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Sea Lamprey Investigations

Original: Fish Division
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Education-Game
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1. An inventory of sea lamprey spawning streams in Michigan

by

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Introduction

The appearance of the sea lamprey, Petromyzon marinus, in the upper Great Lakes and its spread and multiplication in these waters during the past two decades has become a matter of increasing concern to those engaged in the fishing industry and to conservation agencies in those states bordering on the lakes. As early as 1937, Hubbs and Pope (1937) suggested that this predatory parasite would become an increasingly damaging factor in an already depleted fishery. The gravity of the problem today is all too apparent in the large spawning runs of the species observed in Michigan streams and in the reports of lamprey-scarred fish submitted by our commercial fishermen.

In June of 1946, the problem was discussed by the Conservation Commission of the State of Michigan who directed that a comprehensive investigation and study be initiated of the sea lamprey in Great Lakes waters, with the object of attempting to discover or develop effective control methods. Immediately following this directive, information was solicited from commercial fishermen by the conservation officers concerning known spawning streams, percent of total fish taken that were scarred, and the effect of scars on the marketability of the fish. These data were summarized (Shetter, 1948? and I.F.R. Report No. 1086) and are discussed, in part, elsewhere in this report.

The problem received further consideration in September and November, 1946, at conferences called by Dr. John Van Oosten, In Charge, Great Lakes Fishery Investigations, U. S. Fish and Wildlife Service, with representatives from the states bordering on the Great Lakes and from the Province of Ontario attending. At these conferences, the Great Lakes Sea Lamprey Committee was organized and a program of investigation and study was evolved at the second conference with the intent of avoiding duplication of effort in these studies. A summary of the functioning and activities of this committee and the legislation which generated it has been presented by Applegate (1947).

The present report is the first of a series which will discuss the results of various phases of an intensive study of the distribution and life history of the sea lamprey in Michigan waters, which was begun by the Institute for Fisheries Research early in 1947. These investigations represent Michigan's part of the cooperative program of research outlined at the sea lamprey conferences. The initial step in our investigations was an inventory of the size and distribution of sea lamprey spawning runs entering our streams in the spring. This information is vitally important for it provides us with a picture of the population we wish to reduce and a measure of the cost of initiating any proposed controls upon this population. The results of this inventory conducted in 1947 are presented herein, preceded by a summary of the records which illustrate the spread and increase of the sea lamprey in the upper Great Lakes.

History of the sea lamprey in the Great Lakes

A recapitulation of the distribution of the sea lamprey as embodied in published reports and summaries of reports (Hubbs and Pope, 1937;

Shetter, 1948?) is necessary to provide a background for this paper. Additional unpublished records have been added to augment the present known data.

Prior to November 8, 1921, when an adult specimen was recovered in Lake Erie, the sea lamprey had been known in the Great Lakes only from Lake Ontario and its tributaries.[1] In these waters it is apparently native and occurs abundantly in a dwarfed form. Locally it is known as the "lake lamprey" and is about one half the size of the large sea lamprey of marine habit. These adult "lake lampreys" probably do not exceed 15 inches in total length. Their destructive attacks upon native food and game fishes were noted at an early date (Gage, 1893, 1928; Surface, 1898, 1899; Huntsman, 1917; Dymond, Hart and Pritchard, 1929).

Until recent times, the spread of the sea lamprey into the upper Great Lakes was doubtlessly blocked by the Niagara Falls. Although migrating sea lampreys can and do work their way over many man-made dams and natural obstacles, the Falls are unquestionably an insurmountable barrier. It is believed now that access was granted the species to the upper Great Lakes with the construction of the Welland Canal

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[1] Bensley (1915) included Petromyzon marinus provisionally in his "Fishes of Georgian Bay" based on reports of fishermen that lampreys 15 inches long were sometimes taken on whitefish and trout from deep water. Radforth (1944) suggested that these specimens may have found their way into Lake Huron via the Trent Waterway but did not think it likely. We must therefore concur with the opinion of Hubbs and Pope (1937) that this hearsay report was based on a native lamprey (Ichthyomyzon).

between Lakes Ontario and Erie. This canal was first opened to shipping in 1829 and was reconstructed into its present system of seven locks in 1932 (Zimmermann and Bright, 1942). It is interesting to note that there is a lapse of 92 years between the opening of the canal and the appearance of the first identified sea lamprey in Lake Erie. The present locks of the Welland Canal are considered inadequate and are the object of current agitation for improvement of the St. Lawrence Waterway. It is a consideration, that further enlargement and improvement of these structures will implement further re-introduction of sea lampreys from Lake Ontario into the western Great Lakes.

The completion of the Trent Waterway connecting Lake Ontario and Georgian Bay (Lake Huron) in 1918 opened another possible but somewhat improbable means of introduction into the upper lakes. This system consists of approximately 235 miles of circuitous waterway extending from Port Severn, Georgian Bay, to Trenton, Ontario, on Lake Ontario. It embraces 46 boat locks, 32-1/4 miles of constructed canal, and numerous power and water level maintenance dams creating heads as great as 58 feet. Boat traffic in the system is not heavy. There is no reason why the sea lamprey could not have distributed itself into Lake Huron by this route, but since our records indicate initial dispersal and establishment in Lake Erie, we must conclude that they gained entrance to the upper lakes via the Welland Canal.

In the two and one half decades following the capture in 1921 of the first adult specimen in Lake Erie, the sea lamprey has dispersed rapidly throughout the upper lakes establishing itself in Lakes Erie, Huron and Michigan in that order. Recent records indicate that it had become established in Lake Superior at least by 1945. Although its spread

and multiplication has not approached the spectacular quality of another exotic introduction, the smelt, Osmerus mordax, it is nonetheless firmly established and present in large numbers.

A summary is presented herewith, listing in chronological form by drainages, all available records, published and unpublished, which will provide a history of the spread of the sea lamprey in the Great Lakes. Notations concerning the nature of the record and the source are included wherever possible.

1921

Lake Erie and tributaries.--One specimen, 21 inches long, taken off-shore from Merlin, Ontario, in central Lake Erie on November 8, 1921 (Dymond, 1922)

1927

Lake Erie and tributaries.--One specimen caught near West Sister Island, Ohio, on November 14, 1927 (Osburn, Wickliff and Trautman, 1930). One specimen caught near Sandusky, Ohio; identified by Dr. John Van Oosten (Hubbs and Brown, 1929).

1928

Lake Erie and tributaries.--One specimen, 22 inches long, taken at Pointe Aux Pins, opposite Rondeau Harbor, Ontario on (date not given). W. D. Bates who captured this specimen reported to Dr. Van Oosten that he occasionally took large lampreys in his nets (Hubbs and Brown, 1929). One specimen collected near Sandusky, Ohio, in the spring by a Mr. W. M. Tidd (Hubbs and Brown, 1929).

1930

Lake Erie and tributaries.--One specimen, 13.75 inches long, taken by fisherman in the St. Clair River in second week in May, 1930; attached to a 4.5-pound "pikeperch" (Hubbs and Pope, 1937).

1932

Lake Erie and tributaries.--Adult specimen collected in the Huron River at Flat Rock, Wayne County, Michigan, on May 8, 1932 (Creaser, 1932); this was the first record of a spawning migrant and verified establishment of the species in Lake Erie. Penetration into Lakes St. Clair and Huron was probably well begun on or before this date.

1934

Lake Erie and tributaries.--A mature sea lamprey 455 mm. long, collected in Swan Creek, tributary of the Maumee River in Toledo, Ohio, on May 8, 1934; spawning migrant (Hubbs and Pope, 1937).

Lake St. Clair and tributaries.--Reportedly observed in Clinton River at Rochester, Oakland County, Michigan, in spring by Harry Yates of that city; spawning run? (Shetter, 1948?).

1935

Lake Erie and tributaries.--Two mature sea lampreys, 459 and 528 mm., respectively, collected in Swan Creek, Toledo, Ohio, on April 26, 1935; spawning run (Hubbs and Pope, 1937).

1936

Lake Michigan and tributaries.--One 15.5-inch male, presumably on spawning run, taken in outlet of Elk Lake at Elk Rapids, Antrim County, Michigan, on June 13, 1936 (Hubbs and Pope, 1937). One immature adult, not quite 9 inches long, captured 5 miles south of Sturgeon Bay Canal, Door County, Wisconsin, on August 1, 1936 (Hubbs and Pope, 1937). One immature adult, 17 inches long, taken just off St. James on Beaver Island on October 19, 1936 (Hubbs and Pope, 1937). One 16-inch specimen taken 15 miles east of Milwaukee, Wisconsin on March 22, 1936; attached to a 4.5-pound lake trout (Hubbs and Pope, 1937).

1937

Lake Huron and tributaries.--Spawning run reported in Ocqueoc River, Presque Isle County, Michigan (Conservation Officer Marvin Horton's semi-monthly report).

Lake Michigan and tributaries.--One specimen, 19 inches long, taken 27 miles east of Port Washington, Wisconsin, on February 4, 1937; attached to a 3.5-pound lake trout (Hubbs and Pope, 1937). One 20-inch specimen taken NW by W of St. Joseph, Michigan on March 2, 1937 (Hubbs and Pope, 1937).

1938

Lake St. Clair and tributaries.--Spawning observed on May 27, 1938, in the Clinton River in Oakland County, Michigan (T3N, R11E, Section 13) and in Macomb County, Michigan (T3N, R12E, Section 19) by M. B. Trautman and Dr. H. J. Deason (Trautman and Deason, 1938; Unpubl. report).

Lake Huron and tributaries.--Dead specimen picked up in Laparell Creek (T37N, R2W, Section 24), tributary to Cheboygan River, Cheboygan County, Michigan, on July 12, 1938. Identified by Dr. C. W. Creaser.

1939

Lake St. Clair and tributaries.--Nests and spawning migrants observed by Dr. H. J. Deason on May 23 and 27, 1939, in the Clinton River, Oakland and Macomb Counties, Michigan, at locations observed in 1938. Fewer lampreys seen than in 1938 and Deason suggests no increase in size of spawning run in this river (Deason, 1939: Unpubl. report).

1941

Lake Huron and tributaries.--Spawning run observed in the Au Gres River, Iosco County, Michigan, by Dr. D. S. Shetter (Shetter, 1948?).

1943

Lake Huron and tributaries.--A "young" sea lamprey was taken from a lake trout caught off Kettle Point, Ontario, on May 22, 1943 (Radforth, 1944).

Lake Michigan and tributaries.--Spawning run observed in the Platte River, Benzie County, Michigan, by Dr. D. S. Shetter (Shetter, 1948?).

1944

Lake Huron and tributaries.--Spawning runs observed in the Rifle River (Ogemaw County?), Michigan and the Ocqueoc River, Presque Isle County, Michigan, by Dr. D. S. Shetter (Shetter, 1948?).

1945

Lake Huron and tributaries.--Spawning run observed in the Ocqueoc River, Presque Isle County, Michigan, by Dr. D. S. Shetter (Shetter, 1948?). An adult sea lamprey, attached to a sucker, was taken near Topinabee, Michigan, in Mullet Lake, Cheboygan County (Cheboygan River drainage); identified by Dr. C. W. Creaser.

1946

Lake Superior and tributaries.--An immature adult, 9.5 inches long, was taken off Rock Harbor, Isle Royale in early August, 1946; identified by Dr. John Van Oosten. A survey primarily based on interviews with commercial fishermen was made by Michigan conservation officers in the late spring and early summer. Spawning runs were reportedly present in 69 Michigan streams (Shetter, 1948?). These latter records are discussed elsewhere in this report.

1947

Lake Superior and tributaries.--An immature adult, 19.3 inches long, was taken in May, 4 miles off shore in Grand Traverse Bay, east side of Keewenaw Peninsula; attached to lake trout caught trolling; identified by V. C. Applegate. A large adult was taken off Whitefish Point, eastern Lake Superior in February; identified by Dr. C. W. Creaser.

[Sea lamprey spawning runs were verified in 74 Michigan streams and reliably reported in 9 additional streams. A detailed discussion of these data follows.]

The 1947 inventory of sea lamprey spawning streams

As mentioned in several instances previously, a survey of sea lamprey spawning streams was conducted in 1946 by Michigan conservation officers who solicited this, in addition to other information, primarily from commercial fishermen. This information was summarized and has been presented by Shetter (1948). In all, 68 streams in Michigan were reported to have sea lamprey spawning runs. A list of these streams by name and location is appended to this report (Appendix I). These data do not appear elsewhere in our records.

With the advent of a more intensive program of research on the sea lamprey, the need was felt for more precise information as to the size and location of the spawning runs in Michigan waters. Furthermore, it was deemed advisable to have trained fishery biologists verify the presence of sea lampreys as the occurrence of four native species of lampreys in the same region could conceivably result in numerous false reports by individuals not well versed in fish identification.

The mechanics of the 1947 inventory required the cooperation of the Field Administration Division of the Department of Conservation and the public at large, particularly organized groups such as sportsman's

clubs, Boy Scouts, 4-H clubs, etc. Considerable publicity of the program preceded the known spawning season. Posters requesting cooperation from the public in reporting sea lamprey runs were put up by local conservation officers along stream banks, in public buildings and public meeting places. (See Figure 1). These posters requested that the local conservation officer be notified when sea lampreys were observed in streams. The conservation officers were instructed to forward all reports immediately to the district fisheries biologist within whose zone they were located. A memorandum was distributed with the supply of posters to each officer describing the mechanics and requirements of the program. A copy of this memorandum is attached (Appendix II).

All reports were investigated by the district fisheries biologists or other members of the Fish Division. A supply of a special report form was provided each biologist so that desired data of a uniform quality could be recorded at the site of observations as to the location and size of the run and the characteristics of the spawning grounds. A sample of this report form is illustrated in Figure 2. These report forms were mailed to the writer when completed, and periodic summaries were prepared during the spawning season.

Results of the 1947 inventory

A large number of reports of the presence of sea lampreys were received during the course of the inventory and virtually all of these reports were investigated by the district biologists or other members of the Institute and the Fish Division. In all, the presence of migrating sea lampreys or sea lamprey spawning activity was verified in 74 Michigan streams. Their presence in nine additional streams is considered relatively certain, but were not positively identified in these locations

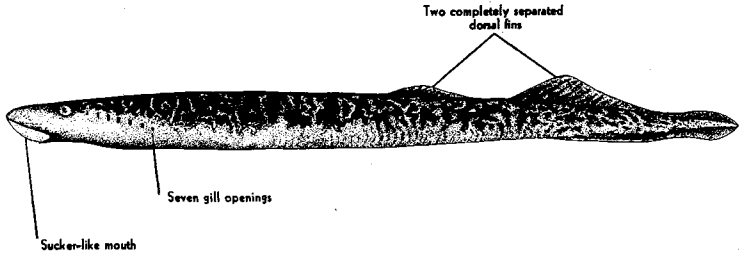
FISHERMEN!

YOUR COOPERATION IS REQUESTED

THE SEA LAMPREY IS SPREADING RAPIDLY THROUGH MICHIGAN WATERS AND IS BELIEVED TO BE A MENACE TO THE COMMERCIAL FISHERIES OF OUR STATE. THE DEPARTMENT OF CONSERVATION IS ENGAGED IN A PROGRAM TO LEARN METHODS OF CONTROL OF THIS FISH PARASITE.

SEA LAMPREYS MIGRATE INTO MANY OF OUR STREAMS AND RIVERS EACH SPRING TO SPAWN.

IF YOU SEE ONE OR MANY OF THESE PARASITES IN A STREAM OR RIVER, PLEASE NOTIFY THE LOCAL CONSERVATION OFFICER OR THE NEAREST STATE FISH HATCHERY. OR, IF THIS IS NOT PRACTICABLE, WRITE CONSERVATION DEPARTMENT, LANSING.



SEA LAMPREY

Adult sea lampreys usually will be more than a foot long. They usually appear mottled with brown and black on the backs and they may have a somewhat golden tint.

MICHIGAN DEPARTMENT OF CONSERVATION

Figure 1.--Poster utilized in 1947 to request aid of public in reporting sea lamprey spawning runs.

Figure 2

INSTITUTE FOR FISHERIES RESEARCH
Division of Fisheries
MICHIGAN DEPARTMENT OF CONSERVATION

REPORT OF SEA LAMPREY SPAWNING RUN

County _____ Main Drainage _____
Name of stream _____ Trib. to _____
Point of examination _____
(Locate to section or fraction if possible)

(Check appropriate answers unless otherwise indicated)

1. How many sea lampreys were observed by you:
   One or several? _____ A large number? _____

2. Under what conditions were they observed:
   During passage upstream? _____
   On or using their spawning beds? _____
   Attached to some species of fish? _____
   Below a dam? _____
   At a weir? _____
   (Other?) _____

3. What is your estimate of the size of the run:
   Scattered migrants only? _____
   A small number of migrants? _____
   A moderate number of migrants? _____
   A large number of migrants? _____

4. If sea lampreys were observed on their spawning grounds, you may be able to estimate the number present and the extent of the spawning grounds:

   What is your estimate of the number of spawners? _____

   What is your estimate of the spawning area being used (use convenient linear measure)? _____

5. Where you made your observations, what was the:

   Water temperature? _____ Air temperature? _____ Time? _____

   Color and turbidity of the water:
   White? _____ Light brown? _____ Brown? _____
   Clear? _____ Turbid? _____ Heavily silted? _____

   Stream bottom type: mud? _____ sand? _____ gravel? _____
   rubble? _____ rocky? _____

   Current: Sluggish? _____ Moderate? _____ Rapid? _____

   Width of stream? _____ Depth _____
   (feet or yards)

due to circumstances beyond the control of the investigators. These latter streams are classified as "reliable reports." A summary of these data is presented in Table 1. All verified and reliably reported sea

(Insert Table 1)

lamprey runs (in 1947) have been plotted upon a distribution map and are presented in Figure 3. The name, location, and other pertinent data for each verified and reliable report is incorporated in Table 2.

(Insert Table 2)

An inspection of Table 1 reveals some interesting facts. Of the 69[1] streams reported to support sea lamprey spawning runs in 1946, 33 or 47.8 percent were reported to contain sea lampreys in 1947. Consequently, 50 or 60.2 percent of the 83 verified and reliable reports established in 1947 are, in effect, new records.

Figure 3 and Table 1 give the impression that the bulk of sea lamprey spawning activity occurs in the northern half of the southern peninsula of Michigan. This is not necessarily so. The spring of 1947 was an extremely wet season and more or less sustained flood conditions existed in southern Michigan (Region 3) streams during this period. High and turbid water interfered materially in stream observations and doubtless many runs were not noted for this reason. In the upper peninsula, the eastern and northern margins (Lake Munuscong area, Whitefish Bay and Lake Superior) are backed with large areas of wild and inaccessible land with relatively few inhabitants to report runs.

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[1] Sixty-eight streams were reported by Shetter (1948). One additional report was revealed in subsequent examination of the data.

Table 1.--Summary of reports of migrating sea lampreys in Michigan streams in 1947.

Drainage	Total reports (1947)[1]	New records in 1947	1946 runs verified or reported in 1947	Total reported in 1946
Region 1				
Lake Superior	2 (1)	1	1	10
Lake Michigan	12	7	5	10
Lake Huron (also Munuscong Lake)	2	0	2	10
Subtotals	16	8	8	30
Region 2				
Lake Michigan	24	15	9	13
Lake Huron	27 (3)	13	14	18
Subtotals	51	28	23	31
Region 3				
Lake Michigan	16 (5)	14	2	4
Lake Huron	0	0	0	2
Lake Erie	0	0	0	1
Lake St. Clair	0	0	0	1
Subtotals	16	14	2	8
Totals	83[1]	50	33	69

[1] Verified and reliable reports combined in totals. Numbers in parentheses are number of reliable reports included. All others were verified.

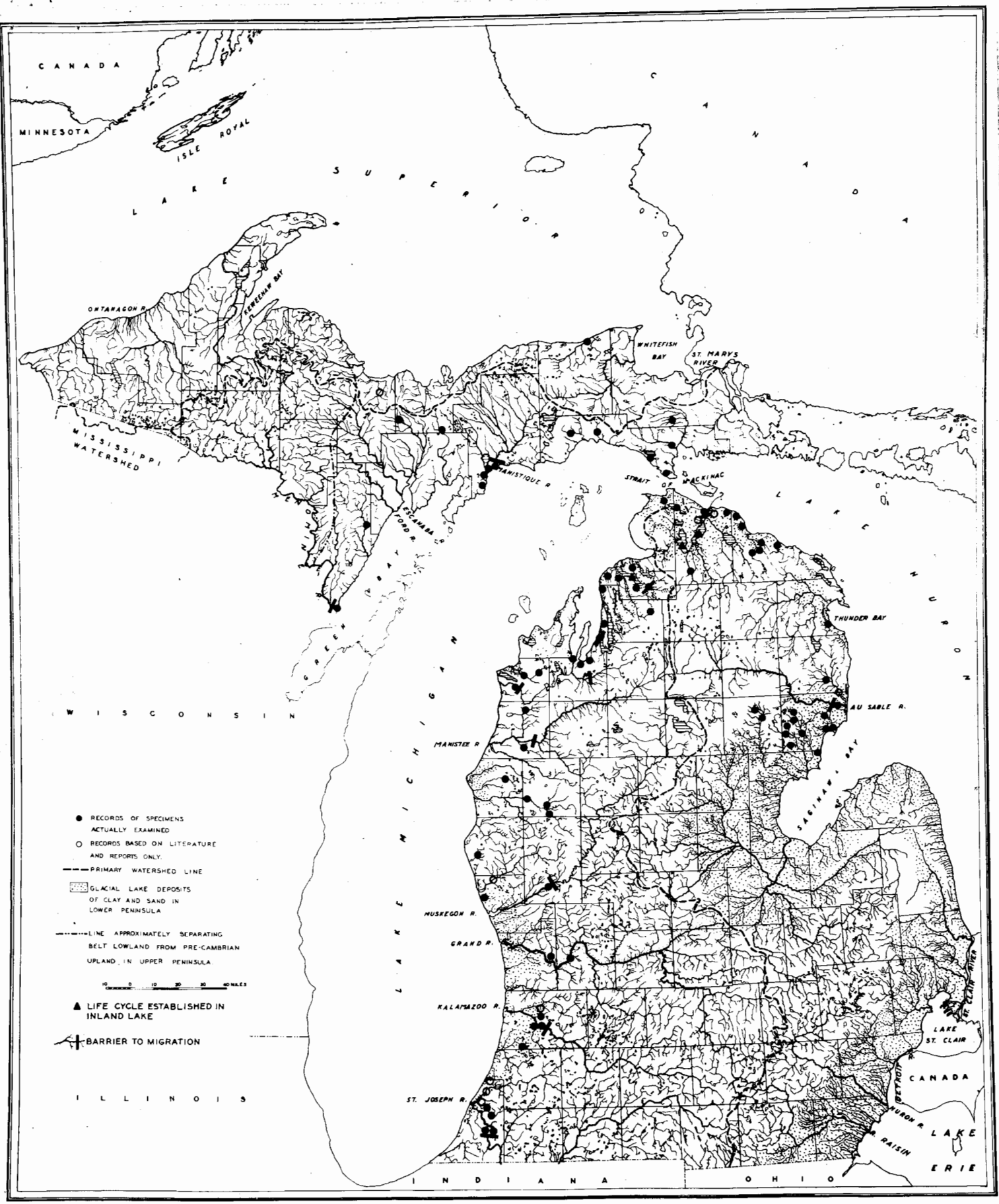

Figure 3.--Distribution of migrating and spawning sea lampreys observed or reported in 1947.

Table 2.--Name and location of streams containing migrating or spawning sea lampreys in 1947 with an estimate of the size of the run.

Upper Peninsula

Region 1

Drainage	Tributary to	County	Stream	Specific location of observations	Spawning run: Verified	Spawning run: Reliably reported	Estimate of size of run	Date observed (1947)	Water temperature (degrees Fahrenheit)	Observers	Run reported in 1946	New record in 1947
Lake Superior	Lake Superior	Luce	Two Hearted River	T50N, R9W, Sec. 27	X	...	?	August 22	...	Cooper, Fukano	...	X
Lake Superior	Lake Superior	Marquette	Chocolay River	T46N, R24W, Sec. 13	...	X	...	?	50°	Reynolds	X	...
Lake Michigan	Lake Michigan (Green Bay)	Menominee	Big Cedar River	T37N, R25W, Sec. 23	X	...	?	June 27	...	Loeb	...	X
Lake Michigan	Lake Michigan (Green Bay)	Menominee	Menominee River	T32N, R27W, Sec. 1	X	...	Large	June 6 to 15	56°	Reynolds	X	...
Lake Michigan	Lake Michigan	Alger	W. Br., Whitefish River	T45N, R22W, Sec. 32	X	...	?	June 18 (?)	...	Roberts, Reynolds	...	X
Lake Michigan	Lake Michigan	Schoolcraft	Manistique River	Paper Mill Dam, Manistique	X	...	Large	June 5 to 25	63°	Shust, Reynolds, Loeb	X	...
Lake Michigan	Lake Michigan	Schoolcraft	Thompson Creek	T41N, R16W, Sec. 32	X	...	Small	July 16	...	Reynolds	X	...
Lake Michigan	Lake Michigan	Schoolcraft	Johnson Creek	T40N, R16W, Sec. 6	X	...	Small	July 16	...	Reynolds	...	X
Lake Michigan	Lake Michigan	Schoolcraft	Bursaw Creek	T40N, R16W, Sec. 23	X	...	Small	July 16	...	Reynolds	X	...
Lake Michigan	Lake Michigan	Alger	Sturgeon River	T44N, R19W, (Sec. 28?)	X	...	Moderate ?	June 26	...	Loeb	...	X
Lake Michigan	Millecoquins River	Mackinaw	Furlong Creek	T43N, R10W, Sec. 8	X	...	Moderate	June 25	63°	Loeb, Applegate	...	X
Lake Michigan	Lake Michigan	Mackinaw	Black River	T43N, R9W, Secs. 1, 13	X	...	Moderate ?	April 20	...	Loeb, Kilpela	...	X
Lake Michigan	Lake Michigan	Mackinaw	Brevoort River	T41-42N, R5W, Secs. 11, 33	X	...	?	July 12, 17	70°	Reynolds, Loeb	X	...
Lake Michigan	Lake Michigan	Mackinaw	Sucker Creek	T40N, R4W, Sec. 10	X	...	?	July 12	73°	Loeb	...	X
Lake Huron	St. Martin's Bay	Mackinaw	Carp River	T42N, R3W, Sect. 19	X	...	?	July 12	68°	Loeb	X	...
Lake Huron	Pine River	Chippewa	Trout Brook	T44N, R3W, Secs. 17, 18	X	...	Small	July 9	66°	Loeb	X=	...

(continued)

Table 2A.--Name and location of streams containing migrating or spawning sea lampreys in 1947 with an estimate of the size of the run.

Lower Peninsula

Region 2

Drainage	Tributary to	County	Stream	Specific location of observations	Spawning run: Verified	Spawning run: Reliably reported
Lake Michigan	Carp Lake	Cheboygan	Mud Creek	T38N, R3W, Sec. 20	X	...
Lake Michigan	Lake Michigan	Emmet	Carp River	T39N, R4W, Sec. 29	X	...
Lake Michigan	Lake Charlevoix	Charlevoix	Loeb Creek	T33N, R8W, Sec. 1	X	...
Lake Michigan	Lake Charlevoix	Charlevoix	Porter Creek	T33N, R6W, Sec. 32	X	...
Lake Michigan	Lake Charlevoix	Charlevoix	Horton Creek	T33N, R6W, Sec. 6	X	...
Lake Michigan	Lake Charlevoix	Charlevoix	Boyne River	T32N, R5W, Sec. 5	X	...
Lake Michigan	Lake Michigan	Charlevoix	McGeach Creek	T33N, R8W, Sec. (?)	X	...
Lake Michigan	Lake Michigan	Antrim	Antrim Creek	T32N, R9W, Sec. 14	X	...
Lake Michigan	Lake Michigan	Antrim	Elk River	Public Service Dam, Elk. Rapids	X	...
Lake Michigan	Lake Charlevoix	Antrim	Jordan River	T31N, R5W, Sec. 31	X	...
Lake Michigan	Lake Michigan	Antrim	Mitchell Creek	T30N, R9W, Sec. 22	X	...
Lake Michigan	Lake Michigan	Grand Traverse	Boardman River	Damin Traverse City	X	...
Lake Michigan	E. arm, Grand Traverse Bay	Grand Traverse	Mitchell Creek	T27N, R10W, Sec. 7	X	...
Lake Michigan	E. arm, Grand Traverse Bay	Grand Traverse	Acme Creek	T28N, R10W, Sec. 34	X	...
Lake Michigan	Lake Michigan	Benzie	Platte River	T26N, R13W, Sec. 6 T26N, R14W, Sec. 8	X	...
Lake Michigan	Lake Michigan	Benzie	Betsie River	T25N, R15W, Sec. 2	X	...
Lake Michigan	Manistee River	Manistee	Big Bear Creek	Bear Cr. trout rearing sta. (T24N, R14W, Sec. 29)	X	...
Lake Michigan	Manistee River	Manistee	Pine Creek	T21N, R14W, Sec. 8	X	...
Lake Michigan	Lake Michigan	Mason	No. Branch, Lincoln River	T19N, R16W, Sec. 13	X	...
Lake Michigan	Lake Michigan	Lake	Pere Marquette R.	T18N, R14W, Secs. 29, 30	X	...
Lake Michigan	Pere Marquette R.	Lake	Baldwin Creek	T17N, R13W, Sec. 10	X	...
Lake Michigan	Pere Marquette R.	Lake	Little So. Branch Pere Marquette River	T17N, R13W, Sec. 27	X	...
Lake Michigan	Lake Michigan	Oceana	Stony Creek	T14N, R18W, Sec. 26	X	...
Lake Michigan	Lake Michigan	Newaygo	Muskegon River	Below Newaygo Power Dam (T12, R13W, Sec. 24)	X	...
Lake Huron	Lake Huron	Cheboygan	Greene Creek	T38N, R2E, Secs. 31, 32	X	...
Lake Huron	Lake Huron	Cheboygan	Cheboygan River	Paper Mill Dam, Cheboygan	X	...
Lake Huron	Burt Lake	Cheboygan	Sturgeon River	T33N, R2W, Sec. 6	X	...
Lake Huron	Lake Huron	Cheboygan	Elliot Creek	T38N, R1W, Sec. 26	...	X
Lake Huron	Cheboygan River	Cheboygan	Laparell Creek	T37N, R2W, Sec. (?)	...	X
Lake Huron	Lake Huron	Presque Isle	Trout Creek	T35N, R5E, Sec. 17	X	...
Lake Huron	Ocqueoc River	Presque Isle	Little Ocqueoc R.	T35N, R3E, Secs. 23, 24	X	...
Lake Huron	Lake Huron	Presque Isle	Carp Creek	T36-37N, R2E, Secs. 1, 36	X	...
Lake Huron	Lake Huron	Presque Isle	Ocqueoc River	(See other reports)	X	...
Lake Huron	Lake Huron	Presque Isle	Milligan Creek	T37N, R2E, Sec. 4	X	...
Lake Huron	Ocqueoc River	Presque Isle	Silver Creek	T35N, R3E, Sec. 18	X	...
Lake Huron	Lake Huron	Alpena	Devils River	T29N, R8E, Sec. (?)	X	...
Lake Huron	Pine River	Alcona	McGillis Creek	T25N, R8E, Sec. 8	X	...
Lake Huron	Tawas Creek	Iosco	Cold Creek	T22N, R8E, Sec. 19	X	...
Lake Huron	Lake Huron	Iosco	Au Gres River	T22N, R5E, Secs. 19, 20	X	...
Lake Huron	Au Gres River	Iosco	E. Br., Au Gres R.	T21N, R6E, Sec. 4 T22N, R6E, Secs. 21-28	X	...
Lake Huron	Au Gres River	Iosco	Hope Creek	T22N, R5E, Secs. 9, 21	X	...
Lake Huron	E. Br., Au Gres R.	Iosco	Hale Creek	T23N, R5E, Secs. 15,17,26	X	...
Lake Huron	Lake Huron	Iosco	Tawas Creek	T22N, R8E, Sec. 30	X	...
Lake Huron	E. Br., Au Gres R.	Iosco	Smith Creek	T23N, R5E, Sec. 13 T23N, R6E, Sec. 19	X	...
Lake Huron	Lake Huron	Iosco	Au Sable River	T24N, R8E, Sec. 35	X	...
Lake Huron	Au Gres River	Iosco	Johnson Creek	T21N, R5E, Sec. 23	X	...
Lake Huron	Tawas Lake	Iosco	Silver Creek	T23N, R8E, Sec. 19	X	...
Lake Huron	Au Sable River	Iosco	Pine River	T24N, R9E, Sec. 6	...	X
Lake Huron	Lake Huron	Ogemaw	Rifle River	T23N, R3E, Sec. 11	X	...
Lake Huron	Rifle River	Ogemaw	Houghton Creek	T24N, R3E, Sec. (?)	X	...
Lake Huron	Lake Huron	Arenac	Whitney Drain	T20N, R7E, Secs. 12, 13	X	...

n estimate

16-a
cont

ower Peninsula

Region 2

Spawning run: Verified	Spawning run: Reliably reported	Estimate of size of run	Date observed (1947)	Water temperature (degrees Fahrenheit)	Observers	Run reported in 1946	New record in 1947
X	...	Small	June 22	71°	Crowe	...	X
X	...	Moderate	April 20-June 22	71°	Crowe, Wykhuis	X	...
X	...	Small	June 23	66°	Crowe	...	X
X	...	Small	June 23	62°	Crowe	...	X
X	...	Small	June 23	59°	Crowe	X	...
X	...	Small	May 23	57°	Crowe	...	X
X	...	?	June 17	...	Crowe, Miles	...	X
X	...	?	June 16	...	Crowe, Miles	...	X
X	...	?	June 6	...	Crowe, Miles	X	...
X	...	?	June 16	...	Crowe, Miles	X	...
X	...	?	June 15	...	Crowe, Miles	...	X
X	...	Moderate	June 6	56°	Lievense	X	...
X	...	?	May 10	...	Lievense	...	X
X	...	?	May 10	...	Lievense	X	...
X	...	?	June 21 (?)	...	Lievense, Waters	X	...
X	...	Moderate(?)	May 9, 20	45°, 54°	Lievense	X	...
X	...	Moderate(?)	June 15	52°	Lievense, Bohland	...	X
X	...	Small	June 28	...	Lievense	...	X
X	...	Small	June 9	70°	Lievense	...	X
X	...	?	June 24	...	Lievense, Kidder	...	X
X	...	?	June 26	62°	Lievense	...	X
X	...	Moderate	June 20 (?)	...	Lievense, Wilkinson, Weaver	...	X
X	...	Small	June 27	69°	Lievense	...	X
X	...	?	April 19	...	Eschmeyer	X	...
X	...	Small	June 19	59°	Crowe	...	X
X	...	Large	May 10-June 11	45°-59°	Crowe	X	...
X	...	?	June 24	...	Crowe	...	X
...	X	?	?	...	Crowe	X	...
...	X	?	?	...	Crowe	...	X
X	...	Small	June 22	68°	Applegate	...	X
X	...	Small	June 23	60°	Applegate	X	...
X	...	Moderate	April 14-July 13	38° - 75°	Applegate	X	...
X	...	Large	May 11-July 19	38° - 78°	Applegate	X	...
X	...	Small	April 19	...	Applegate	...	X
X	...	Small	July 2	59°	Applegate	X	...
X	...	?	April 20 (?)	...	Applegate, Peterson	X	...
X	...	?	June 25 (?)	...	Johnson	...	X
X	...	Moderate	June 13	47°	Allison	X	...
X	...	?	June 13	50°	Allison	...	X
X	...	Small	June 13,17	51°,52°	Allison	X	...
X	...	Moderate	June 13	49°	Allison	...	X
X	...	Moderate	June 13	51°	Allison	...	X
X	...	?	April 23	...	Allison	X	...
X	...	Moderate	June 17	44°	Allison	...	X
X	...	Large	June 18	...	Allison	X	...
X	...	Small	June 17	48°	Allison	...	X
X	...	Moderate (?)	June 25 (?)	...	Allison	X	...
...	X	?	?	...	Allison	X	...
X	...	Moderate (?)	June 13	...	Hughes	X	...
X	...	Small	June 21	...	Hughes	...	X
X	...	?	April 22-23	...	Cooper, Bailey	...	X

Table 2 (continued).--Name and location of streams containing migrating or spawning sea lampreys in 1947 with an estimate of the size of the run.

Lower Peninsula

Region III

Drainage	Tributary to	County	Stream	Specific location of observations	Spawning run: Verified	Spawning run: Reliably reported	Estimate of size of run	Date observed (1947)	Water temperature (degrees Fahrenheit)	Observers	Run reported in 1946	New record 1947
Lake Michigan	Lake Michigan	Muskegon	Duck Lake Outlet	T11N, R18W, Sec. 13	X	...	?	May 2	48°	Predmore	...	X
Lake Michigan	Lake Michigan	Muskegon	White River	T12N, R17W, Secs. 11, 14	...	X	?	May 1 (?)	...	Predmore	X	...
Lake Michigan	Grand River	Ottawa	Sand Creek	T7N, R13W, Sec. 15	X	...	Small	June 16	55°	Yoder	...	X
Lake Michigan	Lake Michigan	Kent	Grand River	4th St. Dam, Grand Rapids	X	...	Moderate	June 6	...	Yoder	...	X
Lake Michigan	Kalamazoo River	Allegan	Swan Creek	T2N, R14W, Sec. 17	X	...	Small	June 14	58°	Yoder	...	X
Lake Michigan	Black River	Allegan	Barbour Creek	T1N, R15W, Sec. 28	X	...	?	June 7	...	Yoder	...	X
Lake Michigan	Lake Michigan	Allegan	Kalamazoo River	Allegan Dam	X	...	Large (?)	May 1	54°	Predmore	X	...
Lake Michigan	St. Joseph River	Berrien	Lemon Creek	T6S, R18W, Sec. 15	X	...	Small	June 16	51°	Yoder	...	X
Lake Michigan	Lake Michigan	Berrien	St. Joseph River	Power House, Berrien Springs	X	...	Large	June 16	...	Yoder	...	X
Lake Michigan	Paw Paw River	Berrien	Blue Creek	Benton Harbor Hatchery	X	...	Small	June 14	53°	Yoder, Brass	...	X
Lake Michigan	St. Joseph River	Berrien	Pipestone Creek	T5S, R18W, Secs. (?)	X	...	Moderate (?)	June 8 (?)	...	Vander Roest	...	X
Lake Michigan	Lake Michigan	Berrien	Paw Paw River	T3-4S, R18W, Secs. (?)	...	X	?	June (?)	...	Vander Roest	...	X
Lake Michigan	Paw Paw River	Berrien	Yellow Creek	T4S, R18W, Secs. 11, 12	...	X	?	June (?)	...	Vander Roest	...	X
Lake Michigan	St. Joseph River	Berrien	Rogers Creek	T3S, R17W, Secs. 5, 6	...	X	?	June (?)	...	Vander Roest	...	X
Lake Michigan	Kalamazoo River	Allegan	Bear Creek	T3N, R14W, Secs. 27, 28	X	...	Small	June (?)	...	Applegate	...	X
Lake Michigan	Big Rabbit River	Allegan	Silver Creek	T3N, R14W, Sec. 2	...	X	Small	June (?)	...	Applegate	...	X

Only one run was verified in this area. It is hoped that in the spring of 1948, a specific survey can be made of the waters flowing into Lake Munuscong and eastern Lake Superior to determine the extent of the establishment of the species in these waters. Mr. Leland Anderson, District Fisheries Biologist at Watersmeet, made such a survey of streams entering Lake Superior in the western third of the Upper Peninsula (District 1) during the past spring. Fifty-six streams were examined by him between May 28 and July 11. Curiously, he found no sign of sea lampreys in these streams at the points examined. In spite of this, there seems little doubt now that the species is established in Lake Superior. However, I believe we may anticipate only small and widely scattered runs of spawning migrants in this basin for several years to come and these will assuredly be difficult to locate.

More easily accessible streams and only moderate flood conditions facilitated the inventory in the northern half of the southern peninsula (Region 2). I believe that we have definitely located the major spawning runs in this area. Unfortunately we have very little accurate data as to the magnitude of the various runs. Only estimates of the numbers could be made and often times not even that was possible. Estimates of the size of the runs that were made by observers in the field may be found in one of the right hand columns of Table 2.

Generally speaking, we have established the presence of sea lamprey spawning runs in every major Michigan watershed in the Lake Michigan basin: the St. Joseph, Kalamazoo, Grand, Muskegon, Pere Marquette, Manistee, Platte, Boardman, Manistique and Menominee rivers. These rivers support the largest runs observed in this basin. In northern Lake Huron (north of Saginaw Bay) four of the five major watersheds attracted spawning

migrants: the Au Gres, Au Sable, Ocqueoc and Cheboygan rivers. Again, these were the largest runs observed in this area.

Perhaps in another season, with more favorable weather and stream conditions, we will find that sea lamprey spawning runs are still entering the Clinton and Huron rivers and possibly other streams in southeastern Michigan (southern Lake Huron, Lake St. Clair and Lake Erie drainages). Although sea lampreys were not reported in the aforementioned two rivers in 1947, they were utilized by them as early as 1938 and 1932 respectively, and there is no reason to assume that they would no longer be entering either stream.

Evidence of establishment in inland lakes

Until this year, there was some conjecture as to whether the sea lamprey could, or would, become established in some of our large and rather deep inland lakes. Primarily through the efforts of Mr. Walter R. Crowe, District Biologist at Indian River, Michigan, we now have proof that small populations of this fish are passing their adult, parasitic period in Burt and Mullet lakes, Cheboygan County. Furthermore, these small populations are apparently creating limited spawning runs of their own in tributaries of the Cheboygan River drainage of which the lakes are a part. The Cheboygan River itself is blocked at its mouth by a power dam which in itself constitutes a virtual barrier to further migration of the large run entering that river each year from Lake Huron. Unfortunately this barrier is accidentally by-passed in two manners: first, a boat lock, adjacent to the dam, is occasionally operated during the spring season and undoubtedly acts as an efficient "fish elevator"; secondly, it is considered fine sport among the younger Cheboygan residents to dip sea lampreys at the base of the spillway during

their periods of concentration there. Frequently, in their excitement they throw the lampreys over the causeway atop the dam into the upper river channel. This has been noted by several reliable observers. By one or both of these methods, spawning migrants are introduced into the drainage each year.

The evidence pointing to establishment in Burt and Mullet lakes is itemized as follows:

(1) A sexually immature adult sea lamprey, 15.1 inches long (weight - 135 grams) was taken in Burt Lake on August 1, 1947. This specimen was attached to a rainbow trout.

(2) A sexually immature adult sea lamprey, 12.2 inches long (weight - 68 grams) was taken in Mullet Lake off the mouth of Nigger Creek on August 1, 1947. This specimen was attached to a sucker.

(3) An adult sea lamprey, attached to a sucker, was taken in Mullet Lake near Topinabee on August 16, 1945. (Specimen identified by Dr. C. W. Creaser).

(4) A spawning migrant was observed in the Sturgeon River (tributary to Burt Lake) at Wolverine on June 24, 1947.

(5) The report of a spawning run in Laparell Creek, tributary to the Cheboygan River below Mullet Lake, is considered very reliable.

Items one to three alone are considered adequate evidence of establishment of the species in these lakes. Data collected elsewhere seem to indicate that transforming and newly transformed sea lampreys generally do not become resident in smaller and/or less suitable lakes in a watershed, but pass directly downstream to "the big lakes."

Other inland lakes, connected more or less directly with the Great Lakes are undoubtedly acting as additional reservoirs for adult populations. We have received several reports of adults being taken during the winter months in Lake Charlevoix (Charlevoix County) on speared whitefish, perch and ciscoes. Dr. A. H. Stockard of the Zoology Department, University of Michigan, reported on November 6, 1947, that fishermen in Lake Charlevoix were spearing sea lampreys that had attached themselves to the bottoms of their power boats. Fishermen trolling in the same lake report sea lampreys attaching themselves to the stern of the moving boat.

We have received several reports indicating the presence of sexually immature adults in Pentwater Lake, Oceana County. Like Lake Charlevoix, this lake is connected directly with Lake Michigan by a short channel. The most reliable of these reports concerned an 18.5-inch sea lamprey attached to a five-pound rainbow trout that was taken on November 1, 1947.

Lake Fenton, Genesee County, Little Traverse Lake, Leelanau County, and Lake Geneserath, Beaver Island alledgedly contained sea lampreys this year, but I consider these reports very doubtful.

Effect of obstructions and barriers to migration

For the purposes of this discussion, a barrier to migration is differentiated from an obstruction to migration in that the former cannot be surmounted by migrating sea lampreys whereas the latter can be passed with varying degrees of difficulty and with, perhaps, some selective action upon the migrating population. The sea lamprey can and does negotiate many natural obstructions (falls) and low or irregularly constructed dams of moderate height. A good example of this is in the Ocqueoc River, Presque Isle County, where nearly one-half of the spawning

migrants work their way over two natural falls, 4.5 and 6 feet high, respectively, and an old cement mill dam. (See Figures 4, 5 and 6). In another instance, migrants are known to pass over (or through ?) an irregularly constructed logging dam of some height situated on Silver Creek, Iosco County (see Figure 7).

On the other hand, in some of our rivers known to have sea lamprey runs, we have man-made dams which apparently form effective barriers to further migration. In the light of present information we tentatively consider certain of these structures to be impassable for two reasons: (1) the nature and/or structure of the dam and the manner of passage of water over it, or through its power units, precludes possibility of surmounting the dam, and (2) as yet, no reports of the presence of sea lampreys have been verified above the barriers (except the Cheboygan dam). Following is a list of these dams, the watersheds they effect and other pertinent data. Only those dams are considered that lie in watersheds known to have sea lamprey spawning runs.

Region 1.

1. Menominee River - Menominee Lower Dam #1 in Menominee, Michigan; approximately 2.5 miles from mouth; built in 1924; concrete; 12' head; spillway 22' wide; fish ladder reported in operation in 1939.

2. Manistique River - Manistique Pulp and Paper Mill dam; about 1 mile from mouth; concrete; 27' head; flow passes through plant machinery; apparently blocked from upper river by this structure. However, sea lamprey spawning formerly occurred in seepage channel alongside flume of dam. Lampreys reached this channel via the

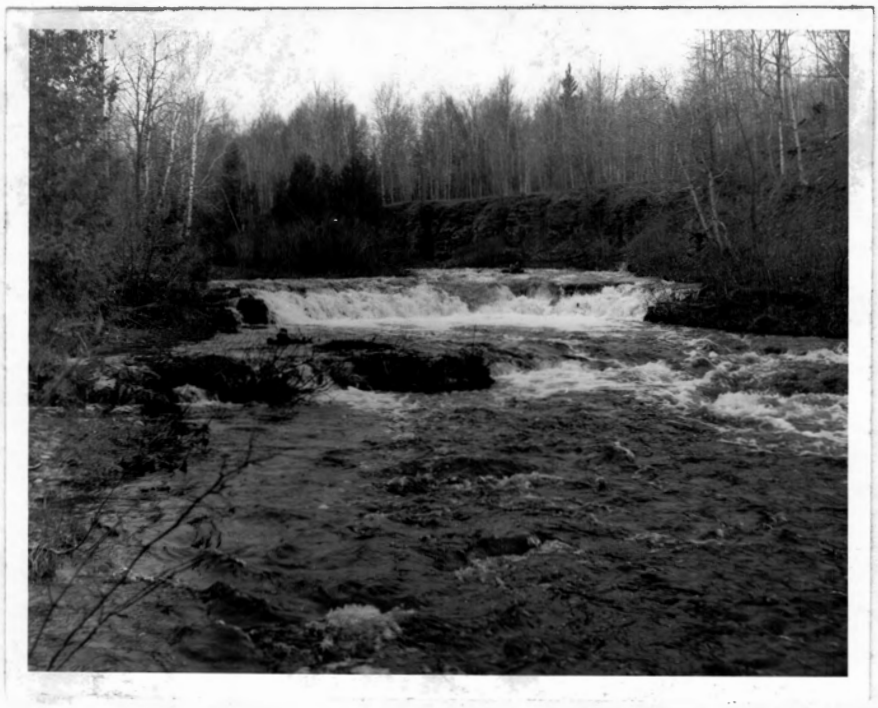

Figure 4.--Lower Falls, Ocqueoc River, Presque Isle County. May 17, 1947.

Figure 5.--Upper Falls, Ocqueoc River, Presque Isle County. May 17, 1947.

Figure 6.--Old mill dam at M-68 bridge, Ocqueoc River, Presque Isle County. May 17, 1947.

Figure 7.--Saw mill dam on Silver Creek, Iosco County. July, 1947.

"hot-pond" overflow and plant sewage disposal pipe. Recent changes in this drain have apparently blocked the lamprey from even this limited spawning area.

Region 2.

1. Cheboygan River - Michigan Public Service Company hydro-electric dam in Cheboygan, Michigan; 3/4 mile from mouth; built in 1868; wood and concrete; 14.5' head; flow through turbines or over spillway; fish chute reportedly inoperative; ship lock present; believed a barrier except when locks operated in spring months. See Figure 8.

2. Au Sable River - Foote Dam (Consumers Power Company), T24N, R8E, Secs. 34-35; approximately 10 miles from mouth; built in 1917; concrete; 38' head; spillway 72' wide; flow through turbines or over spillway; fish ladder present but inoperative; believed to constitute barrier (L. N. Allison). See Figure 9.

3. Elk River - Michigan Public Service Company power dam, Elk Rapids, Michigan; 1/10 mile from mouth; built in 1915 (reconstructed 1930) earth construction; 10' head; 20' wide spillway; flow through turbines or over spillway. No fish chute or ladder present; believed to constitute barrier (W. R. Crowe).

4. Boyne River - Boyne City Power Dam (Michigan Public Service Company), T32N, R5W, Sec. 5; approximately 3-1/2 miles above Lake Charlevoix; built in 1903; concrete and earth; 33' head; 22' wide spillway; flow through turbines

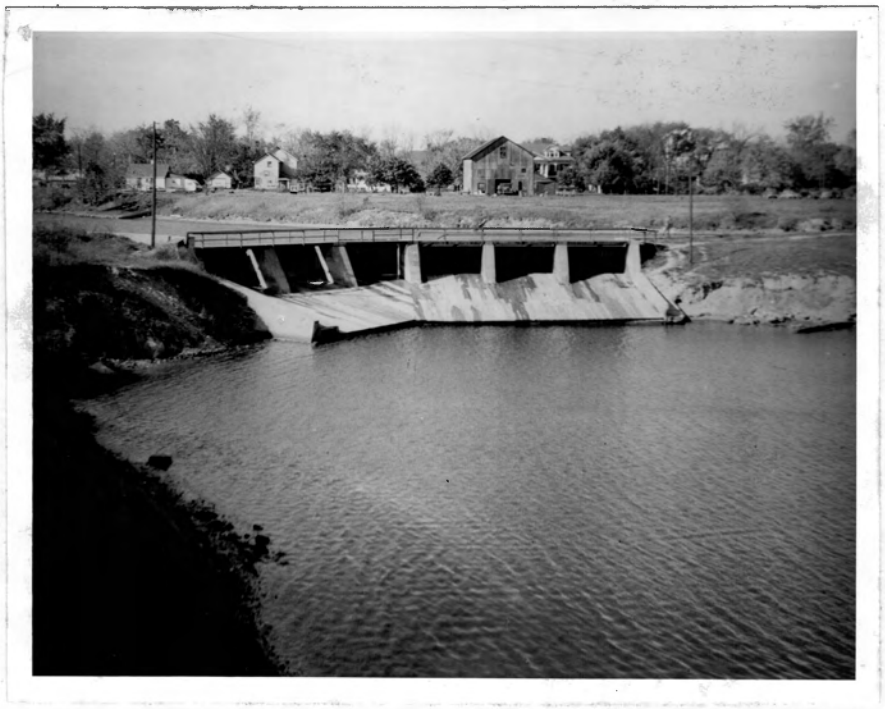

Figure 8.--Power dam on the Cheboygan River in Cheboygan, Michigan.

Figure 9.--Foote Dam on the Au Sable River (Iosco County). Photo by L. N. Allison.

or over spillway; believed to constitute barrier (W. R. Crowe).

5. Boardman River - Three dams are present within 5-1/2 miles of the mouth of the river. The first, a damaged rock and earth fill dam in Traverse City, constitutes only a partial obstruction to migration. Either of two hydro-electric dams, T27N, R11W, Secs. 27 and 34 are believed to constitute effective barriers (S. Lievense).

6. Betsie River - Homestead Dam, T25N, R15W, Sec. 2 (Benzie County); approximately 7 miles from mouth; concrete; flow through turbines or over spillway; fish chute present but reportedly inoperative; believed to constitute barrier (S. Lievense).

7. Manistee River - Tippy Dam (Consumers Power Company), T22N, R13W, Sec. 31; approximately 18 miles from mouth; built in 1917-18; earth dam with concrete core wall; 56' head; 118' wide spillway; flow through turbines or over spillway; fish ladder present but reportedly inoperative; believed to constitute barrier (S. Lievense).

8. Muskegon River - Newaygo Power Dam (Consumers Power Company), T12N, R12W, Sec. 19; approximately 30 miles above Muskegon Lake; built in 1900; concrete; 18' head; 96' wide spillway; flow through turbines or (overflow) through flume at base of dam - velocity of flow very high in flume when opened; fish chute present, but reportedly inoperative; believed to constitute barrier to migration (Eschmeyer, P.E.).

Region 3.

1. Kalamazoo River - Allegan City Power Dam; approximately 21 miles from mouth; concrete; 16' head; 132' wide spillway; flow through turbines or (overflow) through drains at base -- velocity of flow in latter very high when open; fish ladder present, but inoperative; believed to constitute barrier (T. Yoder and H. Hatt).

2. St. Joseph River - Power dam at Berrien Springs, Michigan (Indiana and Michigan Electric Company); approximately 20 miles from mouth; built in 1907; concrete; 23' head; 149' wide spillway; flow through turbines or over spillway; inoperative fish ladder cored into dam; believed to constitute barrier (T. Yoder).

Each of the preceding dams have been plotted in their proper location on the distributional map (Figure 3). Examining the map again, it should be noted that the greater portion of some of our major watersheds lie above these dams. If we are correct in assuming that these structures are barriers to the spawning migration of sea lampreys, we find ourselves in a fortunate situation. In the St. Joseph, Kalamazoo, Muskegon, Manistee, Manistique, Menominee and Au Sable rivers, the sea lamprey is denied access to tremendous potential spawning areas. This condition has doubtlessly restricted, to some degree, the rate of increase of the species and most certainly limits the total numbers which our watersheds might otherwise produce.

It should be considered hereafter that any improvement of the apparently ineffectual fish ladders and chutes present on most of the aforementioned dams will materially aid the sea lampreys in reaching new spawning grounds and increasing their total numbers.

The Cheboygan, Elk Rapids, Manistique and Menominee dams are all located very close to the mouths of their respective rivers. Each year large spawning runs enter these rivers and are in evidence below the dams throughout the migratory period. The fate of these migrants is still questionable. It does not seem likely that they can spawn in the deep estuaries prevalent below these dams. Two alternatives are suggested: (1) that these blocked migrants are eventually diverted to other obstruction-free streams nearby along the shore line or (2) that they remain in the estuary of the river they entered and ultimately die without spawning. We have little evidence to date that either occurs. The writer favors the second contention primarily because of the parallel in physiology and habits between the sea lamprey and the Pacific species of salmon which do die without spawning when blocked from their spawning grounds. Careful observations will be made during the 1948 season in an effort to determine more precisely the fate of the blocked migrants.

Distance of migration

Some interest has been expressed in how far a migrating sea lamprey will travel in quest of a suitable spawning ground. The following examples have been selected from observed spawning ground records and serve only to illustrate this point. All distances are approximate having been computed with a map-measurer on small scale maps.

Region I

Sturgeon River, Alger County . . . . . 39 miles

Trout Brook, Chippewa County . . . . . 22-1/2 miles

Region II - Lake Huron Drainages

Ocqueoc River, Presque Isle County . . . . 19 miles

Au Gres Watershed:

Hale Creek, Iosco County. . . . . .34 miles

Hope Creek, Iosco County . . . . . 25.5 miles

E. Br. Au Gres River, Iosco County . . . . . 23 miles

Au Gres River, Iosco County. . . . . 24 miles

Rifle River, Ogemaw County . . . . . 39 miles

Houghton Creek, Ogemaw County. . . . . 45 miles

Lake Michigan drainage.--

Little So. Br. Pere Marquette, Lake Co. . . 47 miles

Baldwin Creek, Lake County . . . . . 48 miles

Bear Creek, Manistee County. . . . . 32 miles

It seems obvious from these data that the sea lamprey is capable of migrating to the headwaters of any Michigan watershed not blocked by an effective barrier.

Characteristics of sea lamprey spawning grounds

Data relevant to the characteristics of observed sea lamprey spawning grounds was recorded by field observers for 32 streams; 6 in Region 1, 23 in Region 2, and 3 in Region 3. This information is assembled in Table 3. Briefly the tabulated data may be summarized and

(Insert Table 3)

evaluated as follows:

(1) Width and depth: streams varied in width at spawning areas from 4 to 50 feet; variation in depth of spawning areas was 2 to 60 inches. The bulk of spawning activity observed, however, occurred in depths of 12 to 24 inches, although spawning at the extremes noted was common in specific streams that were characteristically shallow or deep. For example, spawning in the Little Ocqueoc River, Presque Isle

Table 3.--Character of sea lamprey spawning grounds.

Stream	County	Color and turbidity						Stream bottom type					Current			Average width of stream (or range in width) (feet)	Depth (inches)	Temperature at time of observations (degrees Fahrenheit)
		White	Light brown	Brown	Clear	Turbid	Heavily silted	Mud	Sand	Gravel	Rubble	Rocky	Sluggish	Moderate	Rapid			
Region 1																		
Furlong Creek	Mackinaw	...	...	X	X	...	...	...	X	X	...	...	...	X	...	9	4 - 6	63
Sucker Creek	Mackinaw	...	...	...	X	...	...	...	...	X	...	...	...	X	...	10	6 - 12	73
Brevoort River	Mackinaw	...	...	...	X	...	...	...	X	X	X	X	...	X	...	35	... to 30	70
Carp River	Mackinaw	...	...	X	...	X	...	...	X	X	X	...	...	...	X	45	... to 36	68
Black River	Mackinaw	...	...	X	...	X	...	...	X	X	X	X	...	...	X	20	... to 36	...
Trout Brook	Chippewa	...	...	...	X	...	...	...	X	X	...	...	...	X	...	10	... to 30	66
Region 2																		
Mud Creek	Cheboygan	...	...	X	X	...	...	X	...	X	...	...	...	X	...	5 - 20	0 - 24	71
Loeb Creek	Charlevoix	X	...	...	X	...	...	X	X	X	...	...	...	X	...	10 - 20	12 - 24	66
Porter Creek	Charlevoix	X	...	...	X	...	...	...	X	X	...	...	...	X	...	5 - 15	12 - 24	62
Horton Creek	Charlevoix	X	...	...	X	...	...	...	X	X	...	...	...	X	...	15 - 40	12 - 24	59
Carp River	Emmet	X	...	...	X	...	...	...	X	X	X	...	...	X	...	20 - 40	0 - 48	71
Trout Creek	Presque Isle	...	X	...	X	...	...	...	X	X	...	X	...	X	...	15	10 - 24	68
Little Ocqueoc R.	Presque Isle	X	...	...	X	...	...	...	X	X	X	...	...	X	...	10	2 - 16	60
Ocqueoc River	Presque Isle	...	...	X	X	...	...	...	X	X	X	X	X	X	X	15 - 50	4 - 60+	42 - 78
Silver Creek	Presque Isle	X	...	...	X	...	...	...	X	X	...	...	...	X	...	3 - 5	3 - 8	59
Smith Creek	Iosco	...	...	...	X	...	...	...	X	X	...	...	...	X	X	5 - 15	0 - 36	44
Au Sable River	Iosco	...	...	...	X	...	...	X	X	X	...	...	...	X	...	20	24+	...
E. Br., Au Gres R.	Iosco	...	X	...	X	...	...	...	X	X	...	...	...	X	X	20 - 40	24 - 60	51 - 52
Au Gres River	Iosco	...	X	...	...	...	...	...	X	X	...	...	X	X	...	30	0 - 24	50
Johnson Creek	Iosco	...	...	...	X	...	...	X	X	X	...	...	X	X	...	5 - 8	0 - 24	48
Cold Creek	Iosco	...	...	...	X	...	...	...	X	X	...	...	...	...	X	5	0 - 30	47
Hope Creek	Iosco	...	X	...	...	...	...	...	X	X	...	...	...	X	X	4 - 15	0 - 36	49
Hale Creek	Iosco	...	X	...	...	...	...	X	X	X	...	...	...	X	X	5 - 20	... to 18	51
Little So. Br., Pere Marquette River	Lake	...	...	...	X	...	...	...	...	X	...	...	X	X	...	30	24	...
Baldwin Creek	Lake	...	X	...	X	...	...	...	...	X	X	X	...	X	...	30	12	62
Big Bear Creek	Manistee	X	...	...	X	...	...	...	X	X	X	...	...	X	...	15	12	52
Platte River	Benzie	X	...	...	X	...	...	...	X	X	X	...	...	X	...	50	24 - 48	...
No. Br., Lincoln R.	Mason	...	...	X	...	X	...	...	X	X	...	X	...	X	...	8	12	70
Stony Creek	Oceana	X	...	...	X	...	...	...	...	X	X	X	...	X	...	20	12	69
Region 3																		
Blue Creek	Berrien	...	...	...	X	...	...	...	...	X	...	...	...	X	...	5	12	53
Swan Creek	Allegan	...	X	...	...	...	...	...	...	X	...	...	...	...	X	15	18	58
Bear Creek	Allegan	X	...	...	X	...	...	...	X	X	...	...	...	X	...	5 - 8	4 - 12	...
Total streams observed: 32 (Frequency)		10[1]	7[1]	6[1]	25[2]	3[2]	0[2]	5	25	32	10	7	3	28	9	Range: 3 - 50	Range: 2 - 60	42 - 78

[1] No data for 9 streams

[2] No data for 4 streams

County, a relatively shallow stream, occurred in depths of 2 to 8 inches. On the other hand, virtually all spawning in the lower reaches of the Ocqueoc River, Presque Isle County, took place between the depths of 36 and 60+ inches.

(2) Current: generally moderate, but spawning observed in both very sluggish and very rapid water.

(3) Color and turbidity: these properties varied considerably. They have no apparent significance except in so far as dark brown or turbid waters hinder or preclude observation and prevent the recording of spawning activities under these conditions.

(4) Temperature: spawning activity was observed at temperatures ranging from 42 degrees Fahrenheit to 78 degrees Fahrenheit. There is some evidence that spawning is more common at temperatures below 50 degrees Fahrenheit than was previously believed.

(5) Stream bottom type: gravel was always present in the locations selected for nest building and spawning. Gravel and sand were the most generally preferred combination, although gravel and sand in combination with rubble and rocks were also commonly used.

The foregoing general observations agree closely with data obtained in a comprehensive study made during the past spring of sea lamprey spawning requirements in the Ocqueoc River Watershed. Any of the recorded physical or mechanical properties or characteristics of a spawning stream or spawning area can and do vary widely with but one exception. Gravel, in combination with sand, or sand and rubble, is always present as this is apparently the basic essential material for nest construction. It seems logical to conclude then that the presence or absence of adequate amounts of gravel is the most important single mechanical factor affecting sea lamprey spawning activity.

Reports of presence of native species of lampreys

In conjunction with the records obtained of sea lamprey spawning streams, eleven reports were received indicating the presence of several native species of lampreys in various streams. These reports have been incorporated in Table 4.

(Insert Table 4)

Research program for 1948

A continuation of this inventory of sea lamprey spawning streams is planned for 1948. Essentially the same procedure will be followed as in the 1947 inventory with the exception that special attention will be paid to surveys of those areas for which we obtained little or no data during the current season, i.e. southern Lake Huron and Lakes St. Clair and Erie drainages, and Munuscong Lake and eastern Lake Superior drainages.

Specific information will be sought as follows:

(1) A check for sea lamprey spawning in the nine streams reliably reported to contain spawning sea lampreys in 1947.

(2) Collection of new records of sea lamprey spawning streams.

(3) Collection of data on the relative abundance of spawning sea lampreys in specific streams as compared with former years. A considerable difference of opinion exists in reports collected in 1947.

(4) Data relevant to the establishment of the species in inland lakes.

(5) Data relevant to the fate of sea lampreys that are blocked from spawning grounds by barrier dams.

Table 4.--Reports of presence of native species of lampreys (1947)

Stream	County	Specific location	Species observed
Region 1			
Ontonagon River	Ontonagon	"Lower part"	Silver lamprey[1]
Snyder Creek	Schoolcraft	T40N, R17W, Sec. 12	American brook lamprey[2]
Deadhorse Creek	Schoolcraft	T40N, R17W, Sec. 14	American brook lamprey
Parent Creek	Schoolcraft	T39N, R17W, Sec. 4	American brook lamprey
Region 2			
(No name)	Cheboygan	T37N, R2W, Sec. 24	American brook lamprey
Laperell Creek	Cheboygan	T37N, R2W, Sec. (?)	American brook lamprey
Hortons Creek	Charlevoix	T33N, R6W, Sec. 6	American brook lamprey
Boyne River	Charlevoix	T32N, R5W, Sec. 5	American brook lamprey
Thunder Bay River	Montmorency	"At Hillman (Mich.)"	Silver lamprey
Region 3			
White Creek	Van Buren	"Hamilton twp., Sec. 4"	American brook lamprey
Swan Creek	Allegan	...	American brook lamprey

[1] Ichthyomyzon unicuspis

[2] Entosphenous lamottenii

Acknowledgments

The success of this inventory was entirely dependent upon the cooperation of many agencies. The able assistance and cooperation of the conservation officers and their district and regional supervisors of the Division of Field Administration is gratefully acknowledged. Members of the Parks and Forestry Divisions contributed assistance as did many members of the Fish Division. Messrs. Leland R. Anderson, Dexter B. Reynolds, W. R. Crowe, L. N. Allison, Stanley Lievense, H. E. Predmore, Jr., Troy Yoder and Howard Loeb, as district fisheries biologists or members of the Institute staff accomplished virtually all of the field work in connection with this study. Considerable credit is due them in this regard.

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APPENDIX I

Streams reported to have had sea lamprey spawning runs in 1946 or from which sea lampreys have presumably been recovered.

REGION I

Fish Division District	Drainage	County	Stream	Remarks	Reported by
1	Lake Superior	Baraga	Huron River		Timmer
1	Lake Superior	Gogebic	Presque Isle River		Grant
1	Lake Superior	Houghton	Pike River		Nelms
1	Lake Superior	Houghton	Pilgrim River		Nelms
1	Lake Superior	Houghton	Sturgeon River		Nelms
1	Lake Superior	Houghton	Ontonagon River	"Lower Ontonagon"	Boyd
2	Lake Superior	Alger	Anna River	Paper mill screen	Carlson
2	Lake Superior	Chippewa	Waiska River		McLean
2	Lake Superior	Marquette	Sand River	T47, 48N, R23W	Maher
2	Lake Superior	Marquette	Chocolay River		Maher
2	Lake Michigan	Delta	Ford River		Anquilm
2	Lake Michigan	Mackinac	Point Aux Chenes Creek		Walker
2	Lake Michigan	Mackinac	Mile Creek	"Below dam" Sec. 21, T43N, R9W	Vanderstar
2	Lake Michigan	Mackinac	Brevoort River		Walker
2	Lake Michigan	Menominee	Menominee River	Tailruce Paper Co. waterwheels at Menominee, Mich.	Wellner
2	Lake Michigan	Schoolcraft	Manistique River		Mellon
2	Lake Michigan	Schoolcraft	Bursaw Creek	T40N, R17W	Mellon
2	Lake Michigan	Schoolcraft	Southtown Creek		Mellon
2	Lake Michigan	Schoolcraft	Thompson Creek	T41N, R16W	Mellon
2	Lake Michigan	Schoolcraft	Middlebrook Creek		Mellon
2	Lake Michigan	Schoolcraft	Middlebrook Creek		Mellon
2	Lake Huron	Chippewa	Carlton Creek		Christopherson
2	Munuscong Lake	Chippewa	Munuscong River		McLean

REGION I (Continued)

2	Lake Huron	Chippewa	Albany Island Creek	T41, 42N, R3E	Christopherson
2	Lake Huron	Chippewa	Black Creek	T45N, R4W	McDonald
2	Lake Huron	Chippewa	Bear Creek	T44N, R4W	McDonald
2	Lake Huron	Chippewa	Trout Brook	T44N, R4W	McDonald
2	Lake Huron	Mackinac	Steele's Creek	T42N, R1W	Hill
2	Lake Huron	Mackinac	Prentic Creek		Hill
2	Lake Huron	Mackinac	Carp River		McDonald
2	Lake Huron	Mackinac	Pine River	T44N, R5W (R4W & R3W) "Great numbers in first 3 weeks in June"	McDonald

REGION 2

Fish Division District	Drainage	County	Stream	Remarks	Reported by
3	Lake Michigan	Antrim	Elk River	Elk Rapids; Mich. Pub. Serv. Co. dam	Miles
3	Lake Michigan	Charlevoix	Jordan River	Also reported by Miles in Antrim Co.	Starback
3	Lake Michigan	Charlevoix	Horton's Creek		Starback
3	Lake Michigan	Emmet	Carp River		Kobaski
3	Lake Huron	Cheboygan	Cheboygan River		Auldrich
3	Lake Huron	Cheboygan	Elliot Creek		Auldrich
3	Lake Huron	Presque Isle	Carp Creek		Burris
3	Lake Huron	Presque Isle	Ocqueoc River		Curtis
3	Lake Huron	Presque Isle	Little Ocqueoc River		Curtis
3	Lake Huron	Presque Isle	Silver Creek		Curtis
4	Lake Michigan	Benzie	Betsie River		Joslin
4	Lake Michigan	Benzie	Platte River		Joslin

4	Lake Michigan	Grand Traverse	Ptobago Creek		Banks
4	Lake Michigan	Grand Traverse	Yuba Creek		Banks
4	Lake Michigan	Grand Traverse	Acme Creek		Banks
4	Lake Michigan	Grand Traverse	Boardman River	Union Street Dam	Banks
4	Lake Michigan	Manistee	Little Manistee		?
4	Lake Michigan	Manistee	Big Manistee	Above and below Tippy dam weir	Marks
7	Lake Michigan	Mason	So. Branch Pere Marquette	T17, R15	Roberts
6	Lake Huron	Alpena	Thunder Bay River	In city of Alpena	Connors
6	Lake Huron	Alpena	Devil River	Sec. 12, T29N, R8E on June 1	Connors
6	Lake Huron	Iosco	Pine River	No. end Van Etten Lake	Leitz
6	Lake Huron	Iosco	Au Sable River		Leitz
6	Lake Huron	Iosco	Van Etten Creek		Leitz
6	Lake Huron	Iosco	Guiley Creek	25 mi. from lake	Leitz
6	Lake Huron	Iosco	Au Gres, East Br.	25 mi. from Bay. Also in Arenac Co., T20N, R7E, Secs. 11, 12, 13 (Fuehr)	Leitz
6	Lake Huron	Iosco	Silver Creek	10 mi. from Bay	Leitz
6	Lake Huron	Iosco	Cold Creek		Leitz
6	Lake Huron	Iosco	Tawas River		Leitz
6	Lake Huron	Presque Isle	Swan River		Curtis
5	Lake Huron	Ogemaw	Rifle River	"upper reaches"	Hughes

REGION 3

District	Drainage	County	Stream	Remarks	Reported by
9	Lake Michigan	Allegan	Kalamazoo River	At Allegan Dam	Plotts
9	Lake Michigan	Allegan	Mann Creek	Trib. to Kalamazoo River	Plotts

8	Lake Michigan	Muskegon	Muskegon River	Below Newaygo Dam=	Wilkinson
8	Lake Michigan	Muskegon	White River		Boutin
11	Lake Huron	Sanilac	Carmody Creek	Near Fort Sanilac	Hawes
11	Lake Huron	Tuscola	Cass River (?)	Edison Dam, Indian Fields Twp.	Predmore
11	Lake Erie	Washtenaw	Huron River		...
11	Lake St. Clair	Oakland	Clinton River	Also in Macomb Co. (H. Hughes)	...

APPENDIX II

MEMORANDUM

TO: Regional and District Supervisors of Field Administration Division and Fish Division and to all Conservation Officers.

RE: Cooperation in Sea Lamprey Investigations

At the June, 1946 meeting of the Conservation Commission the Director was instructed to initiate a comprehensive investigation of the sea lamprey to discover or develop effective control methods and to solicit the cooperation of the neighboring states and of the United States Fish and Wildlife Service in this study.

The Institute for Fisheries Research was assigned the responsibility of carrying out the investigation with assistance from all Divisions. Vernon C. Applegate of the Institute Staff is in charge of this study. Already considerable information has been obtained. A resume of the problem will be found on pages 265-266, and 283-284 of the thirteenth or last biennial report of the department. An article summarizing the problem to date will appear in the May issue of Michigan Conservation and will also be made available in pamphlet form for public distribution.

An important part of the investigation this year will be to secure more complete information as to the location and size of spawning runs. The cooperation of the public is to be secured by publicizing the seriousness of the problem with posters, pamphlets, newspaper articles, radio and contacts with the schools, sportsmen's organizations, Boy Scouts, and 4-H Clubs. The Education Division will make the distribution of the posters and pamphlets to these groups, calling upon other divisions or agencies that can be of assistance.

Conservation Officers are requested to:

(1) Place the posters in public buildings, schools and at important highway stream crossings along the shores of the Great Lakes.

(2) Distribute pamphlets to schools, sportsmen's clubs, Boy Scouts, and 4-H Clubs.

(3) In Regions I and II report promptly all lamprey spawning runs personally observed or reported to the nearest District Fisheries Biologist (see list at end). In Region III phone or or wire (collect) reports to the Institute for Fisheries Research, Ann Arbor, 4121, Ext. 336.

(4) If possible, secure one to three specimens of the lampreys from each run personally observed and freeze or hold in 5% formalin with label giving name, date and location of collection. Such specimens will be checked by the Fisheries Biologist following your report. A key to the lampreys of Michigan is attached to this memorandum and may help in identifying specimens observed by you.

(5) Conservation Officers may be asked to assist the U. S. Fish and Wildlife Service in a periodic examination of fish catches at certain key ports around the Great Lakes to determine the extent of lamprey damage on the various species of fish taken commercially. They may also be requested to aid in securing and holding specimens of sea lampreys taken by commercial fishermen in their nets.

District Fisheries Biologists will report by phone Sunday night of each week to Vernon C. Applegate all verified spawning runs. Weekly summaries for each region will be prepared promptly and copies supplied to Lansing and to all Regional offices and to District offices requesting these summaries.

District Biologists have been instructed to contact all Conservation Officers having territory fronting the Great Lakes in Region I and II and

explain the program and arrange for securing reports from the officers.

/s/ Durward Robson, Chief
Field Administration Division

/s/ F. A. Westerman, Chief
Fish Division

Fish Division personnel in Regions I and II who are to be notified of reports of sea lamprey spawning runs.

Region I

Fish Division District No. 1	-	Leland Anderson, District Biologist State Fish Hatchery Watersmeet, Michigan Phone: 232
Fish Division District No. 2	-	Dexter B. Reynolds, District Biologist State Fish Hatchery Thompson, Michigan Phone: Manistique 28-F-3

Region II

Fish Division District No. 3 (except Presque Isle County)	-	Walter R. Crowe, District Biologist Indian River, Michigan Phone: Indian R. 114 (Cheboygan Exchange)
Fish Division Districts No. 4 and No. 7	-	Stanley Lievense, District Biologist State Fish Hatchery Harrietta, Michigan Phone: 11-F-2
Fish Division Districts No. 5 and No. 6 (except Presque Isle County)	-	Leonard Allison, District Biologist State Fish Hatchery Grayling, Michigan Phone: 2631
Presque Isle County	-	Vernon C. Applegate P.O. Box 72 Rogers City, Michigan Phone: 3282 (Onaway Exchange)

Key to the Lampreys in Michigan[*]

(Petromyzontidae)

I. Dorsal fin continuous, never divided into two distinct fins

A. Teeth and buccal funnel (mouth) degenerate; non-parasitic

Ichthyomyzon fossor - Michigan brook lamprey

B. Teeth and buccal funnel (mouth) well developed; parasitic species

1. Teeth, with very rare exceptions, all unicuspid (with single points)

Ichthyomyzon unicuspis - Silver or Lake lamprey

2. Teeth at least in part bicuspid (with two points)

Ichthyomyzon castaneus - Chestnut lamprey

II. Two distinct dorsal fins

A. Teeth radiating in all directions from the center of the funnel; ranging in size to 40 inches, seldom less than 14 inches; parasitic

Petromyzon marinus - Sea Lamprey

B. Teeth not radiating from center but in several groups; ranging in size to 15 inches; non-parasitic

Entosphenus lamottenii - American brook lamprey

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[*] Modified from Hubbs and Lagler (1941) by Allison and Applegate