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A FISHERIES INVENTORY OF MANISTEE LAKE, MANISTEE COUNTY¹

By

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Manistee Lake is located at the city of Manistee, in Town 21 North, Range 16 and 17 West. Industrial development is extensive on the shores of this lake, but there is no resort development. A municipal boat launching site and two boat liveries afford means of public access.

The Institute for Fisheries Research conducted a fisheries inventory of Manistee Lake in 1957. One investigation,² that consisted primarily of fish collecting, was made during June 11-21. The objective of this work was to determine if rainbow trout, that had recently been planted in the Manistee rivers, were entering this lake en route to Lake Michigan. Poor recovery by anglers of fish from plantings in 1955 and 1956 stimulated this investigation. Another study,³ conducted during August 19-26, was of the nature of a routine inventory. The map of Manistee Lake used for orientation and for recording collection stations was U. S. Lake Survey Chart No. 776, Manistee Harbor. A copy of the chart on which the locations of water analysis and fish collection stations are shown is on file at the Ann Arbor office of the

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²T. M. Stauffer, party leader; M. J. Hansen and F. C. Johnson, assistants.

³C. R. Gilbert, party leader; P. C. Munding and M. Parker, assistants.

Institute for Fisheries Research. A shore outline map of the lake, prepared from Chart No. 776, appears as Figure 1 in this report.

Physical characteristics

The area of Manistee Lake, as determined from the U. S. Lake Survey Chart with a planimeter, is 930 acres. The maximum depth recorded on this map is 49 feet. The extent of shoal (water less than 15 feet deep) is approximately 20 percent of the total area.

Sand and organic materials are the principal bottom soils on the shoals; there is some clay. The soil in the deeper parts of the basin is an organic mixture.

The water is light brown in color. Secchi disk readings at the temperature-chemistry stations in August 1957 ranged from 4 1/2 to 8 feet. The clarity of Manistee Lake at this time was below average, as the usual range in Michigan lakes is 7 to 15 feet.

The main inlets of Manistee Lake are the Big Manistee and Little Manistee rivers. The outlet is a deep channel to Lake Michigan that is navigable for cargo ships.

Temperature and chemical characteristics

Water temperatures in vertical series were recorded at nine stations in June of 1957. Summer-season stratification of the lake had begun by mid-June. In the deeper parts of the basin, a well defined thermocline began at a depth of around 24 feet and extended to within 3 or 4 feet of the bottom. Little or no stratification was evident in areas with depths of 30 feet or less. Some restriction in the thickness of the thermocline was the only significant physical change that occurred in the character of the stratification between June and August. By late August the upper limit of the thermocline generally was at 30 feet and the lower limit close to bottom as in June.

Chemical analyses of the water were made at five temperature-chemistry stations in August. Four of these stations were located approximately where temperatures were recorded in June, while the fifth station (No. 11) was established at a new location. Temperatures and chemical values obtained in August appear in Table 1. The locations of the stations sampled in June and August are illustrated in Figure 1.

Marked variation among stations in values for dissolved oxygen and carbon dioxide is a distinctive feature of the chemical data. Presence of carbon dioxide in the surface water at stations 2, 4, and 5, and especially low values of oxygen at stations 2 and 4, are indicative of pronounced organic pollution in these areas.

Water samples were also taken for determination of chloride, sodium, and calcium content. Such collections were made at the nine temperature stations and one additional station in June, and at four of the five temperature-chemistry stations in August. These samples were forwarded to the Water Resources Commission's technical section, and analyses were made by the Michigan Department of Health laboratory. The results appear in Table 2.

Considerable quantities of organic and inorganic pollutants enter Manistee Lake. Two fish kills have been recorded for this lake within recent years, the most extensive of which occurred from mid-May to early June in 1950.⁴ This die-off evidently resulted from depletion of dissolved oxygen. Complaints have been made about the fish in Manistee Lake having unpleasant flavors. The unnatural taste usually has been described as "oily," resembling that of kerosene. However, some people who frequently fish the lake have not noticed this unusual flavor.

Various reports by the technical staffs of the Water Resources Commission and the predecessor of this agency (Stream Control Commission) are concerned

⁴The details are recorded in a letter from H. A. Young to H. L. Aldrich, dated June 14, 1950.

Table 1.--Temperatures (°F) and chemical data, Manistee Lake,
1957. Oxygen (O₂), carbon dioxide (CO₂), and methyl
orange alkalinity (MO) values in parts per million

Depth in feet	Station No. 2 August 23 4:30 p.m. Air temp. 65				Station No. 4 August 23 5:30 p.m. Air temp. 65				Station No. 5 August 22 6:15 p.m. Air temp. 74			
	Temp.	O ₂ ¹	CO ₂	MO	Temp.	O ₂ ¹	CO ₂	MO	Temp.	O ₂	CO ₂	MO
Sur.	71	2.1	4.9	143	71	3.0	3.7	108	74	6.6	2.0	147
5	71	1.9			71	2.2			74	6.7		
10	71	1.6			71	2.8			74	7.1		
15	71	1.6			72	2.1			74	5.4		
20	73	0.4			73	0.0			73	2.0		
25	73	0.0	5.1	143	73	0.0			73	0.3		
27	..	0.0			..	...			..	...
27.5	..	...			..	0.0	9.0	149	..	...
30	71	...			72	...			71	0.0		
35									66	0.0		
40									62	0.0	33.3	207
43									62	...		
	Maximum depth 30'				Maximum depth 30'				Maximum depth 43'			
	Station No. 6 August 19 4:15 p.m. Air temp. 75				Station No. 11 August 19 2:30 p.m. Air temp. 75							
	Temp.	O ₂	CO ₂	MO	Temp.	O ₂	CO ₂	MO				
Sur.	74	10.2	0.0	141	71.5	9.1	0.0	99				
5	73.5	10.0			70.5	9.3						
10	72	8.9			69	7.8						
15	72	4.5			68	7.9						
20	73	1.6			68	6.4						
25	73	0.0			72	0.0	15.0	150				
27	..	...			70	...						
30	69	0.0										
35	64	...										
40	62	0.0	31.1	225								
	Maximum depth 41.5'				Maximum depth 27.5'							

¹Determinations for dissolved oxygen made with the Rideal-Stewart modification of the Winkler method at stations 2 and 4; the standard Winkler method was used at stations 5, 6, and 11.

Figure 1.--Outline map of Manistee Lake with locations
of water analysis stations where sampling
was done by Institute crews in 1957.

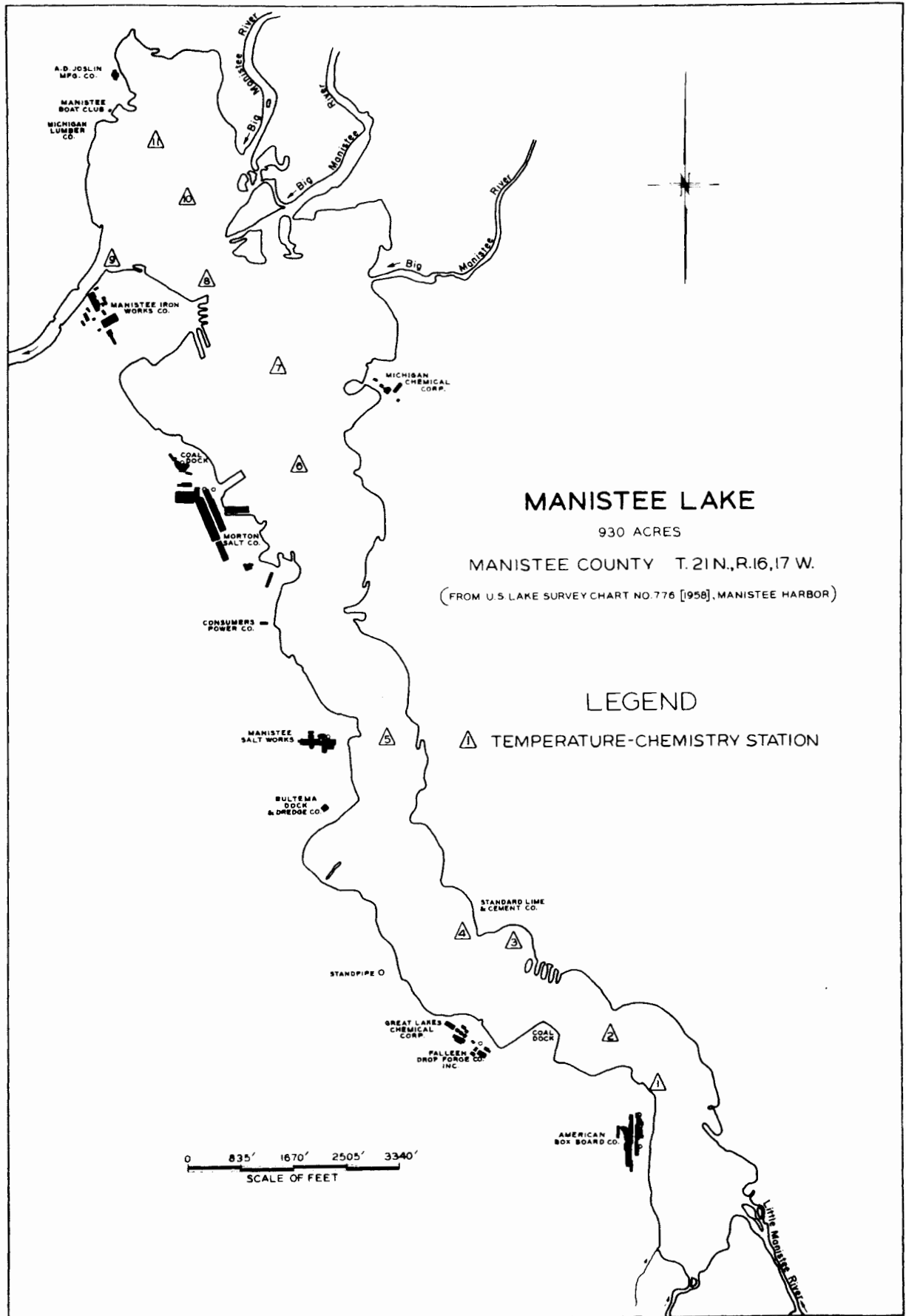


Figure 1

Table 2.--Chlorides, sodium, and calcium in water samples collected from Manistee Lake in June and August, 1957 (parts per million)

Station number ^{1/}	Date	Depth of collection (feet)	Chlorides	Sodium	Calcium
1	June 16	3	150	36	87
		21	200	44	127
2	June 17	3	124	30	56
2	August 23	10	280	57	132
		20	1,050	510	145
3	June 17	1	2,600	270	1,165
4	June 17	24	1,150	127	450
		33	1,850	235	760
4	August 23	5	300	67	135
		17.5	830	135	365
5	June 17	30	1,700	230	620
6	June 17	21	108	270	620
6	August 19	10	250	60	108
		30	1,800	320	620
		40	2,200	440	670
7	June 17	18	250	56	112
8	June 17	21	650	112	245
9	June 18	21	130	34	78
10	June 18	21	34	13	52

^{1/}Locations of stations are shown in Figure 1.

with pollution in Manistee Lake. These references are listed in the "Literature Cited" section at the end of this report. Except as considered in relation to an experiment with rainbow trout and a recommendation for the management of the lake, the subject of pollution is outside the scope of this report.

Biological characteristics

Rooted aquatic vegetation in Manistee Lake is limited mostly to the small area of shoal at depths of less than six feet. The depth limit of rooted vegetation in Michigan lakes is usually around 15 feet. Coloration of the water and depositions of silt and industrial wastes probably are two of the more important factors that confine plants to shallower depths in Manistee Lake.

Although limited in distribution, the vegetation is considerably varied. The inventory crew noted 24 kinds of plants. Coontail (Cerataophyllum) and mud plantain (Heteranthera) were the dominant species. Density of the three general types is recorded as follows: emergent, sparse; floating, medium; submergent, medium to dense. Cover other than vegetation available for fish includes numerous deadheads and pilings.

Fish were collected with gill nets during the investigation of June, 1957, and with gill nets and seines in August. The gill nets were 125 feet long by 6 feet deep, and mesh dimensions ranged from 3/4 inch to 2 inches, square measure.

Twenty-three overnight net sets were made in June, 14 of which consisted of two nets tied end to end, comprising a total of 37 nets. All of this collecting was done off the mouths of the Big Manistee and Little Manistee rivers. The total catch (size range--total lengths in inches--in parentheses) was as follows: 1 brown trout (22.9), 8 rainbow trout (6.9-9.4), 10 northern

pike (13.1-29.1), 159 yellow perch (5.6-9.9), 1 largemouth bass (9.1), 14 bluegills (3.6-7.8), 36 pumpkinseeds (3.3-6.8), 49 rock bass (3.3-8.5), 11 black crappies (5.0-9.4), 11 white suckers (6.4-13.6), 9 redhorse (6.2-18.7), 1 brown bullhead (11.8), 388 alewives (5.6-10.1), 6 bowfins (18.5-27.0), 1 carp (10.3), and 1 common shiner (5.9).

The objective of the netting done in June was to determine if tagged, hatchery-produced rainbow trout planted in the Manistee rivers near Manistee Lake were moving through to Lake Michigan. Extremely few captures were being reported of tagged fish that had migrated to the big lake, so pollution in Manistee Lake was suspected as a barrier to migration. The subject will be discussed in detail later in this report.

In August, 24 single gill-net sets were made. This collecting effort was distributed over the entire lake, rather than concentrated in certain areas as in June. The total catch was: 18 northern pike (14.5-30.6), 55 perch (5.6-12.1), 4 walleyes (14.3-21.5), 4 smallmouth bass (9.9-13.5), 3 largemouth bass (10.0-13.5), 140 bluegills (3.8-8.6), 31 pumpkinseeds (4.1-6.8), 38 rock bass (3.6-9.3), 7 crappies (4.8-10.3), 12 bluegill x pumpkinseed hybrids (4.5-7.1), 5 white suckers (13.0-18.5), 25 redhorse (11.6-18.6), 2 brown bullheads (10.7-12.8), 1 yellow bullhead (9.6), 3 bowfins (19.6-29.3), and 1 carp (21.8).

Young game and pan fish captured in seines were of the same species as those caught with gill nets except that seines took no northern pike or walleyes. Forage species also appeared in seine collections, among which the bluntnose minnow and banded killifish predominated.

The main differences between the gill-net collections of June and August were the absence of trout and alewives, the smaller number of perch, and the greater number of bluegills in the August collection. Variance in net selectivity probably accounted for much of the difference in the catches of

perch and bluegills. Only nets of straight 3/4-inch and 1-inch mesh were used in June, whereas those set during August were of 1-inch, 1 1/2-inch, and experimental mesh--the latter nets consisting of one 25-foot section each of 3/4-, 1-, 1 1/4-, 1 1/2-, and 2-inch mesh. Location of the sets (mostly near the mouths of the inlets in June, and over the entire lake in August), as well as the different seasons, may well have accounted for the different results with trout. The absence of alewives from the later collection may have been due to movement of this species out of Manistee Lake by August.

Judging from data of these investigations and general creel census records, the principal sport fish of Manistee Lake are northern pike, yellow perch, smallmouth bass, bluegills, pumpkinseeds, rock bass, and black crappies. Ciscoes, smelt, muskellunge, and white bass have been caught here in past years, although there are only few records on these fish in the general creel census reports that date from 1929 through 1957. The latest year of record for each species is: cisco, 1944; smelt, 1943; muskellunge, 1936; white bass, 1954. The species of fish that have been collected or reported in Manistee Lake are listed in Table 3.

Presence of the alewife in Manistee Lake is of more than passing interest. This "weed" species was first collected in Lake Michigan in 1949. Since then it has become so plentiful that it is a serious nuisance. The species has little or no commercial value and is readily caught in gill nets used for chubs. Removal from the nets is time-consuming and costly. What effect the alewife will eventually have on the sport fishery of Manistee Lake is unknown. However, it is thought that adults occur here only seasonally (during the spawning period), and that this fish will not constitute a problem.

Table 3.--Fishes collected in 1957 or previously reported
from Manistee Lake

Common name ^{1/}	Scientific name ^{1/}
<u>Game fish</u>	
Brown trout	<u>Salmo trutta</u>
Rainbow trout	<u>Salmo gairdneri</u>
Cisco	<u>Coregonus artedii</u> ^{2/}
Northern pike	<u>Esox lucius</u>
Muskellunge	<u>Esox masquinongy</u> ^{2/}
Yellow perch	<u>Perca flavescens</u>
Walleye	<u>Stizostedion v. vitreum</u>
Smallmouth bass	<u>Micropterus dolomieu</u>
Largemouth bass	<u>Micropterus salmoides</u>
Bluegill	<u>Lepomis machrochirus</u>
Pumpkinseed	<u>Lepomis gibbosus</u>
Rock bass	<u>Ambloplites rupestris</u>
Black crappie	<u>Pomoxis nigromaculatus</u>
Warmouth	<u>Chaenobryttus gulosus</u>
White bass	<u>Roccus chrysops</u> ^{2/}
<u>Coarse fish</u>	
Sea lamprey	<u>Petromyzon marinus</u> ^{2/}
Bowfin	<u>Amia calva</u>
American smelt	<u>Osmerus mordax</u> ^{2/}
Alewife	<u>Alosa pseudoharengus</u>
Redhorse	<u>Moxostoma sp.</u>
White sucker	<u>Catostomus commersoni</u>
Carp	<u>Cyprinus carpio</u>
Brown bullhead	<u>Ictalurus nebulosus</u>
Yellow bullhead	<u>Ictalurus natalis</u>
<u>Forage fish</u>	
Emerald shiner	<u>Notropis atherinoides</u>
Common shiner	<u>Notropis cornutus</u>
Bluntnose minnow	<u>Pimephales notatus</u>
Banded killifish	<u>Fundulus diaphanus</u>
Brook silverside	<u>Labidesthes sicculus</u>
Johnny darter	<u>Etheostoma nigrum</u>

^{1/}The names are those given by R. M. Bailey in "Names of Michigan Fishes," Fish Division Pamphlet No. 22, 1958.

^{2/}Not collected in 1957, but previously reported present.

The catches taken in a weir operated in the Little Manistee River by the U. S. Fish and Wildlife Service for sea lampreys in the spring and summer of 1958 afford further insight into the fish population of Manistee Lake. As the weir was situated less than one-quarter mile from the lake and caught fish swimming upstream, the species taken here probably also occur in the lake. Species caught at this location which have not been recorded for the lake were brook trout, longnose suckers, logperch, creek chubs, sculpins, golden shiners, and mudminnows. Smelt were also captured, which indicates that this fish still frequents the lake at least around the time of its spawning season.

Scales of sport fish collected from Manistee Lake in 1957 have been examined for information on age and growth. The data of the June and August collections have been combined and are summarized in Table 4.

Compared to state-wide averages, pumpkinseeds, rock bass, and crappies of Manistee Lake were growing at average rates. Growth of bluegills and perch was above average. Too few samples of largemouth and smallmouth bass were available to afford reliable values for these species, but the limited data suggest that their rate of growth is at least average.

Rainbow trout⁵

An experiment was begun in 1955 to test the results of planting rainbow trout near the mouths of streams tributary to the Great Lakes. Rainbow trout grow much faster in the large lakes than they do in the streams; when the migrants return to the streams they usually are of large size. Presumably anglers will catch more lake-run fish originating from plantings made near the mouths of the tributaries than from introductions made greater distances

⁵T. M. Stauffer, who is in charge of the study of rainbow trout, has provided the data, contributed to the discussion, and reviewed this section of the report.

Table 4.--Age and growth of sport fish in Manistee Lake^{1/}

(Average lengths based on total lengths in inches;
number of fish in sample in parentheses)

	Age group						
	I	II	III	IV	V	VI	VII
<u>Largemouth bass</u>	...	10.1(3)	9.1(1)	13.5(1)	...	...	...
State average	6.1	8.7	10.0	12.1			
<u>Smallmouth bass</u>	7.5(2)	11.0(1)	11.1(1)	...	...	...	...
State average	5.9	9.0	11.2	13.3			
<u>Bluegill</u>	...	5.7(79)	6.6(31)	7.5(9)	7.9(15)	8.2(1)	...
State average	2.9	4.3	5.5	6.5	7.3	7.8	
<u>Crappie</u>	4.8(1)	5.7(7)	...	9.0(3)	9.4(4)	10.1(2)	...
State average	...	5.9	8.0	9.0	9.9	10.7	
<u>Pumpkinseed</u>	3.2(2)	4.4(12)	5.3(15)	6.1(3)	6.2(12)	...	...
State average	2.9	4.1	4.9	5.7	6.2		
<u>Rock bass</u>	3.0(1)	4.2(13)	4.8(11)	6.4(18)	7.4(10)	7.7(3)	8.7(3)
State average	3.2	4.3	5.2	6.2	7.3	7.9	8.8
<u>Perch</u>	5.2(7)	6.1(8)	7.5(24)	9.0(21)	9.9(33)	...	12.1(1)
State average	4.2	5.8	6.8	7.9	8.8	9.8	10.4
<u>Walleye</u>	...	14.6(2)	...	19.4(1)	21.5(5)	...	...
State average	9.1	12.0	15.9	17.8	18.9		
<u>Northern pike</u>	17.2(9)	19.3(5)	24.1(9)	...	28.2(3)	27.6(1)	...
State average	15.5	19.4	22.2	23.9	25.4	27.7	

^{1/}Ages determined by H. F. Dugan.

from the lakes. As part of this experiment, plantings of jaw-tagged rainbow trout (domestic strain, 8 to 9 inches long at the time of planting) have been made in the Big Manistee and Little Manistee rivers from 1955 through 1957.

As mentioned earlier, extremely few lake-run rainbow trout have been captured that were tagged and released in the Manistee rivers upstream from Manistee Lake. This result stimulated the investigation of possible causes of mortality made in June, 1957. Three of the nine rainbow trout caught in gill nets at that time were tagged fish of the 1957 introduction into the Little Manistee River, and the other six were assumed to be wild trout. While the work on the lake was in progress, a creel census was conducted near the planting sites on the streams. The 1957 planting in the Little Manistee River was exploited heavily soon after it was made, but very little fishing was done for rainbow trout in the lower part of the Big Manistee River.

Planting records and extent of recovery to October 28, 1958, of tagged rainbow trout released in the Manistee rivers are summarized in Table 5. Appreciably fewer recoveries have been reported of tagged, lake-run rainbows that were planted above Manistee Lake than for the majority of plantings made in other localities. On the other hand, a goodly number (48) of such recoveries have been reported from fish planted in the Manistee River below Manistee Lake. If considered alone, these observations would suggest pollution as a possible reason for the extremely small catch of lake-run trout from plantings made above the lake.

Observations which make the argument for pollution less convincing are the following:

(1) It is difficult to conceive that pollution affects the fish stocked in the Big Manistee River because the north end of Manistee Lake where this stream enters is affected but little by pollution.

Table 5.--Summary of returns from jaw-tagged rainbow trout released in the Manistee rivers,
as of October 28, 1958

Stream, and date of planting	Location	Number planted	Recoveries						
			Unspecified growth Number	Stream growth Number Percentage		Lake growth Number Percentage		Totals Number Percentage	
Little Manistee River									
June 16, 1955	1-2 miles above Manistee Lake	2,497	3	108	4.3	0	0.0	111	4.4
May 29, 1956	0-1 mile above Manistee Lake	2,484	0	0	0.0	0	0.0	0	0.0
June 11, 1957	1/4 mile above Manistee Lake	1,997	4	166	8.3	2	0.1	172	8.6
	Totals	6,978	7	274	3.9	2	0.03	283	4.0
Big Manistee River (above Manistee Lake)									
June 16, 1955	4 miles above Manistee Lake	2,496	0	0	0.0	0	0.0	0	0.0
June 11, 1957	1/2 mile above Manistee Lake	1,997	1	0	0.0	1	0.05	2	0.01
	Totals	4,493	1	0	0.0	1	0.02	2	0.04
Big Manistee River (below Manistee Lake)									
May 29, 1956		2,499	1	4	0.2	42	1.7	47	1.9
June 10, 1957		998	7	18	1.8	6	0.6	31	3.1
	Totals	3,497	8	22	0.6	48	1.4	78	2.2

(2) Appreciable numbers of migrant rainbow trout from Lake Michigan enter both streams, including several marked fish of this experiment. A weir, operated by the U. S. Fish and Wildlife Service during the spring of 1958 near the mouth of the Little Manistee River for capture of sea lampreys, caught 598 rainbow trout that were over 12 inches long and 921 that were 12 inches or less in length. These fish were going upstream.

(3) As of October 28, 1958, there has been no reported recovery of fish showing lake growth from plantings made in 1955-57 at 3 of 19 other release sites. Pollution definitely was not a factor in the apparent failure of these introductions.

To summarize the subject, apparently few stocked rainbow trout moved from tributaries downstream through Manistee Lake during 1955 through 1957. Only three planted rainbows were netted in June of 1957, and none were captured the following August. Further, only three fish that had succeeded in reaching Lake Michigan were recovered from the plantings made above Manistee Lake as compared to 48 recoveries from plantings made below Manistee Lake. As pollutants are known to have exerted some adverse effects in the past on other species of fish, failure of rainbow trout planted upstream from Manistee Lake to pass downstream through this lake could be due to pollution. However, in view of the several inconsistencies in this argument, other factors such as presence of large predatory fish (northern pike) and the distance from Lake Michigan at which introductions were made should not be excluded.

Management considerations

Continued abatement of pollution is the only recommendation we make for Manistee Lake. The lake contains a wide variety of sport fish, and most

species are plentiful and attain good size. Growth rates are average to above average. We think that correction of the various pollution problems is the best contribution that can be made to favor the fish and fishermen. Some of the results of contamination in this lake include occasional large-scale mortality of fish, reduction of available habitat for fish and food organisms, and repulsive sights and odors.

The Michigan Water Resources Commission has worked and continues to work intensively on the pollution problems of Manistee Lake. One industry (American Box Board Company) has constructed a pipeline to Lake Michigan to dispose of its wastes; it began to use this method of disposal in the winter of 1957-58. It is expected that other industries will in time handle contaminating by-products by means other than direct discharge into Manistee Lake. While such procedures promise to improve the quality of the water greatly, some adverse aftereffects from past and current waste discharges are likely to continue for some time. Fetterolf (1957) stated, "If all sources of pollution were eliminated immediately, it would probably be many years before chemical and biological reduction processes could sufficiently clear the deeper portions of the lake to support bottom animals."

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