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cc: Fish Division
Institute for Fisheries Research
Education - Game
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Report No. 1218

SEA LAMPREY INVESTIGATIONS

4. An inventory of spawning streams of the sea lamprey, Petromyzon marinus, in Michigan.[1]

(Summary for 1947 and 1948)

by

Vernon C. Applegate

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 commercial fishermen.

In June of 1946, the problem was discussed by the Conservation Commission of the State of Michigan who directed that a comprehensive

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[1] Contribution from the Institute for Fisheries Research of the Michigan Department of Conservation and from the Department of Zoology in the University of Michigan.

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, percentage of total fish taken that were scarred, and the effect of scars on the marketability of the fish. These data were summarized by Shetter (1949) 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, begun early in 1947 by the Institute for Fisheries Research. These investigations represent Michigan's part of the cooperative program of research outlined at the previously cited conferences. The initial step in the investigations was an inventory of the size and distribution of sea lamprey spawning runs entering Michigan streams in the spring. This information is vitally important for it provides a picture of the population to be considered for reduction and a measure of the cost of

initiating any proposed controls upon this population. The results of this inventory conducted in 1947 and 1948 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, 1949) 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.[2] 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).

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[2] 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).

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 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 offshore 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. C. 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 a 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, 1949).

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 (verbal communication).

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, 1949).

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, 1949).

1944

Lake Huron and tributaries.-- Spawning runs observed in the Rifle River (Ogemaw County?), Michigan and the Ocquoc River, Presque Isle County, Michigan, by Dr. D. S. Shetter (Shetter, 1949).

1945

Lake Huron and tributaries.-- Spawning run observed in the Cocquoc River Presque Isle County, Michigan, by Dr. D. S. Shetter (Shetter, 1949). 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 (verbal communication).

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 large female, 490 mm. long, was taken off Whitefish Point in eastern Lake Superior in December, 1946 (Creaser, 1947). 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 68 Michigan streams (Shetter, 1949). 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 offshore in Grand Traverse Bay, east side of Keweenaw Peninsula; attached to lake trout caught trolling; identified by V. C. Applegate.

Tributaries of all basins.-- Sea lamprey spawning runs were verified in 74 Michigan streams and reliably reported in 9 additional streams; see subsequent discussion.

1948

Lake Superior and tributaries.-- A sexually maturing adult, 16.0 inches long, was taken on May 31, 1948, by Rino Merila, fisherman at Portage Entry, on a reef 10 miles north of Pt. Abbay (Baraga County); specimen attached to a 6-pound lake trout taken by hook in 12 fathoms of water; identified by V. C. Applegate. Dr. Raymond E. Johnston of the Minnesota Department of Conservation reported the taking of the first sea lamprey in the Minnesota waters of Lake Superior.

Tributaries of all basins.-- Additional field investigations brought the total spawning runs verified in Michigan streams to 92 with sea lampreys reliably reported in 16 additional streams; see subsequent discussion.

The inventory of sea lamprey spawning streams

As mentioned 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 (1949). In all, 68 streams in Michigan were reported by him to have sea lamprey spawning runs.

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 inventory in the year 1947 required the cooperation of the Field Administration Division of the Department of Conservation and the public at large, particularly organized groups such as sportsmen'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 (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.

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.

The conduct of the inventory in 1948 was essentially the same with the exception that, in general, only those reports that constituted new records of distribution were personally investigated by the biologists. Furthermore, in this year, the district fisheries biologists were instructed to determine as specifically as possible the largest runs occurring in their areas.

Figure 1.--- Poster utilized in 1947 and 1948 to request the aid of the public in reporting sea lamprey spawning runs.

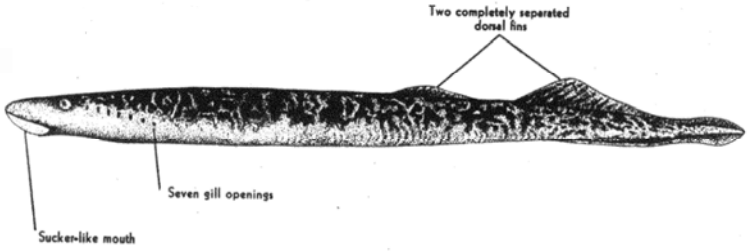
FISHERMEN!

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 2.-- Questionnaire utilized during the inventory by field personnel for reporting sea lamprey runs.

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?) _____

VERY IMPORTANT!

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)

6. Were other species of lampreys observed:
   Michigan brook lamprey? _____ American brook lamprey? _____
   Chestnut lamprey? _____ Silver (lake) lamprey? _____

7. Are you forwarding a sample specimen for final verification:
   Yes? _____ No? _____

- - - - - - - - -

Date that observations were made _____

Time _____ Observer _____
(Please sign)

Source of original report of run _____

- - - - - - - - -

This report is to be prepared after verifying the presence of migrating sea lampreys in a stream or river and may be used to record either the results of personal surveys made or the verification of reports received by you from other persons or agencies.

Please answer all questions, sign the form, and forward as soon as possible to Vernon C. Applegate, P.O. Box # 72, Rogers City, Michigan.

Any notes or comments will be helpful and may be entered in the following space:

Results of the inventory

A large number of reports of the presence of sea lampreys were received during the course of the inventory in both years 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 92 Michigan streams. Their presence in sixteen additional streams is considered relatively certain, but they were not positively identified in these locations 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 lamprey runs 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.

To facilitate grouping the distributional records and comments in both tables and text, I have utilized the administrative regions established by the Department of Conservation. Region 1 is the entire Upper Peninsula. Region 2 is the northern half of the Lower Peninsula with its southern boundary an imaginary line extending from the City of Muskegon to the City of Bay City. Region 3 is the southern half of the Lower Peninsula south of this imaginary line.

Figure 3 and Table 1 give the impression that the bulk of sea lamprey spawning activity occurs in the northern half of the Lower Peninsula of Michigan. This impression is probably correct although I do not believe that the true extent of the sea lamprey spawning populations in the southern half of the Lower Peninsula has been determined. The spring of 1947 was an extremely wet season and in both years more or less

Table 1. Summary of reports of migrating or spawning sea lampreys in Michigan streams in 1947 and 1948.

Drainage	Total reports in 1947[1]	Total reports in 1948[1]	New records in 1948[1]	Grand total of distributional records for 1947 and 1948[1]
Upper Peninsula (Region 1)				
Lake Superior	2 (1)	2	2	4
Lake Michigan	12	8 (2)	5 (2)	17 (2)
Lake Huron (also Munuscong Lake)	2	2	1	3
Subtotals	16	12	8	24
Lower Peninsula (Region 2)				
Lake Michigan	24	15 (2)	6 (1)	30 (1)
Lake Huron	27 (3)	16 (2)	3 (1)	30 (4)
Subtotals	51	31	9	60
Lower Peninsula (Region 3)				
Lake Michigan	16 (5)	15 (7)	5 (3)	21 (8)
Lake Huron	0	1	1	1
Lake Erie	0	0	0	0
Lake St. Clair	0	2 (1)	2 (1)	2 (1)
Subtotals	16	18	8	24
Totals	83[1]	61[1]	25[1]	108[1]

[1] Both verified and reliable reports are combined in totals. Numbers in parentheses are numbers of reliable reports included in figure preceding them.

Figure 3.-- Distribution of migrating and spawning sea lampreys observed or reported in Michigan streams in 1947 and 1948.

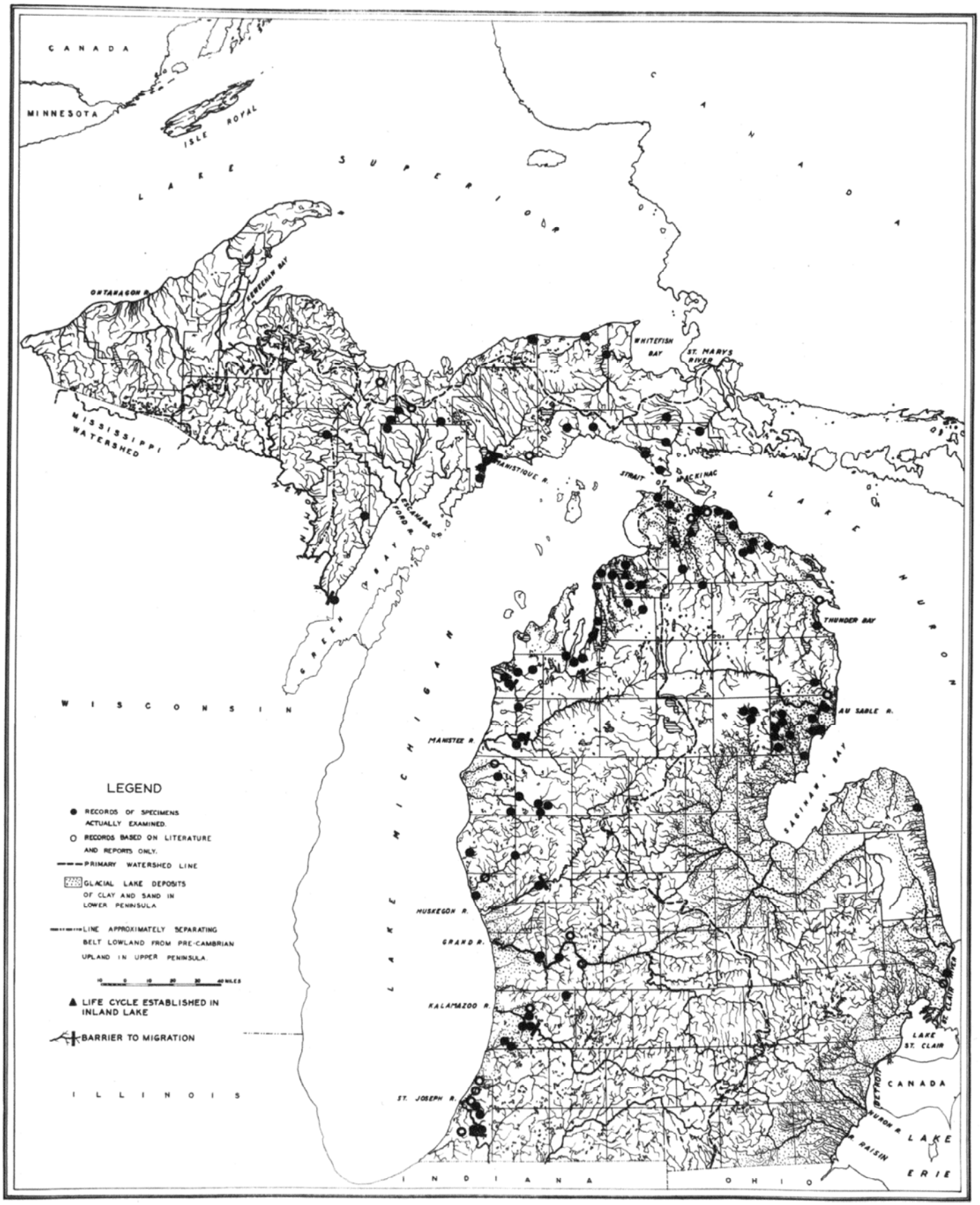

CANADA
MINNESOTA
ISLE ROYAL
LAKE SUPERIOR
ONTONAGON R.
KEWEENAW BAY
WHITEFISH BAY
ST. MARY'S RIVER
MISSISSIPPI WATERSHED
MANISTIQUE R.
STRAIT OF MACKINAC
FORD R.
ESCANABA
GREEN BAY
WISCONSIN
THUNDER BAY
AU SABLE R.
MANISTEE R.
SAGINAW BAY
LAKE MICHIGAN
MUSKEGON R.
GRAND R.
KALAMAZOO R.
ST. CLAIR RIVER
LAKE ST. CLAIR
DETROIT R.
CANADA
ST. JOSEPH R.
HURON R.
RAISIN R.
LAKE ERIE
ILLINOIS
INDIANA
OHIO
LEGEND
RECORDS OF SPECIMENS ACTUALLY EXAMINED.
RECORDS BASED ON LITERATURE AND REPORTS ONLY.
PRIMARY WATERSHED LINE
GLACIAL LAKE DEPOSITS OF CLAY AND SAND IN LOWER PENINSULA
LINE APPROXIMATELY SEPARATING BELT LOWLAND FROM PRE-CAMBRIAN UPLAND IN UPPER PENINSULA
10 0 10 20 30 40 MILES
LIFE CYCLE ESTABLISHED IN INLAND LAKE
BARRIER TO MIGRATION

Table 2. Name and location of streams containing migrating or spawning sea lampreys in 1947 and 1948 with an estimate of the size of the run.

Tributary to	County	Stream	Specific location of observations	Spawning run verified (V) or reliably reported (R) in: 1947	1948	Estimate of size of run
			Upper Peninsula (Region 1)			
Lake Superior Basin						
Lake Superior	Alger	Sucker River	T49N, R13W, S.4	...	V	?
Lake Superior	Luce	Two Hearted River	T50N, R9W, S.27	V	...	?
Whitefish Bay	Luce	Tahquamenon River	T48N, R8W, S.12	...	V	Moderate (?)
Lake Superior	Marquette	Chocolay River	T46N, R24W, S.13	R	...	?
Lake Michigan Basin						
Lake Michigan	Alger	W. Br., Whitefish River	T45N, R22W, S.32	V	...	?
Whitefish River	Alger	Dexter Creek	T45N, R21W, S.32	...	R	?
Lake Michigan	Alger	Sturgeon River	T44N, R19W, (S.28?)	V	...	Moderate (?)
Little Bay De Noc	Delta	Rapid River	T43N, R23W, S.23	...	V	Moderate
Ford River	Dickinson	N. Br., Ford River	T43N, R28W, S.1	...	V	?
Millecoquins River	Mackinac	Furlong Creek	T43N, R10W, S.8	V	V	Moderate
Lake Michigan	Mackinac	Black River	T43N, R9W, S.1, 13	V	...	Moderate (?)
Lake Michigan	Mackinac	Brevoort River	T41-42N, R5W, S.11, 13	V	...	?
Lake Michigan	Mackinac	Sucker Creek	T40N, R4W, S.10	V	...	?
Whitefish River	Marquette	Deer Creek	T44N, R23W, S.23	...	V	Small

Whitefish River	Marquette	Deer Creek	T44N, R23W, S.23	...	V	Small
Green Bay	Menominee	Menominee River	T32N, R27W, S.1	V	...	Large
Green Bay	Menominee	Big Cedar River	T37N, R25W, S.23	V	...	?
Lake Michigan	Schoolcraft	Manistique River	Paper mill dam, Manistique	V	V	Large
Lake Michigan	Schoolcraft	Thompson Creek	T41N, R16W, S.32	V	V	Small
Lake Michigan	Schoolcraft	Johnson Creek	T40N, R16W, S.6	V	...	Small
Lake Michigan	Schoolcraft	Bursaw Creek	T40N, R16W, S.23	V	...	Small
Lake Michigan	Schoolcraft	Bulldog Creek	T41N, R13W, S.4, 9	...	R	?
Lake Huron Basin						
Pine River	Chippewa	Trout Brook	T44N, R3W, S.17, 18	V	...	Small
St. Martin's Bay	Mackinac	Carp River	T42N, R5W, S.19	V	V	Moderate (?)
Munuscong River	Mackinac	Taylor Creek	T34N, R1W, S.22	...	V	Small

Lower Peninsula
(Region 2)

Lake Michigan Basin						
Lake Michigan	Antrim	Antrim Creek	T32N, R9W, S.14	V	...	?
Lake Michigan	Antrim	Elk River	Public service dam, Elk Rapids	V	V	?
Lake Charlevoix	Antrim	Jordan River	T31N, R5W, S.31 and T31N, R6W, S.(?)	V	V	?
Lake Michigan	Antrim	Mitchell Creek	T30N, R9W, S.22	V	...	?
Lake Michigan	Benzie	Platte River	T26N, R13W, S.6 and T26N, R14W, S.8	V	V	Large (?)
Lake Michigan	Benzie	Betsie River	T25N, R15W, S.2	V	V	Moderate (?)
Lake Michigan	Benzie	Crystal Lake Outlet	T26N, R15W, S.20, 29	...	V	Small
Lake Charlevoix	Charlevoix	Loeb Creek	T33N, R8W, S.1	V	...	Small

Lake Charlevoix	Charlevoix	Porter Creek	T33N, R6W, S.32	V	...	Small
Lake Charlevoix	Charlevoix	Horton Creek	T33N, R6W, S.6	V	...	Small
Lake Charlevoix	Charlevoix	Boyne River	T32N, R5W, S.5	V	V	Moderate
Lake Michigan	Charlevoix	McGeach Creek	T33N, R8W, S.(?)	V	...	?
Carp Lake River	Cheboygan	Mud Creek	T38N, R3W, S.20	V	...	Small
Lake Michigan	Emmet	Carp Lake River	T39N, R4W, S.29	V	V	Moderate
Lake Michigan	Grand Traverse	Boardman River	Dam in Traverse City	V	V	Moderate
E. Arm, Grand Traverse Bay	Grand Traverse	Mitchell Creek	T27N, R10W, S.7	V	...	?
E. Arm, Grand Traverse Bay	Grand Traverse	Acme Creek	T28N, R10W, S.34	V	...	?
Lake Michigan	Lake	Pere Marquette River	T18N, R14W, S.29, 30	V	R	
Pere Marquette R.	Lake	Baldwin Creek	T17N, R13W, S.10	V	...	
Pere Marquette R.	Lake	Little So. Br., Pere Marquette River	T17N, R13W, S.27	V	...	Large
Pere Marquette R.	Lake	Middle Br., Pere Marquette River	T17N, R12W, S.10	...	V	
Pere Marquette R.	Mason	So. Br., Pere Marquette River	T17N, R15W, S.27	...	V	
Lake Michigan	Mason	No. Br., Lincoln River	T19N, R16W, S.13	V	...	Small
Lake Michigan	Mason	Great Sable River	T20N, R16W, S.22	...	R	?
Lake Michigan	Manistee	Manistee River	T22N, R14W, S.36	...	V	Moderate
Manistee River	Manistee	Big Bear Creek	T24N, R14W, S.29	V	V	Moderate (?)
Manistee River	Manistee	Pine Creek	T21N, R14W, S.8	V	...	Small
Lake Michigan	Newaygo	Muskegon River	Below Newaygo power dam, T12N, R13W, S.24	V	...	?
White River	Newaygo	So. Br., White River	T14N, R14W, S.30	...	V	Small (?)

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White River	Newaygo	So. Br., White River	T14N, R14W, S.30	...	V	Small (?)
Lake Michigan	Oceana	Stony Creek	T14N, R18W, S.26	V	...	Small
Lake Huron Basin						
Pine River	Alcona	McGillis Creek	T25N, R8E, S.8	V	...	?
Lake Huron	Alpena	Devils River	T29N, R6E, S.11, 12	V	R	?
Lake Huron	Alpena	Thunder Bay River	In City of Alpena	...	R	Moderate (?)
Lake Huron	Arenac	Whitney Drain	T20N, R7E, S.12, 13	V	V	?
Lake Huron	Cheboygan	Green Creek	T38N, R2E, S.31, 32	V	...	Small
Lake Huron	Cheboygan	Elliot Creek	T38N, R1W, S.26	R	V	Small
Lake Huron	Cheboygan	Cheboygan River	Dam in City of Cheboygan	V	V	Large
Cheboygan River	Cheboygan	Laparell Creek	T37N, R2W, S.(?)	R	...	?
Burt Lake	Cheboygan	Sturgeon River	T35N, R2W, S.6	V	...	Small
Mullet Lake	Cheboygan	Pigeon River	T34N, R2W, S.2; also T32N, R1W, S.10 (Otsego County)	...	V	Small
Lake Huron	Iosco	Tawas Creek	T22N, R8E, S.30	V	V	?
Tawas Creek	Iosco	Cold Creek	T22N, R8E, S.19	V	...	Moderate (?)
Tawas Lake	Iosco	Silver Creek	T23N, R8E, S.19	V	...	Moderate (?)
Lake Huron	Iosco	Au Sable River	T24N, R8E, S.35	V	...	Large
Au Sable River	Iosco	Pine River	T24N, R9E, S.6	R	...	?
Lake Huron	Iosco	Au Gres River	T22N, R5E, S.19, 20	V	V	Large
Au Gres River	Iosco	E. Br., Au Gres River	T22N, R6E, S.21, 28	V	...	
Au Gres River	Iosco	Johnson Creek	T21N, R5E, S.23	V	...	
Au Gres River	Iosco	Hope Creek	T22N, R5E, S.9, 21	V	...	
E. Br., Au Gres R.	Iosco	Hale Creek	T23N, R5E, S.15, 17, 26	V	...	

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E. Br., Au Gres R.	Iosco	Smith Creek	T23N, R5E, S.13 and T23N, R6E, S.19	V	...	
Lake Huron	Ogemaw	Rifle River	T23N, R3E, S.11	V	V	
Rifle River	Ogemaw	Houghton Creek	T24N, R3E, S.(?) and T22N, R3E, S.9, 16, 21	V	...	Moderate
Rifle River	Ogemaw	Gamble Creek	T23N, R3E, S.2	...	V	
Lake Huron	Presque Isle	Carp Creek	T36-37N, R2E, S.1, 36	V	V	Moderate
Lake Huron	Presque Isle	Trout Creek	T35N, R5E, S.17	V	V	Small
Lake Huron	Presque Isle	Milligan Creek	T37N, R2E, S.4	V	V	Small
Lake Huron	Presque Isle	Ocqueoc River	T34, 35, 36N, R2, 3E, S.(many)	V	V	Large
Ocqueoc River	Presque Isle	Little Ocqueoc River	T35N, R3E, S.23, 24	V	V	Small
Ocqueoc River	Presque Isle	Silver Creek	T35N, R3E, S.18	V	V	Small

Lower Peninsula
(Region 3)

Lake Michigan Basin

Lake Michigan	Allegan	Kalamazoo River	Allegan dam	V	R	Large (?)
Kalamazoo River	Allegan	Swan Creek	T2N, R14W, S.17	V	V	Small
Kalamazoo River	Allegan	Bear Creek	T3N, R14W, S.27, 28	V	...	Small
Kalamazoo River	Allegan	Rabbit River	T4N, R11W, S.8	...	V	Small
Rabbit River	Allegan	Silver Creek	T3N, R14W, S.2	R	...	Small
Black River	Allegan	Mid. Fork, Black River	T1N, R15W, S.20	...	V	Small
Black River	Allegan	Barbour Creek	T1N, R15W, S.28	V	V	Small
Lake Michigan	Berrien	St. Joseph River	Power house, Berrien Springs	V	V	Large
St. Joseph River	Berrien	Lemon Creek	T6S, R18W, S.15	V	R	Small
St. Joseph River	Berrien	Rogers Creek	T3S, R17W, S.5, 6	R	...	?

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St. Joseph River	Berrien	Pipestone Creek	T5S, R17-18W, S.(?)	V	R	Moderate (?)
St. Joseph River	Berrien	Hickory Creek	T6S, R19W, S.(?)	...	R	Small
Lake Michigan	Berrien	Paw Paw River	T3, 4S, R18W, S.(?)	R	...	?
Paw Paw River	Berrien	Blue Creek	Benton Harbor hatchery	V	V	Small
Paw Paw River	Berrien	Yellow Creek	T4S, R18W, S.11, 12	R	V	Small
Lake Michigan	Kent	Grand River	4th St. dam, Grand Rapids	V	R	Moderate
Grand River	Kent	Thornapple River	T6N, R10W, S.16	...	R	Small
Grand River	Kent	Rogue River	T8N, R11W, S.2	...	R	?
Lake Michigan	Muskegon	Duck Lake Outlet	T11N, R18W, S.13	V	...	?
Lake Michigan	Muskegon	White River	T12N, R17W, S.11, 14	R	...	?
Grand River	Ottawa	Sand Creek	T7N, R13W, S.15, 33	V	V	Small
Lake Huron Basin						
Lake Huron	Huron	Rock Falls Creek	T16N, R16E, S.19	...	V	?
Lake St. Clair Basin						
St. Clair River	St. Clair	Belle River	T4N, R17E, S.31	...	R	?
Lake St. Clair	St. Clair	St. Clair River	T5N, R17E	...	V	?

sustained flood conditions existed in southern Michigan (Region 3) streams during the migratory and spawning period. High and turbid water interfered materially in stream observations and doubtless many runs were not noted for this reason. These conditions were particularly evident in southeastern Michigan where very few runs were reported in either year. Perhaps in a future season, with more favorable weather and stream conditions, it will be found that sea lamprey spawning runs are still entering the Huron and Clinton rivers and possibly other streams in the southeastern area. Although sea lampreys were not reported in the aforementioned two rivers in 1947 or 1948, they were utilized by them as early as 1932 and 1938 respectively, and there is no reason to assume that they would no longer be entering either stream. However, I do not believe that extensive sea lamprey spawning activity will ever be found in this region. Sluggish currents and particularly the predominantly sandy and/or silted character of the stream beds in this area preclude spawning by the sea lamprey. The latter require at least some small gravel with which to build their nests and spawning was only observed in Region 3 where small areas of gravel occurred in the streams.

In the Upper Peninsula, the eastern and northern margins (Lake Munuscong area, Whitefish Bay and Lake Superior proper) are backed with large areas of wild and inaccessible land with relatively few inhabitants to report runs. Only four runs have been verified in this area. In 1947 and 1948, specific surveys were made of the streams flowing into Lake Munuscong and eastern Lake Superior to determine the extent of the establishment of the species in these waters. In 1947, Mr. Leland Anderson, District Fisheries Biologist at Watersmeet, made a survey

of the streams entering Lake Superior in the western third of the Upper Peninsula. Fifty-six streams were examined by him between May 28 and July 11. He found no sign of sea lampreys in these streams at the points examined. Mr. Anderson repeated this survey in 1948 and again found no evidence of sea lampreys.

In June, 1948, Dr. Frank Jobes of the U. S. Fish and Wildlife Service inspected many of the streams flowing into Lake Superior in the eastern two-thirds of the Upper Peninsula. Other than evidence of a moderate spawning run in the Tahquamenon River, he found no other sign of sea lamprey runs. Other field personnel of the Conservation Department captured specimens to verify runs in two additional Lake Superior tributaries.

In spite of this paucity of information, there is 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.

A survey of the streams of the eastern tip of the Upper Peninsula from St. Ignace to the Sault Ste. Marie was made by me in June, 1948. Reports had previously been sparse or lacking for this area. Twenty watersheds and/or small streams were examined including five on Drummond Island. With one exception, no sea lampreys, or evidence of sea lampreys, were found in these streams at the time of the survey. Generally, in all of the watersheds examined in this area, the streams had a low gradient and the current was sluggish in both tributaries and main channel. Bottom types were almost exclusively silt, sand, or clay in varying combinations. Silt loads were heavy in the larger watersheds.

Stream characteristics in this area (eastern Chippewa and Mackinac counties) are quite unsuitable for sea lamprey spawning.

Sea lampreys were found in Taylor Creek, a tributary of the Munuscong River. Unlike the balance of this watershed which was examined, Taylor Creek had a moderate gradient, clear water, and areas of rock, rubble, and gravel riffle. Spawning activity observed was limited.

More easily accessible streams, only moderate flood conditions, and extensive areas in streams suitable for sea lamprey spawning 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 actual magnitude of the various runs. Only estimates of the numbers could be made and often times not even that was possible. Estimates that were made by observers in the field of the size of the runs may be found in the right hand column 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) all major watersheds attracted spawning migrants: the Rifle, Au Gres, Au Sable, Thunder Bay, Ocqueoc and Cheboygan rivers. Again, these were the largest runs observed in this area.

Evidence of establishment in inland lakes

Until this inventory, 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. 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) An adult, female sea lamprey was captured by fishermen in the Pigeon River (Otsego County, T32N, R1W, S.10) on June 11, 1948. Identified by W. R. Crowe. Sea lamprey redds observed by W. R. Crowe in the Pigeon River (Cheboygan County, T34N, R2W, S.10) on or about June 9, 1948. The Pigeon River is a tributary of Mullet Lake.

(6) 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 established 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 also 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. Reports of the presence of sexually immature adults in Big Platte Lake, Benzie County, and White Lake, Muskegon County are likewise considered reliable.

Lake Fenton, Genesee County, Little Traverse Lake, Leelanau County, Lake Geneserath, Beaver Island, Round Lake, Kalkaska County, Pipestone Lake, Berrien County, and Big Paw Paw Lake, Berrien County, allegedly contained sea lampreys in 1947 or 1948 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 Cequeoc 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. In another instance, migrants are known to pass over (or through?) an irregularly constructed logging dam of some height situated in Silver Creek, Iosco County.

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 Number 1 in Menominee, Michigan; approximately 2.5 miles from mouth; built in 1924; concrete; 12-foot head; spillway 22 feet wide; fish ladder reported in operation in 1959.

2. Manistique River - Manistique Pulp and Paper Mill dam; about 1 mile from mouth; concrete; 27-foot 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 "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-foot head; flow through turbines or over spillway; fish chute reportedly inoperative; ship lock present; believed a barrier except when locks operated in spring months.

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

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-foot head; 20-foot wide spillway; flow through turbines or over spillway. No fish chute or ladder present; believed to constitute barrier.

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-foot head; 22-foot wide spillway; flow through turbines or over spillway; believed to constitute barrier.

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.

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.

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-foot head; 118-foot wide spillway; flow through turbines or over spillway; fish ladder present but reportedly inoperative; believed to constitute barrier.

8. Muskegon River - Newaygo Power Dam (Consumers Power Company), T12N, R12W, Sec. 19; approximately 30 miles above Muskegon Lake; built in 1900; concrete; 18-foot head; 96-foot 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.

Region 2.

1. Kalamazoo River - Allegan City Power Dam; approximately 21 miles from mouth; concrete; 16-foot head; 132-foot 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.

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-foot head; 149-foot wide spillway; flow through turbines or over spillway; inoperative fish ladder cored into dam; believed to constitute barrier.

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 Michigan 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. Experiments will be conducted in 1949 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 1.

Sturgeon River, Alger County. . . . . .39.0 miles

Trout Brook, Chippewa County. . . . . .22.5 miles

Region 2.

Ocqueoc River, Presque Isle County. . . . . .19.0 miles

Au Gres Watershed:

Hale Creek, Iosco County. . . . . 34.0 miles

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

E. Br. Au Gres River, Iosco County. . . . . 23.0 miles

Au Gres River, Iosco County. . . . . .24.0 miles

Rifle River, Ogemaw County. . . . . .39.0 miles

Houghton Creek, Ogemaw County. . . . . 45.0 miles

Little So. Br. Pere Marquette, Lake Co. . . . . .47.0 miles

Baldwin Creek, Lake County. . . . . .48.0 miles

Bear Creek, Manistee County. . . . . 32.0 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.

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