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DISTRIBUTION OF SEA LAMPREY AMMOCOETES IN LAKE MICHIGAN TRIBUTARIES OF THE UPPER PENINSULA OF MICHIGAN, 1955-1959

By

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Introduction

Selective toxicants developed by the U. S. Bureau of Commercial Fisheries have repeatedly shown their effectiveness by virtually eradicating ammocoetes of the sea lamprey (Petromyzon marinus) in the tributaries of the Upper Great Lakes in which they have been applied.[1] A portion of Michigan's role in the cooperative effort to control this parasite has been the determination of the distribution of ammocoetes[2] in streams, to facilitate the later application of larvicides. Results of the surveys of State of Michigan tributaries of Lake Superior were summarized by Stauffer and Hansen (1958). The present report is based largely on collections made at 295 stations in 25 tributaries of northern Lake Michigan (between St. Ignace and Menominee) in 1955-1959. These collections were made primarily to determine the abundance and distribution of sea lamprey ammocoetes. Supplementary information on ammocoete distribution was obtained from surveys of four streams (70 collections in 2 of the 25 streams mentioned above, and 90 collections in 2 others) in 1952-1958, which were made principally to determine the distribution of game fish.

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[1] Programs and Progress, 1959. Mimeographed report of Great Lakes Fisheries Investigations, Bureau of Commercial Fisheries, Fish and Wildlife Service, U. S. Dept. of Interior.

[2] The terms ammocoete and larva refer to the sea lamprey unless stated otherwise.

The streams that were surveyed included 14 of the 15[3] streams which had the largest adult sea lamprey spawning runs in 1958-1959;[1] four of eight[4] streams which had smaller runs; seven small streams in which there were no known sea lamprey runs; and two large streams with power dams near the mouth. A total of 62 streams (the five streams excluded above and 57 others) which were less than 12 miles long were not surveyed.

Methods

When sampling to determine ammocoete distribution, two or three men spent 30 to 60 minutes at each station, collecting ammocoetes and fish with a direct-current shocker of the type described by Pratt (1952). A portable alternating-current shocker powered by a six-volt motorcycle battery was used at several remote locations in 1959. In both types of collecting, the primary purpose was to collect ammocoetes, although other fish were also sampled. A direct-current shocker was used in the streams which were surveyed primarily to determine the distribution of game fish (but where some ammocoetes were also taken). For these game-fish surveys, "positive"[5] stations are reliable, but "negative" stations are not completely reliable for indicating ammocoete distribution.

All ammocoetes collected were preserved in a 10 percent solution of formaldehyde for identification in the laboratory. Original identifications were made by W. C. Wagner, M. J. Hansen, or the author and were verified by W. R. Crowe, G. P. Cooper, or the author. The characters used to distinguish the various species of ammocoetes (Petromyzon marinus, Lampetra lamottei, Ichthyomyzon spp.) have been described by Vladykov (1950), Hubbs and Lagler (1947), and Stauffer and Hansen (1958).

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[3] Bursaw Creek, Schoolcraft County, the stream with the sixth largest run was not surveyed.

[4] Beattie Creek, Delta County and Crow and Cataract rivers, and Point Patterson Creek, Mackinac County were not surveyed.

[5] Positive stations are those at which ammocoetes were collected; negative stations produced no ammocoetes.

Distribution of Ammocoetes

The general study areas are shown in Figure 1 and the locations of the collecting stations in Figures 2-7. In Figures 2-7, estimates of abundance based on catch per hour of electrofishing are indicated at each station ("rare" = 1-25 ammocoetes per hour, "common" = 26-99 per hour, and "abundant" = 100 or more per hour). Each stream system surveyed is discussed in the order in which it appears in Figures 2-7, progressing from west to east along the northern shore of Lake Michigan. Unless stated otherwise, the estimates of abundance and distribution for each stream are based on the direct-current shocker collections in which the collection of ammocoetes was the primary purpose. The number of samples taken and an evaluation of the stream as a sea lamprey producer are given. Within a particular system, the location and abundance of ammocoetes in the main stream are discussed first. The length of main stream inhabited by ammocoetes refers to the portion of the stream between the uppermost positive station and the mouth. Tributaries of the main stream which contained ammocoetes are listed (progressing upstream from the mouth) and the general abundance of larvae is noted. Lakes in a stream system, which may complicate the application of larvicide, are mentioned. Tributaries of the main stream which were dry or where ammocoetes were not found are listed. Game fish populations in the areas inhabited by ammocoetes are mentioned because of their possible importance in the selection and application of larvicides.

1. Cedar River.--On the basis of 61 collections, this stream (Fig. 2) was judged to be one of the largest producers of sea lampreys along the north shore of Lake Michigan. Ammocoetes were common in the lower 42 miles

Figure 1.--General areas (shaded) where sea lamprey ammocoetes were collected in tributaries of northern Lake Michigan, 1955-1959. The figure numbers refer to subsequent illustrations.

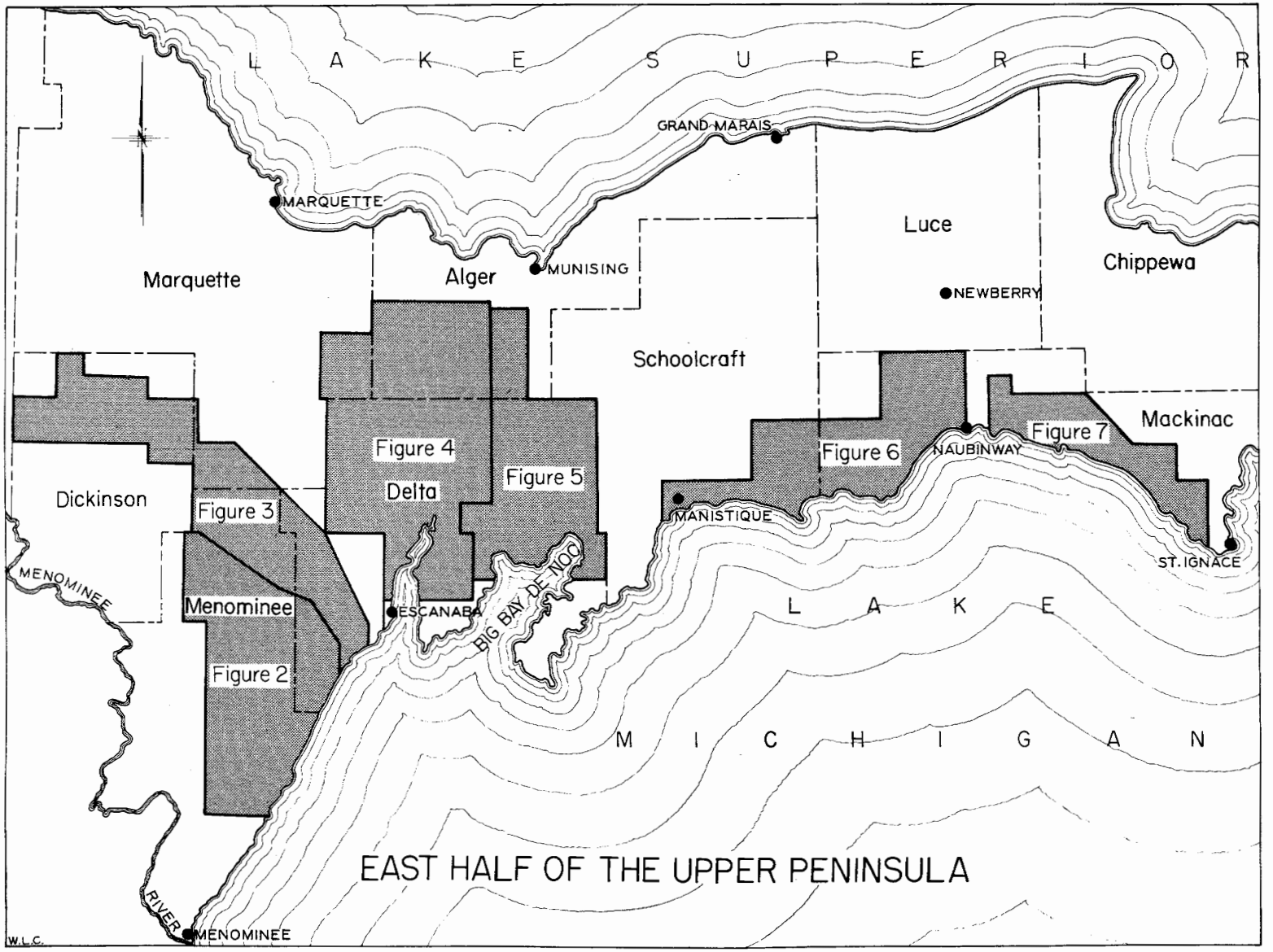
L A K E S U P E R I O R
GRAND MARAIS
MARQUETTE
MUNISING
Luce
Chippewa
Marquette
Alger
NEWBERRY
Schoolcraft
Figure 4
Figure 5
Figure 6
Figure 7
Mackinac
NAUBINWAY
Delta
Dickinson
Figure 3
MANISTIQUE
ST. IGNACE
MENOMINEE
Menominee
ESCANABA
BIG BAY DE NOC
L A K E
Figure 2
M I C H I G A N
EAST HALF OF THE UPPER PENINSULA
RIVER
MENOMINEE
W.L.C.

Figure 1

Figure 2.--Collection stations on the Cedar River, Menominee County and Bark River, Delta County. Open circles are stations at which no sea lamprey larvae were taken. Letters within circles indicate the abundance of ammocoetes (A = abundant, C = common, R = rare).

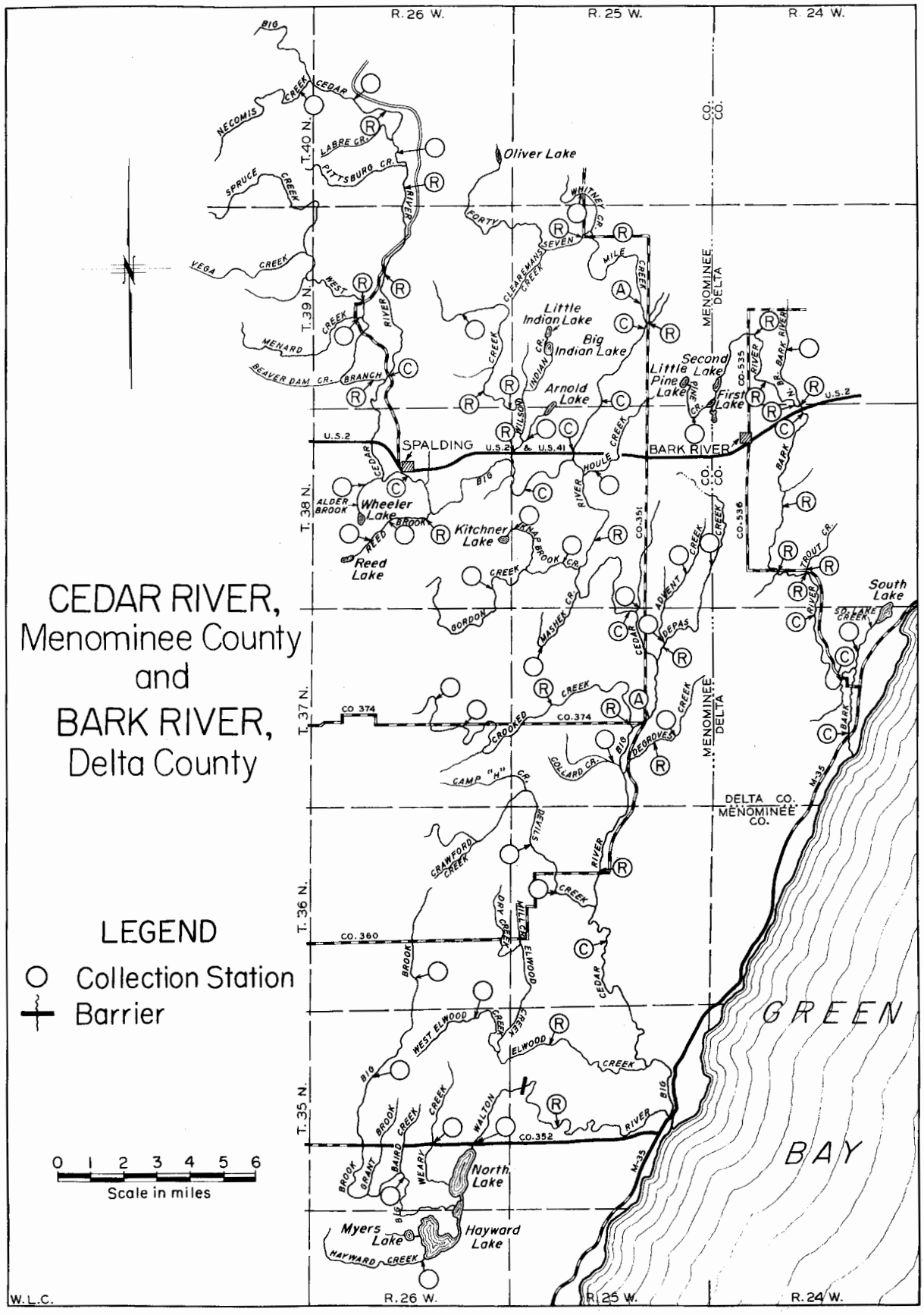
CEDAR RIVER,
Menominee County
and
BARK RIVER,
Delta County
LEGEND
Collection Station
Barrier
0 1 2 3 4 5 6
Scale in miles
R. 26 W.
R. 25 W.
R. 24 W.
T. 40 N.
T. 39 N.
T. 38 N.
T. 37 N.
T. 36 N.
T. 35 N.
SPALDING
BARK RIVER
Oliver Lake
Little Indian Lake
Big Indian Lake
Second Lake
Little Pine Lake
First Lake
Arnold Lake
Wheeler Lake
Kitchner Lake
Reed Lake
South Lake
North Lake
Myers Lake
Hayward Lake
MENOMINEE
DELTA
DELTA CO.
MENOMINEE CO.
GREEN
BAY
W.L.C.

Figure 2

of the main stream and rare in the next 9 miles. Larvae were also found in nine tributaries: Walton River, Elwood, Degroves, Crooked, Depas, Forty Seven Mile, and Wilson creeks, Reed Brook, and the West Branch. Ammocoetes were generally rare in the tributaries, with the exception of Forty Seven Mile Creek, where a large population was present. Six stations above a dam on Walton River were negative, indicating that it is a barrier to upstream-migrating sea lampreys.

Sea lamprey larvae were not found at stations on Devils and Collard creeks, an unnamed tributary (entering the main stream two miles above Depas Creek), Mashek, Knap Brook and Houle creeks, Alder Brook, and Necomis Creek. An unnamed tributary (entering the main stream one-half mile below Wilson Creek) was dry.

Some smallmouth bass (Micropterus dolomieui) and rock bass (Ambloplites rupestris) were collected in the portion of the main stream in which ammocoetes were found. Moderate numbers of northern pike (Esox lucius), yellow perch (Perca flavescens), and rock bass were found in the Walton River, below the dam. Depas Creek, Forty Seven Mile Creek, and Reed Brook contained populations of brook trout (Salvelinus fontinalis). Rainbow trout (Salmo gairdneri) were taken in Degroves and Wilson creeks. No game fish were found in Elwood and Crooked creeks or the West Branch.

2. Bark River.--The survey of this stream (15 collections) indicated that it supported moderate numbers of ammocoetes. Larvae were common to rare at 9 stations between the mouth and a point 18 miles upstream (about 2 miles below Second Lake), but none were taken at a single station upstream from this point (Fig. 2). Ammocoetes were rare near the mouths of Trout Creek and the North Branch.

Single stations on South Lake Creek and on Pine Creek (a tributary of First Lake) were negative. Two unnamed tributaries (one-half mile above South Lake Creek and immediately below County Road 536) were dry.

Moderate numbers of brook trout and a few rock bass were found in the main stream. No game fish were collected from Trout Creek and the North Branch.

3. Ford River.--In 1953-1956, 31 collections were made in the Ford River (Fig. 3), primarily to determine the abundance and distribution of game fish. In 1959, 17 collections were made to obtain further information on ammocoete distribution. Although relatively few lamprey larvae were collected (perhaps in part because the collection of ammocoetes was not the primary purpose of the work in 1953-1956), the presence of larvae in a section of stream 108 miles long indicated that this stream produced large numbers of sea lampreys.

Ammocoetes were collected at 12 stations in the main stream, between the mouth and a point near the village of Channing (86 miles upstream). They were also present (but usually rare) in six tributaries: Ten Mile and Twenty Four Mile creeks; a small unnamed tributary in the southwest one-quarter of T. 41 N., R. 24 W.; the West Branch of the Ford River; a small unnamed tributary near the center of T. 42 N., R. 26 W.; and Two Mile Creek.

Ammocoetes were not collected in 1959 at single stations near the mouths of Finnlands and Five Mile creeks; at a single (1955) station in Camp Creek; or at five stations in the North Branch in 1953-1954. No larvae were taken at single stations in 1954 near the mouths of an unnamed tributary (T. 43 N., R. 27 W.), and Stafford, Hayes, and Turner creeks.

Brook trout were common and brown trout (Salmo trutta) and rainbow trout were scarce in the Ford River, upstream from the village of Ralph. Below Ralph, a small population of rock bass and smallmouth bass was present. Except for brook trout in Two Mile Creek, few game fish were taken in the tributaries where ammocoetes were collected.

Figure 3.--Collection stations on the Ford River, Delta, Menominee, Marquette and Dickinson counties. Open squares and circles are stations at which no sea lamprey larvae were taken. Letters within squares and circles indicate the abundance of ammocoetes (C = common, R = rare). Squares represent collections in 1953-1956, and circles represent collections in 1959.

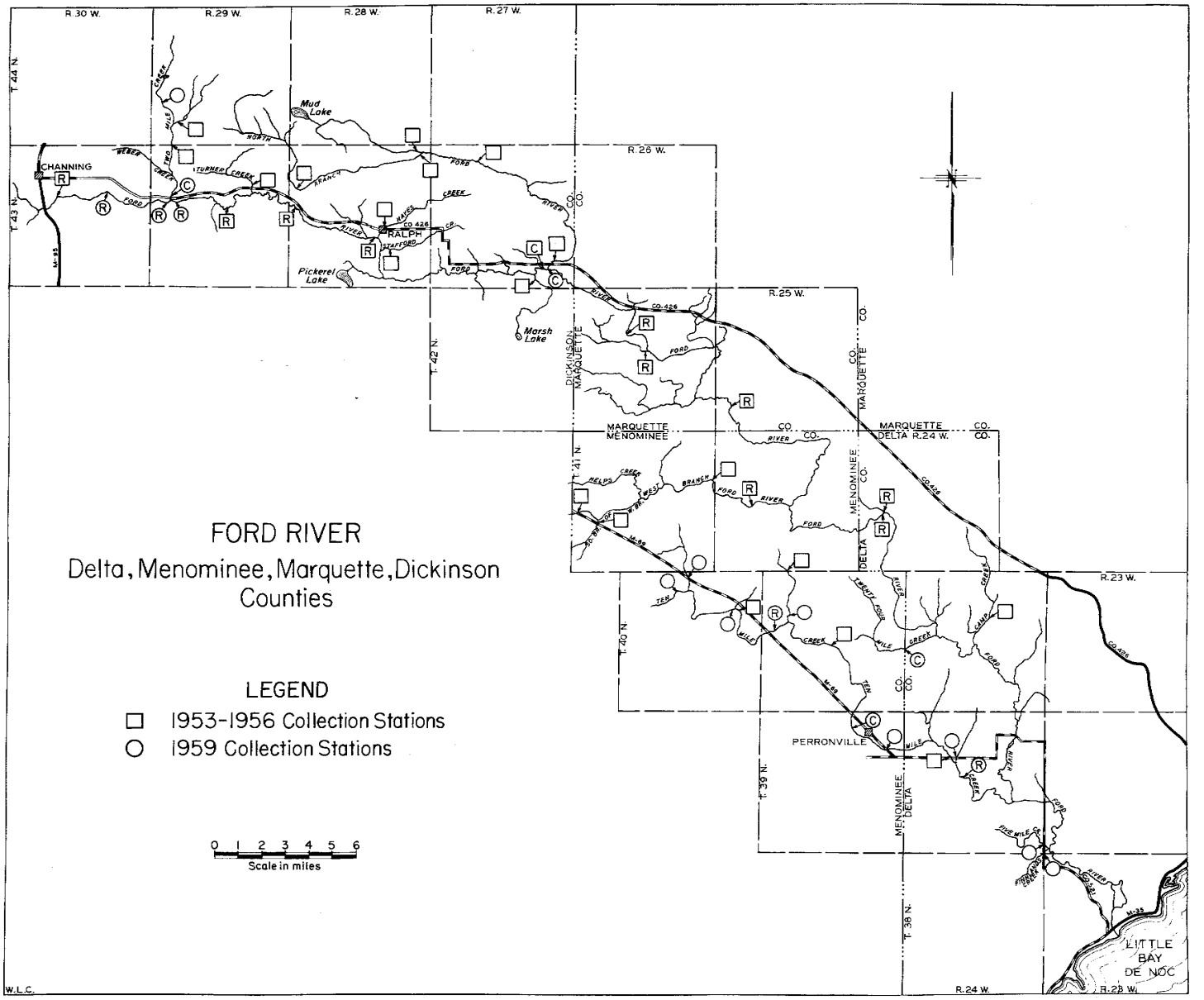
FORD RIVER
Delta, Menominee, Marquette, Dickinson Counties
LEGEND
1953-1956 Collection Stations
1959 Collection Stations
0 1 2 3 4 5 6
Scale in miles
R. 30 W.
R. 29 W.
R. 28 W.
R. 27 W.
R. 26 W.
R. 25 W.
R. 24 W.
R. 23 W.
T. 44 N.
T. 43 N.
T. 42 N.
T. 41 N.
T. 40 N.
T. 39 N.
T. 38 N.
CHANNING
RALPH
PERRONVILLE
Mud Lake
Pickerel Lake
Marsh Lake
DICKINSON CO.
MARQUETTE CO.
MENOMINEE CO.
DELTA CO.
LITTLE BAY DE NOC
W.L.C.

Figure 3

4. Escanaba River.--In October, 1958, collections were made in the upper half of the Escanaba System (59 stations--locations not shown in Fig. 4), to determine the abundance and distribution of game fish. Although at least a few larvae of one or more of the various species of lampreys are normally collected during game fish surveys, none were found, suggesting that perhaps no ammocoetes (of any species) occurred in the Escanaba River above the dam at Escanaba.

5. Days River.--This small stream, which was sampled at eight stations, apparently produced moderate numbers of ammocoetes. Larvae were found (rare t o common) at three stations in the middle reaches of the main stream (Fig. 4). Although no ammocoetes were collected at one station near the mouth, they probably were present throughout the lower 16 miles of the main stream. Sampling near the mouths of three small tributaries (an unnamed creek entering the main stream three miles above the mouth, the West Branch, and an unnamed creek entering the main stream at the township line between T. 41 and 42 N.) yielded no larvae.

Brook trout, smallmouth bass and rock bass were collected near the mouth of the Days River but no game fish were taken at the stations where ammocoetes were found.

6. Tacoosh River.--A survey of this small stream (5 stations) showed that ammocoetes were extremely rare (Fig. 4). Only one ammocoete was found, at the station nearest the mouth. The four other stations were negative.

7. Rapid River.--Collections were made at 13 stations in this stream system (Fig. 4). In the main stream, ammocoetes were rare to common from the mouth to County Road 432, a distance of 16 miles, but were not taken at the one station above this road. Ammocoetes were also found in Inman Creek.

Figure 4.--Collection stations on the Days and Tacoosh rivers, Delta County; Rapid River, Delta and Marquette counties; Whitefish River, Delta, Alger and Marquette counties and Squaw Creek, Delta County. The lower portion of the Escanaba River is also shown. Open circles are stations at which no sea lamprey larvae were taken. Letters within circles indicate the abundance of ammocoetes (A = abundant, C = common, R = rare).

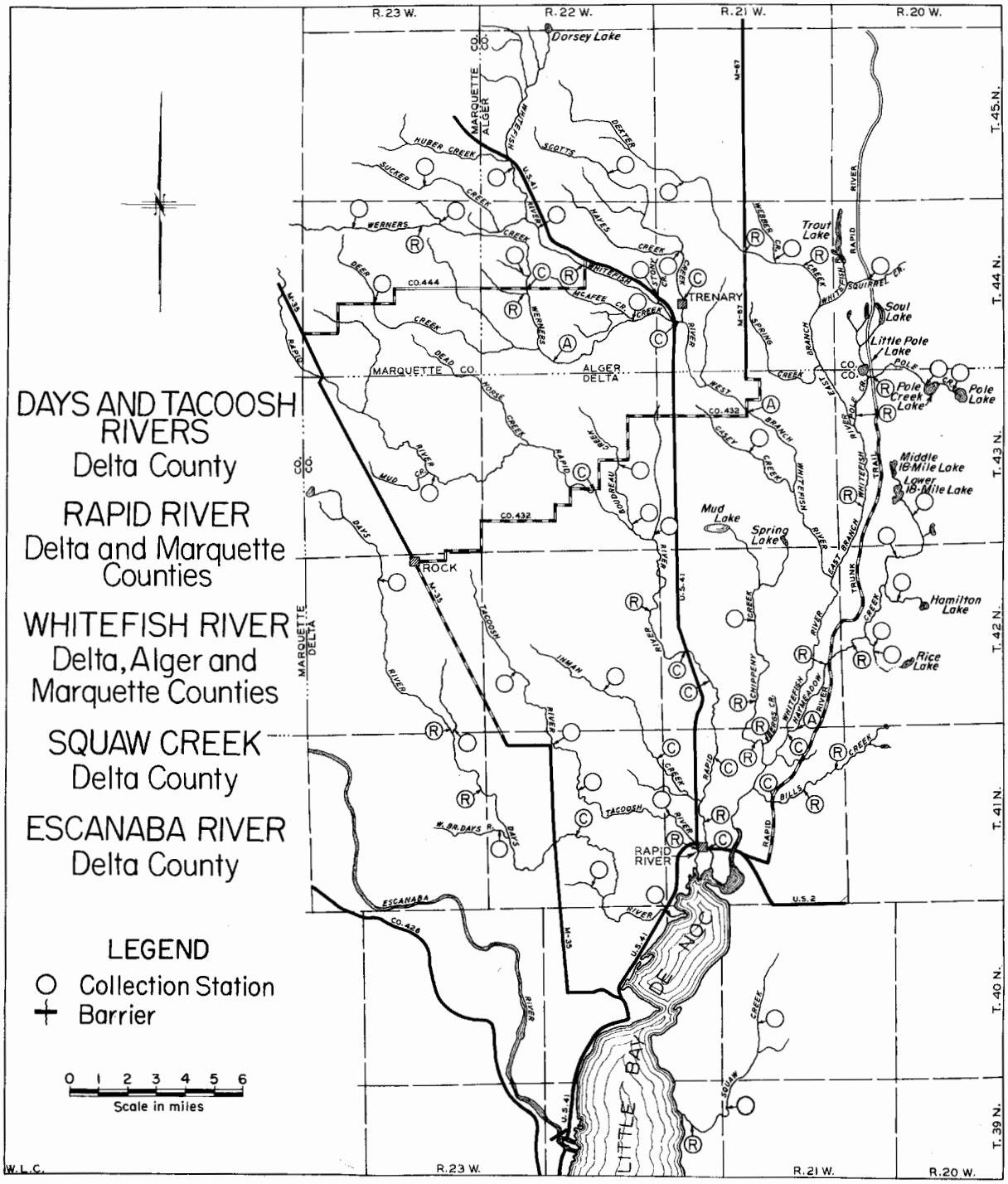
DAYS AND TACOOSH RIVERS
Delta County
RAPID RIVER
Delta and Marquette Counties
WHITEFISH RIVER
Delta, Alger and Marquette Counties
SQUAW CREEK
Delta County
ESCANABA RIVER
Delta County
LEGEND
Collection Station
Barrier
0 1 2 3 4 5 6
Scale in miles
R.23 W.
R.22 W.
R.21 W.
R.20 W.
T.45 N.
T.44 N.
T.43 N.
T.42 N.
T.41 N.
T.40 N.
T.39 N.
Dorsey Lake
Trout Lake
Soul Lake
Little Pole Lake
Pole Creek Lake
Pole Lake
Middle 18-Mile Lake
Lower 18-Mile Lake
Mud Lake
Spring Lake
Hamilton Lake
Rice Lake
TRENARY
ROCK
RAPID RIVER
LITTLE BAY DE NOC
MARQUETTE CO.
ALGER CO.
DELTA CO.
MARQUETTE
ALGER
DELTA
M-35
M-67
U.S.41
U.S.2
CO.444
CO.432
CO.426
W.L.C.

Figure 4

No ammocoetes were taken at one station at the mouth of a small unnamed tributary (one mile below Boudreau Creek) and at two stations on Boudreau Creek.

Limited numbers of brook trout, rainbow trout, yellow perch and rock bass were collected from the main stream, but no game fish were seen in Inman Creek.

8. Whitefish River.--Collecting at 46 stations in this large stream system demonstrated that it contained a large number of ammocoetes (Fig. 4). Larvae were common or abundant at three stations in the main stream (includes the West Branch) and rare at one location about four miles west of Trenary, 26 miles upstream from the mouth. Ammocoetes were not taken at two stations above this point. Larvae also occurred (rare to abundant) in six tributaries: Bills, Chippeny, and Haymeadow creeks; the East Branch and Scotts and Werner creeks.

Single stations on Casey, Stony, and Sucker creeks were negative. An unnamed tributary entering the main stream 1.5 miles upstream from County Road 432 was dry at a point one-half mile above the mouth.

Small numbers of brook trout, yellow perch and pumpkinseeds (Lepomis gibbosus) were collected in the main stream. Brook trout were found in Haymeadow Creek, the East Branch, and Werner Creek. No game fish were taken in Bills, Chippeny, and Scotts creeks.

9. Squaw Creek.--On the basis of three collections, this small stream was judged to produce only small numbers of ammocoetes (Fig. 4). They were rare at one station near the mouth, but none were found at two stations in the upper portion of the stream. No game fish were collected at any of the stations.

10. Big River.--No ammocoetes of any species were collected at a station near the mouth of this small stream (Fig. 5).

11. Ogontz River.--Moderate numbers of ammocoetes were produced in this relatively small stream (Fig. 5). Collecting in the main stream (includes the

Figure 5.--Collection stations on the Big and Ogontz rivers, Delta County; Sturgeon River, Delta and Alger counties; and Fish Dam and Little Fish Dam rivers, Delta County. Open circles are stations at which no sea lamprey larvae were taken. Letters within circles indicate the abundance of ammocoetes (A = abundant, C = common, R = rare).

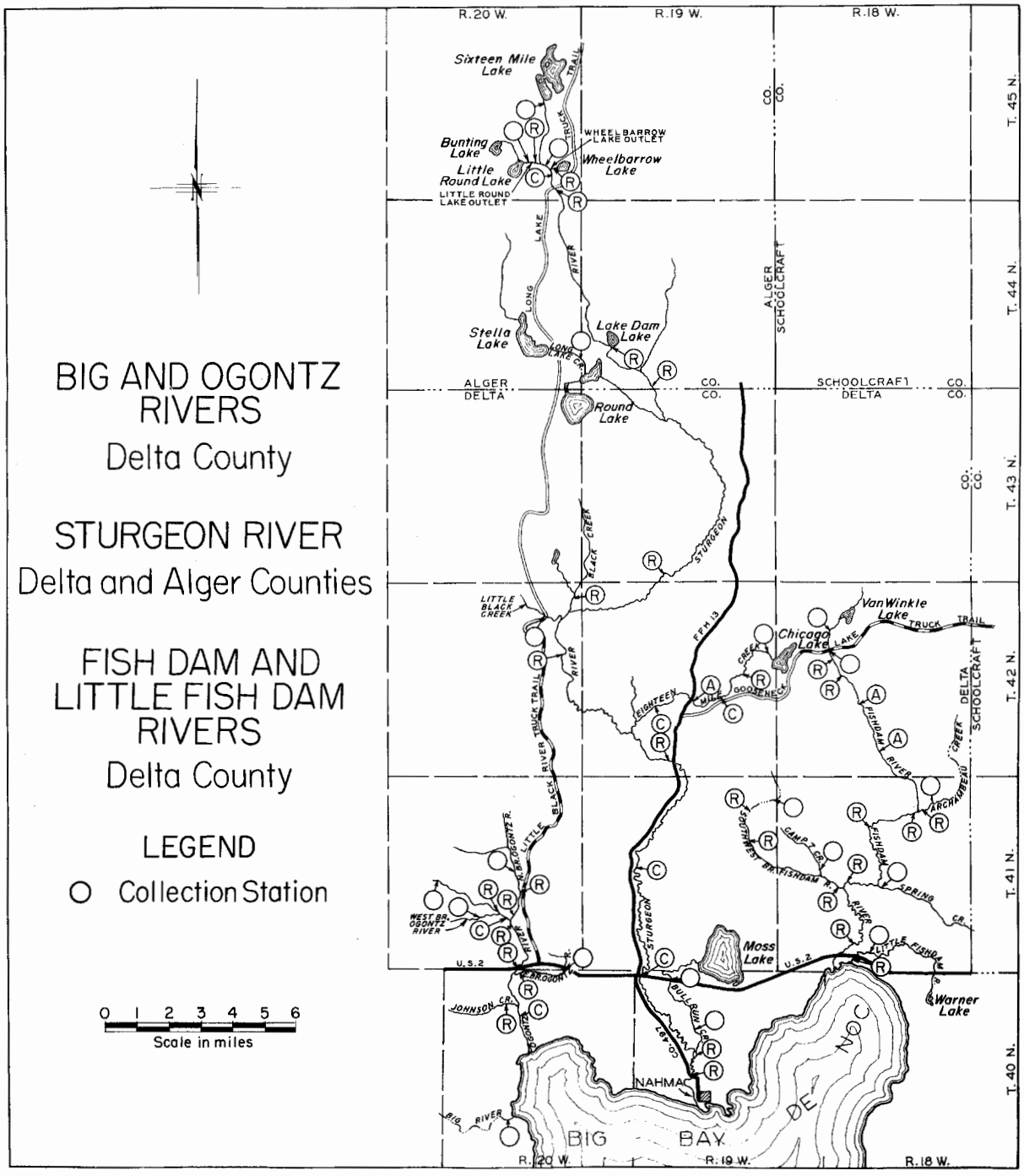
BIG AND OGONTZ RIVERS
Delta County
STURGEON RIVER
Delta and Alger Counties
FISH DAM AND LITTLE FISH DAM RIVERS
Delta County
LEGEND
Collection Station
0 1 2 3 4 5 6
Scale in miles
R.20 W.
R.19 W.
R.18 W.
T. 45 N.
T. 44 N.
T. 43 N.
T. 42 N.
T. 41 N.
T. 40 N.
Sixteen Mile Lake
Bunting Lake
Little Round Lake
LITTLE ROUND LAKE OUTLET
WHEEL BARROW LAKE OUTLET
Wheelbarrow Lake
Stella Lake
Lake Dam Lake
Round Lake
ALGER CO.
SCHOOLCRAFT CO.
DELTA CO.
Van Winkle Lake
Chicago Lake
Moss Lake
Warner Lake
NAHMA
BIG BAY DE NOC
U.S.2
M-183

Figure 5

North Branch) indicated that ammocoetes were rare to common in the lower five miles of stream (five positive stations), but none were taken at one station above this area. Ammocoetes were found in all of the tributaries (Johnson Creek, the East Branch, and the West Branch).

Sparse populations of brook trout and northern pike occurred in the main stream.

12. Sturgeon River.--Sampling at 26 stations indicated that this large stream was one of the major producers of ammocoetes among the tributaries of northern Lake Michigan (Fig. 5). Ammocoetes were rare to common in the main stream from the mouth to a point two miles below Sixteen Mile Lake, a distance of 42 miles. Two stations above this area were negative. (The lower negative station may not be a reliable indication of larval distribution however, because the collecting was done in a beaver pond, where the habitat may have been unsuitable.)

Ammocoetes were found in five tributaries of the Sturgeon River: Bull Run, Eighteen Mile, and Black creeks; and Wheelbarrow and Little Round Lake outlets. Ammocoetes were generally rare in the tributaries except for a portion of Eighteen Mile Creek, where they were common at two stations and abundant at another. Lake Dan Lake, through which the main stream flows, may also contain ammocoetes (no collecting attempted).

No ammocoetes were collected at single stations on Little Black and Long Lake creeks.

Small numbers of brook, brown and rainbow trout, and northern pike, yellow perch and rock bass were taken from the portion of the main stream that contained ammocoetes. Northern pike and rock bass were found at the mouth of Bull Run Creek. In Eighteen Mile Creek, brook trout, brown trout and northern pike were collected. Brook trout were taken in Wheelbarrow Lake Outlet but no game fish were seen in Black Creek and Little Round Lake Outlet.

13. Fish Dam River.--An extensive survey (18 stations) demonstrated that moderate numbers of ammocoetes were present in this stream (Fig. 5). In the main stream they occurred from the mouth upstream to a point just below Gooseneck Lake Truck Trail, a distance of 14 miles. Ammocoetes were rare in the lower eight miles of this area (four stations) and in the upper one mile (two stations), but were abundant in the middle portion (two stations). Two stations in the main stream above Gooseneck Lake Truck Trail were negative. Ammocoetes occurred in two tributaries (the Southwest Branch and Archambeau Creek).

A single station near the mouth of Spring Creek was negative.

Brook and brown trout were present in the Fish Dam River, but no game fish were collected from the Southwest Branch and Archambeau Creek.

14. Little Fish Dam River.--This small stream produced few, if any, sea lampreys (Fig. 5). A single ammocoete was found at a station near the mouth but a station one-half mile above the mouth failed to produce ammocoetes of any species. The stream above this point was swampy and probably unsuitable for sea lamprey reproduction. The single ammocoete taken near the mouth may have originated from the Fish Dam River.

15. Manistique River.--The survey of this stream (66 collections) indicated that only a few ammocoetes occurred near the mouth and none in the upstream areas. A 27-foot dam located about one mile from the mouth (Fig. 6), operated by the Manistique Pulp and Paper Mill, is believed to be a barrier to upstream-migrating sea lampreys (Applegate, 1950). The structure feeds water to the plant machinery through a flume about 200 feet wide and 3,000 feet long. A seepage channel, fed by leakage from the flume and a small stream (Weston Creek), runs along the west side of the flume and flows into a mill pond (immediately above the paper mill) which drains into the river below the paper mill. In the past, sea lampreys have gained access to the seepage channel and may

Figure 6.--Collection stations on the Manistique River, Bulldog Creek and Milakokia River, Schoolcraft County and Millecoquins River, Mackinac County. Open circles are stations at which no sea lamprey larvae were taken. Letters within circles indicate the abundance of ammocoetes (A = abundant, R = rare).

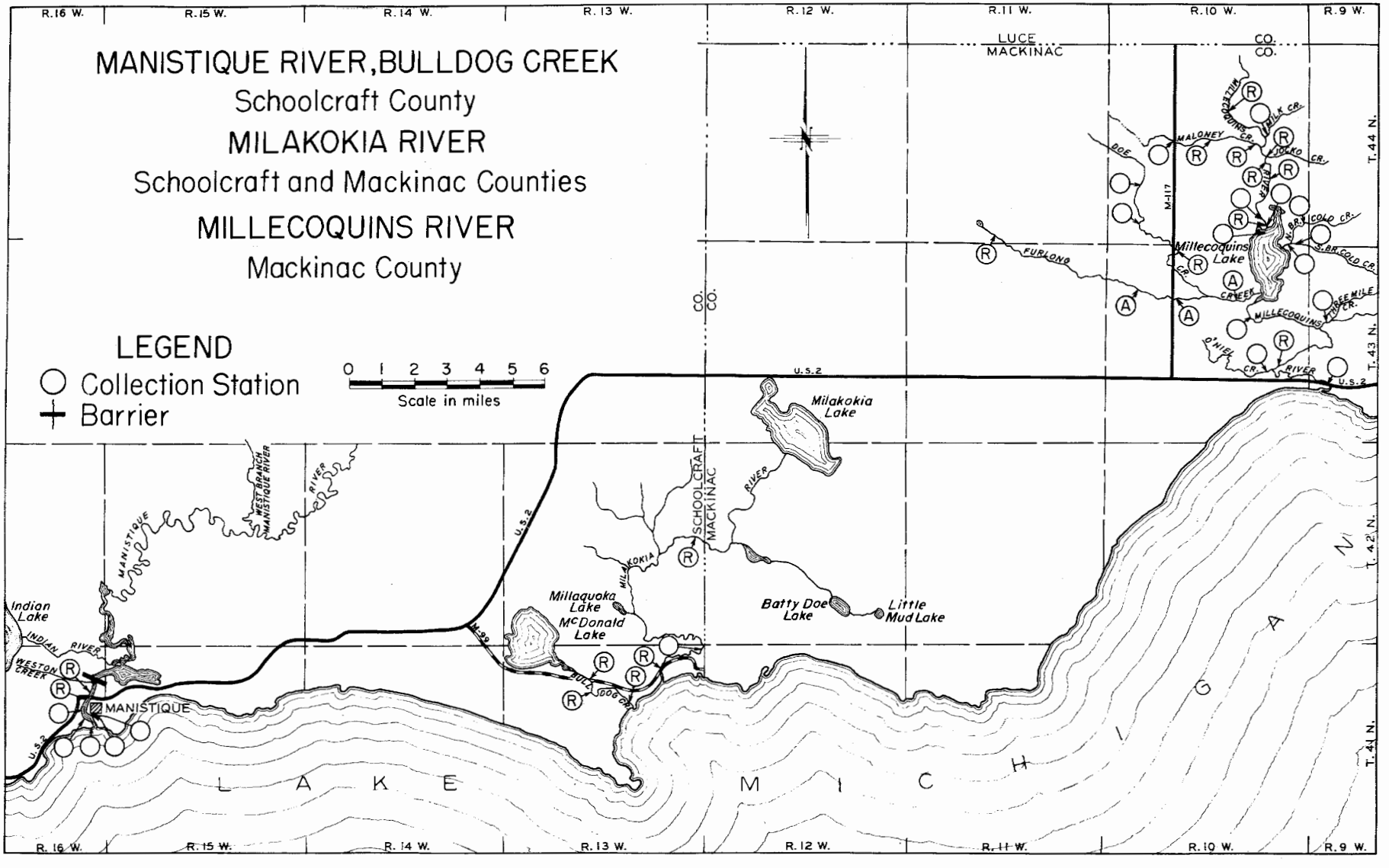
MANISTIQUE RIVER, BULLDOG CREEK
Schoolcraft County
MILAKOKIA RIVER
Schoolcraft and Mackinac Counties
MILLECOQUINS RIVER
Mackinac County
LEGEND
Collection Station
Barrier
Scale in miles
R.16 W.
R.15 W.
R.14 W.
R.13 W.
R.12 W.
R.11 W.
R.10 W.
R.9 W.
T.44 N.
T.43 N.
T.42 N.
T.41 N.
LUCE CO.
MACKINAC CO.
SCHOOLCRAFT CO.
MACKINAC CO.
MANISTIQUE
Indian Lake
INDIAN RIVER
WESTON CREEK
WEST BRANCH MANISTIQUE RIVER
MANISTIQUE RIVER
Milakokia Lake
MILAKOKIA RIVER
Millaquoka Lake
McDonald Lake
BULLDOG CR.
Batty Doe Lake
Little Mud Lake
Millecoquins Lake
FURLONG CR.
DOE CR.
MALONEY CR.
MILLECOQUINS CR.
MILLECOQUINS RIVER
COLD CR.
S.BR. COLD CR.
THREE MILE CR.
THREE MILE RIVER
O'NEIL CR.
M-117
U.S.2
M-99
LAKE MICHIGAN

Figure 6

have escaped upstream through leaks in the flume. However, access to the seepage channel was presumably blocked in 1954.

A few ammocoetes were taken with a direct-current shocker at stations in the seepage channel and in the mill pond (above the paper mill but below the dam); none were caught, however, at five stations below the paper mill (although mature adult sea lampreys were found). The examination of a small portion of a barge load of bottom material (dredged by the U. S. Corps of Engineers) and of 178 orange-peel dredge lifts (111 square feet of bottom sampled) from Manistique Harbor also failed to produce ammocoetes of any species. The wastes from the paper mill may prevent the use of this part of the river by ammocoetes.

Evidence is strong that the Manistique River above the paper mill dam does not support sea lamprey ammocoetes. In 1957, 36 collections (locations not shown in Fig. 6) were made in the Indian River, a major tributary of the Manistique River, primarily to determine game fish distribution. Of 993 ammocoetes collected at 24 of these stations, none were sea lampreys. During the same survey, seven collections were made in Stutts Creek (a major tributary of the West Branch of the Manistique River). Of 227 ammocoetes collected at seven stations, none were sea lampreys.

In October, 1952, 16 fish collections were made in the Fox River (a major tributary of the Manistique River, not shown in Fig. 6). Of 476 ammocoetes collected at 14 stations, none were sea lampreys (Cooper, 1954).

16. Bulldog Creek.--This small stream produced only limited numbers of ammocoetes (Fig. 6). They were rare at the three stations between the mouth and McDonald Lake, a distance of two miles. A few largemouth bass (Micropterus salmoides) were collected in this section of stream.

17. Milakokia River.--Few ammocoetes were found in this small stream (Fig. 6). Three stations (two positive, one negative) indicated that ammocoetes

were rare in the lower 10 miles of stream. A few brook trout, northern pike, rock bass, yellow perch and pumpkinseeds were found in this section of the stream.

18. Millecoquins River.--Sampling at 27 stations indicated that this stream system produced moderate numbers of ammocoetes (Fig. 6). Collecting at three stations in the main stream below Millecoquins Lake yielded 1 larva and collecting at six stations above the lake produced 12, suggesting that ammocoetes were present (but rare) throughout 14 miles of the main stream. Ammocoetes were also present in Furlong, Jocko, and Maloney creeks. The greatest concentration in the Millecoquins System was found in Furlong Creek in which larvae were abundant at three stations. Although one sample from Millecoquins Lake near the mouth of the upper Millecoquins River was negative, ammocoetes may occur in the southern portion of the lake, near the mouth of Furlong Creek.

No ammocoetes were collected in O'Neil Creek (one station), Three Mile Creek (one station), Cold Creek (three stations), and Milk Creek (one station). Water temperatures (53° F. or below) in the latter three streams were probably too low to provide suitable sea lamprey spawning habitat (Stauffer and Hansen, 1958).

Northern pike, yellow perch and rock bass were found in Millecoquins River below Millecoquins Lake, and brook trout were found in the upper Millecoquins River and its tributaries. No game fish were found in Furlong Creek.

19. Black River.--Ammocoetes (of the various species present) were caught in the Black River during the collection of rainbow trout with an alternating-current shocker (as part of a separate research project) at 11 stations each year in 1952-1958. Abundance of sea lamprey ammocoetes in the Black River thus

cannot readily be compared with abundance in other streams because of the differences in objectives and technique. Nevertheless, the collections in the main stream indicated that larvae were present from the mouth to a point five miles upstream (Fig. 7). Ammocoetes were also present in the East Branch of the Black River and Peters and O'Neil creeks.

Ammocoetes were not found at single stations in an unnamed tributary (one-half mile above the mouth of the Black River) or in Silver Creek.

Brook, brown, and rainbow trout were abundant in the areas inhabited by ammocoetes.

20. Sucker Creek.--One station in the estuary of this very small stream yielded no ammocoetes (Fig. 7); immediately above the estuary, the stream was dry.

21. Hog Island Creek.--This small stream contained only a small population of ammocoetes. They were rare at two stations and not found at two others (Fig. 7), indicating that relatively few ammocoetes inhabited the lower four miles of the stream. Brook trout were abundant.

22. Davenport Creek.--No ammocoetes were taken at four stations in this small stream (Fig. 7). Low water temperatures (53° F. or below) and the predominantly cold-water fish population (brook trout and slimy sculpins, Cottus cognatus) suggested that this stream was probably not suitable for sea lamprey reproduction.

23. Paquin Creek.--This small stream yielded only small numbers of ammocoetes. Larvae were rare at two of three stations between the mouth and a power dam (six-foot head), three miles upstream (Fig. 7). No ammocoetes were taken in two collections above the dam, suggesting that the dam is a barrier to upstream-migrating adult sea lampreys. A single station on a tributary (entering the main stream immediately above Highway U. S. 2) was also negative.

Figure 7.--Collection stations on the Black River, Sucker, Hog Island, Davenport and Paquin creeks, Cut and Brevoort rivers, Pointe Aux Chene Creek and Moran River, Mackinac County. Open circles are stations at which no sea lamprey larvae were taken. Letters within circles indicate the abundance of ammocoetes (R = rare, P = present).

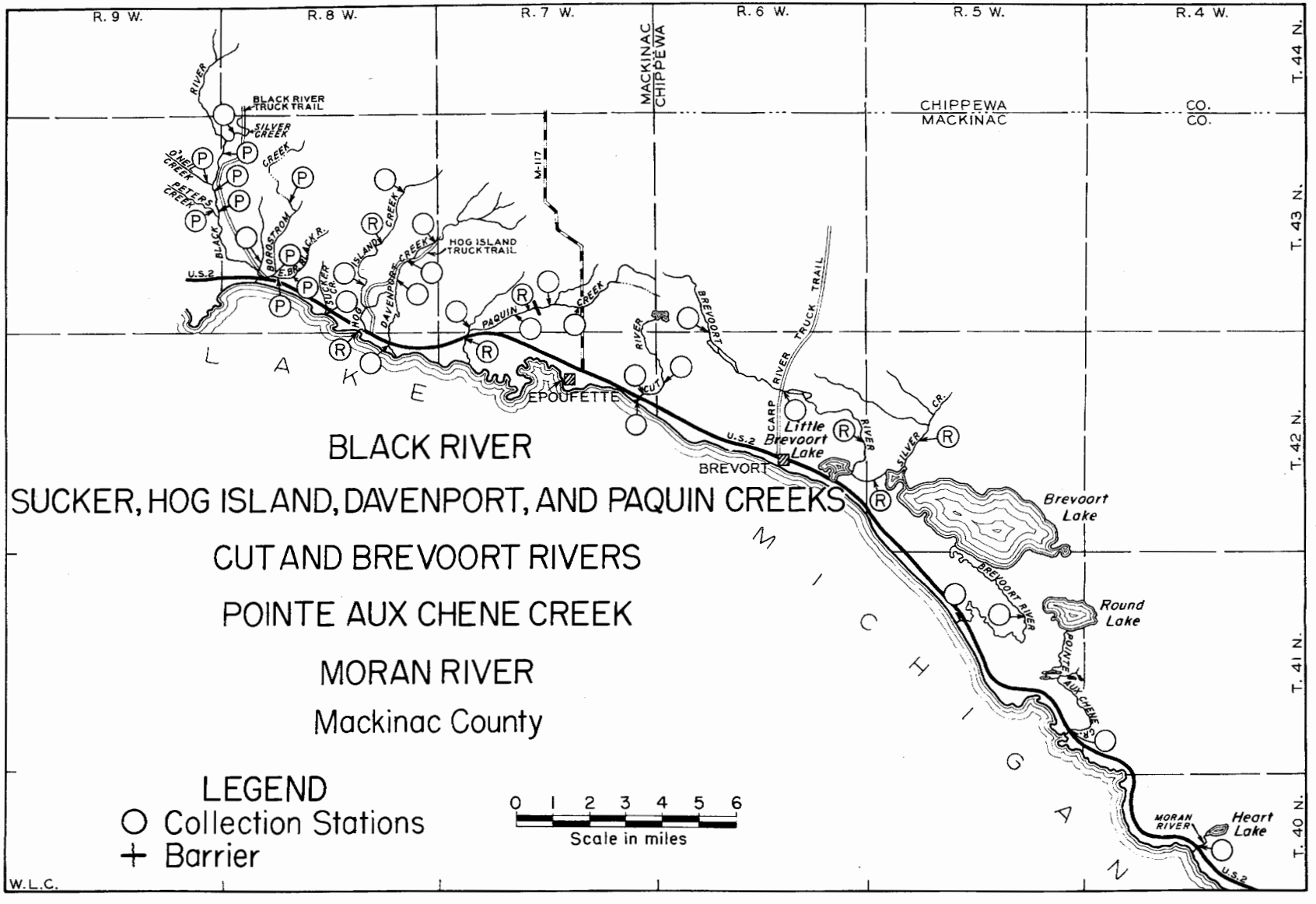
R. 9 W.
R. 8 W.
R. 7 W.
R. 6 W.
R. 5 W.
R. 4 W.
T. 44 N.
T. 43 N.
T. 42 N.
T. 41 N.
T. 40 N.
MACKINAC
CHIPPEWA
CHIPPEWA
MACKINAC
CO.
CO.
BLACK RIVER
TRUCK TRAIL
SILVER CREEK
O'NEIL CREEK
PETERS CREEK
BLACK R.
BORGSTROM
N.BR. BLACK R.
U.S.2
SUCKER CR.
HOG ISLAND CREEK
DAVENPORT CREEK
HOG ISLAND TRUCK TRAIL
M-117
PAQUIN CREEK
L A K E
EPOUFETTE
CUT RIVER
BREVOORT
CARP RIVER
TRUCK TRAIL
Little Brevoort Lake
SILVER CR.
Brevoort Lake
BREVOORT RIVER
Round Lake
POINTE AUX CHENE
MORAN RIVER
Heart Lake
M I C H I G A N
BLACK RIVER
SUCKER, HOG ISLAND, DAVENPORT, AND PAQUIN CREEKS
CUT AND BREVOORT RIVERS
POINTE AUX CHENE CREEK
MORAN RIVER
Mackinac County
LEGEND
Collection Stations
Barrier
0 1 2 3 4 5 6
Scale in miles
W.L.C.

Figure 7

Brook and rainbow trout were abundant in the area inhabited by ammocoetes.

24. Cut River.--No ammocoetes of any species were taken in three collections from this small stream (Fig. 7). The abundance of brook trout and slimy sculpins further suggested that this stream may not be suitable for sea lamprey reproduction.

25. Brevoort River.--The seven collections made in this stream system were inadequate to assess its importance as a producer of sea lampreys. Evaluation is complicated by Little Brevoort and Brevoort lakes (not sampled) which may or may not contain ammocoete populations. Although no ammocoetes were taken at two stations in the main stream below Brevoort Lake, they were rare at one station between Brevoort and Little Brevoort lakes and at one station about a mile above Little Brevoort Lake. None were collected at two stations in the headwaters of the main stream. Ammocoetes were rare at a single station in ~~Spring~~ Silver Creek (about one-half mile above its mouth).

Brook trout, northern pike, yellow perch and rock bass were found in the main stream. Brook trout were also collected from Silver Creek.

26. Pointe Aux Chene Creek.--No ammocoetes of any species were taken at the one station near the mouth of this small, stagnant stream.

27. Moran River.--No ammocoetes were collected at the single station near the mouth of this small stream.

Summary

Twenty-five tributaries of northern Lake Michigan, between St. Ignace and Menominee, were surveyed with a direct-current shocker in 1955-1959 to determine the distribution and abundance of sea lamprey ammocoetes. Game-fish surveys of two of these streams and two other tributaries, in 1952-1958, provided supplementary information. Ammocoetes were found in 20 of the 27 streams examined. Stream systems judged to contain the largest population of larvae were (from west to east) the Cedar, Ford, Whitefish and Sturgeon rivers.

Streams with moderate populations were the Bark, Days, Rapid, Ogontz, Fish Dam, Millecoquins and Black rivers. Streams which contained at least a small population of ammocoetes were (from west to east): Tacoosh River, Squaw Creek, Little Fish Dam and Manistique rivers, Bulldog Creek, Milakokia River, Hog Island Creek, Paquin Creek, and Brevoort River.

The collection data for the surveys of tributaries of northern Lake Michigan are summarized in Table 1.

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Gerald P. Cooper and Paul H. Eschmeyer read the manuscript and made suggestions. William L. Cristanelli prepared the illustrations.

Table 1.--Dates of survey, amount of collecting effort, numbers of sea lamprey ammocoetes collected, and estimated number of miles of stream inhabited by sea lamprey ammocoetes in tributaries of northern Lake Michigan

Stream number[1]	Stream	Date of collection Month[2]	Year	Number of stations	Collecting time (hours)	Total number of ammocoetes collected[3]	Miles of stream inhabited by ammocoetes[4] Main stream	Tributaries
1	Big Cedar River	6,7,8	1959	61	51	898	51	37
2	Bark River	7	1959	15	11	198	18	2
3	Ford River	8	1953	4	5	8	86	22
		10	1954	22	16	12	..	..
		7	1955	4	2	2	..	..
		10	1956	1	1	31	..	..
		8	1959	17	14	118	..	..
4	Escanaba River	9,10	1958	59	30	0	0	0
5	Days River	8	1959	8	6	81	16	0
6	Tacoosh River	7,8	1959	5	5	1	1	0
7	Rapid River	8,9	1957	8	6	244	16	2
		7	1959	5	4	38	..	..
8	Whitefish River	8,9	1957	4	2	179	26	42
		8	1958	6	6	304	..	..
		7,8	1959	36	24	262	..	..
9	Squaw Creek	9	1957	2	1	6	1	0
		8	1958	1	1	0	..	..
10	Big River	8	1958	1	1	0	0	0
11	Ogontz River	8	1957	6	5	112	5	4
		8	1958	3	3	15	..	..
		7	1959	4	3	2	..	..
12	Sturgeon River	8,9	1957	10	9	223	42	10
		7,8	1958	14	13	374	..	..
		8	1959	2	2	6	..	..
13	Fish Dam River	8	1957	8	6	200	14	5
		7	1958	10	10	16	..	..
14	Little Fish Dam River	7	1958	2	2	1	1	0
15	Manistique River (below dam)	6	1956	7	5	16	1	0
	Indian River and Stutts Creek	10	1957	43	31	0	0	0
	Fox River	10	1952	16	22	0	0	0

Stream number[1]	Stream	Date of collection: Month[2]	Year	Number of stations	Collecting time (hours)	Total number of ammocoetes collected[3]	Miles of stream inhabited by ammocoetes[4]: Main stream	Tributaries
16	Bulldog Creek	8	1957	3	3	23	2	0
17	Milakokia River	8	1957	3	3	16	8	0
18	Millecoquins River	7,8	1957	27	22	423	14	12
19	Black River	10[5]	1952-58	11	..	...	3	5
20	Sucker River	8	1957	1	1	0	0	0
21	Hog Island Creek	8,9	1955	4	5	11	4	0
22	Davenport Creek		1955	4	4	0	0	0
23	Paquin Creek	9	1955	6	7	2	2	0
24	Cut River	9	1955	3	4	0	0	0
25	Brevoort River	7	1957	7	7	10	11	1
26	Point Aux Chene Creek	8	1957	1	1	0	0	0
27	Moran River	8	1957	1	1	0	0	0

[1] Stream number refers to the number arbitrarily assigned to each stream in the text.

[2] Months are numbered consecutively from June (6) to October (10).

[3] Ammocoetes which were metamorphosing are included.

[4] The distance from the uppermost positive station to the mouth of the stream (measured from Michigan Conservation Department masterplan maps, scale, 1 inch = 1 mile).

[5] Except several collections made in September (1953) and November (1953-1954).