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GREAT LAKES FISHERY RESEARCH BY THE MICHIGAN DEPARTMENT OF CONSERVATION, 1958*

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Michigan's fishery research on the Great Lakes and their immediate tributary waters during the past year has been directed principally toward the study of various aspects of the life history of the sea lamprey. This work is supported by an earmarked item of $43,500 in the 1958-1959 budget of the Institute for Fisheries Research. Although this sum is small as compared to the amounts being expended for sea lamprey control and research by the United States and Canadian governments, it is, nevertheless, one of the few allotments in the Department of Conservation's budget which was not reduced for the current fiscal year.

Research on other fishery problems in the Great Lakes has been on a far smaller scale than would seem appropriate if considered in terms of the extensive portions of these waters which lie within the State's boundaries or the importance of their sport and commercial fisheries. Work has been necessarily limited because the Department's funds for fishery activities come almost entirely from the sale of sport-fishing licenses, which are not required for angling in Michigan waters of the Great Lakes. The passage of a legislative act to require a license for sport fishing has long been urged by the Department and for some years has ranked high among the objectives of the Michigan United Conservation Clubs.

The following accounts of research results are based on reports or information provided by Department staff members who are principally responsible for the respective activities discussed.[1]

Sea lamprey research

Michigan's sea lamprey research is under the direct supervision of T. M. Stauffer and is carried out principally from the Marquette Office of the Institute for Fisheries Research. The staff assigned to the work includes two other fishery biologists (M. J. Hansen and W. C. Wagner), a technician and a secretary, in addition to five seasonal employees. In 1958 the work was concerned principally with a study of the distribution and abundance of sea lamprey ammocoetes in streams; the duration of the ammocoete stage; the distribution and abundance of ammocoetes in Ogontz Bay, Lake Michigan; and the migration of ammocoetes in streams.

Distribution and abundance of ammocoetes in streams.--The development of a selective toxicant for sea lamprey larvae by the U. S. Bureau of Commercial Fisheries,

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*Presented in part at the 1958 annual meetings of the Great Lakes Fishery Commission at Ann Arbor on December 4, and of the Upper Great Lakes Fishery Committee at Columbus, Ohio, on December 14.

[1]Not mentioned elsewhere is the annual meeting of the Lake Erie Fish Management Committee, which was held on June 4-5, 1958, at the Detroit-Leland Hotel. Michigan was the host at this meeting (of which G. P. Cooper was chairman), which brought together 61 fishery biologists, administrators, and commercial and sport fishermen from the states and Province bordering Lake Erie and from the federal fishery agencies of Canada and the United States.

and the repeated demonstrations of its effectiveness within the past year, have added much significance to the State's collection of data since 1954 on the occurrence and distribution of sea lamprey larvae in tributaries of Lakes Superior and Michigan.

A paper entitled "Distribution of Sea Lamprey Ammocoetes in Michigan Tributaries of Lake Superior, 1955-1957," by Thomas M. Stauffer and Martin J. Hansen, which appeared in August 1958 as Miscellaneous Publication No. 11 of the Institute for Fisheries Research, summarized the results of field collections with a direct-current electric shocker in 60 streams tributary to Lake Superior. In 1958, in close coordination with the expanding control program of the U. S. Bureau of Commercial Fisheries, 58 additional collections were made in 10 Lake Superior streams, either to determine the presence or absence of sea lamprey ammocoetes or to ascertain precisely the upstream limits of their distribution (and thus facilitate the application of lampricides). Sea lamprey ammocoetes were found in two streams (AuTrain River, Alger County, and Big Garlic River, Marquette County) where their presence was not previously known.

Thirty-seven collections were made in seven tributaries of Lake Michigan in the vicinity of Bay de Noc to determine the upstream limits of distribution of sea lamprey ammocoetes. (The occurrence of ammocoetes in five of the streams had been established in 1957.) The 1958 work continued similar surveys made in Upper Peninsula tributaries of Lake Michigan in 1956 and 1957.

Duration of the ammocoete stage.--The importance of knowing the duration of the ammocoete stage in the life cycle of the sea lamprey has varied greatly within the brief history of the sea lamprey control program. The length of larval life loomed as an extremely important factor when the use of electrical barriers to prevent the upstream spawning migration of adults was expected to be the primary method of control; lost much of its significance when the development of effective larvacides first became highly probable; and resumed a considerable measure of importance in the face of repeated recent demonstrations that larvae occur in substantial numbers in stream deltas and even in portions of the lakes far removed from streams, where they are not vulnerable to routine applications of larvacides.

Observations on the duration of the ammocoete stage were continued in the Carp Lake River, Emmet County. An inclined-plane trap has been operated near the mouth of this stream since 1950, to capture downstream migrants and to act as a barrier to the upstream migration of adults. Newly transformed sea lampreys, as well as lamprey larvae, have been taken each year since the trap was installed (Table 1). In the 1957-1958 season the trap took 4,796 recently transformed sea lampreys and 561 ammocoetes (of which 95 percent were sea lampreys).

The continuing occurrence of sea lampreys in the Carp Lake River inclined-plane trap strongly suggests that larval life may be materially longer than the 4 or 5 years commonly assigned to it (largely on the basis of the length-frequency distribution of larvae in stream collections). Unfortunately, however, the possibility that mature sea lampreys gained access to the stream above the barrier within the years 1950-1954 cannot be excluded on the basis of the available data. Annual checks of spawning areas and larval populations have shown, nevertheless, that no recruitment to the population occurred in 1955-1958. At a sampling station in the stream above the barrier, the average length of lamprey larvae collected continued a gradual rise, from 4.0 inches in July 1955 to 5.2 inches in October 1958 (Table 2); the smallest sea lamprey ammocoete taken during the 4-year period was 2.1 inches long, even though shorter Michigan or American brook lamprey ammocoetes were frequently collected.

Table 1.--Numbers of sea lampreys caught in an inclined-plane trap in the Carp Lake River, 1950-1958

Migratory season	Number of recently transformed sea lampreys	Number of larvae[1]
1950-51	15,103	12,647
1951-52	4,069	1,414
1952-53	6,861	2,838
1953-54	10,238	14,827
1954-55	3,893	3,725
1955-56	2,401	22,822
1956-57	2,640	4,884
1957-58	4,796	561
Total	50,001	63,718
Average annual catch	6,250	7,965

[1] Includes all species trapped.

Table 2.--Number and size of sea lamprey ammocoetes collected with a direct-current shocker, upstream from an inclined-plane trap, Carp Lake River, 1955-1958

Date of collection	Total number collected	Number collected per hour	Length in inches	
			Smallest	Average
July, 1955	562	336	2.2	4.0
October, 1955	218	109	2.9	4.2
July, 1956	147	37	2.1	4.2
October, 1956	137	68	3.1	4.2
July, 1957	87	23	3.3	4.8
November, 1957	79	45	3.6	5.0
July, 1958	167	84	3.8	5.1
October, 1958	92	48	3.3	5.2

That sea lamprey larvae were still abundant above the Carp Lake River barrier in the summer of 1958 is shown not only by the data summarized in Table 2, but also by the collection of 1,874 sea lamprey ammocoetes at 4 stations in the stream above the barrier on June 23-July 3. (These were released after being marked by the injection of cadmium sulfide. It is hoped that recoveries in the inclined trap and/or by future sampling in the stream will provide information on population density, distance and direction of migration, and mortality rate.)

Collections of sea lamprey ammocoetes also were made in 1955-1958 in the Black River, Mackinac County, where a barrier dam was operated in 1951-1957 and an electrical barrier in 1958. Upstream escapement of adult lampreys is known to have occurred during one or more of these years, however, and may have resulted in recruitment to the population of sea lamprey larvae. These apparently inconclusive data are being held for possible later interpretation; stream collections will be continued in 1959 in both the Black and the Carp Lake rivers.

Sea lamprey ammocoetes in Ogontz Bay, Lake Michigan.--The presence of sea lamprey ammocoetes at several localities (some more than 1 mile from the nearest stream mouth) along the north shore of Lake Michigan was demonstrated by an Institute survey party in 1957. In 1958, a more intensive study was made of the abundance and distribution of ammocoetes in Ogontz Bay (located in northern Green Bay), Lake Michigan.

Ogontz Bay was selected because of its known sea lamprey ammocoete population, favorable environmental conditions, and its connection with the Ogontz River, which supports a substantial population of sea lamprey ammocoetes. The 146-acre study area was situated along the shoreline, off the mouth of the river. Water depth ranged from several inches near shore to 5 feet along the outer perimeter. The substrate, composed of varying proportions of sand, silt, and clay, appeared to offer suitable ammocoete habitat.

Since preliminary reconnaissance had indicated that certain locations within the study area might be more productive of larvae than others, 10 subdivisions were established within the main area on the basis of bottom type and proximity to the mouth of the Ogontz River. Five subareas were located in shallow water along the shoreline, and five were situated in relatively deep water beyond the 3-foot contour. Sampling stations were randomly selected. The collections were made with an orange-peel dredge which sampled 1 square foot of the bottom per lift; 25 or 50 dredge lifts were made at each station.[2]

Nine sea lamprey ammocoetes were collected from 232 sampling locations in 6,150 dredge lifts. Eight ammocoetes (length range, 4.0-5.0 inches) were collected from the five shoreline areas and one (5.1 inches) from the outer (deep) areas. Preliminary population estimates were calculated for each subarea by multiplying the mean number of ammocoetes taken per station by the inflation factor. The sum of these resulted in a population estimate of 1,120 ammocoetes in the deep water areas (standard error, 1,118) and 4,820 ammocoetes in the shallow water areas (standard error, 1,844). Although the standard errors are large, the results indicate, nevertheless, the presence of substantial numbers of sea lamprey ammocoetes (most over 4 inches in length) in Ogontz Bay.

Migration of ammocoetes.--The downstream movement of large numbers of sea lamprey ammocoetes has been demonstrated by the catches in the inclined-plane trap in the Carp Lake River (Table 1). An experiment to obtain further information on the direction of movement was begun in July 1957 in the Chocolay River, Marquette County. More than 400 ammocoetes were marked (by the injection of cadmium sulfide beneath the outer layer of skin), and released at each of two stations which were separated by about 200 feet of stream. Collections were made periodically at a middle station, located between the two marking sites. Thirty-four ammocoetes recovered in July-November 1957 and 39 recovered in April-October 1958 had been released at the

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[2] The advice of Don W. Hayne, Institute biometrician, was followed closely both in planning the study and in the analysis of the data.

upstream marking station. Throughout the experiment (terminated October 30, 1958) no ammocoetes originating from the downstream marking site were recovered at the middle collecting station, indicating that most (perhaps all) of the movement of sea lamprey ammocoetes in this portion of the Chocolay River was downstream. The length-frequency distributions of the lampreys marked and of those recovered in 1957 suggested that movement was independent of length. (An upward shift in the length-frequency distribution of marked lampreys recovered in 1958 was undoubtedly the result of growth during the experimental period.)

Sea lampreys in the Inland Waterway.--Of eventual, if not immediate significance in the sea lamprey control program in the Great Lakes is the occurrence of a resident population of sea lampreys in the Inland Waterway. This Waterway, located near the northern tip of the Lower Peninsula, is composed of a series of large inland lakes (Black, Burt, Mullett, Crooked, Round) and their interconnecting streams, and drains into Lake Huron via the Cheboygan River. Although a 14-foot dam is located near the mouth of the river, a by-passing boat lock may have permitted the introduction of sea lampreys into the Waterway.

In August, 1958, 37 collections were made in 9 tributary streams in the Waterway. (Tributaries of Black Lake were not included because it is protected by a dam which is believed to be an effective barrier to the upstream migration of sea lampreys.) Moderate numbers of sea lamprey ammocoetes were found in the Maple and Sturgeon rivers (tributaries of Burt Lake), the Pigeon River (which drains into Mullett Lake) and Laperell Creek, a small tributary of the Cheboygan River.

Scarring of fish in Burt and Mullett lakes has been reported from time to time in recent years, but no serious effect on the fish populations of the Inland Waterway has as yet been observed.

Identification of ammocoetes.--Although adults of the five species of lampreys which occur in the Great Lakes watershed are usually readily recognizable, the identification of ammocoetes of some of the species has presented a much more difficult problem. Field characters used by Stauffer and Hansen in separating ammocoetes of sea lampreys from those of other species, with an extremely high degree of confidence, are described in their 1958 publication on ammocoete distribution in Lake Superior tributaries, mentioned above. A stream survey with a direct-current shocker in the Upper Manistee River by Walter R. Crowe and other Department personnel, on September 16-25, 1958, provided sizable numbers of two species of lampreys commonly associated with sea lamprey larvae, but whose ammocoetes have previously resisted specific identification. The study of a large series of ammocoetes, transforming individuals, and adults of the chestnut lamprey (Ichthyomyzon castaneus) and the northern brook lamprey (Ichthyomyzon fossor) indicated that ammocoetes of these two species can be separated with confidence, largely on the basis of differences in pigmentation of the tail region and of the lateral-line organs.[3]

Rainbow trout

Great-Lakes-run rainbow trout grow to a large size and are highly prized by Michigan anglers. A study of various aspects of their life history and of the effect of artificial stocking is being conducted by members of the Marquette staff of the Institute (Stauffer, Hansen, Wagner), assisted from time to time by Regional and

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[3] Reeve M. Bailey, Curator of Fishes of the University of Michigan Museum of Zoology, gave helpful advice and assistance to Crowe (as well as to Stauffer and Hansen) in the identification of lamprey ammocoetes.

District personnel of the Fish Division. Progress was made in 1958 in a series of stocking experiments, a survival and tag-retention study in a hatchery, and observations on the effect of electrical barriers on upstream migration during the spawning season.

Stocking of rainbow trout near the mouths of Great Lakes tributaries.--Michigan began an experiment in the spring of 1955 to determine whether stocking of various strains of rainbow trout near the mouths of tributaries of the Great Lakes will materially increase runs of "steelheads." The three strains of fish that have been used include a "domestic" strain (reared from eggs taken from hatchery brood stock), "Michigan wild" (eggs from Great-Lakes-run rainbow trout taken during their spawning migration), and "West Coast" (eggs from sea-run rainbow trout, supplied by the State of Washington). All trout planted have been marked (most with jaw tags), and most of the fish have been 2 years old at the time of stocking (in late May or June). The plantings have been well publicized. Recovery percentages are based on voluntary returns from anglers (no rewards have been offered for the return of tags).

By October 28, 1958, a total of 90,418 rainbow trout (71,050 domestic, 9,919 West Coast, and 9,449 Michigan wild) had been released at 24 locations, and 2,493 recoveries (2.8 percent) had been reported. Returns from anglers made up 91 percent of this total; the remainder were reported by weir attendants of the U. S. Bureau of Commercial Fisheries, commercial fishermen, or from other sources. The recovery data presented below are based only on fish recovered by anglers.

Of 20,168 domestic rainbow trout stocked in 1955 and 26,916 in 1956, 3.0 percent were recovered. Approximately half of the recoveries showed "lake growth" (an increase in length of 3 inches or more between the time of release and recapture). No returns from the 1955 planting and only 28 from the 1956 planting were reported in 1958; few additional recoveries are expected.

In 1957, 15,989 domestic, 5,980 West Coast, and 2,987 Michigan wild rainbow trout were released; of these, 634 trout (2.5 percent) were recovered by late November, 1958. Of the recaptures, 26 percent displayed lake growth and 66 percent showed little or no increase in size (no length data for 8 percent of the recoveries).

A comparison of the returns from the different strains of rainbow trout stocked in 1957 indicates that domestic and Michigan wild rainbow trout produced substantially the same percentage recovery of fish showing lake growth (Table 3). West Coast steelheads produced only half as great a return. The total recovery percentage (including all three growth categories) was highest for domestic rainbow trout, smaller for Michigan wild, and smallest for West Coast steelheads.

The 1958 plantings included 7,477 2-year-old domestic, 500 1-year-old domestic, 3,939 3-year-old West Coast, and 6,462 3-year-old Michigan wild rainbow trout. Most of the fish were stocked in Lake Superior, where sea lamprey predation is known to be less severe than in lakes Michigan and Huron. Preliminary examination of the data for this most recent planting suggests, however, a somewhat lower first-year recovery rate than for the earlier plantings.

The percentage recovery of rainbow trout showing lake growth has been closely comparable, to date, for fish planted in the lakes near the mouths of streams and fish planted in streams near the mouth (Table 4). The total percentage recovery of trout (growth categories combined) from stream plantings was double the recovery percentage from plants in the lakes, however, because fish planted in streams were more readily available to anglers and many were caught during the first few days after planting.

Table 3.--Number and percentage (in parentheses) of tagged rainbow trout recovered from plantings of different strains of this species in the Upper Great Lakes in June 1957[1]

Strain of trout	Type of growth			Total
	Stream	Lake[2]	Unknown	
Domestic	11 (0.4)	21 (0.7)	5 (0.2)	37 (1.2)
West Coast	2 (0.1)	9 (0.3)	... ...	11 (0.4)
Domestic	62 (2.1)	50 (1.7)	7 (0.2)	119 (4.0)
West Coast	2 (0.1)	23 (0.8)	... ...	25 (0.8)
Michigan wild	11 (0.4)	44 (1.5)	7 (0.2)	62 (2.1)

[1] Plantings of 1,000 fish of each strain were made near the mouth of each of three different streams in the comparison of two strains (upper portion of table) or three strains (lower portion of table); each entry in the table represents total returns (to October 28, 1958) from the stocking of 3,000 fish.

[2] A length increase of 3 inches or more between the time of stocking and recovery was regarded as "lake growth."

Table 4.--Number and percentage (in parentheses) of recoveries from rainbow trout stocked in the Great Lakes and in streams (near their mouths), 1955-1958

Type of growth	Planting locality[1]	
	Lake	Stream
Stream	295 (0.6)	876 (2.0)
Lake[2]	441 (0.9)	416 (1.0)
Unknown	79 (0.2)	172 (0.4)
Total	815 (1.7)	1,464 (3.4)

[1] The recoveries are from 47,279 rainbow trout stocked in lakes and 43,139 stocked in streams in 1955-1958 (all strains combined).

[2] A length increase of 3 inches or more between the time of stocking and recovery was regarded as "lake growth."

The majority of the recaptured fish showing lake growth were taken either during the first fall after stocking or in the spring of the following year; 80 percent of the tagged fish recaptured were caught in the stream in which (or off the mouth of which) they had been planted.

Survival of tagged rainbow trout held in a hatchery.--A study of mortality and growth of tagged rainbow trout was begun at the Thompson Hatchery on April 19, 1957, to help evaluate more accurately the returns of tagged fish from the Great Lakes plantings described above. The types of marks used on five lots of 200 fish each and the percentage mortality from all causes by October 21, 1958, were as follows (all tags were placed on the lower jaw): unmarked--9.1 percent; right pectoral and pelvic fins clipped--13.2; No. 10 ring tag, right maxillary clip--15.2; No. 8 ring tag, left maxillary clip--18.8; and No. 3 jaw tag, adipose clip--19.5.

The percentage loss of tags by October 21 was 0.7 for No. 10 ring tags, 5.2 for No. 8 ring tags, and 6.9 for No. 3 jaw tags. Growth of fish in the three lots of tagged fish was similar; the average length of fish remaining in each of the three groups was 17.2 or 17.3 inches. Fin-clipped and unmarked fish apparently grew somewhat faster (average length in October 1958, 17.7 and 17.9 inches respectively). Although a complete statistical analysis of the data has not yet been made, it seems apparent that the tags have caused some mortality and a slight retardation of growth among the rainbow trout in this experiment.

Diversion of rainbow trout by electrical weirs.--Attempts were made in 1957 and 1958 to determine the extent to which electrical weirs block or divert upstream migrations of rainbow trout in the Huron River, Baraga County, and in the Black River and the East Branch of the Black River, Mackinac County. These structures, built by the U. S. Bureau of Commercial Fisheries for sea lamprey control, are equipped with an alternating-current electrical field and (with the exception of the East Branch weir) a direct-current guiding field.

In the estuary of the Huron River, 2 miles downstream from the weir, nine adult rainbow trout were trapped, tagged, and released during the 1957 spawning migration and four during the 1958 migration. None were recaptured in the Huron River weir.

In 1958, 41 mature rainbow trout were caught in a fyke net approximately 1/8 mile downstream from the East Branch weir and 1/4 mile downstream from the Black River weir. Eight were later recaptured in the Black River weir, four at the East Branch weir, and three by anglers below the weirs. Excluding the fish caught by anglers, 32 percent of the trout tagged and released were passed through the barriers. (The average time elapsing between tagging and recapture at the weirs was 16 days [range, 4-31 days]). In a further test, six adult trout were tagged and released 40 feet below the Black River weir; three were later recaptured in the weir.

The above data suggest that some spawning-run rainbow trout may be diverted or blocked by the electrical barriers. However, sampling (with a direct-current shocker) of young-of-the-year rainbow trout in the Black River in October 1958 indicated that the production in this stream was approximately equal to the 1952-1957 average. Annual sampling of young-of-the-year rainbow trout has also been undertaken in three Lake Superior tributaries which have electrical barriers (Huron River, Baraga County; Chocolay River, Marquette County; and the Two Hearted River, Luce County). Collections in these streams have not extended over a sufficient number of years, however, to provide reliable indices of "normal" rainbow trout reproduction.

Occurrence of sea lamprey scars on rainbow trout.--The operation of a barrier dam (1951-1957) or an electrical barrier (1958) near the mouth of the Black River, Mackinac County, and a creel census of fishing in the river during the annual spring and fall upstream runs of rainbow trout, have permitted the examination of a number of trout in 1951-1958 to determine the incidence of lamprey scarring. Substantial percentages of the trout examined each year bore one or more lamprey scars (Table 5). A general upward trend in scarring rate was observed, from 22 percent in 1951 to 56 percent in 1956, followed by a moderate reduction in 1957 and 1958. The lower scarring rate in 1954, 1957, and 1958 may have been related at least in part to the smaller average length of the fish examined in those years. (Larger fish are more likely to be scarred because they are better able to survive sea lamprey attacks, or are more susceptible to attack, or because they are older and therefore have been exposed to attack over a longer period of time.)

Table 5.--Number and percentage of rainbow trout scarred by sea lampreys in the Black River, Mackinac County, 1951-1958

Year	Number of fish examined	Fish scarred		Average total length of fish examined[1] (inches)
		Number	Percentage	
1951	336	73	22	20.0
1952	325	115	35	22.3
1953	187	83	44	20.7
1954	129	40	30	18.5
1955	134	74	55	20.4
1956	43	24	56	20.7
1957	57	23	40	19.5
1958	156	44	28	19.4

[1] Only fish over 15 inches in length were examined for scars.

Walleyes in Lake Michigan

A subpopulation of Lake Michigan walleyes which spawn in the Muskegon River, Michigan, has been the subject of a study which was begun by the Michigan Department of Conservation in 1947. A power dam blocks the upstream migration 39 miles from the mouth of the stream. Large numbers of walleyes are caught below the dam each year in dip nets and transferred to five upstream impoundments. Tagging studies conducted by Walter R. Crowe have shown that the spring run up the river amounted to more than 100,000 fish in 1953 and 1954, and that most walleyes left the river and re-entered Lake Michigan before June 1. Seven tagged walleyes from this study were recovered in 1958 (one by an angler and six in the dipnets during the 1958 transfer); few additional returns are expected.

The transfer of walleyes from the lower Muskegon River to upstream impoundments has provided an opportunity for Department employees[4] to examine large numbers of fish each year to determine the incidence of lamprey scarring and lymphocystis. In 1954-1958, the percentage of these (largely) Lake Michigan walleyes with lamprey scars has remained at about 2 percent (Table 6). The incidence of lymphocystis observed has shown an upward trend, from 0.3 percent in 1952 to a high of 7.0 percent in 1958.

Table 6.--Frequency of occurrence of lamprey scars and lymphocystis among walleyes in the Muskegon River, 1952-1958

Dates of examination	Number of fish examined	Percentage with lamprey scars	Percentage with lymphocystis
April 6-18, 1952	10,000	0.6	0.3
April 4-18, 1953	7,669	1.0	0.4
April 6-20, 1954	7,868	1.9	0.8
April 1-12, 1955	10,000	2.0	4.3
April 3-15, 1956	10,000	2.2	3.9
April 1-15, 1957	4,403	2.1	6.1
April 1-15, 1958	6,177	1.9	7.0

A joint study, with the U. S. Bureau of Commercial Fisheries, of the walleyes in the Bay de Noc area of northern Lake Michigan, which was begun on September 12-21, 1957, when 770 walleyes (average total length, 13.6 inches; range, 9.4-25.0) were tagged, was continued on April 30-May 9, 1958, when 604 additional fish (average length, 18.4 inches; range, 12.3-30.0) were marked.[5] From the total of 1,374 walleyes tagged, 97 (7 percent) recoveries have been reported (69 by anglers and 28 by commercial fishermen). Of the 604 walleyes tagged in 1958, 377 were marked with No. 3 strap tags on the upper jaw and 227 were marked with "spaghetti"-type tags; returns by December 1, 1958, were 6.1 percent and 11.0 percent, respectively, suggesting an advantage favoring the spaghetti tags (possibly because they are more conspicuous and thus more likely to be seen by fishermen).

Smallmouth bass in Lake Michigan

A manuscript entitled, "The life history of the smallmouth bass at Waugoshance Point, Lake Michigan," by W. C. Latta, which is based on field work conducted in 1953-1955, is well advanced and will be published in an Institute publication series, probably in 1959.

Of 371 smallmouth bass tagged in the Bay de Noc area of northern Lake Michigan on September 12-21, 1957, only 12 (3.2 percent) had been reported by anglers by

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[4] In recent years the transfer has been under the direct supervision of District Fisheries Supervisor Edward H. Andersen.

[5] Walter R. Crowe is representing the Institute for Fisheries Research in this study.

December 1958. Ten of the recoveries were at distances less than 5 miles from the locality of release; one fish had moved a minimum of 10 miles and another had traveled 25 miles before being caught. The limited data suggest that this population of bass is relatively localized and that it is only lightly exploited by sport fishermen.

Hydrographic survey of Saginaw Bay

A report on a hydrographic survey of Saginaw Bay is being completed jointly with the U. S. Bureau of Commercial Fisheries. Field work for this project consisted of three synoptic cruises in 1956, during which hydrographic data and bottom fauna collections were made at 50 to 60 stations. Additional samples were obtained during the spring and fall of 1957.

In 1958, Dr. Frank F. Hooper continued work on the bottom fauna and made some progress in an analysis of the benthic production of the Bay. The taxonomy of the more important benthic animals has been worked out. Charts showing the distribution and abundance of the principal bottom animals at the time of the three synoptic cruises are being prepared. Most of his effort in connection with this study is now being directed toward an analysis of production rates of some of the more important benthic invertebrates.

The "red worm" of yellow perch in Saginaw Bay

During the past two years the Department has received an increasing number of inquiries from anglers regarding a "red worm," Philonema (Nematoda), found in perch caught in Saginaw Bay, Lake Huron, and Brest Bay, Lake Erie. Because the parasite may be several inches long, and is a conspicuous red in color, it did not seem that anglers would have only recently observed it, had it previously been present in any numbers. Therefore, it appeared that this parasite was extending its range and intensity of infestation. Since there are no distribution records available for the "red worm" of perch in the Great Lakes, a study of the distribution, percentage of fish infested and degree of infestation was initiated by Leonard N. Allison, the Department's fish pathologist, in the fall of 1957. To date, perch have been collected from Wildfowl and Tawas Bay in Saginaw Bay and near Alpena, Lake Huron. About 40 percent of the perch from Saginaw Bay locations and 15 percent of those taken near Alpena were infested. Further collections will be made as opportunity permits.

Fishery statistics

Commercial fisheries.--The routine collection of records of commercial fish production in State of Michigan waters of the Great Lakes was continued in 1958. The collection by the Department of daily records on locality fished, kind and amount of gear used, and the species and pounds of fish caught, for the past 30 years (beginning in 1929) has provided data for the detailed statistical analysis (by the U. S. Bureau of Commercial Fisheries, which receives the records after preliminary tabulation by the Fish Division) of production, fishing intensity, and abundance of the commercial species. The records have proven extremely useful in revealing population trends and have been drawn upon repeatedly as adjuncts to biological investigations. The records for the past 20 years, for example,

document clearly the catastrophic decline of the lake trout in the Upper Great Lakes following the invasion of the sea lamprey.

Since the lake trout is near extinction in Michigan waters of Lake Huron and Lake Michigan, the commercial production of this species in Lake Superior, which has been declining without interruption since 1952, is being watched with particular concern. Production in Michigan waters of Lake Superior was 681,817 pounds in the first 10 months of 1958, as compared to 757,917 pounds during the same period in 1957 (Table 7). The indicated 10-percent decrease in 1958 is much less severe than the staggering 31-percent drop in 1957 (from 1,223,900 pounds in 1956); however, the smaller decrease in 1958 probably cannot safely be interpreted as an indication of an abatement in sea lamprey predation.

Table 7.--Monthly commercial catch of lake trout (pounds) in State of Michigan waters of Lake Superior, 1957-1958

Month	Year 1957	Year 1958
January	43,092	38,014
February	8,691	10,289
March	18,295	33,310
April	96,147	127,149
May	184,232	150,460
June	120,669	104,218
July	87,790	78,278
August	83,828	65,985
September	99,361	63,851
October	15,812	10,263 1/
Ten-month total	757,917	681,817
November	25,548	8,982 1/
December	65,313	.....
Grand total	848,778	690,799 1/

1/ Incomplete

Sport fisheries.--Information on the species and numbers of fish taken by anglers in Michigan waters of the Great Lakes is extremely limited. The total catch by sportsmen, although believed to be extremely large, can only be vaguely estimated. The Department recognizes the urgent need to initiate a sound stratified-random-sample creel census which will provide reliable information on the extent, quality, and productivity of the sport fisheries, at least in representative Michigan waters of the Great Lakes.

In recent years, the only records on sport fishing in the Great Lakes have been obtained in the state-wide general creel census, which has been conducted by Michigan conservation officers (and compiled by the Institute for Fisheries Research) since 1927. Although the census is directed primarily toward fishing in inland waters, an

average of 8,600 anglers per year were interviewed while fishing in the Great Lakes or their connecting waters in 1953-1957. The records might not represent a random sample of the fishing, but the summarized records for 1953-1957 (Table 8) provide some indication of the species composition of the catch.

Yellow perch far exceeded all others in numbers; rock bass, walleyes, northern pike, and smallmouth bass were other species which occurred regularly in the anglers' catch. Freshwater drum and white bass were of some importance in the catches recorded in the waters connecting Lake Erie and Lake Huron; pumpkinseeds, smelt, and largemouth bass contributed substantially to the Lake Huron catches; and round whitefish and lake trout appeared prominently in the creels of the few Lake Superior anglers who were censused.

The average catch per hour by fishermen in Great Lakes waters (all lakes and connecting waters combined), revealed by general creel census records, ordinarily has been higher than in inland waters (3.0 as compared to 1.4 as a 10-year mean for 1946-1955). This approximate index of fishing quality is hardly meaningful when combined as an average for all Great Lakes waters, however. Only the average catch per hour in Lake Huron for 1953-1957 (Table 8) was substantially and consistently above the state-wide average for inland waters; in other Great Lakes waters the records suggest an average fishing quality roughly similar to the mean for inland waters of the State.

Lake trout

The Fish Division carried out experimental fishing operations in five large inland lakes during the 1958 lake trout spawning season to determine the feasibility of collecting lake trout eggs in these waters to aid in the rehabilitation of the species in the Upper Great Lakes. Fishing with gill nets and large commercial trap nets yielded sufficient ripe fish to produce the following numbers of green eggs:[6]

Lake	County	Number of eggs collected
Torch	Antrim	19,044
Glen	Leelanau	52,000
Crystal	Benzie	122,886
Elk	Grand Traverse	215,694
Higgins	Roscommon	285,775
Total		695,399

In general, large-mesh gill nets (overnight sets) were more effective than trap nets for taking lake trout for spawn collection.

Eggs again were collected in 1958 by Superintendent Russell Robertson from brood stock lake trout which are being reared at the Marquette Hatchery (from eggs collected in Lake Superior in the fall of 1952). Fifty females averaging 23.6 inches in total length and 4.2 pounds in weight yielded 148,176 eggs (Table 9). The brood fish were examined and eggs were collected at 2- to 3-day intervals between October 3 and October 30.

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[6] Data provided by M. J. DeBoer, Supervisor of Hatchery Operations.

Table 8.--Summary of the Michigan general creel census for the Great Lakes and connecting waters, 1953-1957[1]

Water, and year	Number of anglers	Hours fished	Number of fish caught	Catch per hour	Species					
					Yellow perch	Wall-eye	Rock bass	Nor-thern pike	Small-mouth bass	Others
Lake Erie[2]										
1954	119	295	1,622	5.50	1,622	...	...	...	...	...
1955	326	701	991	1.41	942	11	...	...	...	38
1956	437	1,053	885	0.84	885	...	...	...	...	...
1957	55	103	82	0.80	77	...	...	2	...	3
Total	937	2,152	3,580	1.66	3,526	11	...	2	...	41
Lake Huron										
1953	1,300	3,010	13,093	4.35	12,378	...	208	52	11	444
1954	3,989	13,534	62,425	4.61	58,993	3	390	192	740	2,107
1955	4,813	14,148	63,617	4.50	60,930	115	421	75	287	1,789
1956	3,074	9,814	32,192	3.28	31,282	...	133	20	214	543
1957	3,548	9,722	26,748	2.75	25,484	...	327	50	9	878
Total	16,724	50,228	198,075	3.94	189,067	118	1,479	389	1,261	5,761[3]
Lake Michigan										
1953	219	687	1,287	1.87	985	77	17	105	95	8
1954	311	1,088	2,456	2.26	2,179	...	...	241	31	5
1955	424	1,105	1,489	1.35	933	188	37	12	294	25
1956	706	2,572	3,314	1.29	2,277	615	93	17	311	1
1957	1,734	6,475	4,734	0.73	2,581	1,757	85	5	187	119
Total	3,394	11,927	13,280	1.11	8,955	2,637	232	380	918	158
Lake Superior										
1953	67	152	68	0.45	...	...	...	...	...	68
1954	21	64	178	2.78	...	...	...	...	...	178
1955	10	21	61	2.91	50	...	1	...	...	10
1956	26	70	34	0.49	...	...	...	...	...	34
1957	73	516	169	0.33	131	...	...	...	...	38
Total	197	823	510	0.62	181	...	1	...	...	328[4]
Connecting waters, Lake Erie-Lake Huron										
1953	699	1,575	2,677	1.70	1,399	70	492	14	88	614
1954	2,519	6,620	6,908	1.04	3,297	467	1,263	75	176	1,630
1955	3,824	9,699	6,999	0.72	4,116	973	644	38	264	964
1956	5,365	12,640	14,551	1.15	9,485	868	1,144	129	691	2,234
1957	6,944	19,039	16,898	0.89	12,694	780	1,179	520	302	1,423
Total	19,351	49,573	48,033	0.97	30,991	3,158	4,722	776	1,521	6,865[5]

continued

Table 8, continued

Water, and year	Number of anglers	Hours fished	Number of fish caught	Catch per hour	Species					
					Yellow perch	Wall-eye	Rock bass	Nor-thern pike	Small-mouth bass	Others
Connecting waters, Lake Huron-Lake Superior										
1953	142	467	549	1.18	284	83	23	157	1	1
1954	274	827	607	0.73	329	127	4	127	7	13
1955	199	470	513	1.09	213	220	24	52	...	4
1956	342	743	682	0.92	267	60	103	85	13	154
1957	1,382	4,615	5,183	1.12	2,865	946	435	426	52	459
Total	2,339	7,122	7,534	1.06	3,958	1,436	589	847	73	631

1/ Summary prepared by K. G. Fukano.

2/ No records for Lake Erie in 1953.

3/ Five-year total for Lake Huron includes (among other species): 1,882 pumpkinseeds, 1,046 smelt, and 423 largemouth bass.

4/ Five-year total for Lake Superior includes (among other species): 41 lake trout, 13 rainbow trout, and 11 brook trout.

5/ Five-year total for connecting waters between Lake Erie and Lake Huron includes (among other species): 1,677 freshwater drum and 2,461 white bass.

Table 9.--Number of eggs produced by brood stock lake trout reared at the Marquette Hatchery

Year	Age of fish	Mature females			Mature males			Number of green eggs produced 1/	
		Number	Average total length (inches)	Average weight (pounds)	Number	Average total length (inches)	Average weight (pounds)	Total	Average per mature female 2/
1954	V	18	20.2	2.3	31	20.8	2.6	18,120	1,007
1955	VI	52	21.4	3.0	146	21.3	3.0	90,720	1,890
1956	VII	49	22.0	3.4	113	22.8	3.8	94,176	2,093
1957	VIII	54	22.8	3.6	78	24.2	4.5	138,888	2,621
1958	IX	50	23.6	4.2	78	24.5	4.7	148,176	2,964

1/ Numbers based on counts of 240 eggs per ounce in 1954 and 216 in 1955-1958.

2/ Mature females which were found to be spent at the time of stripping (4 in 1955, 4 in 1956, and 1 in 1957) were not included in the computation of the averages.

Between 1954 (the first year in which any females in this group of fish matured) and 1958, the egg production per mature female increased progressively from 1,007 to 2,964.

Eggs also were collected at the Marquette Hatchery from the mature females among 552 "lean" lake trout and 370 "hybrids" ("lean" x siscowet) which have been reared from eggs collected in the fall of 1952. (A few males, but no females, from these two lots of fish matured in 1957 as age-group IV.) Eighty-eight mature "lean" females yielded 95,040 eggs, or an average of 1,080; 36 "hybrid" females produced 34,848 (968 per fish). The 922 brood fish of this year class were marked with No. 4 monel strap tags on the lower jaw in August 1958, so that egg production and dates and periodicity of spawning of individual fish could be recorded. The earlier application (in 1957) of No. 3 strap tags on the upper jaw of the 9-year-old brood lake trout proved generally unsatisfactory because of excessive tearing of jaws and loss of tags. A fully satisfactory tag for marking brood lake trout held at a hatchery is not yet available.[7] Experiments in the branding of lake trout for individual identification are planned.

INSTITUTE FOR FISHERIES RESEARCH

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20 " Director's Office
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[7] Results with other types of tags are given in a short article entitled, "The survival and retention of tags, and growth of tagged lake trout in a rearing pond," by Paul H. Eschmeyer, which has been published in The Progressive Fish-Culturist. (January, 1959, Vol. 21, No. 1)