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REPORT ON THE SURVEY OF HIGGINS LAKE, ROSCOMMON AND CRAWFORD COUNTIES

by

J. W. Moffett and C.J.D. Brown

Higgins Lake is situated in the northwest part of Roscommon County, although its northern most tip extends into Crawford County (T. 24, 25 N., R. 3, 4 W.). Roscommon is the nearest town and is the center of activity for residents of the lake. Higgins Lake is the prime headwater of the Muskegon River system. Water from this lake drains through "the cut" into Marl Lake and thence eight miles south to Houghton Lake.

A contour map of Higgins Lake was prepared for the Institute for Fisheries Research by the M.E.C.W. during the winter of 1936-37. This was used as a base for plotting certain information pertinent to the inventory[*] which was carried out by the Institute for Fisheries Research during August of 1939.

This lake has never had much of a reputation for its fishing, but recent reports indicate that there has been an actual decline in the

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[*] The inventory party included the following personnel: Hugo Kilpela, leader, Fred Locke, David Anderson and Pat Galvin, assistants.

perch and pike populations during the last few years, so that present conditions are worse than those of earlier times.

The almost perfect beaches all the way around the lake, and not the fishing, are responsible for the intensive utilization of this lake for summer resort purposes. There are approximately 500 cottages, 20 hotels, 50 resorts, and 75 boat liveries on the lake's shores, and many summer residents and tourists come to enjoy the swimming and boating afforded there. The well developed state park on the southeast shore is an added attraction to transient summer vacationists.

The long axis of Higgins Lake runs in a northwest-southeast direction. The basin is roughly divided into two parts by a long spit extending out from the southwest side. The shores along the northeast and southwest are bounded by moraines of considerable height, while those on the northwest, southeast are sandy outwash plains.

According to I. D. Scott in his book "Inland Lakes of Michigan," the basin of Higgins Lake was formed by the melting of large, irregular ice blocks which had been buried there in glacial times. He states that the lake has passed through 3 different levels; one 16 feet, another 8 feet, and the third 2 feet higher than the present level. The lowering of the lake from its former higher levels was caused by the erosion or cutting in the outlet which is located at the southeast end of the lake.

During lumbering days, a dam was placed in the outlet of this lake which raised the water level about 40 inches. Each spring the lake was lowered to its normal level and the flood water used for logging operations. This dam was no longer maintained when lumbering activity ceased.

Another dam was placed at the outlet in 1911 for the purpose of permanently raising the water level. The damage caused to lake property resulted in the dam's removal the following year.

At the present time there is a two foot dam in the outlet which maintains a more or less constant level. This dam is probably passable to fish in high water but may be a barrier in periods of very low water.

Hggins Lake has a surface area of about 9,600 acres. Approximately one-third of the entire lake is shoal (water less than 20 feet in depth). The maximum depth is 141 feet. This point is located one mile straight south of the state forest park and about three-quarters of a mile east of the mouth of Big Creek. There are four major depressions in which the water exceeds 100 feet in depth.

The lake bottom down to the70-80 foot contour is composed mostly of sand and gravel. A band of marl exists between the 20 and 30 foot contours and patches of marl are found over the sunken islands and near Old Point Comfort. The bottom in the deeper water is almost entirely of muck except for small patches of clay near each of the sunken islands. Boulders are common along the northeast and southwest shores, where the moraines reach almost to the water's edge.

The drainage area of Higgins Lake is small, probably not exceeding 50 square miles. There are but two tributaries, Big Creek and Little Creek, which enter the lake at the northwest end. Big Creek is only a few feet wide, and Little Creek is intermittent. The springs along the northeast shore and those entering beneath the lake surface probably constitute the main water supply. At any rate, the incoming surface water is much less than the discharge at the outlet, which makes the assumption of under-surface springs logical. The "cut" or outlet is on the southeast end of the lake and flows 11 miles, where it enters Houghton Lake.

The water in Higgins Lake is very clear when compared to that of other lakes in the region. During the survey a Secchi disc (a white plate 6 inches in diameter) was visible down to 22-27 feet. Although the

lake appears blue because of sky reflection and the comparatively great depth, the water is actually colorless.

The general physical features of Higgins Lake are indicative of low productivity. The lack of protected bays and the extensive sand on the shoals do not allow abundant growth of vegetation and fish-food organisms. The sand itself lacks vital elements necessary for plant growth and even if this were not the case, the constant movement of the bottom prevents the establishment of these growths. Since the long axis of this lake is almost parallel to the direction of the prevailing winds, the agitation of bottom deposits in the shallow water is even more intense than in lakes not so oriented. No young plants can establish themselves due to the cutting effect of the sand.

In the deeper areas (water over 25 feet) there is hardly sufficient light for plants to carry on their life processes.

The temperature data taken during August are probably near the annual maximum. Surface temperatures ranged between 70.5°F. and 73.0°F. at the same time the air temperature varied between 73° and 85°F. The following table summarizes the temperatures in this lake at the seven stations sampled.

TEMPERATURE AND CHEMISTRY OF WATERS IN HIGGINS LAKE

AS RECORDED DURING A SURVEY IN AUGUST, 1939

Station No.	1	2	3	4	5	6	7
Location	In south end 1 mile off State Park	Middle of section line between Secs. 21 and 28	Off sunken island in corner of Sec. 20	In NE corner of Sec. 18	Slightly NE from center of Sec. 14	In SE corner of Sec. 2. 1 mile west of corner	Stream section so. of State Forest headquarters
Date	8/8/39	8/10/39	8/11/39	8/15/39	8/16/39	8/17/39	8/19/39
Time	10:00 a.m.	3:30 p.m.	3:45 p.m.	10:30 a.m.	12:00 M.	11:00 a.m.	9:30 a.m.
Air Temp. °F.	73	78	77.5	79	85	81	73
Water Temp.							
Surface °F.	72.3	72.3	70.5	73.0	73.0	72.6	55
Bottom °F.	49.6	48.4	50.4	50.2	48.9	44.6	...
Depth at bottom in feet	85	100	85	85	98	138	1
Thermocline							
Location	36-51 ft.	45-54 ft.	33-39 ft.	39-51 ft.	39-51 ft.	36-54 ft.	...
Temp. Top °F.	70.0	67.6	48-51 ft. 70.2	70.2	69.3	70.9	...
Temp. Bottom °F.	54.3	52.9	53.6	54.7	54.3	54.6	...
Oxygen in ppm.							
Surface	7.6	8.3	7.8	7.9	6.5	8.4	7.1
Bottom	8.2	6.8	8.0	7.8	7.3	6.6	...
Carbon dioxide in ppm.	0.0	0.0	0.0	0.0	0.0	0.0 1.5 bottom	0.0
Methyl orange alk. in ppm.							
Surface	105	105	109	103	110	102	126
Bottom	111	124	110	115	110	114	...
pH							
Surface	8.0	8.0	8.2	8.2	8.2	8.2	8.2
Bottom	8.0	8.0	8.0	8.2	8.0	8.0	...

There is a great difference between the temperature of surface water and that on the bottom of the deeper areas, which means that a thermocline (a region of rapidly decreasing temperature) is present. This layer of water known as the thermocline occurs somewhere between 33 and 54 feet of water at all the deep water stations and varied in thickness from 9-18 feet. The actual temperature drop from the top to the bottom of this zone was about 15°F. This condition is well shown if the temperature data at station six (see above table) are examined. There was only 1.5°F. drop in temperature between the surface and the 36-foot level. Then in the next 18 feet the temperature dropped 16.3°F.; in the 86 feet of water below this zone (thermocline) the temperature dropped only 10°F.

Because of the lack of extensive organic deposits in Higgins Lake, the oxygen supply remains abundant at all depths. There was even more oxygen at the bottom than at the surface for certain of the stations. The above table gives a summary of the oxygen concentration for the waters at all stations. The concentration throughout the whole lake ranged between 6.5 and 8.4 parts per million. This means that the deep water as well as the shallow has an abundance of oxygen for the needs of all fish life throughout the entire year.

There was no free carbon dioxide in the lake water even at the greatest depths.

The waters of Higgins Lake are moderately hard. Total alkalinity tests (methyl orange) showed a range between 102 and 126 parts per million. The water is distinctly alkaline, giving pH readings of 8.0-8.2. Ordinarily, the moderately alkaline waters are more productive than are those of an acid nature, other conditions being favorable. No pollution of any sort has been reported for the lake.

The chemical conditions in this lake are very suitable for high productivity. Since oxygen is abundant at all depths, the whole lake is available as a home and forage ground for fish inhabitants. Temperature conditions are certainly more suitable for the cold water game fish. It is too cold for the good production of bluegills, bass and walleye pike. The bottom waters remain cold the year around even if the immediate surface may at times become unsuitably warm for a short interval during the summer. Because of the cold temperatures and relatively barren shoals, fish production is greatly limited.

The vegetation in Higgins Lake is very sparse. As already pointed out, the intense wave action affecting the movement of sand on the shoals prohibits the establishment of plants except in the most protected bays and along the shelf where the greater depth of water is a protection against bottom agitation. This plant zone, i.e. the one along the shelf, is limited to a strip growing between the 10 and 25 foot contours. It rarely exceeds 200 feet in width and extends around the whole lake. It is the only important plant zone in Higgins Lake.

Practically all of the plants growing in this area are of the submergent type (plants that rarely reach the surface) and include four common pondweeds; (Potamogeton perfoliatus, Potamogeton praelongus, Potamogeton natans and Potamogeton angustifolius); muskgrass (Chara) and the brushy pondweed, (Najas flexilis).

The very limited beds of emergent vegetation are composed almost exclusively of bulrush (Scirpus). The few small patches of plants in the protected bays are composed of the sago pondweeds (Potamogeton pectinatus, Potamogeton filiformis) and some water buttercup (Ranunculus aquatilis).

As has already been stated, the lack of adequate weed beds in Higgins Lake is probably one of the chief reasons for its low fish productivity. Plant materials are the basic food of all fish, although seldom utilized directly for that purpose. They feed and offer shelter to those numerous invertebrate animals, such as insects, snails, etc., which in turn are directly utilized by the fishes. The abundance of fish then is almost invariably in direct proportion to the density of the weed beds. The possible exceptions to this are those cases of small shallow ponds or lakes where the weeds may even crowd out the fish.

Almost all natural waters have suspended in them a great many different kinds of small animals and plants (plankton). Most of these plankter forms are too small to see with the naked eye. At times their abundance is so great that they even impart color to the water they occupy. This class of fish food is very fundamental. It is one of the basic foods for many of the aquatic insects and crustaceans which in turn are eaten by the larger fishes. Plankton also is an important direct food for the forage fishes and the fry and fingerlings of most game species.

Ten plankton samples were taken at various stations in Higgins Lake during the survey. The plankton content averaged 0.84 cubic centimeters (volume by water displacement) per cubic meter of water. The population was composed almost wholly of waterfleas and copepods (zooplankton). These quantitative measurements indicate a rather low plankton supply, but it is a known fact that the plankton is generally low in productivity during the period of the year when this study was made. Conditions in Higgins Lake seem favorable to the production of a moderate zooplankton population.

A study of the other fish food organisms in Higgins Lake shows them to be likewise rather scarce. A summary of the food organisms found on the plants and lake bottom is given in the following table.

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In 24 quantative samples taken from the different types of bottom, there was an average of 77 organisms per square foot of bottom surface. The volume of these samples (by water displacement) averaged 0.9 cc. per square foot.

The bottom composed of marl and silt produced the most food organisms with an average of 123 organisms having a volume of 1.9 cc. per square foot. The other types of bottom follow in the order of their productivity: rubble-sand, sand-clay, sand-marl, and muck-marl. One plant sample, which is not comparable to the other samples, yielded 15 organisms having a volume of 0.84 per pound of plants. The plant beds here, as well as in most of the other inland lakes, produce the largest quantity of food organisms.

Midges (Chironomidae), freshwater shrimp (Amphipoda) and caddis flies (Trichoptera) are the predominate organisms present in the lake. Midges were the most common species found on the marl-silt bottoms; caddis flies on rubble-sand, shrimp on sand-clay and on muck-marl, followed closely by midges on the latter.

Bottom food-organisms are rather sparse when compared to the more productive lakes of the region. However, these samples taken during the survey are probably lower than the annual average, since by August the populations of aquatic insects are greatly reduced by the spring and summer emergencies, leaving only the very young of the next year's brood.

An effort was made by the survey party to get a cross section of the fish population. Gill nets, fyke nets and seines were used in taking fish. A summary of the species taken or reported is included in the following table.

FISH COLLECTED OR REPORTED DURING A SURVEY OF

HIGGINS LAKE - AUGUST 7-25, 1940 - AND STOCKING RECORD

Species	Number	Size range, standard length in inches	Estimated % population	Total stocking during last 6 years
Game fish				
Yellow perch	80	5.9 - 10.0	...	...
Yellow perch	68	1.4 - 5.3	49.4	647,000
Rock bass	89	3.9 - 11.4	...	...
Rock bass	12	1.3 - 3.9	32.3	...
Smallmouth bass	13	8.4 - 16.6	...	...
Smallmouth bass	17	1.1 - 4.9	9.6	...
Whitefish	23	11.7 - 17.9	7.4	...
Walleyed pike	3	16.0 - 17.7	0.9	9,800,000
Cisco	1	6.5	0.4	...
Northern pike	Reported	...	...	...
Rainbow trout	...	...	...	16,350
Coarse fish				
Common sucker	6	6.5 - 18.5	...	...
Common sucker	8	1.5 - 4.1	...	...
Forage fish				
Straw colored shiner	366	0.9 - 2.2	...	...
Blunt nosed minnow	265	1.3 - 2.4	...	...
Johnny darter	100	1.1 - 2.0	...	...
Spot-finned shiner	80	1.1 - 2.6	...	...
Spot-tailed shiner	73	1.1 - 2.7	...	...
Rosy-faced shiner	3	2.0 - 2.6	...	...
Common shiner	2	3.2 - 5.2	...	...
Steel colored shiners	1	2.1	...	...
Mimic shiner	1	1.7	...	...
Brook stickleback	1	0.9	...	...
Northern red-finned shiner	1	1.6	...	...

Assuming that the collections made represent a fair estimate of the kinds and abundance of each game species, then 49.1% of the fish in Higgins Lake are yellow perch, 32.3% rock bass, 9.6% smallmouth bass, 7.4% whitefish, 0.9% walleyed pike, and 0.4% cisco. Northern pike and lake trout were reported from this lake, but none were taken by the survey party. The common sucker was the only coarse fish taken. Garpike were reliably reported as fairly numerous though none were seen or taken during the survey.

Eleven species of forage fishes (see above table) were collected. The straw colored shiner and blunt nosed minnow were the predominant species. The forage fishes were not very abundant.

In the winter of 1933-34, a planting of 250,000 lake shiners was made in Higgins Lake. It was hoped that this species might be established to bolster the forage fish population. Subsequent checks were made to determine the success of this experiment. One specimen was taken during November, 1934, but this had hook scars, which is evidence that it was probably an escaped bait minnow and was not a part of the original plant. In July and October of 1935, 4 specimens were taken by seining operations. Three of these were probably part of the original plant and the third was a young fish, indicating natural reproduction. The latest check up was made in September of 1938. No specimens were taken. We are not certain as to the success of establishing this species, but feel safe to conclude that it has not reached the abundance hoped for. For the most part, plantings of forage fishes have not been successful in substantially increasing the food of the predacious game fishes. More careful experimental work should be done on this problem.

During the ~~five~~ six years previous to ~~1939~~ 1940, the stocking in Higgins Lake was confined to three species: 647,000 yellow perch, 9,800,000 walleyed pike, and ~~9,600~~ 16,350 rainbow trout. These latter were small (6 months old

fingerlings) and probably did not stand much of a chance for survival. During 1939 yellow perch and walleyed pike were the only species planted.

A study was made of the growth rate of those game species collected during the survey. The results of this study are given in the following table.

GAME FISH GROWTH RATE STUDIES -- HIGGINS LAKE

Species	No. of Fish	Std. Length in Inches	Total Length in Inches	Weight in Ounces	Age Group
Rock bass	1	3.1	3.9	0.8	II
" "	6	4.0	5.0	1.8	III
" "	10	5.1	6.4	3.3	IV
" "	1	6.8	8.5	7.8	V
" "	11	7.6	9.5	12.0	VI
" "	8	7.6	9.5	11.5	VII
" "	21	8.1	10.0	13.1	VIII
" "	6	8.5	10.6	16.0	IX
" "	3	8.9	10.9	15.8	X
Yellow perch	4	5.3	6.1	1.4	II
" "	20	5.9	7.1	2.3	III
" "	15	7.1	8.3	3.7	IV
" "	12	7.7	9.1	5.2	V
" "	2	8.7	10.3	7.6	VI
" "	3	8.7	10.3	8.0	VII
Smallmouth bass	6	4.5	5.4	1.4	I
" "	6	8.1	9.7	8.0	II
" "	3	10.8	13.3	21.5	III
" "	2	11.5	14.4	23.5	IV
" "	1	12.9	15.7	36.0	V
" "	1	14.0	16.6	48.0	VI
Whitefish	1	9.9	11.7	7.3	III
"	2	14.3	16.8	23.25	VI
"	7	13.9	16.5	20.0	VII
"	4	14.3	16.9	21.0	VIII
"	8	14.4	17.0	22.0	IX
"	1	13.7	16.4	24.0	X
Walleyed pike	2	16.4	19.2	40.0	VI
" "	1	17.7	20.8	54.0	?

The rock bass in Higgins Lake reach legal size during their fifth summer. Three 10-year-old fish averaged almost 11 inches in total length and one pound in weight. Yellow perch attain legal length during their third summer, and by the time they are 7 years old they average 10.3 inches

in total length and 1/2 pound in weight. The growth rate of perch is below average for the other large lakes of the region.

Small-mouthed bass showed a better than average growth rate. They reach legal length in the late third or early fourth year. One seven year old fish was 16 1/2 inches long and weighed three pounds. Most of these bass were probably of wild stock, since none have been planted during the past 6 years. Whitefish reach a length of 17 inches and a weight of 1 1/4 pounds in 8 years. Specimens which were 9 and 10 years of age were no larger than the 8 year olds. It is possible that they reach their maximum length in about the eighth year.

Only three walleyed pike were taken. Two of these were in their fifth summer and averaged 19.2 inches in total length and 2 1/2 pounds in weight. The scales from the third one could not be read. This represents about average growth rate for this species, but very little can be said from a study of only two fish.

A creel census taken by the CCC during the winter of 1935-36 and analyzed by R. W. Eschmeyer gave the following results. The census covered a period between January 13 and April 4, 1936. During this period, 365 fishermen were checked. Of these fishermen, 166, or 45.5%, took no fish. The number of fish caught was 785 in 1,397 man-hours of fishing. The catch per hour was 0.6 fish and the catch per fisherman was 2.2 fish. Of those fish taken, 76.8% were perch, 14.3% common suckers, 4.4% whitefish, 2.4% cisco, 1.9% northern pike, and 0.2% bullheads. These catches, of course, did not show any small-mouthed bass which were protected by the regular closed season.

The spawning facilities in Higgins Lake are exceptionally good for those game species requiring a gravelly bottom on which to build nests. This would serve the needs of small-mouthed bass and lake trout. There is no place that northern pike can spawn because they need shallow, weedy

backwater or slow-running inlet or outlet streams. So little is known about the requirements of the walleyed pike that we cannot project as to the adequacy of natural means in this lake. Perch require weed beds for their natural propagation and so are rather limited in Higgins Lake. It is not known how extensive the weed beds should be in Higgins Lake to supply the desirable amount of spawning grounds for perch. However, it is suspected that even limited plant beds will take care of enormous quantities of perch spawn.

The biological conditions, as well as the physical conditions already mentioned, place Higgins Lake in the class of low productivity. The small drainage basin and poor soil conditions surrounding the lake furnish very little organic matter to "fertilize" the water. As a result, soil conditions in the lake are very poor, which determins at least in the part the growth of plants and other fundamental fish foods. All of these factors are inherent in the lake itself and are not the effect of man made changes. The lake will always produce fish and, if properly managed, may produce better fishing than now exists. However, we should become reconciled to the fact that its upper limits of production are not as high as those of many other waters and that at present no practical means of substantially changing these conditions are known.

Management Suggestions

Previous to October of 1939, Higgins Lake had the designation of a pike lake. It was then changed by action of the Conservation Commission to the "all other lakes" classification. This seems, in the light of this study, to be a wise change. Northern pike have never been abundant in this lake chiefly because there is little or no spawning grounds. It is quite possible that those pike present were migrants from Houghton Lake. The situation as regards to walleyed pike probably is similar to that of

northern pike. This species has not established itself in sufficient numbers to make decent walleye fishing in spite of heavy plantings, and probably never will as long as conditions in the lake remain essentially the same.

Perch and small-mouthed bass seem to be fairly well suited to conditions in Higgins Lake, but we are of the opinion that all factors concerned here are most favorable to cold water species. The temperature, as shown in a previous table, is suitable for trout from the top of the lake to the bottom. Should surface temperatures become too high, the extensive deep water areas are still completely available to fish. At no place and no time is the oxygen deficient in this lake.

We believe that a real effort should be made to establish lake trout and possibly brook trout. Reasonably large numbers of large sized fish should be stocked along with the complete cessation of stocking other species. Plantings of fingerling trout would certainly be wasted effort with a large number of hungry perch and bass already present in the lake. This undoubtedly explains why certain previous plantings of trout were completely unsuccessful.

If after a thorough trial, trout are not established in the lake, then it should be left to the perch and small-mouthed bass. Natural facilities for the propagation of these two species are sufficiently numerous to keep the lake stocked without artificial plantings. There are probably more perch produced naturally in Higgins Lake at present than can find food and grow to a reasonable size. The problem is one of food, and additional stocking simply tends to make less food for more fish. Stocking may cause an increase in numbers but at the same time a decrease in size.

The small-mouthed bass have already proven their ability to get along without stocking, as have the rock bass.

Conditions are entirely unsuited to bluegills. If this species should be established, which is very doubtful, growth would be very slow in such cold, barren water. The introduction of large-mouthed bass and crappies should likewise be avoided.

Higgins Lake has been stocked with a great many different kinds of fish since the first records in 1874. Aside from the common Michigan game fish, there have been plantings of Atlantic salmon, landlocked salmon, California salmon, and Montana grayling. None of these species have shown up in catches, and it is assumed that each was a failure.

No predators of importance were noted at Higgins Lake. Reports of garpike indicate a considerable number of this species. There is no evidence to show that the presence of garpike, in moderate numbers, has any serious effect on the fish population. On the other hand, they are probably beneficial in that they tend to remove injured or diseased fish.

The only parasite recorded was the bass tapeworm. No serious infestations of this parasite were reported. It is doubtful if the present incidence has any serious effect on the bass population. These worms are not harmful to man.

One of the paramount needs in increasing productivity of Higgins Lake is the presence of more extensive weed beds and cover. Structures designed to reduce wave action will be helpful in increasing the vegetation. Such structures should be solidly built and arranged to protect certain scattered shoal patches which have other characteristics suitable for plant growth.

Cover devices of the type already present in the lake should be increased in number. These should be well scattered around the lake in water between 8 and 20 feet in depth. Concentration of shelters in barren parts of shoals tend to concentrate the fish of these areas and make them more readily available to a <u>few</u> fishermen.

If permission is granted for deadhead removal, some provision should be made to add cover devices sufficient to take their place. In a lake so barren of cover, the presence of logs undoubtedly has a very good influence.

No improvement of spawning facilities is recommended. As already stated, conditions are satisfactory for perch, bass, lake trout and possibly brook trout. Lake trout use the gravel and rubble shoals while brook trout should find conditions satisfactory in the spring areas where the cold spring water bubbles up through the gravel and sand, also in the short spring runs at the north end of the lake.

The present water level maintained by the dam seems to be near the optimum. Water fluctuation should be avoided as much as possible. A reasonably constant level is essential to good productivity.

A more comprehensive creel census would be of great aid in determining the general trends and needs of this lake. Some project might be worked out whereby the lake residents could make this possible.

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