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ANALYSIS OF THE FISH CATCH FOR ONE YEAR IN THE WATERLOO PROJECT AREA *

ALBERT S. HAZZARD AND R. WILLIAM ESCHMEYER

INTELLIGENT management of the fishing in any area requires: (1) an adequate survey of physical, chemical, and biological characteristics of the waters; and (2) a "creel census" of the representative waters continued over a period of years.

A survey is essential to determine the conditions for the species of fish present and the need for environmental improvements; also, to ascertain whether the existing game species require encouragement by plantings and whether introduction of new species is desirable to improve the fishing.

A complete census of the fish yield is necessary to evaluate the benefits of environmental improvements and fish stocking, as well as to demonstrate fluctuations in the yield of game fish under existing regulations. Such a census in the Waterloo Area ¹ will be particularly valuable in showing the effect of winter fishing upon summer fishing, the type of fishing practiced, and any changes in the character or the intensity of the fishing which may come about as the development of this area proceeds. At present the lakes in the Waterloo Project are used principally by anglers from near-by counties, but as organized camps are completed and facilities for other kinds of camping are improved, it is almost a certainty that the fishing pressure will increase, and thus necessitate greater efforts on the part of the agency responsible for maintaining the fish supply; hence the importance of a census at this time and of continuing such a project.

The Institute for Fisheries Research proposed survey and census projects for the Waterloo Area (National Parks Service) when, in 1934, its coöperation in the development of the fishing was requested.

* Contribution from the Institute for Fisheries Research of the Michigan Department of Conservation and the University of Michigan.

¹ A submarginal area in Jackson and Washtenaw counties, Michigan.

The creel census was started immediately and, except for a short period, has been continuous. A detailed survey of the lakes was carried on by the Institute, assisted by the personnel of the Waterloo Project, during the summer of 1936. The results of this investigation will be reported in a subsequent paper.

The census was secured by selected crews of local employees of the Area. These men were coached in methods of taking data and were checked frequently for accuracy and completeness of their records. Each census clerk was responsible for a certain section of shore line or, where the area was small, for an entire lake. Upon leaving the lake anglers were asked to display their catch and to report on methods employed, period fished, number of undersized fish caught, etc. For a more complete description of the methods used in creel census studies see Eschmeyer (1936).

All labor and immediate supervision of the census were provided by the Waterloo Project. The Institute assisted in an advisory capacity and later tabulated, summarized, and interpreted the information obtained.

The census of winter fishing was not complete for the season, but extended from January 6 to 19 and from February 21 to March 31. A continuous record of the fish yield was secured from the opening of the summer season, June 25, to the time of ice formation, November 30.

The lakes where this census was conducted and their approximate areas are as follows:

	<i>Acres</i> ²		<i>Acres</i> ²
Cassidy.....	36	Big Portage.....	480
Clear.....	136.7	Cedar.....	56
Green.....	78.3	Crooked.....	70
Mill.....	204	Doyle.....	10
Mirror.....	4	Mud.....	64
Sugarloaf.....	204.8		
Walsh.....	10.2		
Waterloo Mill Pond (lower).....	10.5		

According to reports, the other lakes in the Waterloo Project supported little or no fishing except Trist Mill Pond, which was not

² Areas listed in the first column are based on plane-table survey and are quite accurate; those in the second column were determined from the United States Geological Survey maps and are only approximate.

covered by the census. Waterloo Mill Pond (lower) was only partly covered, but is included in the discussion. The information obtained from the census is discussed separately for winter fishing and for summer fishing. The catches during the two seasons are then compared and the effect upon the total fish population is calculated.

WINTER FISHING

The combined area of the twelve lakes under observation during part of the winter was approximately 1,308.5 acres. It was reported that five of these lakes (Cassidy, Doyle, Green, Mirror, and Walsh) were not fished. Information on the catch in the other seven during a 54-day period is shown in Table I.

It will be noted that winter fishing was negligible on all except

TABLE I

INFORMATION ON WINTER FISHING (1936) ON SEVEN LAKES IN THE WATERLOO AREA FOR THE PERIODS JANUARY 6-19 AND FEBRUARY 21-MARCH 31 (54 DAYS)

Data summarized	Lake							Total	Percentage of total
	Clear	Crooked *	Mill	Mud	Portage	Sugarloaf	Waterloo Mill Pond (lower)		
Number of fisherman days.....	499	6	18	18	364	11	12	928	..
Number of fish caught (total).....	3,881	3	6	4	1,349	5	29	5,277	..
Catch per hour.....	1.7	0.1	0.1	0.1	0.8	0.1	..	..	..
Large-mouthed bass....	1	..	..	..	2	..	..	3	tr. †
Black crappie.....	3,493	..	..	..	330	4	6	3,833	73
Bluegill †.....	25	..	..	..	46	1	6	78	1
Common sunfish †.....	..	..	..	..	250	..	..	250	5
Perch.....	313	..	..	4	62	..	10	389	7
Rock bass.....	..	..	..	..	552	..	..	552	10
Walleye.....	..	..	..	..	1	..	..	1	tr.
Northern pike.....	48	3	6	..	71	..	3	131	2
Gar.....	..	..	..	..	5	..	4	9	tr.
Carp.....	..	..	..	..	4	..	..	4	tr.
Sucker.....	..	..	..	..	3	..	..	3	tr.
Dogfish.....	1	..	..	..	23	..	..	24	tr.

* Incomplete.
 † Figures probably include a number of hybrids.
 ‡ Trace — less than 0.5 per cent.

Clear and Portage lakes. A total of 5,277 fish, caught at an average rate of 1.2 fish per hour, was reported by the census takers. In 1935, according to the Michigan general census, made by Conservation officers and representing a sampling of the fishing, the lakes in the two lower tiers of counties, which include the Waterloo Area, yielded a catch per hour of 3.1 fish in January, 3.3 in February, and 1.2 in March. The catch per hour on the lakes in the Waterloo Area in the winter of 1936 was much lower, therefore, than that in southern Michigan, as reported in the 1935 general census.

Of all fish recorded during the winter of 1936 in the Waterloo Area, 3,833, or 72.6 per cent, were black crappies. Rock bass, all taken in Portage Lake and nearly all during the month of March, were second in abundance. They constituted about 10.5 per cent of the reported winter catch for the Area. Perch, sunfish, and northern pike were each represented by over a hundred specimens. A few individuals of a number of other species were taken. In general, the fishing centered on the black crappie, and this species was fished for primarily in Clear Lake.

Concentration of winter fishing on relatively few lakes has been noted in creel census studies elsewhere in Michigan (Hazzard and Eschmeyer, 1937). The reason for such concentration may be explained by the catch, which averaged 0.1 fish per hour for all lakes except for Portage and Clear lakes, where the yield was respectively 0.8 and 1.7 fish per hour. Why some lakes should provide better winter fishing than others cannot be accounted for at present.

Fishing was not intensive during the period when the census was not taken. Snow was exceptionally deep, a condition which made access to some of the lakes difficult, and the weather was unusually cold. It is probable, therefore, that the entire catch for the Area during the winter was not over 7,500 fish, a catch of about 5.7 fish per acre for the twelve lakes.³

SUMMER AND FALL FISHING

Relatively detailed information is available on the summer and fall fishing on the lakes in the Area. It was estimated by the Waterloo Project that the census takers secured records of 90 per cent of the fish yield. Unless otherwise indicated, the information given below

³ A complete census of winter fishing was conducted on the lakes during 1936-37.

is based on the records submitted and represents, therefore, about 90 per cent of the actual fishing.

Data for each lake were tabulated by weekly intervals in the complete report, but in this paper are summarized for the season. There follows a discussion of the results of the census.

Number of fishermen (Table II). — The total number of fishermen from whom reports were obtained during the season ranged from 2,141 on Portage Lake to 3 on Mud Lake. The small amount of fishing on Mud and Green lakes may be explained by the fact that in both suffocation under the ice practically eliminated the entire fish population during the preceding winter. Records of 8,325 fisherman days were obtained. If they represent 90 per cent of the fishing, the total may be estimated at 9,250, an average of approximately seven fisherman days per acre for the twelve lakes during the summer and fall.

Fishermen taking no fish (Table II). — Twenty-nine per cent of all the fishermen caught no legal-sized fish. The percentage of unsuccessful anglers varied from 3 in Doyle Lake to 81 in Waterloo Mill Pond. On the four lakes which supported over a thousand fisherman days (Clear, Mill, Portage, and Sugarloaf) the number taking no fish varied from 21 per cent on Mill Lake to 40 on Sugarloaf.

Number of legal-sized fish taken (Table II). — Records indicate a yield of 37,163 fish. The total number taken was therefore estimated at 41,292 fish, an average of about 32 per acre for the twelve lakes. The per acre catch ranged from about one per eight acres in Mud Lake to 114 per acre in Doyle Lake. The yield of the different lakes varied decidedly.

It would be interesting and useful to know what proportion of the total number of legal-sized fish occurring in the lakes these annual catches represent. Some clue to this problem may be afforded as a result of complete or nearly complete fish mortality in two lakes in the area. Mr. Gerald P. Cooper, formerly of the Institute staff, counted samples of the fish which were killed by suffocation during the winter of 1936, and from his counts calculated that the total population in Mud Lake had been 72,000 game fish averaging approximately six inches in length, and in Green Lake, 90,000 game fish averaging about seven inches. Since these counts did not include fish of the smaller sizes or the fish which died and remained in deeper water, they are probably conservative. If the

TABLE II

DATA ON THE FISHING ON TWELVE LAKES IN THE WATERLOO AREA
FOR THE PERIOD JUNE 25 — NOVEMBER 30, 1936

Lake	Number of fish- men	Fishermen taking no fish		Number of legal- sized fish taken	Total hours fished	Fish per fish- man	Fish per hour	Average size of fish (inches)	Hours per fish- man day	Estimated number of fish per acre *
		Number	Percent- age							
Cassidy.....	23	5	22	151	75.0	6.6	2.0	8.7	3.3	4.7
Cedar.....	452	74	16	2,795	1,293.0	6.2	2.2	7.6	2.9	55.4
Clear.....	1,579	592	37	4,967	4,949.8	3.1	1.0	7.7	3.1	40.3
Crooked.....	750	86	11	4,901	1,944.9	6.5	2.5	7.4	2.6	77.7
Doyle.....	163	5	3	1,024	359.5	6.3	2.8	7.4	2.2	113.8
Green.....	42	17	40	118	198.0	2.8	1.7	7.7	4.7	1.66
Mill.....	1,513	322	21	8,243	7,099.3	5.4	1.2	7.5	4.7	44.8
Mirror.....	27	9	33	153	46.0	5.7	3.3	7.3	1.7	42.5
Mud.....	3	0	0	7	13.5	2.3	0.5	6.6	4.5	0.12
Portage.....	2,141	695	32	9,306	9,659.9	4.3	0.9	8.2	4.5	21.5
Sugarloaf.....	1,590	634	40	5,211	5,579.5	3.3	0.9	8.1	3.5	28.2
Walsh.....	26	2	8	278	107.0	10.7	2.6	7.5	4.1	30.2
Waterloo Mill Pond (lower) †.....	16	13	81	9	33.5	0.6	0.4	..	2.1	0.95
Totals or averages for records available...	8,325	2,454	29	37,163	31,358.9	4.5	1.2	7.8	3.8	31.6
Totals for all fishing *	9,250	2,727	..	41,292	34,843.2	..	..	..	..	..

* It is assumed in this column that the 90 per cent coverage by census was representative of all fishing. The figures used indicate, therefore, the estimated total catch per acre.

† Data represent less than 90 per cent of the fishing.

populations in Mud and Green lakes are representative, the Waterloo Area lakes probably contain an average of 1,000 game fish per acre, averaging from six to seven inches in length. At least 50 per cent of the fish counted were over six inches long, so that a conservative estimate of those available to the angler would be 500 to the acre. On the basis of this estimate, fishing in summer and fall removed less than 7 per cent of the total number of the legal-sized fish.

Hours fished (Table II). — A total of 31,358.9 fishing hours was recorded. From this it is estimated that there were about 35,000 hours of fishing, or an average of 26.6 hours per acre. The average fishing day was 3.8 hours, but it varied considerably in different lakes.

Catch per hour and per angler (Table II). — On the average, the

TABLE III

CATCH OF FISH, BY SPECIES, FROM TWELVE LAKES IN THE WATERLOO AREA, SUMMER AND FALL OF 1936

Lake	Bluegill *	Common sunfish *	Yellow perch	Large-mouthed bass †	Small-mouthed bass †	Rock bass	Black crappie	Bullhead	Northern pike	Dogfish	All others ‡	Total
Cassidy	80	18	19	12	..	22	..	..	..	..	..	151
Cedar	1,985	387	150	126	85	4	9	46	..	..	3	2,795
Clear	3,015	335	215	374	69	328	451	147	4	1	28	4,967
Crooked	2,770	995	601	168	100	32	..	225	5	5	..	4,901
Doyle	517	222	60	35	16	3	157	10	3	1	..	1,024
Green . . . . .	..	7	84	..	..	..	..	26	..	..	1	118
Mill	5,798	1,284	495	143	70	42	123	218	63	7	..	8,243
Mirror	115	31	1	3	3	..	..	..	..	..	..	153
Mud . . . . .	..	3	4	..	..	..	..	..	..	..	..	7
Portage	7,661	295	269	375	50	136	240	99	165	4	12	9,306
Sugarloaf . . .	2,728	671	613	132	36	173	116	499	202	34	7	5,211
Walsh	137	37	75	6	3	..	..	20	..	..	..	278
Waterloo Mill Pond . . . .	..	..	..	..	..	7	..	..	..	2	..	9
Totals	24,806	4,285	2,586	1,374	432	747	1,096	1,290	442	54	51	37,163
Percentage of total	67	12	7	4	1	2	3	3	1	tr. §	tr.	

* Figures probably include a number of hybrids.
 † Identification of bass species probably not reliable.
 ‡ Includes 38 minnows, 3 warmouth bass, 9 gars, and 1 unknown fish.
 § Trace — less than 0.5 per cent.

fishermen caught about 4.5 fish each, at the rate of 1.2 fish per hour. The catch ranged from about one fish for two hours of fishing on Waterloo Mill Pond and Mud Lake to over three fish per hour on Mirror Lake. On the four lakes supporting the most fishing the average catch ranged from 0.9 to 1.2 fish per hour. These figures are somewhat below the average (1.8) for the two lower tiers of counties, as was revealed by the 1935 general census for Michigan.

Average size of fish caught (Tables II, IV). — The average sizes of all fish taken in the different lakes did not vary greatly, but certain species ran larger in some lakes than in others. Portage Lake, for example, produced the largest bluegills, sunfish, and perch; Cedar Lake, the largest bass; Sugarloaf, the largest rock bass, black crappies, and northern pike; and Clear Lake the largest bullheads.

TABLE IV

AVERAGE TOTAL LENGTH IN INCHES OF FISH OF VARIOUS SPECIES CAUGHT
JUNE 25 — NOVEMBER 30, 1936

Species omitted for lakes where fewer than 100 individuals
of a species were taken.

Species	Cedar	Clear	Crooked	Mill	Portage	Sugar- loaf
Bluegill.....	7.2	6.9	7.0	7.2	7.7	7.1
Sunfish.....	6.8	6.5	6.9	6.9	7.3	6.7
Yellow perch.....	8.1	7.9	7.3	7.6	8.2	8.2
Large-mouthed bass.	13.3	12.3	12.7	12.7	12.7	12.6
Small-mouthed bass.	..	..	11.9	..	..	..
Rock bass.....	..	7.8	..	..	7.2	8.6
Black crappie.....	..	8.4	..	8.4	8.5	10.8
Bullhead.....	..	10.5	8.2	9.2	..	10.2
Northern pike.....	..	..	..	..	18.6	19.9

Catch by species (Table III). — Bluegills represented 67 per cent of all fish caught during the summer and fall, and were dominant in the catch in every lake. Sunfish, some possibly bluegills or hybrids between bluegills and sunfish, represented 12 per cent of the catch. Four of every five fish were either bluegills or sunfish. Other species taken, together with the percentages of the entire yield represented by them, were: perch, 7; large-mouthed bass, 4; small-mouthed bass, 1; rock bass, 2; black crappies, most prominent in the winter catch, 3; bullheads, 3; northern pike, 1. Fish taken in relatively insignificant numbers include dogfish, minnows, warmouth bass, and gars.

Residence of the anglers. — Only 6 per cent of the fishermen were nonresidents. Of these 514 fishermen, 467 (91 per cent) were from Ohio. Eleven other states were represented, as follows: Illinois, 18; Indiana, 6; Florida, 3; Kentucky, 2; New Hampshire, 1; New York, 2; Pennsylvania, 5; Virginia, 2; Iowa, 2; California, 1; and Missouri, 1. Four fishermen were from Canada. The percentage of nonresidents was very much lower than has been found for certain other waters in northern Michigan.

Of the 7,440 residents 93 per cent were from three counties (Jackson, 43 per cent; Wayne, 29; and Washtenaw, 21). Twenty-three other counties were represented, all except two of them by

TABLE V

DATA ON THE USE AND EFFECTIVENESS OF THE SEVERAL METHODS OF FISHING

Method	Hours recorded		Fish taken		Fish taken per hour	Average length of fish (inches)
	Number	Per-centage	Number	Per-centage		
Still-fishing	22,351.44	85	29,618	94	1.3	7.5
Trolling	1,161.75	4	828	2	0.7	8.9
Casting	2,886.25	11	1,109	4	0.4	12.0

fewer than twenty fishermen. The lakes mostly attract fishermen living within a radius of fifty miles. In contrast, over half the fishing on Fife Lake, Grand Traverse and Kalkaska counties, was by anglers living two hundred miles or more away (Eschmeyer, 1937).

Woman anglers. — Sixteen per cent (1,367) of the anglers were women, of whom an even hundred were nonresidents.

Fishing methods (Table V). — Still-fishing, which was employed by 85 per cent of the anglers, yielded 94 per cent of the fish caught. Trolling made up 4 per cent of the fishing and accounted for 2 per cent of the catch. Eleven per cent was by casting, which produced 4 per cent of the fish taken. Still-fishing yielded, in general, the smallest fish and casting the largest. This relatively close correlation between size of fish and number of fish per hour taken by any one method is in accord with findings on other Michigan lakes (Eschmeyer, 1936, 1937).

Data are available for the effectiveness of each method in taking fish of each of the species most commonly caught in the several lakes, but this information is too copious to be included. It may be stated briefly that still-fishing was decidedly the most used and the most effective method in catching bluegills and sunfish. Trolling was the most effective, but the least used, in catching large-mouthed bass.

Baits used (Table VI). — Worms were the most popular bait. They were used in 75 per cent of the fishing and accounted for 83 per cent of the fish. Minnows were employed for 10 per cent of the fishing and insects for 6 per cent. These three natural baits yielded 97 per cent of all the fish taken. The remaining 3 per cent were

TABLE VI

USE AND EFFECTIVENESS OF VARIOUS KINDS OF BAIT

Bait used	Hours each bait was used		Fish taken by each bait		Fish taken per hour	Average size of all fish (inches)
	Number	Percentage	Number	Percentage		
<i>Natural</i>						
Worms.....	17,711.9	75	23,581	83	1.3	7.3
Insects.....	1,386.5	6	2,393	8	1.7	7.7
Minnows.....	2,406.5	10	1,686	6	0.7	10.1
<i>Artificial</i>						
Spinners.....	148.5	1	71	0.5	0.5	13.2
Plugs.....	1,700.5	7	615	2	0.4	12.0
Artificial flies.....	116.0	1	83	0.5	0.7	9.0

caught on artificial lures (spinners, plugs, and flies). Spinners and plugs yielded, on the average, the largest fish, also the fewest fish per hour.

Natural bait was decidedly the best for taking bluegills. Insects were first in effectiveness, worms second. Sunfish were caught most readily with worms; their next favorite food was insects. Of the artificial lures used for large-mouthed bass spinners ranked first, plugs second. Almost all the perch, which preferred minnows to worms, were taken by natural bait. These preferences were generally the same for each lake.

DISCUSSION AND CONCLUSIONS

(1) The average yield on the lakes of the Waterloo Area for the year 1936 is estimated at 37.7 fish per acre. This is believed to represent less than 8 per cent of the fish available to the fisherman. If this assumption is correct, it is evident that these lakes are not intensively fished at present and could support a much greater fishing pressure without any danger of depletion.

(2) A considerable variation in the yield of fish per acre is apparent in the different lakes. As a general rule, the larger lakes attracted the most anglers, but the intensity of fishing (in terms of fisherman hours per acre), catch per hour, and number of fish removed per acre were greater in the smaller lakes. The reasons

for such variation may be revealed when a study of the survey data is completed. This interpretation should make it possible, at least in some instances, to suggest for the poorer lakes environmental improvements which will increase their yield.

(3) The results of the census indicate that ice fishing has little, if any, harmful effect upon the yield during summer and fall. This conclusion is in accordance with the authors' findings (1937) on several lakes in the northern part of the state. The number of fish removed by winter fishing is only a fraction of that caught during the rest of the year; in Waterloo lakes it consists principally of species which are not of greatest importance in summer fishing (crappie, rock bass, perch, pike and sunfish). Furthermore, these species, with the probable exception of the sunfish, are highly predaceous and are known to consume large numbers of young bluegills, so that winter fishing as practiced on such lakes may actually benefit open-water fishing by reducing predation of the bluegills.

(4) Continuation of fish-yield studies in the Waterloo Project by means of creel census is highly desirable in order to establish the normal yield for these waters, to note annual fluctuation in the catch, to ascertain changes in fishing pressure, and to determine the effectiveness of stocking and environmental improvements.

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1. An adequate survey of physical, chemical and biological characteristics of the waters.
2. A "creel census" of the representative waters continued over a period of years.

The survey is essential to determine the conditions for the species of fish present and the need for environmental improvements. Also, to ascertain if the game species present require encouragement by plantings and if introduction of new species is desirable to improve the fishing.

A continuous census of the fish yield is necessary to evaluate the benefits of environmental improvements and fish stocking as well as to demonstrate fluctuations in the yield of game fish under existing regulations. Such a census in the Waterloo Area** will be particularly valuable in showing the effect of winterfishing upon the summer fishing, the type of fishing practiced, and any changes in the character or intensity of

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** A submarginal land area located in Jackson and Washtenaw counties, Michigan.

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The Institute proposed survey and census projects for the Waterloo Area (National Parks Service) when its cooperation in the development of the fishing was requested. The creel census was started immediately and, except for a short period, has been continuous. A detailed survey of the lakes was carried on by the Institute during the summer of 1936, assisted by personnel of the Waterloo Area. The results of this investigation will be reported in a subsequent paper.

The census was taken by selected crews of local employees of the area. These men were coached in methods of taking the data and were checked frequently for accuracy and completeness of the records. Each census taker was responsible for a certain section of shore line or for an entire lake where the area was small. Upon leaving the lake, anglers were asked to display their catch and to report as to methods employed, period fished, number of undersized fish caught, etc. For a more complete description of the methods used in creel census studies, see Eschmeyer (1936).

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The census of winter fishing was not complete for the season, but extended from January 6 to 19 and from February 21 to March 31. A continuous record of the fish yield was secured from the opening of the summer season (June 25) to the time of ice formation (November 30).

The lakes ^hwere this census was conducted and their approximate areas are as follows:*

Cassidy	36 Acres	Big Portage	480 Acres
Clear	136.7 "	Cedar	56 "
Green	78.3 "	Crooked	70 "
Mill	204 "	Doyle	10 "
Sugarloaf	204.8 "	Mud	64 "
Walsh	10.2 "		
Waterloo Mill			
Pond (Lower)	10.5 "		
Mirror Lake	4 "		

* Areas in the second column were determined from U. S. Geological Survey maps and are only approximate. Areas listed in the first column are based on plane table survey and are quite accurate.

According to reports, the other lakes in the Waterloo Project supported little or no fishing except for Trist Mill Pond which was not covered by the census. Waterloo Mill Pond (lower) was only partially covered by the census but is included in the discussion.

The information obtained from the census is discussed separately for winter fishing and for summer fishing.

Winter Fishing

The combined area of the 12 lakes under observation during a portion of the winter was approximately 1308.5 acres. According to reports, 5 of these (Walsh, Green, Doyle, Mirror and Cassidy) were not fished. Information on the catch in the other seven lakes for a 54-day period is shown in Table 1.

Table 1

Information on the Winter Fishing (1936) on 7 Lakes in the Waterloo Area

For the Periods January 6-19 and February 21-March 31

(54 days)

	Name of Lake							Total	% of Total
	Portage	Mill	Sugarloaf	Clear	Mud	Waterloo Mill Pond (Lower)	Crooked ¹		
No. of Fisherman-days	364	18	11	499	18	12	6	928	...
No. of Fish Caught (Total)	1349	6	5	3881	4	29	3	5277	...
Catch Per Hour	0.8	0.1	0.1	1.7	0.1	...	0.1	...	...
Large-mouthed Bass	2	...	...	1	...	...	...	3	tr.
Black Crappie	330	...	4	3493	...	6	...	3833	73
Bluegills ²	46	...	1	25	...	6	...	78	1
Common Sunfish ²	250	...	...	...	...	...	...	250	5
Perch	62	...	...	313	4	10	...	389	7
Rock Bass	552	...	...	...	...	...	...	552	10
Walleye	1	...	...	...	...	...	...	1	tr.
Northern Pike	71	6	...	48	...	3	3	131	2
Gar	5	...	...	...	...	4	...	9	tr.
Carp	4	...	...	...	...	...	...	4	tr.
Sucker	3	...	...	...	...	...	...	3	tr.
Dogfish	23	...	...	1	...	...	...	24	tr.

¹ Incomplete

² Figures probably include a number of hybrids.

It will be noted that winter fishing was negligible on all except Clear and Portage lakes. A total of 5,277 fish were reported by the census-takers, taken at an average rate of 1.2 fish per hour. In 1935, according to the Michigan general census, taken by Conservation Officers and representing a sampling of the fishing, the lakes in the lower two tiers of counties, which include the Waterloo Area, yielded a per hour catch of 3.1 fish in January, 3.3 fish in February and 1.2 fish in March. The catch per hour on the lakes in the Waterloo Area in the winter of 1936 was therefore much lower than the catch in southern Michigan as reported in the 1935 general census.

Of all fish recorded in the Waterloo Area during the winter of 1936, 3,833 or 72.6 per cent were black crappies. Rock bass, all taken in Portage Lake and nearly all caught during the month of March, were second in abundance in the catch. They constituted about 10.5 per cent of the reported winter catch for the area. Perch, sunfish and northern pike were each represented in the catch by over a hundred specimens. A few individuals of a number of other species were taken. In general the fishing centered on the black crappie and this species was fished for primarily in Clear Lake.

Concentration of winter fishing on relatively few lakes has been noted in creel census studies elsewhere in Michigan (Hazzard and Eschmeyer, 1937). The reason for such concentration may be explained by the catch which averaged 0.1 fish per hour for all lakes except for Portage and Clear lakes which yielded respectively 0.8 and 1.7 fish per hour. Why some lakes should provide better winter fishing than others cannot be accounted for at present.

Fishing was not intensive during the period when the census was not taken. Snow was exceptionally deep, making access to some of the lakes difficult, and the weather was unusually cold. It is therefore probable that the entire catch for the area during the winter was not over 7,500 fish,

a catch of about 5.7 fish per acre for the 12 lakes.*

Summer and Fall Fishing

Relatively detailed information is available on the summer and fall fishing on the lakes in the area. It was estimated by the Waterloo Project that the census-takers secured records of 90 per cent of the fish yield. Unless otherwise indicated, the information given below is based on the records submitted and therefore represents about 90 per cent of the actual fishing.

Data for each lake were tabulated by weekly intervals in the complete report, but are summarized for the season in this paper. Following is a discussion of the results of the census.

Number of fishermen (Table 2): The total number of fishermen contacted during the season varied from 2,141 on Portage Lake to 3 on Mud Lake. The small amount of fishing on Mud and Green lakes may be explained by the fact that in both lakes suffocation under the ice practically eliminated the entire fish population during the preceding winter. Records were obtained of 8,325 fisherman-days. If this represents 90 per cent of the fishing, the total may be estimated at 9,250, an average of approximately 7 fisherman-days per acre for the 12 lakes during the summer and fall.

Fishermen taking no fish (Table 2): Twenty-nine per cent of all the fishermen caught no legal-sized fish. The percentage of unsuccessful anglers varied from 3 per cent in Doyle Lake to 81 per cent in Waterloo Mill Pond. On the four lakes which supported over a thousand fisherman-days (Sugarloaf, Clear, Mill and Portage) the number taking no fish varied from 21 per cent on Mill Lake to 40 per cent on Sugarloaf.

* A complete census of winter fishing is being conducted on the lakes this year (1936-1937).

Table 2

Data on the Fishing on 12 Lakes in the Waterloo Area

For the Period of June 25th to November 30, 1936

Lake	No. of Fishermen	Fishermen Taking No Fish		No. of Legal Fish Taken	Total Hours Fished	Fish Per Fisherman	Fish Per Hour	Average Size of Fish (Inches)	Hours Per Fisherman Day	Approximate No. of Fish Per Acre ¹
		No.	%							
Cedar	452	74	16	2795	1293.0	6.2	2.2	7.6	2.9	55.4
Sugarloaf	1590	634	40	5211	5579.5	3.3	0.9	8.1	3.5	28.2
Clear	1579	592	37	4967	4949.8	3.1	1.0	7.7	3.1	40.3
Crooked	750	86	11	4901	1944.9	6.5	2.5	7.4	2.6	77.7
Mill	1513	322	21	8243	7099.3	5.4	1.2	7.5	4.7	44.8
Portage	2141	695	32	9306	9659.9	4.3	0.9	8.2	4.5	21.5
Cassidy	23	5	22	151	75.0	6.6	2.0	8.7	3.3	4.7
Walsh	26	2	8	278	107.0	10.7	2.6	7.5	4.1	30.2
Green	42	17	40	118	198.0	2.8	1.7	7.7	4.7	1.66
Mirror	27	9	33	153	46.0	5.7	3.3	7.3	1.7	42.5
Waterloo Mill Pond (Lower) ²	16	13	81	9	33.5	0.6	0.4	...	2.1	0.95
Doyle	163	5	3	1024	359.5	6.3	2.8	7.4	2.2	113.8
Mud	3	0	0	7	13.5	2.3	0.5	6.6	4.5	0.12
Totals or Averages for Records Available	8325	2454	29	37163	31394.9	4.5	1.2	7.8	3.8	31.6
Totals for All Fishing ¹	9250	2727	..	41292	34883.2	...	...	...	...	31.6

¹ It is assumed, in this column that the 90% coverage by census was representative of all fishing. The figures used therefore represent the estimated total catch per acre.

² Data represents less than 90% of fishing.

Number of legal-sized fish taken (Table 2): Records indicate a yield of 37,163 fish. The total number taken was therefore estimated at 41,292 fish, an average of about 32 fish per acre for the 12 lakes. The per acre catch varied from about one fish per 8 acres in Mud Lake to 114 fish per acre in Doyle Lake. The yield varied decidedly for different lakes.

It would be interesting and useful to know what proportion of the total number of legal sized fish present these annual catches represent. Some clue to this may be afforded as a result of complete or nearly complete fish mortality in two lakes in the area. Mr. Gerald P. Cooper, formerly of the Institute staff, counted samples of the fish which were killed by suffocation during the winter of 1936 and from these counts calculated that the total population in Mud Lake had been 72,000 game fish averaging approximately 6 inches and in Green Lake, 90,000 game fish of an average size of 7 inches. Since these counts did not include the smaller sizes nor the fish which died and remained in deeper water, these figures are probably conservative. If the populations in Mud and Green lakes are representative, the Waterloo Area lakes probably contain an average of 1,000 game fish per acre averaging from six to seven inches in length. At least 50 per cent of the fish counted were over six inches in length, so that a conservative number of those available to the angler would be 500 to the acre. On the basis of this estimate, fishing in summer and fall removed less than 7 per cent of the total number of legal-sized fish.

Hours fished (Table 2): A total of 31,394.9 fishing hours were recorded. From this it is estimated that there were about 35,000 hours of fishing or an average of ~~26.1~~ 26.5 hours per acre. The average fishing day was 3.8 hours, but this also varied considerably in different lakes.

Catch per hour and per angler (Table 2): On the average, the fishermen caught about 4 1/2 fish each at the rate of 1.2 fish per hour. The catch varied from about one fish for two hours of fishing on Waterloo Mill Pond and Mud Lake to over three fish per hour on Mirror Lake. On the four lakes supporting the most fishing, the average catch ranged from 0.9 to 1.2 fish per hour. These figures are somewhat below the average (1.8) for the lower two tiers of counties as revealed by the 1935 general census for Michigan.

Average size of fish caught (Tables 2 and 4): The average size of all fish taken did not vary greatly in the different lakes, but certain species ran larger in some lakes than in others. As examples: Portage Lake produced the largest bluegills, sunfish and perch; Cedar Lake, the largest bass; Sugarloaf, the largest rock bass, black crappie and northern pike; and Clear Lake the largest bullheads.

Catch by species (Table 3): Bluegills represented 67 per cent of all fish caught during the summer and fall, and were dominant in the catch in every lake. Sunfish, some possibly bluegills or hybrids between bluegills and sunfish, represented 12 per cent of the catch. Four of every five fish caught were either bluegills or sunfish. Other species taken, together with the percentage of the entire yield represented by them, were: perch 7%, large-mouthed bass 4%, small-mouthed bass 1%, rock bass 2%, black crappie, most prominent in the winter catch, 3%, bullheads 3%, northern pike 1%. Fish taken in relatively insignificant numbers include dogfish, minnows, warmouth bass and gar.

Residence of the anglers: Only six per cent of the fishermen were non-residents. Of these 514 fishermen, 467 (91 per cent) were from Ohio. Eleven other states were represented as follows: Illinois 18, Indiana 6, Florida 3, Kentucky 2, New Hampshire 1, New York 2, Pennsylvania 5, Virginia 2, Iowa 2, California 1, and Missouri 1. Four fishermen were from Canada. The percentage of non-residents was very much lower than

Table 3

Catch of Fish, by Species, From 12 Lakes
In the Waterloo Area, Summer and Fall of 1936

Lake	Bluegills ²	Common Sunfish ²	Yellow Perch	Large-mouthed Bass ³	Small-mouthed Bass ³	Rock Bass	Black Crappie	Bull-heads	Northern Pike	Dog-fish	All Others ¹	Total
Cedar	1985	387	150	126	85	4	9	46	...	...	3	2795
Sugarloaf	2728	671	613	132	36	173	116	499	202	34	7	5211
Clear	3015	335	215	374	69	328	451	147	4	1	28	4967
Crooked	2770	995	601	168	100	32	...	225	5	5	...	4901
Mill	5798	1284	495	143	70	42	123	218	63	7	...	8243
Portage	7661	295	269	375	50	136	240	99	165	4	12	9306
Cassidy	80	18	19	12	...	22	...	...	...	...	...	151
Walsh	137	37	75	6	3	...	...	20	...	...	...	278
Green	...	7	84	...	...	...	...	26	...	...	1	118
Mirror	115	31	1	3	3	...	...	...	...	...	...	153
Waterloo												
Mill Pond	...	...	...	...	...	7	...	...	...	2	...	9
Doyle	517	222	60	35	16	3	157	10	3	1	...	1024
Mud	...	3	4	...	...	...	...	...	...	...	...	7
Totals	24806	4285	2586	1374	432	747	1096	1290	442	54	51	37163
% of Total	67	12	7	4	1	2	3	3	1	tr.	tr.	

¹ Includes 38 minnows, 3 warmouth bass, 9 gar and 1 unknown

² Figures probably include a number of hybrids.

³ Identity of bass species probably not reliable.

Table 4

Average ^{Total} Length ^{in inches} of Fish of Various Species

Caught June 25th to November 30, 1936. Species Omitted

For Lakes Where Fewer Than 100 Individuals
of That Species Were Taken

Species	Cedar	Sugarloaf	Clear	Crooked	Mill	Portage
Bluegills	7.2	7.1	6.9	7.0	7.2	7.7
Sunfish	6.8	6.7	6.5	6.9	6.9	7.3
Yellow Perch	8.1	8.2	7.9	7.3	7.6	8.2
Large-mouthed Bass	13.3	12.6	12.3	12.7	12.7	12.7
Small-mouthed Bass	...	...	...	11.9	...	...
Rock Bass	...	8.6	7.3	...	...	7.2
Black Crappie	...	10.8	8.4	...	8.4	8.5
Bullheads	...	10.2	10.5	8.2	9.2	...
Northern Pike	...	19.9	...	...	...	18.6

has been found for certain waters in northern Michigan.

Of the 7,440 residents, 93 per cent were from three counties (Jackson 43%, Wayne 29% and Washtenaw 21%). Twenty-three other counties were represented, all except two of them by fewer than 20 fishermen. The lakes obviously mostly attract fishermen living within 50 miles or less of the lakes. In contrast, over half the fishing on Pige Lake, Grand Traverse and Kalkaska counties, was by anglers living 200 or more miles away (Eschmeyer, 1937).

Woman anglers: Sixteen per cent (1,367) of the anglers were women. An even hundred of these were non-residents.

Fishing methods (Table 5): Still-fishing was employed by 85 per cent of the anglers and yielded 94 per cent of the fish caught. Trolling made up 4 per cent of the fishing and accounted for 2 per cent of the catch. Eleven per cent of the angling was by casting which produced 4 per cent of the fish taken. Still-fishing yielded, on the average, the smallest fish and casting the largest. This relatively close correlation between size of fish and number of fish per hour taken by any one method is in accord with findings on other Michigan lakes (Eschmeyer, 1936, 1937).

Data are available for the effectiveness of each method in taking fish of each of the most commonly caught species in each of the several lakes, but this information is too lengthy to be included. It may be stated briefly that still-fishing was decidedly the most used and most effective method in catching bluegills and sunfish. Trolling was the most effective, but least used, in catching large-mouthed bass.

Baits used (Table 6): Worms were the most popular bait. They were used in 75 per cent of the fishing and accounted for 83 per cent of the fish. Minnows were employed for 10 per cent of the fishing and insects for 6 per cent of the fishing. These three natural baits yielded 97 per cent of all the fish taken. The remaining 3 per cent were taken on artificial lures (spinners, plugs and flies). Spinners and plugs yielded, on the average, the largest fish, also the fewest fish per hour.

Table 5

Data on the Use and Effectiveness
of the Several Methods of Fishing
in Taking Fish

Method	Hours Covering Each Method		Fish Taken by Each Method		Fish Per Hour	Average Length Of Fish (in.)
	No.	%	No.	%		
Still Fishing	22351.44	85	29618	94	1.3	7.5
Trolling	1161.75	4	328	2	0.7	8.9
Casting	2886.25	11	1109	4	0.4	12.0

Table 6

Use and Effectiveness of
Various Kinds of Bait

Bait Used		Hours Covering Each Bait		Fish Taken by Each Bait		Fish Per Hour	Average Size of All Fish (Inches)
		No.	%	No.	%		
Natural	Worms	17711.9	75	23581	83	1.3	7.3
	Insects	1386.5	6	2393	8	1.7	7.7
	Minnows	2406.5	10	1686	6	0.7	10.1
Artificial	Spinners	148.5	1	71	0.5	0.5	13.2
	Plug	1700.5	7	615	2	0.4	12.0
	Artificial Fly	116.0	1	83	0.5	0.7	9.0

Natural bait was decidedly best for taking bluegills. Insects ranked first in effectiveness, worms second. Sunfish were taken most readily on worms with insects taking second place. Of the artificial lures used for taking large-mouthed bass, spinners ranked first, plugs second. Almost all of the perch were taken on natural bait, minnows being preferred to worms by this species. These preferences were generally similar for each lake.

Discussion and Conclusions

1. The average yield on the lakes of the Waterloo Area for the year 1936 is estimated at 37.7 fish per acre. This is believed to represent less than 8 per cent of the fish available to the fisherman. If this assumption is correct, it is evident that these lakes are not intensively fished at present and could support a much greater fishing pressure without any danger of depletion.

2. A considerable variation in the yield of fish per acre is evident in the different lakes. As a general rule, the larger lakes attracted the largest number of anglers, but the intensity of fishing (in terms of fishermen hours per acre), catch per hour and number of fish removed per acre were greater in the lakes of smaller size. The reason for such variations may be revealed when a study of the survey data is completed. This interpretation should make it possible, at least in some instances, to suggest environmental improvements for the poorer lakes which will increase their yield.

3. The results of this census indicate that ice fishing has little, if any, harmful effect upon the fish yield during summer and fall. This is in accordance with the authors' ~~find~~ findings (1937) on a number of lakes in the northern part of the state. The number of fish removed by winter fishing is only a fraction of that caught during the rest of the year and in Waterloo lakes consists principally of species which are not of greatest

importance in summer fishing (crappie, rock bass, perch, pike and sunfish). Furthermore these species, with the probable exception of the sunfish, are highly predacious and are known to consume large numbers of young bluegills so that winter fishing as practised on such lakes may actually benefit open water fishing by reducing predation of the bluegill.

4. Continuation of fish yield studies in the Waterloo Project by means of creel census is highly desirable in order to establish the normal yield for these waters, to note annual fluctuation in the catch, to study changes in fishing pressure and to determine the effectiveness of stocking and environmental improvements.

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- _____ 1937. Analysis of the Game-fish Catch in a Michigan Lake--Second Season. Trans. Am. Fish. Soc., Vol. 66 (in press).
- HAZZARD, A. S. and ESCHMEYER, R. W. 1937. A Comparison of Summer and Winter Fishing in Michigan Lakes. Trans. Am. Fish. Soc., Vol. 66 (in press).

County:

Township

T. _____ R. _____ Sec. _____

Lake or stream:

Winter Fish Take Totals Eight Pct.

Ice Angling Does Not Hurt Summer Yield

Less than 8 per cent of the fish caught in lakes of the Waterloo area between Ann Arbor and Jackson were taken during the winter months, R. W. Eschmeyer, of the Institute for Fisheries Research, reports. The conclusion is based on a day-to-day fish census taken by people working in the Waterloo area in various government projects.

"This compilation corroborates previous conclusions that ice fishing has little, if any, harmful effect upon the fish yield during the summer and fall," Eschmeyer says. Previous reports were based upon creel censuses made on Fife Lake in Grand Traverse County. The Waterloo reports are the first data on lakes in Southern Michigan.

"The number of fish removed by winter fishing is only a small fraction of those caught during the rest of the year," says Eschmeyer.

Original: Fish Division
cc: Waterloo Project ..
Mr. Ruhl
Mr. Eschmeyer

Appendix. to Rept. 411)

Tables not used in the paper presented at the Michigan Academy (1937).

Table I

Data on the fishing in the lakes of the Waterloo area (Summer and fall of 1936) . It is estimated that this information covers 90 percent of all fishing for the period mentioned.

Date	No. of fisherman	Fisherman taking no fish		NO. of legal fish taken	Total hours fished	Fish per fisherman	Fish per hour	Ave. size of fish	Hours per fisherman day
		NO.	%						
June 25-30	55	12	22	334	199.5	6.1	1.7	7.1	3.6
July 1-7	26	6	23	115	88.0	4.4	1.3	7.9	3.4
July 8-14	35	11	31	93	80.5	2.7	1.2	8.7	2.3
July 15-21	68	3	4	426	198.5	6.3	2.1	8.0	2.9
July 22-28	38	4	10	241	86.7	6.3	2.8	8.0	2.3
July 29-Aug. 4	41	4	10	322	116.5	7.9	2.8	7.0	2.8
Aug 5-11	27	4	15	188	80.5	7.0	2.3	7.8	3.0
Aug 12-18	37	14	38	94	103.2	2.5	0.9	8.0	2.8
Aug 19-25	17	1	6	107	44.5	6.3	2.4	7.8	2.6
Aug 26-Sept. 1	23	10	43	102	65.0	4.4	1.6	8.0	2.8
Sept. 2-8	25	8	8	196	64.7	7.8	3.0	7.4	2.6
Sept. 9-15	20	3	15	151	53.0	7.6	2.8	7.2	2.7
Sept. 16-22	6	-	-	45	13.7	7.5	3.3	7.4	2.3
Sept. 23-30	8	-	-	87	23.5	10.8	3.7	8.1	2.9
Oct. & Nov.	26	-	-	294	75.2	11.3	3.9	7.3	2.9
Total or Average	452	74	16	2795	1293.0	6.2	2.2	7.6	2.9

Table I (cont.)

SUGARLOAF LAKE									
Date	No. of fisherman	No. taking no fish		No. of legal fish taken	Total hours fished	Fish per fisherman	Fish per hour	Ave. size of fish	Hours per fisherman day
		No.	%						
June 25-30	259	76	29	1299	1138.2	5.0	1.1	8.2	4.4
July 1-7	189	91	48	456	733.2	2.4	0.6	8.4	3.9
July 8-14	94	44	47	166	310.7	1.8	0.5	9.3	3.3
July 15-21	172	108	63	325	574.7	1.9	0.6	8.5	3.3
July 22-28	151	72	48	278	542.2	1.8	0.5	7.6	3.6
July 29-Aug. 4	127	58	46	268	434.2	2.1	0.6	7.6	3.4
Aug. 5-11	110	39	35	324	334.7	2.9	0.9	8.9	3.0
Aug. 12-18	78	35	45	206	232.2	2.6	0.9	9.1	3.0
Aug. 19-25	70	15	21	304	191.5	4.3	1.6	7.9	2.7
Aug. 26-Sept. 1	53	28	53	131	151.2	2.5	0.9	7.5	2.9
Sept. 2-8	121	44	36	449	391.5	3.7	1.1	9.0	3.2
Sept. 9-15	39	11	28	230	139.0	5.9	1.7	7.5	3.6
Sept. 16-22	31	6	19	164	109.0	5.3	1.5	8.0	3.5
Sept. 23-30	27	4	15	160	77.0	5.9	2.1	8.1	2.9
Oct. & Nov.	69	6	9	451	220.2	6.5	2.0	8.3	3.2
Total or Average	1590	637	40	5211	5579.5	3.3	0.9	8.1	3.5

Table I (con't.)

CLEAR LAKE										
Date	No. of fisherman	Fisherman		No. of legal fish	Total hours fished	Fish per fisherman	Fish per hour	Ave. size of fish	Hours per fisherman	Average per day
		taking No.	no fish %							
June 25-30	271	91	34	1315	1087.2	4.9	1.2	7.9	4.0	
July 1-7	208	66	32	739	677.7	3.6	1.1	7.6	3.3	
July 8-14	139	44	32	419	381.2	3.0	1.1	8.3	2.7	
July 15-21	22 ¹³⁶	50	37	470	406.7	3.5	1.2	8.2	3.0	
July 22-28	92	46	50	203	289.2	2.2	0.7	7.6	3.1	
July 29-Aug. 4	54	15	28	204	177.7	3.8	1.1	7.8	3.3	
Aug. 5-11	104	42	40	323	285.0	3.1	1.1	6.9	2.7	
Aug. 12-18	107	43	40	327	306.2	3.0	1.1	7.3	2.9	
Aug. 19-25	140	54	39	358	414.5	2.6	0.9	7.3	3.0	
Aug. 26-Sept. 1	90	31	34	184	255.7	2.0	0.7	6.9	2.8	
Sept. 2-8	112	37	33	298	347.2	2.7	0.9	6.8	3.1	
Sept. 9-15	26	15	58	32	68.0	0.8	0.3	11.2	2.6	
Sept. 16-22	43	25	58	33	101.5	0.8	0.3	7.1	2.4	
Sept. 23-30	9	4	44	17	24.5	1.9	0.7	8.5	2.7	
Oct. & Nov.	48	29	60	55	127.5	1.1	0.4	8.7	2.7	
Total or Average	1579	592	37	4967	4949.8	3.1	1.0	7.7	3.1	

Table I (con't.)

CROOKED LAKE									
Date	No. of fisherman	Fisherman taking no fish		No. of legal fish	Total hours fished	Fish per fisherman	Fish per hour	Ave. size of fish	hours per fisherman day
		No.	%						
June 25-30	127	6	5	1039	411.5	8.2	2.5	7.4	3.2
July 1-7	49	9	18	309	142.5	6.3	2.2	7.5	2.9
July 8-14	38	8	21	163	79.5	4.3	2.1	7.9	2.1
July 15-21	57	6	11	312	143.2	5.5	2.2	7.8	2.5
July 22-28	84	12	14	513	198.2	6.1	2.6	7.6	2.4
July 29-Aug. 4	53	8	15	302	136.2	5.7	2.2	7.5	2.6
Aug. 5-11	29	8	28	115	81.7	4.9	1.4	7.7	2.8
Aug. 12-18	78	9	12	424	194.0	5.4	2.2	7.6	2.5
Aug. 19-25	39	1	3	375	96.0	9.6	3.9	7.3	2.5
Aug. 26-Sept. 1	49	5	10	337	127.0	6.9	2.7	7.3	2.6
Sept. 2-8	79	10	13	340	178.2	4.3	1.9	7.1	2.3
Sept. 9-15	18	-	-	159	44.5	8.8	3.6	7.2	2.5
Sept. 16-22	16	-	-	210	36.7	13.1	5.7	7.2	2.3
Sept. 23-30	16	1	6	147	33.5	9.2	4.4	7.3	2.1
Oct. & Nov.	18	3	17	156	42.2	8.7	3.7	6.6	2.3
Total or Average	750	86	11	4901	1949.9	6.5	2.5	7.4	2.6

Table L (con't.)

MILL LAKE									
Date	No. of fisherman	No. taking no fish		No. of legal fish	Total hours fished	Fish per fisherman	Fish per hour	Ave. size of fish	Hours per fisherman day
		No.	%						
June 25-30	209	20	10	1916	1107.7	9.2	1.7	7.8	5.3
July 1-7	104	17	16	791	510.5	7.6	1.5	7.4	4.9
July 8-14	90	18	20	564	408.7	6.3	1.4	7.4	4.5
July 15-21	144	16	11	851	675.5	5.9	1.3	7.4	4.7
July 22-28	107	25	23	498	475.7	4.7	1.0	7.2	4.4
July 29-Aug.4	85	17	20	449	393.3	5.3	1.1	7.3	4.6
Aug.5-11	182	51	28	1002	775.7	5.5	1.3	7.1	4.3
Aug.12-18	194	50	26	723	947.2	3.7	0.8	7.4	4.9
Aug.19-25	89	16	18	461	369.7	5.2	1.2	7.6	4.2
Aug.26-Sept.1	110	28	25	360	493.2	3.3	0.7	7.4	4.5
Sept.2-8	106	17	16	403	570.7	3.8	0.7	8.0	5.4
Sept. 9-15	31	9	29	122	134.7	3.9	0.9	7.5	4.3
Sept.16-22	33	18	55	72	133.0	2.2	0.5	7.5	4.0
Sept. 23-30	7	4	57	10	32.0	1.4	0.3	8.0	4.6
Oct.& Nov.	22	16	73	21	71.7	0.9	0.3	11.3	3.3
Total or Average	1513	322	21	8243	7099.3	5.4	1.2	7.5	4.7

Table I (con't.)

PORTAGE LAKE									
Date	No. of fisherman	Fisherman taking no fish		No. of legal fish	Total hours fished	fish per fisherman	fish per hour	Ave. size of fish	Hours per fisherman <small>per day</small>
		No.	%						
June 25-30	374	89	24	2457	1885.2	6.6	1.3	8.2	5.0
July 1-7	274	102	37	1074	1305.2	3.9	0.8	8.2	4.8
July 8-14	105	34	32	340	394.5	3.2	0.9	8.4	3.8
July 15-21	133	37	28	661	596.0	5.0	1.1	8.1	4.5
July 26-28	128	44	34	458	565.1	3.6	0.8	8.2	4.4
July 29-Aug.4	114	57	50	270	519.5	2.54	0.5	8.0	4.6
Aug.5-11	128	59	46	371	495.5	2.9	0.7	7.8	3.9
Aug.12-18	125	49	39	389	540.0	3.1	0.7	8.4	4.3
Aug.19-25	61	26	43	160	234.0	2.6	0.7	8.6	3.8
Aug.26-Sept.1	69	23	33	249	321.0	3.6	0.8	8.9	4.7
Sept.2-8	149	49	33	595	670.0	4.0	0.9	8.0	4.5
Sept.9-15	95	19	20	673	389.7	7.1	1.7	8.0	4.1
Sept.16-22	155	35	23	843	765.0	5.4	1.1	8.8	4.9
Sept. 23-30	97	20	21	443	434.7	4.6	1.0	8.2	4.5
Oct. & Nov.	134	52	39	323	544.5	2.4	0.6	9.4	4.1
Total or Average	2141	695	32	9306	9659.9	4.3	0.9	8.2	4.5

Data on the effectiveness of various methods and baits in taking several species of fish. (tables 2 and 3)

Table II

Number of fish of three species taken by each method (still fishing, trolling and casting) and the catch per hour of these species on each of the methods (Bluegills, Common Sunfish and Large-mouthed Bass)

Bluegills

Lake	Still Fishing		Trolling		Casting	
	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.
Cedar	1679	2.1	24	0.2	23	0.2
Sugarloaf	2490	0.6	-	-	70	0.07
Clear	2340	0.8	278	0.3	57	0.1
Crooked	2536	1.6	21	0.2	3	0.04
Mill	5036	0.9	5	0.1	10	0.03
Portage	6891	0.9	12	0.2	43	0.05
Total or Ave.	20972	1.2	340	0.2	0.2	0.08

Common Sunfish

Lake	Still Fishing		Trolling		Casting	
	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.
Cedar	302	0.4	-	-	-	-
Sugarloaf	623	0.2	0	-	-	-
Clear	254	0.08	-	-	-	-
Crooked	923	0.6	-	-	-	-
Mill	1061	0.2	-	-	-	-
Portage	244	0.03	-	-	-	-
Total or Ave.	3407	0.25	-	-	-	-

Large-mouthed Bass

Lake	Still Fishing		Trolling		Casting	
	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.
Cedar	24	0.03	16	0.2	43	0.3
Sugarloaf	58	0.01	-	-	61	0.06
Clear	104	0.03	105	0.1	73	0.2
Crooked	66	0.04	66	0.5	19	0.3
Mill	47	0.01	-	-	68	0.2
Portage	154	0.02	7	0.09	129	0.02
Total or Ave.	453	0.02	194	0.22	393	0.18

Table III

Data on the effectiveness of several kinds of bait in taking fish (Bluegills, Large-mouthed Bass, Common Sunfish and Perch).

Bluegills

Lake	Natural Bait				Artificial Bait							
	Worms		Insects		Minnows		Spinner		Plug		Artificial Fly	
	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.
Cedar	1245	2.0	1669	6.6	45	0.3	1	0.05	25	0.3	-	-
Sugar loaf	2159	0.7	60	0.8	92	0.1	-	-	25	0.05	-	-
Clear	2210	0.8	198	1.5	50	0.09	6	0.1	14	0.04	32	0.5
Crooked	2391	1.6	79	6.6	55	0.3	-	-	-	-	-	-
Mill	4253	0.9	190	1.3	15	0.1	-	-	5	0.02	1	0.06
Portage	4156	0.9	1644	1.6	44	0.07	1	0.02	33	0.06	-	-
Total or Ave.	16414	1.15	2240	3.06	301	0.16	8	0.06	102	0.09	33	0.28

Large-mouthed Bass

Cedar	19	0.03	-	-	37	0.3	5	0.3	24	0.3	-	-
Sugar loaf	-	-	8	0.1	38	0.05	-	-	46	0.1	1	0.03
Clear	88	0.03	3	0.02	89	0.2	14	0.3	67	0.2	17	0.3
Crooked	43	0.03	2	0.2	71	0.4	2	0.2	16	0.5	-	-
Mill	36	0.01	-	-	4	0.03	3	1.2	53	0.2	2	0.1
Portage	80	0.02	12	0.01	47	0.08	12	0.2	74	0.1	-	-
Total or Ave.	266	0.02	25	0.08	286	0.18	36	0.4	280	0.23	20	0.14

Table III contd.

Common Sunfish

Lake	Natural Bait						Artificial Bait					
	Worms		Insects		Minnows		Spinner		Plug		Artificial Fly	
	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.
Cedar	241	0.4	-	-	2	0.01	-	-	-	-	-	-
Sugarloaf	593	0.2	-	-	9	0.01	-	-	5	0.01	-	-
Clear	289	0.1	7	0.05	-	-	-	-	-	-	-	-
Crooked	920	0.6	2	0.2	11	0.06	-	-	2	0.07	-	-
Mill	1155	0.2	-	-	4	0.03	-	-	5	0.02	-	-
Portage	146	0.03	40	0.04	8	0.01	-	-	-	-	-	-
Total												
or Ave.	3344	0.26	49	0.1	34	0.02	-	-	12	0.03	-	-

Yellow Perch

Cedar	98	0.2	-	-	15	0.1	-	-	-	-	-	-
Sugarloaf	355	0.1	-	-	199	0.3	-	-	-	-	-	-
Clear	147	0.05	5	0.04	17	0.03	-	-	-	-	-	-
Crooked	450	0.3	3	0.25	87	0.5	-	-	-	-	-	-
Mill	397	0.08	-	-	11	0.08	-	-	-	-	-	-
Portage	154	0.03	17	0.02	22	0.04	-	-	-	-	-	-
Total												
or Ave.	1601	0.13	25	0.10	351	0.18	-	-	-	-	-	-

Table IV

Data on Residence of Anglers
Residence of resident anglers (by counties) for each lake.*

County	Names of Lakes						Total of County
	Cedar	Sugarloaf	Clear	Crooked	Mill	Portage	
Jackson	5	312	582	25	693	1610	3227
Oakland	2	13	13	1	20	182	231
Washtenaw	53	457	190	437	448	13	1598
Wayne	380	727	545	239	267	-	2158
Calhoun	-	2	-	-	3	13	18
Eaton	-	3	11	-	-	2	16
Hillsdale	-	2	2	-	-	-	3
Ingham	-	12	35	2	8	81	138
Kalamazoo	-	3	-	-	1	2	6
Kent	-	2	-	-	2	1	5
Monroe	-	2	1	5	-	2	10
Saginaw	-	3	-	-	-	2	5
Shiawassee	-	1	1	3	-	-	5
Benzie	-	-	1	-	-	-	1
Cass	-	-	1	-	-	-	1
Chippewa	-	-	1	-	-	-	1
Huron	-	-	1	-	-	-	1
Livingston	-	-	1	-	-	-	1
Ottawa	-	-	1	-	-	-	1
Tuscola	-	-	1	-	-	-	1
Gratiot	-	-	-	-	1	-	1
Ionia	-	-	-	-	1	-	1
Lenawee	-	-	-	-	5	2	7
Muskegon	-	-	-	-	1	-	1
Berrien	-	-	-	-	-	1	1
St. Clair	-	-	-	-	-	2	2
Totals	440	1538	1387	712	1450	1913	7440

*A total of 93% of the resident anglers were from 3 counties (Jackson 43%, Wayne 29% and Washtenaw 21%).

Table V

Residence of non-resident anglers (by states) for each lake*.

State	Cedar	Sugarloaf	Clear	Crooked	Mill	Portage	Total of state
Illinois	2	-	3	10	-	3	18
Indiana	-	3	-	-	-	3	6
Ohio	-	32	157	19	54	205	467
Florida	-	-	1	2	-	-	3
Kentucky	-	-	1	-	1	-	2
New Hampshire	-	-	1	-	-	-	1
New York	-	-	2	-	-	-	2
Pennsylvania	-	-	4	1	-	-	5
Virginia	-	-	1	1	-	-	2
Iowa	-	-	-	2	-	-	2
California	-	-	-	*	-	1	1
Missouri	-	-	-	-	-	1	1
Canada	3	1	-	-	-	-	4
Total	5	36	170	35	55	213	514

*6% of all fishing was by non-residents.

Table VI

Number of woman anglers and percentage of all anglers represented by women.

Lake	Residents		Non-residents	
	No.	%	No.	%
Cedar	52	12	2	-
Sugarloaf	316	21	16	-
Clear	206	15	20	-
Crooked	189	27	9	-
Mill	216 ^{2b)}	18	7	-
Portage	243	13	46	-
Total	1267	15	100	1

Number of fish caught and catch per hour (by species) in various kinds of weather.

Table VII

Catch of fish, by species, in cold mild and warm weather.

Bluegills

Lake	Cold		Mild		Warm	
	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.
Cedar	181	2.0	366	1.5	1414	1.5
Sugarloaf	39	0.5	253	0.3	2348	0.5
Clear	178	0.5	1056	0.7	1461	0.6
Crooked	253 235	2.9	1013	1.1	1522	1.6
Mill	448	0.7	257	0.8	5009	0.8
Portage	7	1.4	877	0.7	6777	0.8
Total or Ave.	1088	1.3	3822	0.9	18531	1.0

Common Sunfish

Cedar	50	0.5	56	0.2	277	0.3
Sugarloaf	-	-	58	0.07	606	0.1
Clear	-	-	-	-	-	-
Crooked	83	1.0	380	0.8	532	0.6
Mill	125	0.2	25	0.07	1104	0.2
Portage	-	-	-	-	-	-
Total or Ave.	258	0.6	519	0.2	2519	0.3

Yellow Perch

Cedar	-	-	-	-	-	-
Sugarloaf	69	0.9	186	0.2	346	0.08
Clear	-	-	-	-	-	-
Crooked	18	0.2	328	0.4	255	0.3
Mill	80	0.1	23	0.07	376	0.06
Portage	4	0.8	-	-	243	0.03
Total or Ave.	171	0.5	537	0.23	1220	0.12

Bullheads

Cedar	-	-	-	-	-	-
Sugarloaf	-	-	126	0.1	359	0.08
Clear	9	0.02	53	0.04	77	0.03
Crooked	-	-	116	0.1	106	0.1
Mill	39	0.06	12	0.04	167	0.03
Portage	-	-	-	-	94	0.01
Total or Ave.	48	0.04	307	0.07	803	0.05

Table VIII

Catch of fish, by species, in clear weather, cloudy weather and rain.

Lake	<u>Bluegills</u>					
	Clear		Cloudy		Rain	
	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.
Cedar	1577	1.7	370	1.2	37	1.1
Sugarloaf	1349	0.4	1225	0.5	125	1.0
Clear	1910	0.6	1008	0.6	44	0.4
Crooked	1835	1.3	878	1.6	42	2.6
Mill	3262	0.9	2527	0.8	-	-
Portage	5452	0.8	1908	0.8	292	0.8
Total or Ave.	15385	1.0	7916	0.9	540	1.2

<u>Common Sunfish</u>						
Cedar	256	0.3	111	0.4	20	0.6
Sugarloaf	269	0.08	391	0.2	-	-
Clear	237	0.08	89	0.05	-	-
Crooked	614	0.4	356	0.7	22	1.4
Mill	544	0.1	740	0.2	-	-
Portage	198	0.03	87	0.04	-	-
Total or Ave.	2118	0.2	1774	0.3	42	1.0

<u>Black Crappie</u>						
Cedar	-	-	-	-	-	-
Sugarloaf	54	0.02	57	0.03	5	0.04
Clear	337	0.1	91	0.05	20	0.2
Crooked	-	-	-	-	-	-
Mill	48	0.01	75	0.02	-	-
Portage	183	0.03	57	0.02	-	-
Total or Ave.	622	0.04	280	0.03	25	0.12

<u>Bullheads</u>						
Cedar	17	0.02	26	0.09	3	0.09
Sugarloaf	328	0.1	162	0.07	2	0.02
Clear	90	0.3	55	0.03	2	0.02
Crooked	191	0.1	31	0.06	3	0.2
Mill	136	0.04	82	0.02	-	-
Portage	79	0.01	-	-	9	0.03
Total or Ave.	841	0.1	356	0.05	19	0.07

Table IX

Catch of fish, by species, in heavy wind, light wind and calm.

Lake	<u>Bluegills</u>					
	Heavy wind		Light wind		Calm	
	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.
Cedar	262	1.3	1347	1.5	352	1.8
Sugarloaf	115	0.6	1854	0.5	756	0.6
Clear	285	0.8	1996	0.6	509	0.6
Crooked	467	1.8	1824	1.4	479	1.4
Mill	356	0.8	4016	0.7	1405	1.2
Portage	551	0.6	6897	0.8	213	0.6
Total or Ave.	2036	1.0	17934	0.9	3714	1.0

<u>Common Sunfish</u>						
Cedar	42	0.2	296	0.3	45	0.2
Sugarloaf	-	-	548	0.1	117	0.09
Clear	27	0.07	247	0.07	56	0.07
Crooked	172	0.7	643	0.5	180	0.5
Mill	124	0.3	848	0.2	304	0.2
Portage	24	0.03	257	0.03	14	0.04
Total or Ave.	389	0.26	2839	0.2	716	0.18

<u>Bullheads</u>						
Cedar	-	-	-	-	-	-
Sugarloaf	-	-	329	0.08	168	0.1
Clear	32	0.09	89	0.03	26	0.03
Crooked	-	-	174	0.1	40	0.1
Mill	15	0.04	135	0.02	68	0.06
Portage	-	-	88	0.01	11	0.03
Total or Ave.	47	0.65	815	0.05	313	0.06

<u>Yellow Perch</u>						
Cedar	10	0.05	104	0.1	33	0.02
Sugarloaf	108	0.5	398	0.1	120	0.09
Clear	23	0.06	175	0.05	-	-
Crooked	110	0.4	352	0.3	139	0.4
Mill	30	0.07	300	0.06	133	0.1
Portage	15	0.02	239	0.03	10	0.03
Total or Ave.	296	0.18	1568	0.10	435	0.13

Black Crappie
Table IX con't.

Lake	Heavy wind		Light wind		Calm	
	No.	Catch per hr.	No.	Catch per hr.	No.	Catch per hr.
Cedar	-	-	-	-	-	-
Sugarloaf	-	-	-	-	-	-
Clear	29	0.08	263	0.08	146	0.2
Crooked	-	-	-	-	-	-
Mill	-	-	107	0.02	-	-
Portage	27	0.03	192	0.02	21	0.06
Total						
or Ave.	56	0.06	562	0.04	167	0.13