 and 2021, particularly those that were part of the Michigan and Huron targeted treatment strategies. Treatment supervisors reviewed and calculated treatment costs for all streams considered for treatment.

2022 Objectives:

1. Optimize stream treatment schedules to prioritize treatments deferred in 2020/2021 and those in dire need of treatment as we evaluate and respond to the impacts of the pandemic.
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 2023.

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.

2021 Membership

Matt Symbal (Chair), Pete Hrodey, Kevin Mann, Cheryl Kaye, and Jessica Collier (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 (Commission); Rob McLaughlin (University of Guelph); Dale Burkett, Michael Siefkes, and Chris Freiburger (Commission Secretariat).

Progress towards goals described in the Commission 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.

2021 Outcomes:

1. Planning continued on 18 barrier construction projects to prevent sea lamprey from accessing spawning habitat.
2. Monitored elevated vibration levels caused by new Harpersfield Dam construction and installation of vibration mitigation features.
3. Rebuild of Nicholston Dam on the Nottawasaga River (Lake Huron) is complete.
4. Continued monitoring of fish movement through Denny's Dam fishway, including ongoing discussions with the Saugeen Ojibwa Nation.
5. Routine maintenance at all purpose-built sea lamprey barriers was completed to ensure adult sea lampreys do not have access to spawning habitat.

6. Inspected 184 existing barriers in the Great Lakes to assess whether structures would prevent upstream migration and to identify repairs necessary to minimize the number of parasitic lampreys originating from untreated sources.
7. Review of 58 fish passage projects on 35 tributaries was initiated or completed to determine the effect of fish passage and dam or culvert removals to sea lamprey control operations.
8. Completed larval sea lamprey electrofishing and habitat assessments to determine production potential on the Black, Kalamazoo, Huron and Pere Marquette rivers in Michigan, as well as the Root and Iron rivers in Wisconsin. Fish community sampling occurred on the Garden, Echo, and Root rivers (Lake Huron). Surveys were conducted upstream and downstream of low-head barriers in Canadian tributaries of Lake Huron and Lake Ontario for long term monitoring of barrier impacts on fish movement.

2022 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 (Lake Erie).
4. 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. Modify fish hatchery weir on Beaver Dam Brook to block lamprey and improve fish guidance weir at NYDEC fish hatchery.
6. Continue working on priority Great Lakes GLFER barrier projects with the USACE to limit sea lamprey access to spawning habitat.
7. Investigate use of existing surrogate species data and geographic information systems (GIS) data to predict infestation risk upstream of blocking barriers.
8. 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.

2021 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. 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 with fyke nets. Trapping conducted

in 2021 captured nine unmarked adult lamprey in the upper Cheboygan River. Sterilized male sea lampreys (n=1,455) were released into Sturgeon, Pigeon, and Maple rivers during the spawning run.

3. 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, 2016-2021. Based on trap catches, it blocked >99% of the adults each year. No sea lamprey larvae have been discovered since 2019.
4. Several BTF members and participants are involved with the Supplemental Control Program workgroup. During 2021, the group refined sampling protocols and conducted fieldwork on SUPCON streams to collect baseline data. Trapping of adult sea lampreys occurred on 12 streams, while larval population and habitat surveys occurred on 12 streams.

2022 Objectives:

1. Remain involved in 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 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. The Cheboygan Work Group (CWG) will continue to assess the upper Cheboygan River population during 2022 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.
4. Continue operation of the NEMO seasonal barrier on the Black Mallard River to prevent the migration of spawning sea lamprey to the upper river.
5. 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.

<u>Larval Assessment Task Force</u>

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.

2021 Membership
Aaron Jubar (Chair); Tonia Van Kempen, Lexi Sumner, and Joseph Lachowsky (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 Commission 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.

2021 Outcomes:

1. Two new sea lamprey producing tributaries were detected in Lake Superior: Pike River and Knife River lentic area. Several unexpected sea lamprey infestations were identified in tributaries which were historically infested but that have not harbored sea lamprey larvae for >10 years. In Lake Michigan, Sunny Brook was found infested for the first time since 1991. In Lake Huron, the Little Black River was infested but had not been treated since 1967. Also, in Lake Huron, sea lampreys were detected above the East AuGres River barrier for the first time since 1987.
2. Residual larval sea lamprey populations were found in three U.S. streams: Hungarian Creek, Boston Lily Creek, and Carp River (Marquette). Hungarian Creek will be treated in 2022.
3. Larval surveys were conducted in the upper Tittabawassee River (tributary to the Saginaw River in Lake Huron) and led to the detection of sea lamprey larvae above Sanford and Edenville Dams, which both failed during spring 2020.

2022 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. Prioritize and conduct distribution surveys on all streams scheduled for treatment during 2022, with emphasis on addressing data gaps resulting from the pandemic. Conduct distribution surveys on all streams expected to be treated during 2023.

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

2021 Outcomes:

Post-treatment assessments were conducted on streams treated during 2020 and early 2021. The presence of residual larvae in St Marys Plot 151 triggered a retreatment of that plot. The Garden River, which was treated in 2020 after being deferred for several years, produced one residual larvae during treatment evaluation surveys.

2022 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.

2021 Outcomes:

1. Multi-station larval habitat identification training that was planned for spring 2021 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. Larval Assessment staff continued to work with Commission Communications staff on the development of a larval lamprey identification guide, which will serve as an important resource for both new and experienced staff at all agent offices..

2022 Objectives:

1. Larval habitat identification and quantification training will be held at each respective station during early spring 2022
2. Continue to edit larval assessment protocols and operating procedures as necessary.
3. Provide larval assessment support to new and ongoing Commission-funded research projects including, but not limited to: larval pheromone extraction, eDNA techniques, TFM resistance, and TFM
4. Work with Commission Communications staff to finalize the larval lamprey identification guide and facilitate distribution to control agents and partner agencies.

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

2021 Outcomes:

1. Year three of the 2019-2021 Targeted Effort treatment strategy was implemented. The 2021 Targeted Effort strategy included 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 Rank-and-Reset strategy in 2022 across all lake basins.
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. Ludington staff provided lamprey identification training for HBBS SupCon crews.

2022 Objectives:

1. The lake-specific Targeted Treatment Strategy will resume in 2023, beginning with Lake Superior, followed by Lake Michigan and Lake Huron in 2024 and 2025, respectively. Extensive surveys are planned throughout Lake Superior to identify streams for inclusion in the 2023 Targeted Treatment Strategy.
2. Continue to work with the Trapping Task Force to target streams for trapping out-migrating juveniles for control.

3. 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.

2021 Membership
Scott Miehls (Chair), Jean Adams, Ted Castro-Santos, and Jim Luoma (USGS), Ryan Booth and Tonia Van Kempen (DFO-SLCC), Sean Lewandoski and Matt Symbal (USFWS-MBS), Weiming Li and 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 Commission 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.

2021 Outcomes:

- All 29 index streams were trapped during spring 2021 as well as 10 additional non-index streams. Collaboration with partners around the basin made this possible given continued COVID travel restrictions. GLFWC conducted trapping operations on the Bad, White, Fish Creek, and Marengo rivers and KBIC assisted with SupCon transformer trapping efforts on the Cranberry River and Traverse River during Fall 2020. Mark-recapture population estimates were obtained for 23 of the index streams with model estimates required for six. An index estimate was produced for all lakes. A data analysis protocol is being developed (to complement the trapping protocol).
- A manuscript describing the new adult sea lamprey index is now published as part of SLIS III and is available online at: https://doi.org/10.1016/j.jglr.2021.04.009. Title: Quantifying Great Lakes sea lamprey populations using an index of adults. Jean V. Adams, Jessica M. Barber, Gale A. Bravener, Sean A. Lewandoski.
- A manuscript describing development of wounding and abundance targets is now published as part of SLIS III and available online at https://doi.org/10.1016/j.jglr.2021.04.002. Title: A case study of setting threshold suppression targets for sea lamprey in the Great Lakes. Ted J. Treska, Mark P. Ebener, Gavin C. Christie, Jean V. Adams, Michael J. Siefkes.

2022 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.

2021 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: Transformer trapping will occur in 12 of the 13 SupCon streams for assessment (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). Trapping will not continue in the Garlic River due to land owner access denial.

2021 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. Pheromone, alarm cue, and antagonist research was able to continue. No new methods were deployed in 2021.
2. The Sea Lamprey Management Strategy Evaluation (SLaMSE) model was updated to incorporate subjective knowledge regarding recruitment, growth and the need to treat streams; termed "expert judgement". Streams with low adult density, regular producers, and or are challenging to treat with lampricide show promise as possible trapping for control options. SupCon will be targeting these stream types within its study design.
3. Assessment phase of SupCon is underway. Twelve of 13 streams were trapped and larval assessment completed on all study streams. Adult trapping and larval assessment work occurred in Cranberry River, Traverse River, Bills Creek, Furlong Creek, Bellevue Creek, Root River, Pigeon River, Sturgeon River, Maple River, Black Mallard River, Long Lake Outlet, and Tawas Lake Outlet. Transformer trapping was conducted in these streams for fall 2021 with trapping effort increased on Furlong Creek, where 75 transformers were captured in 2020.

2022 Objectives:

1. Continue trapping transformers for control in newly discovered, or streams deferred from treatment in the current year, to mitigate escapement to the lakes,. Larval assessment crews observed a large number of transformed sea lamprey in the Munuscong River during 2021 assessment. Plans are underway for Service and/or USGS personnel to conduct trapping during fall 2021.
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.

2021 Outcomes:

1. Milt Pheromones – No new milt pheromone components were identified due to COVID-19 restrictions that limited travel from China to MSU for additional compound identification. In the field, two tests involving milt were conducted: 1) Milt was applied to the stream with no other pheromone compounds to determine if milt alone could attract and retain females on nests in a similar manner as the gill-released pheromones, and 2) Spermine was tested at higher concentrations than the concentration tested in 2020 to determine the behavioral effects on ovulated females across a range of concentrations. Both tests were conducted in a 50m stretch in the upper Ocqueoc River. Preliminary results suggest milt alone did attract and retain females to the odor source at comparable rates to spermiating male washings and these results were consistent with those from 2020 where milt increased odor source retention. Full results will be made available at a later date when analyses are finalized. An initial chemical screening of the seminal plasma used in experiments indicated the presence of some bile acids found in gill-released pheromones. We are currently investigating the potential sources of these bile acids. In 2021, tests were only conducted on ovulated females as environmental conditions did not allow for tests on spermiating males. With a lack of rain until early July, our experimental site at the Trout River used for male behavioral assays only had a few centimeters of water and minimal flow.

2022 Objectives:

1. Milt Pheromones – Test milt pheromones in a migratory setting to determine behavioral responses of migratory stage sea lamprey to this new pheromone source. Test ceramides C14 and C20 in the field to determine behavioral effects on ovulated females. Test milt pheromones on spermiating males. If travel restrictions are eased, continue fractionation and chemical identification of milt compounds.

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

2021 Outcomes:

1. Data analysis was completed in laboratory tests of two pulse-modulation schemes to defeat habituation to the alarm cue repellent when applied for >4 hours. The high/low concentration scheme appears effective and merits progression to testing in the field. Graduate student Mikaela Hanson completed the work and successfully defended her M.S. thesis.
2. Sixty migratory sea lampreys equipped with acoustic transmitters were released into the White River, MI to evaluate migratory preferences for channel habitat (depth, substrate, water velocity, vegetation) in complex river channels. The data are currently being analyzed by Ph.D. student Kandace Griffin and will be presented at the 2022 GLATOS annual meeting.

3. A laboratory experiment evaluated the repellency of several fractions of the alarm cue odor collected from sea lamprey carcasses (M.S. student Emily Mensch). The cue was contained in both lipid- and water-soluble fractions. A mixture of the 33 most abundant compounds that were isolated and described from the water soluble fraction of the extract did not prove effective as a repellent. The alarm cue is likely to be composed of minor components contained in the extract.
4. Preliminary data indicated putrescine, a component of the alarm cue extract and human saliva, both of which induce the alarm response in sea lamprey, may be a component of the alarm cue and/or repellent kairomones from mammalian predators. A laboratory experiment demonstrated that putrescine is not repellent to sea lamprey.
5. A manuscript was submitted for publication describing a chemical component of the alarm cue that is new to science and that has anti-inflammatory action in standard laboratory tests.
6. Previous field evaluations of PZS and 3sPZS indicate the antagonist mixture prevented ovulated females from locating a male pheromone source in a pristine stream and substantially reduced mating in a high-density spawning stream during 3-hour long experiments. In 2021, the Li lab along with Dr. Nicholas Johnson investigated if the efficacy of the antagonist treatment can be maintained for a 24-hour period over the course of the spawning season in a high-density spawning ground in the Carp Lake Outlet downstream of the sea lamprey barrier. They applied 1) vehicle (50% methanol) or 2) a mixture of PZS and 3sPZS upstream of the spawning grounds for 24 hours and tracked tagged male and female movements with a passive integrated transponder array, surveyed for sea lamprey nest location, abundance, and occupancy data, conducted behavioral observations, and sampled nests for embryos daily. A comprehensive analysis of the behavior and water chemistry data is underway. Results will be made available when analyses are completed.

   Phase 1 of the design-test-learn cycle to discover analogs with increased antagonistic activity was completed through an ongoing collaboration between the Li lab and Dr. Edmund Ellsworth (Department of Pharmacology & Toxicology, MSU). Dr. Ellsworth and the Medicinal Chemistry Core Facility team synthesized new candidate antagonists by making structural modifications to the existing antagonists. The Li lab conducted electro-olfactogram recordings and two-choice flume experiments to characterize whether the analogs inhibited 3kPZS-induced olfactory responses or behavioral attraction, respectively; identified 2 out of 10 analogs tested that reduced the 3kPZS olfactory response by >50%; and identified 8 out of 15 analogs tested that disrupted ovulated female preference for 3kPZS in a flume. Results from electrophysiology recordings and behavioral experiments will drive the next round of analog synthesis in the iterative design-test-learn cycle.

2022 Objectives:

1. A proposal has been submitted to the Commission to continue development of a selective fish passage device that utilizes the alarm cue to selectively guide and trap sea lamprey migrating with native fishes. Previous testing of a mesocosm version of the fishway proved highly effective. Selection for funding by the Commission is

pending the SLRB review and recommendation. If funded, work will commence in 2022.

2. Continuation of the 2021 White River study, with alarm cue released at strategic points in the river to guide migrating sea lamprey towards their habitat preferences,. The results of the work should provide operational guidance for use of the repellent in fishing/trapping of sea lamprey in rivers without dams.
3. A research proposal will be developed to continue the process to identify the chemical constituents of the sea lamprey alarm cue.
4. Results of all alarm cue (repellent) research that involved field tests of potential control tactics will be compiled and transferred to the SupCon team for use in that effort.
5. The Li lab is still in the initial planning stages for 2022 experiments. The results from the 2021 Carp Lake Outlet experiment will inform the next steps and guide deployment of antagonist treatments. They will design experiments to continue to assess the efficacy of the antagonists in halting reproduction in natural spawning populations. Dr. Ellsworth and Li lab will also synthesize additional candidate antagonists and assess their pheromone antagonistic activity with electro-olfactogram recordings and two-choice flume assays for phase 2 of the project.

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

2021 Outcomes:

1. Worked with LATF members to identify and target 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.

2022 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 (Commission) 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, 2021:

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 Commission, USFWS, DFO, and USGS during the 2021 season.

2021 Shows, events, and programs:

Milwaukee County Historical Society, Virtual—March 11 (Commission)
MSU Science Festival, Virtual—April 10 (Commission)
CTC Earth Day, Virtual—April 22 (Commission)
University of Michigan Press Meet the Author Event, Virtual—April 27 (Commission)
MEFI Kids Fishing Day, Detroit, MI—May 7 (Commission)
Lake St. Clair Water Festival, Virtual—May 11 (Commission)
Norlite Nursing Center Parade, Norlite, MI – May 12 (MBS)
Gwinn 6th Graders, Dead River, MI – May 13 (MBS)
MEFI Kids Fishing Day, Detroit, MI—May 15 (Commission)
Lake Erie Water Festival, Virtual—May 18 (Commission)
Bay Cliff Health Camp, Big Bay, MI – May 24-27 (MBS)
Detroit Riverfront Kid's Fishing Day, Detroit, MI — June 20 (Commission)
Grovefest, Fremont, OH — June 26 (Commission)
MSU 4-H Extension, Munising, MI – July 6 (MBS)
Brown Trout Festival, Alpena, MI—July 18 (USGS)
Lake Superior Days, Marquette, MI—July 18 (MBS)
Hoeft State Park, Rogers City, MI—July 22 (USGS)
Perry's Victory, Put-in-Bay, OH—July 24 (Commission)
Skandia Days Parade, Skandia, MI – July 31 (MBS)
MSU 4-H Extension, Munising, MI – August 8 (MBS)
Hoeft State Park, Rogers City, MI—August 12 (USGS)
Garden River First Nation Powwow, Ketegaunseebee – August 21 (DFO)
Owen Sound Salmon Spectacular, Owen Sound, ON—August 27-September 5 (Commission)
Nautical North Family Adventures glass bottom boat tours, Cheboygan, MI—August 29 (USGS)
Sportsmen for Youth, Muskegon, MI—September 11 (Commission)
Houghton High Schoolers, Houghton, MI – September 21 (MBS)
Sandy Knoll 3rd Graders, Marquette, MI – September 24 (MBS)
Cranbrook Institute: Rouge River Water Festival, Virtual—October 12 (Commission)
Maumee River Sturgeon Release, Toledo, OH—October 2 (Commission)

PERMANENT EMPLOYEES OF THE SEA LAMPREY CONTROL PROGRAM

FISHERIES AND OCEANS CANADA

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
Stefanie Grand A/Assistant Supervisor

Lampricide Application Coordinators:

Peter Grey: Supervisor
Jamie Storozuk: Supervisor

Lampricide Analysis Technicians:

Stefanie Grand
Jerome Keen
Richard Middaugh

Lampricide Application Technicians:

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

Barriers:

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

Team Leader, Assessment: Tonia Van Kempen

Assessment Biologists:

Ryan Booth Adult Supervisor
Fraser Neave Larval Supervisor (On Assignment)
Kevin Tallon Larval Supervisor (On Assignment)
Lexi Sumner A/Larval Supervisor (Lower Lakes)
Joe Lachowsky A/Larval Supervisor (Upper Lakes)

Assessment Technicians:

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

Administrative Support:

Lisa Vine: Finance and Administrative Officer
Melanie McCaig: Administrative Clerk

Maintenance:

Brian Greene: Foreman

Environmental Biologist:

Gale Bravener 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

Jenna Tews, Station Supervisor

Administrative Support:
Danya Sanders
Vacant (CS)

Database Management and IT Support:
Daniel McGarry

Lampricide Control Fish Biologists:
Vacant, Treatment Supervisor
Vacant, Treatment Supervisor
Chris Eilers, Lauren Freitas,

Lampricide Control Lead Physical Science Technician:
Barry Shier

Lampricide Control Physical Science Technicians:
Vacant
Kevin Butterfield
Vacant

Lampricide Control Biological Science Technicians:
Bobbie Halchishak (CS)
Vacant (CS)
Vacant (CS)
Vacant (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
Vacant (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:
Janet McConnell (CS)
Randy Parker (CS)
Kevin Hensiak (CS)
Cory Racine (CS)
Vacant (CS)
Vacant (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