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A FISHERIES SURVEY OF GULL LAKE, KALAMAZOO AND BARRY COUNTIES

by

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Gull Lake is one of the most popular resort lakes in the Lower Peninsula. It is located in Kalamazoo and Barry Counties (T. 1 N., 1 S., R. 9, 10 W.) and lies approximately twelve miles northeast of Kalamazoo. The lake was mapped by an Institute for Fisheries Research Party in January, 1941, and a biological inventory was made the following summer, August 20 to 30, 1941.*

The shores have been extensively developed for summer homes, cottages and a considerable number of permanent residences. More than 600 dwellings are located immediately adjacent to the lake. There are also two resorts, one hotel and three boat liveries. Two golf courses and the Kellogg Bird Sanctuary are nearby. Boating and swimming are popular, probably being of greater interest in the summer than fishing. In 1941 there were approximately 125 motor boats, 100 outboard motors, and 90 sailboats on Gull Lake, according to an estimate made by Mr. Glenn . Todd of Richland. Fishing has been more common in winter than in summer.

* The mapping party consisted of Lee Anderson, leader; Royal Howe and Richard Wilson, assistants. The Biological Survey Party included Fred Locke, leader; Burton Hunt, Boyd Walker, Raymond Buller and Stanley Lievense, assistants.

The long axis of Gull Lake extends in a northwest-southeast direction. The lake is over four miles long and more than one mile wide for most of its length. It has a surface area of 2,030 acres and a maximum depth of 110 feet. The deepest place is located one-third mile west of Sunnybank Point. Another depression, 108 feet deep, is located about 1,500 feet directly east of Interlochen. The lake has one large island (Island Park) located toward the southern end, off shore from Indian Point. The topography of the lake bottom is very irregular, not greatly different from the adjacent terrain.

The surrounding country is slightly rolling in character and is mostly cultivated. The soil is sand and gravel on the high land and rich loam or muck in the low basin areas.

Scott (Inland Lakes of Michigan, pp. 330-331) gives a brief description of the geology of Gull Lake as follows:

"This basin is sunk below the surface of the extensive outwash plain which developed in the wide angle between the Michigan and Saginaw lobes when the ice border stood a few miles from the lake. The lake is large for a typical pit but may be included in this class until more detailed studies are made.

"One of the first observations to be made at Yorkville, which is situated on the outlet, is that the lake has been dammed, causing what appears to be a serious flooding of the lake. The flooding of the outlet is clearly in excess of eight feet and it is, therefore, surprising to find the shores of the lake uniformly dry. The explanation is soon found in unmistakable evidence of an abandoned level more than six feet above the present lake at which stage the major adjustments of the shores took place.

"The lake furnishes a wealth of material for physiographic study which could not be attempted at the time this work was done and, therefore, a brief description of conditions near Midland Park is given as a key to other adjustments. At this locality the broad flat upon which the cottages are built is the exposed terrace of the higher level. It ends abruptly at the foot of a steep cliff, twenty or more feet in height, which marks the former shoreline. On the terrace may be found two distinct sand bars which swing northward towards Bryant Point. The bar nearer the lake stands at the lower elevation, indicating a halt in the lowering of the lake level.

"At present the adjustments are not important. Ice action is perhaps the most effective, but prominent ramparts are not found on account of the sandy character of the material on the shore."

There is an earth-fill dam, 21 feet in height, located in the outlet one-half mile downstream from the lake. It is owned by the Gull Lake Association and serves to maintain a desired water level. In autumn the water is lowered to prevent damage to shoreline properties by ice.

Gull Lake receives its water supply from springs and from several small tributaries which enter the north end of the lake. The principal inlets are those from Miller Lake and Little Long Lake. The outlet drains southward to the Kalamazoo River which in turn flows into Lake Michigan.

The shoreline of the lake is fairly regular. It has a development of 1.7 which means that the shoreline is only 1.7 times longer than if the lake were perfectly round and of the same area. Ordinarily a long shoreline is indicative of high productivity because its irregularity gives rise to protected bays which are known to produce more food organisms and fish.

The shoal area is the shallow part of a lake that is generally covered with vegetation. The shoals may have a regular slope from the shoreline out

to a rather level bottom or they may have the appearance of a nearly flat shelf separated from the deeper regions by a more or less abrupt drop-off. In Gull Lake the latter type is predominant with the shelf varying considerably in width. In the north end it is rather narrow with a steep drop-off. In the south end the shoals are wide and the drop-off varies from very steep at Sunnybank Point to more moderate slopes elsewhere. Shoals are generally well lighted and favorable to the growth of plants if wave action is not severe; broad shoals induce plant growth which is vital to fish life. The shoal areas of Gull Lake have been estimated to be approximately 30 per cent of the total surface area.

The shoal bottom is composed of sand and gravel in the shallow water zone (less than 10 feet). Here the wave action is strong and tends to keep the sand washed clean. Marl bottom extends from the edge of the sand and gravel to the drop-off which is about at the 30-foot contour. In the bays at the outlet and at Bay View there is little sand and gravel visible since marl covers all the shoal bottom. Marl also covers the bottom in the shallow area midway between the Miller Lake inlet and Ross Township Park. Vegetation is abundant on most of the marl shoals. Owing to its exposure to the prevailing northwest winds, Island Park on the northwest side has broad, sandy shoals that extend down to a depth of 20 feet.

The rest of the lake bottom is largely a marl and pulpy peat mixture. This prevails over most of the main basin. In the 108-foot depression at the north end, marl is found with muck from depths of 90 to 108 feet. Two small areas of marl and muck occur northwest of the 110-foot depression. In the large, shallow bay at the Miller Lake inlet, some fibrous peat is found.

The water of Gull Lake is clear. An eight-inch black and white disk was visible when lowered to depths as great as 14 to 16 feet below the surface. The water appears slightly bluish-green. This is probably due to the very fine marl particles in suspension.

A series of temperature and chemical analyses were made from the surface to the bottom in each of the two major depressions. Samples were also taken from the surface at the outlet and from a depth of 50 feet in the southeast bay off Todd's boat livery. The data collected are presented in the table below.

North Depression-8/21/41-11:30 A.M.					South Depression-8/21/41-4 P.M.			
Depth in feet	Temperature °F.	Oxygen p.p.m.	Methyl Orange Alkalinity p.p.m.	pH	Temperature °F.	Oxygen p.p.m.	Methyl Orange Alkalinity p.p.m.	pH
0	77	9.3	118	8.4	73	6.7	118	8.4
3	77	...	...	...	73	...	...	...
6	77	...	...	...	73	...	...	...
9	77	...	...	...	73	...	...	...
12	77	...	...	...	73	...	...	...
15	77	...	...	...	73	...	...	...
18	77	...	...	...	73	...	...	...
21	77	...	...	...	73	...	...	...
24	77	...	...	...	73	...	...	...
27	77	...	...	...	73	...	...	...
30	77	...	...	...	71	9.2	124	8.4
33	69	6.8	127	8.4	68	...	...	...
36	61	...	...	...	62	...	...	...
39	56	...	...	...	58	...	...	...
42	53	9.2	146	8.4	53	10.9	145	8.4
45	52	...	...	...	52	...	...	...
48	51	...	...	...	51	...	...	...
51	51-	...	...	...	...	...	...	...
60	...	1.9	...	...	...	...	...	...
65	...	...	...	...	50	...	...	...
70	49	...	...	...	...	...	...	...
80	...	...	...	...	49	...	...	...
85	48	...	...	...	...	...	...	...
100	...	...	...	...	...	2.5	...	...
106	48-	0.1	152	7.4	49	1.2	160	7.4
		Near Outlet 8/25/41					Southeast Bay 8/25/41	
0	71.5	8.4	120	8.4	Depth 50 ft. 62	0.15	160	7.4

As can be seen, there is a great difference in the temperature and chemical conditions at the surface and at the bottom in Gull Lake. This condition is not unusual for the deeper lakes in Michigan. Early in the summer season after a period of more or less uniform water temperature in the spring, differences begin to develop in the temperature between the top and bottom. Naturally, the surface water warms up more quickly but the heat it secures is not readily transmitted into the deep water as one might suspect. A layer known as the thermocline (zone of rapid change in temperature) prevents the mixing of the upper and lower waters. The surface waters circulate, but only down to the thermocline. The lower waters do not circulate, and so remain at comparatively low temperatures. This phenomenon is known as thermal stratification. Dissolved oxygen which ordinarily remains abundant in circulating water often becomes depleted in the water below the thermocline. This is especially true if the lake bottom is covered with much decaying peat or other organic material. The oxygen is usually entirely used up or else greatly diminished during late summer and early fall. This is significant in fish management because water without considerable oxygen is not suitable for fish. In the fall, however, as the surface water becomes cold and the winds increase in intensity, the whole lake mixes again and conditions become more or less uniform from top to bottom.

Gull Lake undoubtedly passes through this stratification period each summer. At the time of the survey, the thermocline was located between 30 and 42 feet in both depressions. There was abundant oxygen in the thermocline and probably sufficient to support fish down to the 50-foot level. This condition makes it possible for cold water fish to survive in Gull Lake, there being a rather extensive layer of water between 30 and 45 feet which is low in temperature (52 - 69°F.) and high in oxygen.

The water in Gull Lake is moderately hard (Methyl Orange Alkalinity 118-160 p.p.m.) and strongly alkaline (pH 7.4-8.4). These conditions as to hardness and alkalinity are very favorable to good fish production. Moderately hard waters are usually much more productive than soft waters and, also, alkaline waters are usually much more productive than acid waters.

The abundance and kinds of water plants are dependent upon the above chemical factors as well as on favorable physical conditions such as type of bottom, wave action, etc. A list of the plants collected and their approximate abundance in Gull Lake is presented in the following table.

Common Name	Scientific Name	Abundance
Waterweed	(Anacharis canadensis)	Few
Water marigold	(Megalodonta Beckii)	Few
Hornwort	(Ceratophyllum demersum)	Common
Horsetail	(Equisetum fluviatile)	Few
Water milfoil	(Myriophyllum sp.)	Common
Bushy pondweed	(Najas flexilis)	Abundant
White water lily	(Nymphaea odorata)	Few
Yellow water lily	(Nuphar advena)	Few
Large-leaf pondweed	(Potamogeton amplifolius)	Common
Pondweed	(Potamogeton gramineus var. graminifolius f. myriophyllus)	Common
Floating-leaf pondweed	(Potamogeton natans)	Few
Pondweed	(Potamogeton strictifolius var. rutiloides)	Rare
Sago pondweed	(Potamogeton pectinatus)	Common
Clasping-leaf pondweed	(Potamogeton Richardsonii)	Few
Whitestem pondweed	(Potamogeton praelongus)	Common
Flat-stemmed pondweed	(Potamogeton zosteriformis)	Few
Three-square	(Scirpus americanus)	Few
Softstem bulrush	(Scirpus validus)	Few
Bulrush	(Scirpus sp.)	Few
Common Cattail	(Typha latifolia)	Few
Bladderwort	(Utricularia vulgaris var. americana)	Few
Wild celery	(Vallisneria americana)	Common
Musk grass	(Chara)	Abundant
Musk grass	(Nitella)	Common

Gull Lake is well supplied with submerged vegetation from the edge of the sand and gravel shoals to depths as great as forty feet. The most productive areas are in the southwest end where broad shoals extend far outward and plants may be found all the way across the lake from Idlewild to Crescent and Willow Beaches. Emergent and floating vegetation occur principally in

the shallow bay supplied by water from the Miller Lake inlet. The vegetation in Gull Lake is sufficiently abundant to be of considerable importance to the fish populations. The plants provide efficient food and shelter for small organisms, thus increasing the abundance of fish food both directly and indirectly. They also protect young game and forage fish from larger predacious forms and, in this way, aid in maintaining a balanced population. Some fish also require plants for spawning.

The plankton in Gull Lake was of moderate abundance at the time of the survey. It was principally zooplankton (water fleas). Plankton is a term applied to minute organisms that are free-floating in the water. They are important food for young fish and also for the adults of some species such as the cisco and bluegills.

The greatest variety and abundance of fish food organisms was among the plants. Here snails and scuds (fresh-water shrimps) were common. However, water mites, mayflies, dragonflies, damsel flies, alder flies and midge larvae were frequently found. On the sand and gravel bottom scuds were most common. Snails, water mites, mayfly nymphs and larvae of midge and other insects were less frequent. In the marly bottom of the shoals snails, mayfly nymphs and midge larvae were most common. The larvae of the plankton midge (Corethra) and the common midge were abundant in the deeper zones of the lake; mussels and aquatic earthworms were common, and often snails and alder fly larvae were found.

These organisms are a vital part of the productivity of a lake and are common food for many species of both game and forage fish.

Fish collections were made by the survey party in order to get some idea of the kinds, abundance and condition of the fish present. A list of the species of fish found or reported for Gull Lake, their relative abundance and the recent plantings of game fish are given in the following table.

Species	Abundance	Stocking (1934-1940)
GAME FISH		
Largemouth bass	Common	22,900 fingerlings 348 adults
Smallmouth bass	Common	19,200 fingerlings
Northern pike	Few	None
Walleye pike	Few	None
Yellow perch	Very common	116,800 fingerlings
Rock bass	Common	None
Bluegill	Common	872,000 fingerlings
*Pumpkinseed	...	...
Green sunfish	Very common	None
Long-eared sunfish	Rare	None
Cisco	Common	None
FORAGE FISH		
Common shiner	Common	...
Black-nosed shiner	Common	...
Black-chinned shiner	Common	...
Straw-colored shiner	Few	...
*Pug-nosed shiner	...	...
*Rosy-faced shiner	...	...
*Northern weed shiner	...	...
Blunt-nosed minnow	Very common	...
Horny-headed chub	Common at outlet	...
Creek chub	Few	...
Log perch	Abundant	...
Johnny darter	Common	...
Iowa darter	Common	...
Rainbow darter	Common	...
Least darter	Few	...
Silversides	Abundant	...
Menona killifish	Few	...
Tadpole cat	Common	...
Brook stickleback	Rare	...
Muddler	Reported	...
COARSE FISH		
Common sucker	Common	...
Yellow bullhead	Common	...
OBNOXIOUS FISH		
Long-nosed gar	Common	...
Dogfish	Reported	...

*Collected by G. P. Cooper in 1935.

Yellow perch and green sunfish appear to be the most abundant of the eleven game fishes present in the lake. Both large- and smallmouth bass are common as well as bluegills, rock bass and cisco. Since gill netting is often not very effective in capturing bluegills, this species may be much more abundant than collections showed. Of the 20 species of forage fish collected, log perch, silversides and blunt-nosed minnows were the most abundant. Judging from the kinds and abundance of forage fish, Cull Lake should be able to support a fairly large population of the predacious game fish, at least in the shoal portions.

The common sucker and yellow bullhead were the only coarse fish present. Dogfish and long-nosed gar are reported to be fairly common, although never numerous.

Scale samples were taken from all of the game fish collected for the purpose of determining the age and growth rate of each fish. The results of this study are given in the table below.

Species	Age*	Number of specimens	Average total length in inches	Average weight Pounds	Average weight Ounces
Smallmouth bass	0	1	3.3	...	0.25
	I	1	7.1	...	2.7
	II	1	11.2	...	11.4
	III	3	13.8	1	6.7
	IV	5	14.1	1	6.9
	V	4	15.7	2	1.1
	VI	1	16.8	2	12.0
	VII	2	17.2	2	12.5
	VIII	1	17.3	2	13.0
Largemouth bass	0	7	2.1	...	0.09
	I	19	6.4	...	1.9
	II	2	8.6	...	4.4
	III	4	10.4	...	8.8
	IV	2	11.6	...	12.6
	VI	2	14.1	1	7.0
Rock bass	I	9	2.7	...	0.3
	II	8	4.4	...	0.9
	III	3	5.5	...	1.7
	IV	5	7.4	...	4.5
	V	1	8.4	...	6.2
	VI	4	9.0	...	9.8
	VII	2	10.6	...	13.6
	VIII	1	10.8	...	14.9
	IX	1	11.0	...	14.0
Bluegill	I	5	2.6	...	0.2
	II	5	4.0	...	0.7
	III	7	5.9	...	2.2
	IV	1	7.5	...	4.5
	VI	1	9.0	...	9.5
	VII	1	9.0	...	9.4
Green sunfish	III	4	5.3	...	1.9
	V	1	7.4	...	5.4
Northern pike	IV	3	27.2	4	3.2
	V	1	34.1	9	4.5
Perch	0	1	2.6	...	0.1
	II	12	6.7	...	1.9
	IV	2	8.8	...	4.6
	VII	1	14.4	1	5.0
Cisco	I	1	7.8	...	2.1
	III	3	9.0	...	3.8

*Age determinations by W. C. Beckman.

Samples of fish taken for growth rate studies were probably adequate except in the case of the cisco and the northern pike. While several dozen fish of a species may not be considered enough for a complete study of growth rate, the trend of growth is generally clear from a sample of this size. In general the growth rate of the game fish in Gull Lake is about equal to the tentative averages established for the state.

The growth of the northern pike is good. One specimen in its sixth summer weighed over nine pounds. Smallmouth bass reached legal length during their third summer of life, rock bass during their fourth or fifth, bluegills during their fourth or fifth, green sunfish during their fourth and yellow perch during their second or third.

A study of the general creel census data since 1928, taken by the conservation officers, shows the bluegill to be the game fish most commonly caught. However, most of the reports were made from winter catches and may not represent the yearly take. Large- and smallmouth bass as well as yellow perch appear frequently in the creel census records.

Spawning facilities are certainly adequate for both large- and smallmouth bass, bluegills and rock bass, on the varied and extensive shoals. However, conditions in this lake are, for the most part, generally more favorable to smallmouth than to largemouth bass. Perch likewise find an abundance of room to spawn on the extensive weed beds. The spawning grounds of northern pike are almost surely limited to the two or three small bays and to the inlets and outlet streams. Pike may run the inlet streams and spawn in the lakes above. Their ability to maintain a limited population in Gull Lake is evidence of the adequacy of spawning facilities since this species has not been planted. Ample protection is found for the young of all species in the extensive submerged zone of plants bordering the shoals.

Management Suggestions

Gull Lake is at present in the "all other lakes" classification and our investigations have shown no good reason why this should be changed. The rather extensive zone of comparatively cold water with an abundant oxygen supply makes a considerable portion of this lake suitable for cold water fish the year around. We believe that trout will live and thrive in this lake and recommend an experimental planting of 2,000 (8-10 inch) lake trout and 3,000 legal size rainbows. It is very probable that earlier plantings of lake trout were unsuccessful, largely because they were introduced as fry, unable to escape the large population of perch and bass. All trout plantings should be made in the fall just before ice forms, since the predacious species are less active and naturally feed less extensively at that time. Since there are no known spawning facilities for rainbow trout, and possibly limited spawning grounds for lake trout, regular plantings will probably be necessary every two or three years. The size and frequency of plantings can only be determined after watching and checking the effectiveness of the original experimental introduction. This experiment will be followed out by the Institute.

Since most of Gull Lake is far more suited to smallmouth bass than largemouth bass, it is only logical that smallmouth should be encouraged and all stocking of largemouth be discontinued. It should not be necessary to stock smallmouth because there is a great abundance of spawning grounds for this species. Perch, bluegills and rock bass likewise have adequate natural spawning facilities and will maintain themselves to the full capacity of the lake without stocking. Cisco, rock bass and northern pike are present in moderate abundance, which is evidence that these species can maintain themselves by natural propagation because they have not been planted in the lake.

We have reason to believe that a combination of trout, cisco, perch, smallmouth bass and bluegills will be compatible in this lake. However, this can only be proven by a fair test as suggested above.

No predator or parasite control is recommended. Over 90 per cent of the smallmouth bass taken, and many of the largemouth bass, were infested with the bass tapeworm, but unfortunately there is no practical means of controlling this parasite once it is established in a lake. It may be necessary to make some future plantings of smallmouth since it is known that this tapeworm prevents the normal development and release of the eggs. Many fish become entirely egg-bound. However, young-of-the-year largemouth and, to a less extent, smallmouth were taken in many of the seine hauls made by the survey party. This indicates that, in spite of the heavy tapeworm infestation, both species of bass are reproducing successfully.

The extensive bed of water plants takes care of the cover needs of the fish pretty well. No shelters are recommended, although some good might be derived from them. The extensive use of boats, big and small, would limit the use of shelter devices to the areas along the drop-off, and this zone is already adequately supplied with cover.

The present arrangement of controlling the water level in the lake seems to be for the best good of those concerned. Fluctuation should be prevented as much as possible in the interest of the fisheries.

INSTITUTE FOR FISHERIES RESEARCH

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