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INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
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REPORT NO. 812

A FISHERIES SURVEY OF MISSAUKEE LAKE, MISSAUKEE COUNTY

by

L. E. Perry

Introduction

Location and Drainage

Missaukee Lake is the largest of a group of several lakes in west central Missaukee County (T. 22 N., R. 7-8 W., Secs. 1, 2, 3, 6, 7, 10, 11, 12). Lake City is located on its northeastern shores, making it easily accessible to the public. The state highway, M-55 and M-66, follows the beach for over a mile on the east side and the Pennsylvania Railroad passes along the south shore.

The lake has no outlet and is actually part of no drainage system; however, it is located approximately on the border between the drainage basins of the Manistee and Muskegon Rivers and any drainage would probably be in the direction of the Muskegon Basin.

Acknowledgments

For a number of years Missaukee Lake has been the subject of much correspondence between the citizens of Lake City and the Department of Conservation in various attempts to improve the fishing of the lake. Prominent among those who have had an active interest in the lake and have requested investigations are Congressman A. J. Engel and the Lake City Chamber of Commerce. A petition was also submitted by a group of citizens requesting the improvement of spawning conditions for pike in the lake by the construction of dams to maintain water over the beds.

At various times brief investigations of the lake have been made by members of the Department of Conservation. In 1927, Dr. Jan Metzelaar visited the lake and collected fish. Other observations were made in connection with the introduction of Great Lakes shiners in the lake in 1935. On August 26-30, 1939, a party of the Institute for Fisheries Research made a study of the fish in the lake.* It was not until the summer of 1941,

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* The 1939 fish party consisted of: H. Kilpela, leader; D. Anderson, F. Locke and P. Galvin, assistants.

however, that a detailed biological survey was completed. On July 11-14, 1941, the fish survey was made, and on August 12-14, 1941, a biological inventory of the lake was made by Institute parties.[1]

An outline and bottom contour map of Missaukee Lake was prepared in February, 1941, by the United States Forest Service with the aid of Camp Axin of the Civilian Conservation Corps.

Past and Present Use

During more active lumbering days Missaukee Lake was used to float logs to mills. Sawmill trash and deadheads are still found on the southeast shores of the lake. At present the lake provides a source of culinary water for Lake City.

The relationship of Lake City to Missaukee Lake has undoubtedly had an important effect on its development. With Lake City situated on the immediate shores, recreation facilities of the lake are utilized extensively by the townspeople as well as by vacationers who come greater distances. The surrounding land is wooded and the beaches are sandy, which make the lake desirable for the many summer cottages which are most numerous around the south and east shores. Seven resorts, five boat liveries and two hotels were present on the lake shore at the time of the recent survey. Lake City State Park is located on the northeast corner, easily accessible from town and the state highway.

Missaukee Lake is more or less heavily fished, both summer and winter, although fishing is reported not to be as good in recent years as it was some time ago when pike were more predominant in the catch. Several attempts have been made to stock the lake with walleyes, but these have met with little success. The lake is now best known for its pan fish.

Physical Characteristics

Geological Origin

The following description of the geology of Missaukee Lake is extracted from I. D. Scott's "Inland Lakes of Michigan" (pp. 347-348).

"Missaukee Lake is the largest of a group of ten or more lakes which are located in west central Missaukee County.....

"All of these lakes lie in pits in an outwash plain and of these the Missaukee Lake depression is by far the largest; it is nearly circular with a diameter of somewhat less than two and one-half miles. The lakes either have no outlets or drain eventually into Missaukee, the southeastern member of this group. Inasmuch as the drainage of the region in general is to the southeast, Missaukee Lake occupies the key position and it has no natural outlet, the artificial channel operating only at infrequent periods of exceptionally high water. The Missaukee Lake depression, although it

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[1] The 1941 biological inventory party consisted of: J. L. Funk, leader; E. W. Roelofs and S. Lievense, assistants. The 1941 fish party comprised: W. C. Beckman, leader; L. Anderson, P. Galvin, and M. Pawlick, assistants.

contains the deep holes characteristic of pits is, nevertheless, very shallow. The writer's information is that the general depth of water is approximately fifteen feet and, inasmuch as the surface of the lake stands about ten feet below the surface of the outwash, the total depth is twenty-five feet. The shallowness of the water must hinder the development of the larger waves but, nevertheless, adjustments of the shore have taken place, due probably to the ease with which the outwash material is worked.

"The adjustments are found above the present surface of the lake and indicate the usual higher level in past time. Along the south and east shores the depression has regular walls, and an almost unbroken, wave-steepened cliff faces the lake. At the foot of the cliffs there is now exposed a broad sand flat which continues beneath the water to a decided "drop-off" wherever the water is deep, as at the east end. The effects of current action are best seen along the very irregular north shore and are too numerous for specific mention in this brief report. Before leaving Lake City a well developed bar may be seen, and along the north shore examples of exposed spits, bars enclosing lagoons, and land-tied islands are numerous. The north shore bars are distinct but stand at a lower elevation than that at Lake City which is interpreted as an indication that these forms were in process of formation when the lake level subsided.

"The extinction of former embayments by draining and vegetal accumulation is another interesting phase of a physiographic study of this lake, the details of which should prove to be well worth while."

Shape of Basin and Extent of Drainage

Missaukee Lake is roughly oval in outline, the longest axis extending about two and one-half miles in an east-west direction. It is about one and one-half miles wide. The north shore is irregular and has changed somewhat with the receding water level. There were formerly broad connections on the north and northwest with Goose and Crooked Lakes, but these do not exist at present. The other shores are more definitely defined.

The lake is shallow and has a very irregular bottom. The greatest depth (27 feet) is found near the southeast corner; however, several places of more than twenty feet are found in the central and eastern parts. The slope of the bottom is very gradual from the north and west. In some places on the west the ten-foot contour is over one and one-half miles from shore. The other slopes are not so gradual.

At the time of the survey in 1941, the lake had neither inlet nor outlet, but it drained, by seepage, a considerable area of partly wooded, rolling land on the northwest, including several lakes. The total drainage area is approximately twenty square miles. The soil is sand on the northwest side of the lake and coarser glacial till on the southeast. Except for a small marshy area on the west, the entire lake shore is sand and gravel.

Water Fluctuation

The water level of Missaukee Lake was formerly several feet higher than it is now; however, the fluctuation is not believed to be extreme at present.

The lake has neither inlet nor outlet and receives its water supply from seepage and springs; hence, control of the level is not possible.

Some physical features of the lake are summarized in Table I.

Table I
Physical data of Missaukee Lake, Missaukee County

Area (acres)	Maximum depth (feet)	Shore development	Dominant bottom types		Color of water	Transparency (Secchi disc in feet)
			0 ft.-15 ft.	Over 15 ft.		
1,985	27	1.6	Sand, pulpy peat	Pulpy peat	Light brown	8

Shore development is an index to the length of shoreline of a lake. It expresses the number of times the shoreline is greater than that of a perfectly round lake of the same area. The higher the index the longer the shoreline and the greater the number of embayments and protected areas. Missaukee Lake has a fairly regular shoreline with few protected areas. The prevailing winds have a clear sweep across the lake and cause considerable wave action on the unprotected beaches, especially on the southeast shores. This is undoubtedly the principal reason for the limited extent of plant growth in some regions of the lake.

Discussion of Physical Factors in Relation to Fisheries

With large areas of shallow water, sand and pulpy peat bottom, Missaukee Lake is suitable to the production of most species of warm-water fishes. The extreme wave action is detrimental in some areas but favorable conditions are present in other parts of the lake.

Temperature and Chemical Characteristics

Temperature

The water in Missaukee Lake has a nearly uniform temperature from top to bottom. At the time of the survey, August 13, 1941, it was 71°F. at the surface and 69°F. at 23 feet. Because of the large area and shallow depth, there is probably never much difference between the surface and bottom waters and no thermal stratification ever exists.

Chemical Conditions

Dissolved oxygen was present in sufficiently large amounts from surface to bottom. Analyses showed 8.4 parts per million at the surface and 7.7 p.p.m. at 23 feet. This is ample for any species of game fish. It is fairly certain that oxygen is adequate throughout the entire year in nearly all the water of the lake.

The water of Missaukee Lake is moderately soft (Methyl Orange alkalinity 95 p.p.m.) and alkaline (pH 8.2). In general, alkaline lakes that have a sufficient amount of salts to make the water moderately hard are the most productive types. These are the best conditions for desirable plant beds.

Pollution

No serious pollution of the water was observed by the survey party.

Table II
Chemical and temperature data of Missaukee Lake,
Missaukee County

Date	Temperature (°F.)		Oxygen (p.p.m.)		M. O. alkalinity range (p.p.m.)	pH range
	Surface	Bottom	Surface	Bottom		
8/13/41	71	69	8.4	7.7	95	8.2

Discussion of Temperature and Chemical Factors in Relation to Fisheries

Missaukee Lake has warm water that is suitable to warm-water game fish. It has a moderately soft, alkaline water which is favorable. No pollution was noticed. In general, the lake is probably capable of supporting a fair-sized population of warm-water fishes.

Biological Characteristics

Vegetation

A list of the plants and their relative abundance as collected by the inventory party is given in Table III.

Table III
Names and relative abundance of plants found in
Missaukee Lake, Missaukee County

Common name	Scientific name	Abundance
Water shield	(Brasenia Schreberi)	F
Spike rush	(Eleocharis palustris)	R
Rush	(Juncus sp.)	R
Water marigold	(Megalodonta Beckii)	F
Water milfoil	(Myriophyllum exalbescens)	C
Bushy pondweed	(Najas flexilis)	F
Yellow water lily	(Nuphar variegatum)	F
White water lily	(Nymphaea odorata)	F
Pickerel weed	(Pontederia cordata)	R
Large-leaf pondweed	(Potamogeton amplifolius)	C
Pondweed	(P. angustifolius)	F
Pondweed	(P. Friesii)	C
Pondweed	(P. gramineus v. graminifolius f. myriophyllus)	R
Floating-leaf pondweed	(P. natans)	F
Sago pondweed	(P. pectinatus)	R
Whitestem pondweed	(P. praelongus)	F
Robbins' pondweed	(P. Robbinsii)	C
Flat-stemmed pondweed	(P. zosteriformis)	A
Three-square	(Scirpus americanus)	F
Softstem bulrush	(S. validus)	F
Musk grass	(Chara)	F

A = Abundant, C = Common, F = Few, R = Rare
Identifications by B. M. Robertson.

Scattered patches of submerged water plants were found over most of the lake bottom above a depth of 15 feet, except where wave action prevents their growth. Emergent and floating types are found along the undisturbed north and west shores.

Aquatic vegetation is adequate in Missaukee Lake to meet the needs of all fish in the lake. Its importance is mainly that of supplying shelter and spawning beds and harboring fish food organisms.

Fish Foods

Collections of small free-floating organisms (plankton) showed this form of fish food to be present in moderate abundance at the time of collection. Such isolated collections, however, are not reliable because of such great variations in their number from time to time and place to place.

The organisms that inhabit the bottom soils and plants are the most important source of fish food especially in a lake like Missaukee and which has a large bottom area in relation to the volume of water. Collections showed the presence of very few organisms in the pulpy peat of the deeper

water, but the sand of shallower water was much more productive. The greatest number of organisms was found among the plants which is quite according to expectations. Scuds (fresh-water shrimps) and midge larvae were the predominant forms. These are both important as food for fish. The many forage fish that were found along the shores of the lake undoubtedly provide an important part of the diet of the larger game fishes such as bass and pike. A list of the forage fish collected is presented in Table IV.

Fish Present

The fish found in Missaukee Lake are listed in Table IV.

Table IV
List of fish and their relative abundance in
Missaukee Lake, Missaukee County

Name	Abundance	Stocking (1935-1941)
GAME FISHES		
Largemouth bass	Common	...
Smallmouth bass	Common	1,500 fingerlings
Bluegill	Common	6,000 fry
		39,000 fingerlings
Pumpkinseed	Common	...
Rock bass	Abundant	...
Walleye	Few	1,715,000 fry
		537 adults
Perch	Abundant	122,500 fingerlings
Northern pike	Few	...
Bluegill x pumpkinseed hybrid	Few	...
COARSE FISHES		
Common sucker	Few	...
Brown bullhead	Common	...
Carp	Reported	...
FORAGE FISHES		
Black-nosed shiner	Common	...
Mimic shiner	Abundant	...
Straw-colored shiner	Few	...
Common shiner	Few	...
Blunt-nosed minnow	Common	...
Henona killifish	Common	...
Johnny darter*	...	...
Iowa darter*	...	...
Great Lakes shiner	None collected	510,000

* Collected by J. Metzelaar, August 15, 1927.

The most common game fishes were large- and smallmouth bass, perch, bluegills, pumpkinseeds and rock bass. These were frequently caught in the nets and appeared to be fairly abundant. Two species of coarse fish were collected: the common sucker and the brown bullhead. One carp was reported through creel census reports. Eight species of forage fish were also collected or reported.

Missaukee Lake was one of several lakes stocked with Great Lakes shiners in 1935 and 1936 in an attempt to introduce these forage fish from the Great Lakes into the inland waters of Michigan. In nearly all cases they failed to survive. Several attempts were made at later dates to recover these shiners in Missaukee Lake, but at no time were any found. Two Institute reports have been written on these investigations. They are No. 533, by W. R. Crowe, and No. 715, by W. F. Carbine.

The presence of walleyes in Missaukee Lake has been a much discussed subject. In 1927, Metzelaar reported an occasional record of walleyes in the lake and recommended further stocking. This was undertaken seriously and they were stocked in large numbers for several years, including several plantings of adult fish. Returns from these plants have been somewhat discouraging and it is now believed that the value of further stocking is questionable. Walleyes have been taken by anglers from time to time but they have never assumed an important role in the fishery of the lake. Some reports were received two years ago to the effect that better catches were being made and in 1938 they were rather encouraging. Since adult fish were planted each year from 1933 to 1936 and thousands of fry nearly each year from 1930 to 1940, there is no definite evidence that the walleyes taken by anglers have resulted from natural propagation. No young walleyes were caught during the fish surveys of 1939 and 1941. Four adults were caught in 1939 by the investigators but none in 1941. Their present abundance in the lake is uncertain and it is not known to what extent they reproduce naturally, if at all.

Creel Census

The conservation officers of Missaukee County have conducted a fairly complete general creel census on the lake and for several years recorded catches for nearly every month of the fishing season. During the years 1934, 1937 and 1940, the census was limited to a very short period and the results cannot be compared with other years.

Few conclusions can be drawn from these tables (Tables V and VI), but they show some interesting trends in the fishing. The catch per hour (Table V) fluctuates greatly but over a period of several years no definite increase or decrease in fishing success is noticeable. It appears that fishing is practically the same now as in 1928 as far as the number of fish caught per hour is concerned. In Table VI there is evidence that the largest catches of fish some 15 years ago were mostly northern pike and bullheads. At present, both these species are apparently taken less frequently and the catch is mostly of pan fishes. This same change in the character of the catch has been reported for Houghton, Otsego and several other larger Michigan lakes, and is believed to be correlated with changes in water level which drastically affect the reproduction of northern pike.

Table V
Summary of creel census of Missaukee Lake,
Missaukee County

Year	Number of lines	Number taking no fish	Number hours fished	Number of legal fish caught	Catch per hour	Catch per line	Number of sublegal fish caught	Av. no. of hours per line	Period of census
1928	...	1	222	453	2.04	...	62	...	Mar.-Sept.
1929	...	1	679	666	0.98	...	61	...	Mar.-Aug.
1930	...	36	1,223	995	0.81	...	47	...	May -Dec.
1931	...	43	617	188	0.30	...	0	...	Jan.-Sept.
1934	...	4	75	22	0.29	...	0	...	Jan.
1936	28	7	58½	86	1.47	3.1	26	2.1	May -June
1937	13	8	49	5	0.10	0.4	0	3.8	Jan.
1938	95	48	310⅓	241	0.78	2.5	6	3.3	Jan.-July
1939	153	29	455⅓	520	1.14	3.4	219	3.0	Jan.-Sept.
1940	30	5	62	45	0.73	1.5	0	2.1	June

Table VI
Number and species of fish reported in creel census,
Missaukee Lake, Missaukee County

Year	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Perch	Northern pike	Walleye	Bullhead	Common sucker	Carp
1928	8	1	...	3	8	31	54	...	317	14	...
1929	2	11	63	7	14	91	155	20	302	1	...
1930	47	6	26	...	30	162	194	...	527	1	1
1931	16	2	40	...	3	51	38	...	30	8	...
1934	...	...	...	...	...	...	22	...	...	...	...
1936	2	1	8	8	64	...	...	...	3	...	...
1937	...	...	...	...	...	...	...	...	...	5	...
1938	3	2	36	95	81	17	6	...	1	...	...
1939	34	3	223	159	51	34	1	...	15	...	...
1940	1	3	1	16	18	6	...	...	...	...	...

Growth of Game Species

By studying the scales of the fish collected, the ages of game fish were determined. This information, together with the average lengths and weights, permits an analysis of the rate of growth (Table VII). Collections of both fish surveys (1939 and 1941) are included. The last column of the table gives the average lengths of game fish at different ages for the state of Michigan.

Table VII
Growth of game fish collected in 1939-1941
from Missaukee Lake, Missaukee County.

Name	Age*	Number of individuals	Average total length (inches)	Average weight (pounds, ounces)		Tentative average length for Michigan* (inches)
Largemouth bass	I	1	4.2	...	0.5	5.5
	II	5	8.3	...	4.2	8.4
	III	3	10.7	...	9.2	10.8
	IV	2	12.6	...	15.3	12.1
	V	2	13.8	1	4.8	13.3
	VI	1	14.0	1	5.0	14.4
Smallmouth bass	I	5	4.8	...	0.8	6.0
	III	5	10.9	...	9.8	10.7
	IV	2	12.0	...	12.6	13.3
	V	1	13.9	1	5.5	13.8
Perch	I	12	3.4	...	0.2	4.7
	II	15	5.2	...	0.9	6.2
	III	45	5.9	...	1.3	7.1
	IV	8	7.1	...	2.2	7.8
	V	2	6.9	...	1.7	9.4
Northern pike	V	2	31.2	7	6.6	*
Bluegill	II	1	5.6	...	2.0	4.3
	III	1	5.5	...	1.9	5.6
	IV	4	6.2	...	2.8	6.7
	V	2	6.8	...	3.6	7.4
	VI	9	6.9	...	3.9	7.8
	VII	6	7.5	...	5.0	7.9
	VIII	2	7.9	...	5.7	8.3
Walleye	III	1	18.1	2	4.0	**
	V	1	19.5	2	4.0	...
	VI	2	20.6	2	9.5	...
Pumpkinseed	II	3	3.6	...	0.5	4.4
	III	6	4.2	...	0.9	5.8
	IV	11	5.7	...	2.3	6.4
	V	17	6.1	...	2.8	6.8
	VI	11	6.2	...	3.2	7.1
	VII	4	6.3	...	3.0	7.8
	VIII	1	7.0	...	3.9	...
Rock bass	II	1	3.9	...	0.7	4.3
	IV	11	5.4	...	1.8	5.6
	V	6	6.0	...	2.3	6.6
	VI	12	7.4	...	4.5	8.3
	VII	14	7.7	...	5.0	8.7
Pumpkinseed x bluegill hybrid	V	1	6.5	...	2.8	...
	VI	1	7.4	...	4.8	...

* Determined by W. C. Beckman.
** The average northern pike reaches 14 inches during its second summer (Age I).
*** The average walleye reaches 14 inches during its third summer (Age II).

By comparison of lengths of Missaukee Lake fish with the Michigan averages it is seen that both large- and smallmouth bass have normal growth. No definite data are available on the northern pike and the walleyed pike, but their growth is probably near normal in this lake. The other fish--perch, bluegills, pumpkinseeds and rock bass--have slower growth and reach legal length a year or even two years (perch) later than average. Slow growth is usually caused by overcrowded conditions in a lake that does not permit the fish to have adequate food and space. This may be possible in Missaukee Lake.

Natural Propagation

Weed beds and the solid sand and gravel bottom in shallow areas provide adequate spawning facilities for the basses, perch and all sunfishes. Young fish, which probably resulted from natural propagation, were reported. Grassy and marshy areas on the west side of the lake are suitable for the spawning of northern pike, particularly during years of high water level.

The spawning of walleyes in Missaukee Lake is questionable as already mentioned. Recent investigations of the Institute (No. 695) reveal that this species will spawn on large rubble in wave-swept shallow areas. The possibility of spawning in other habitats is not yet certain. In Missaukee Lake there is little that can be classed in this category, but there are gravel beds on the wind-swept east shore that might serve the purpose. However, in view of the fact that walleyes have repeatedly been planted in the lake with no apparent success, it is not likely that natural propagation of these fish is adequate to maintain a population.

Management Proposals

Designation of Lake

Missaukee Lake is in the "all other lakes" category. In view of the information at hand, this is the proper designation for the lake.

Stocking

The stocking of all fish in Missaukee Lake should be discontinued for the present. The basses and all sunfishes are present in fairly great abundance. In fact, the perch, bluegills, pumpkinseeds and rock bass are possibly becoming overcrowded as evidenced by their subnormal growth rate. Spawning facilities are adequate for all these species and further stocking is not advisable. The stocking of walleyes should be discontinued until more definite information can be obtained on the success of previous plants. If possible, the likely spawning areas should be examined in April and May and the presence of young walleyes swimming at the surface shortly after hatching should be watched for in order to determine the extent of natural reproduction. Also, a check should be made in the summer of 1945, after two years of no planting, to determine by netting whether reproduction has occurred.

Predators and Parasites

Loons and turtles were the only predators observed on the lake. The most important predation would be that of the larger game fish on the smaller ones. This type is desirous to control the population of pan fish.

Liver cysts were found in the bluegills, pumpkinseeds and rock bass. The yellow grub and black spot were found to infect the perch. The bass tapeworm was found in both the large- and smallmouth bass, and black spot and undescribed intestinal tapeworms were found in the northern pike. None of these infestations were severe and control is not necessary or practicable.

In 1933, shortly after a planting, parasitized adult walleyes were found. Three worms were identified as Proteocephalus sp., Bothriocephalus cuspidatus and Necechinorhynchus tenellus (see Institute for Fisheries Report No. 217). These infestations were slight and not considered serious. No further reports of this nature have been received, so it is not suspected that these parasites are a factor in preventing the establishment of walleyes in the lake.

Shelter

Shelter for both young and adult fish is adequate in the form of dense vegetation around the north and west shores and patches of weeds over most of the lake bottom. Many deadheads also provide cover.

Regulation of Water Level

Although the water level of Missaukee Lake has receded considerably, there is apparently no way of controlling it since the lake has neither inlet nor outlet. Former connections with other lakes no longer exist. The request of a petition to regulate the water level of the lake is not compatible with existing conditions.

Improvement of Spawning Facilities

Spawning facilities are adequate for all fish in the lake except possibly the walleye, and further information on the spawning of walleyes is necessary before improvement of beds is possible.

Other Suggestions

Continued investigation of the walleye spawning possibilities in Missaukee Lake is recommended as already mentioned above. Any observations of young-of-the-year of this species should be reported to the Institute.

INSTITUTE FOR FISHERIES RESEARCH

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