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FISHERIES SURVEY REPORT ON LONG LAKE, ALPENA AND PRESQUE ISLE COUNTIES

by

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A large number of requests have been received by the Department of Conservation during the past three years for an investigation of the fisheries of Long Lake in Alpena and Presque Isle Counties (T. 32, 33 N., R. 8 E.). In response to these requests a regular inventory was authorized by the department and carried out by the Institute for Fisheries Research* during the last three weeks in June 1939. An outline-contour map of this lake had been prepared for the Institute by the Michigan E. C. W. during the winter of 1935-36. This map was used as a base for plotting other information such as vegetation beds, bottom soils, sampling stations etc.

Long Lake is one of the very popular resort lakes in the Lower Peninsula. There are approximately 225 cottages, 25 resorts, 2 hotels and 25 boat liveries on its shores and thousands of summer residents utilize the swimming, boating and fishing afforded there.

Reports of past fishing on this lake show small-mouthed bass to be the most prized game fish present but according to these same reports this

*The survey party making this study included Hugo Kilpela, Leader; Fred Locke, Dave Anderson and Pat Galvin, assistants.

species has declined considerably in the last few years. At the present time yellow perch and Northern pike predominate the catches. According to past creel census reports, submitted by conservation officers since 1927, these species have always been the most numerous.

According to I. D. Scott in his book entitled "Inland Lakes of Michigan," the basin of Long Lake lies on the exposed terrace of the old glacial lake Algonquin. It is quite probable that the original basin existed in preglacial times as a trough in the limestone bedrock still exposed in ~~open~~ a few places in the vicinity. Glacial ice enlarged this trough and produced the present basin of the lake. The southeast end of the lake is closed by a flat sand plain. The outlet cut through this plain and the lake was greatly lowered from its original level. The dam at the outlet has raised the water level sufficiently to cover part of the sand plain on the southeast end which was previously exposed.

Long Lake is approximately 7½ miles long and a mile wide, occupying an area of 5652 acres. Its long axis is in a northeast, southwest direction although it is bent almost due west at the north end. This makes the lake almost parallel to the prevailing winds and accounts for the intense wave action so common there.

The basin is fairly regular with no very sharp drop-off. The five-foot contour varies in its distance from shore from 150 feet on the sides to about 2500 feet on the northwest end. The lake is relatively shallow, having a maximum depth of 25 feet. A depression occurs a little northwest of the lake's center and the place of maximum depth was found ½ mile northeast of Little Gravel Point.

The shoal (water less than 15 feet in depth) occupies 58 per cent of the lake's surface area. The bottom here consists mostly of sand with gravel and limestone boulders dispersed over the whole area, these latter being exposed more generally near shore in water less than five feet in depth. Sand and marl cover the bottoms of the intermediate zone and a mixture of marl and muck constitutes the bottom in the depressions.

The drainage basin of Long Lake includes less than 100 square miles. Six small creeks are tributary to this lake, the two largest of which are Silver Creek and Fitzgerald Creek. These enter from the north and west respectively and do not contribute much water except possibly during the spring run-off. The outlet, Long Lake Creek, is on the extreme southwest end of the lake. Its general course is southeast to Devils Lake and then east to Lake Huron, the entire length being $5\frac{1}{2}$ miles.

A dam $1\frac{1}{2}$ feet high is maintained across the outlet by the Long Lake Improvement Association. The purpose of this structure is to maintain a constant level in the lake. No provision has been made at this dam for the upward or downward migration of fish. The dam is reported to be a barrier to fish migration except during flood water stages.

As might be expected, the water in Long Lake is moderately clear and "clean" and without visible color. Secchi disc readings were uniform at 18 feet, which means a 6-inch disc disappeared from view at this depth. Ordinarily, clear, colorless waters are not capable of large fish production.

The physical features characteristic of Long Lake have both good and bad points in terms of fish production. The extensive shoal area offers abundant opportunity for plant and fish food development. However, a

great deal of this area is rendered somewhat useless by the intense wave action and shifting bottom. Sand bottoms are not especially productive because they lack the essential basic foods for aquatic plants and animals. Coupled with this lack of food is the instability of such bottoms. Wave action, initiated by the wind, causes the sand to shift and under such conditions plants and animals have difficulty in establishing themselves. Because of the restriction of good food producing areas, the fish population is also restricted.

The temperature and chemical factors operating in a body of water also have great influence on the kind and abundance of fish it will produce. The results of temperature and chemical tests made on Long Lake are presented in the following table. (See page 5).

During the period of the survey the water temperature was almost uniform from surface to bottom. It is almost certain that there is no thermal stratification in this lake throughout the entire growing season. Its maximum temperature is probably reached about mid August and there is every reason to believe the bottom waters warm up to or within a very few degrees of the surface. Most of the larger, deeper lakes of the state show great temperature differences between surface and bottom water during middle to late summer and early fall. Because of its shallow basin and intense wave action, a more or less constant mixing of the waters of Long Lake occurs.

The oxygen supply from top to bottom is likewise very uniform and there is no doubt that sufficient oxygen is present in all parts of the lake to maintain fish life. During the survey, tests showed the oxygen to range from 5.4 parts per million to 8.1 parts per million from the surface to the bottom.

Results of Temperature and Chemical Analyses Made on Long Lake

Station No.	1	2	3	4
Location	Deepest Point T. 33N., R. 8E., Sec. 32	On shoal just off Three Pines Resort	On shoal off mouth of Sucker Creek	In depression east of mouth of Fitzgerald Creek
Date	6/13/39	6/14/39	6/13/39	6/20/39
Time of Day	8:00 A.M.	7:45 A.M.	10:30 A.M.	7:30 A.M.
Air Temp. °F.	66	62	66.5	65
Water Temp. °F.				
Surface	64.9	61	61.5	63
Bottom	64.6	.....	.....	64.2
Bottom Depth in ft.	22	4	3	22
Oxygen in ppm.				
Surface	8.0	6.6	5.4	8.1
Bottom	8.0	.....	.....	8.1
Carbon Dioxide, ppm.				
Surface	0.0	0.0	8.0	0.0
Bottom	0.0	.....	.....	0.0
phth Alkalinity ppm.				
Surface	11.0	5.0	0.0	6.0
Bottom	9.0	.....	.....	9.0
Methyl Orange Alkalinity ppm.				
Surface	141	148	205	110
Bottom	136	.....	.....	114
pH				
Surface	8.0	8.0	8.0	8.2
Bottom	8.0	.....	.....	8.2

The only carbon dioxide present in the water was found near the mouth of Sucker Creek. The small amount present even at this station is certainly of no consequence to the well being of fish.

The water is distinctly alkaline in Long Lake (pH 8.0). This is to be expected in view of the presence of considerable limestone in the drainage. The water is moderately "hard," having a total alkalinity (methyl orange) range between 110 and 205 ppm. The hardest water is contributed by the Sucker Creek tributary.

Temperature conditions in Long Lake make it suitable for only warm-water fish. The summer maximum is unquestionably above the toleration limit of trout. The chemical conditions are very suitable for fish. Marl deposits impede the extensive growth of aquatic plants but the limiting factor is probably not nearly so important as the wave action in causing plant restriction. No pollution of any kind was observed.

Good healthy weed beds are an almost certain sign of a good fish lake. It is true that certain small lakes and ponds may have too many weeds, but we know of no instance where weeds are too thick for fish in lakes of a few hundred acres or larger. Aquatic vegetation in Long Lake is not very abundant. Moderate beds of emergent plants occur in both ends of the lake and are best developed in the northwest end and in several of the sheltered bays.

Submerged plant beds are common also in the northwest end of the lake in water from 5 to 20 feet in depth. Some scattered patches are found along the west side in the protected areas and out in the deeper waters. The floating type of vegetation, such as water lilies, is very scarce in Long Lake.

The most abundant emergent species is the common bullrush (Scirpus), Others of this category are: spike rush (Eleocharis), horsetail (Equisetum), sedges (Carex), cattail (Typha), bog rush (Juncus) and others of less importance.

The submerged varieties are led in abundance by musk grass (Chara) which blankets considerable areas of the marl bottoms. Others present to a greater or less degree include four common pondweeds (Potamogeton angustifolius, P. natans, P. pectinatus, P. gramineus), bladderwort (Utricularia), coontail (Ceratophyllum), water milfoil (Myriophyllum), wild celery (Vallisneria) and at least 10 other species which occur only rarely.

The floating types include, the yellow water lily (Nuphar advenum), water buttercup (Ranunculus) and arrowhead (Sagittaria).

As has been pointed out above, the greatest limiting factors of aquatic vegetation in Long Lake is the character and instability of the lake bottom. Shifting sand or wind swept rocky shoals are not capable of supporting plants. The entire southwest half of the lake is of this type and here only those plants which are adapted to the deeper unmolested waters are able to survive.

The fish-food organisms of lakes are found in several distinct habitats. Many small microscopic forms known as plankton, float freely through the water. It would be almost impossible to find a single drop of water in any inland lake which was free from these small animals and plants, but the number and kinds may vary greatly in different lakes and even in the same lake from week to week. This source of food is very important in fish production. Not that all large fish utilize it directly, but it is the source of food for smaller forms such as insect larvae and minnows which in turn make up the food supply of the larger game fishes. Plankton is also extremely important in that it constitutes the first food of all young lake fishes.

The plankton in Long Lake seems to be fairly abundant. At the time of the survey the greatest majority was phytoplankton or plant, except at two stations. These latter showed unusually large concentrations of animal or zooplankton (water fleas). One sample contained 0.35 cubic inch per cubic foot of water.

Since plankton populations vary greatly throughout the year, it is not possible to estimate the value of this source of food from one collection taken only on one date.

The bottom food organisms of Long Lake are of greatest abundance between the 9 and 15 foot contours. The weed beds offer the best opportunity for these organisms to develop because many of them depend upon the aquatic vegetation for food and shelter. The bottom in the extensive shallow water areas which is composed of sand, gravel and boulders and devoid of plants is also rather productive of food organisms.

The relation between the bottom types and fish food production is shown in the following table. It will be noted that plants produce the most food, assuming that a three-pound sample of plants is the equivalent of one square foot of bottom. The marl-sand, rubble-gravel types show approximately the same quantity of food per square foot and muck the least amount.

The numerically dominant form in Long Lake was the fresh-water shrimp (Amphipods). Mayflies and midges were likewise abundant. The predominant organisms found in each habitat were as follows: Caddis flies, moths and fresh-water shrimps on aquatic vegetation; fresh-water shrimp and mayflies in rubble and gravel and fingernail clams, midges and mayflies in muck.

These studies show the fish food organisms to be relatively abundant in Long Lake when compared to other large lakes in the region.

Summary of Bottom Food Organisms in Long Lake, Alpena and Presque Isle Counties

June 13 - 27, 1939

The numbers and volumes represent averages per square foot of bottom except for plants.

Bottom type	Sand and marl	Muck	Rubble and gravel	Aquatic plants
				Ave. per 3-lb. sample
Ave. depth in ft.	8.3	22.5	0.6	13.0
No. of samples	13	4	3	2
Vegetation	Chara and Potamogeton in some samples.	none	none	Potamogeton and Myriophyllum, Chara
Census				
Flatworms	1.2	0.5	...	0.5
Aquatic earthworms	1.4	5.0	...	...
Leeches	0.2	...	2.7	...
Snails	2.3	4.5	0.7	5.5
Clams	3.1	24.5	...	1.5
Freshwater shrimps	19.7	0.5	48.7	11.0
Water mites	0.6	...	...	...
May flies	16.0	11.5	34.7	9.0
Dragon flies	1.5	...	...	6.5
Damsel flies	0.8	...	0.3	2.0
Dobson flies	1.1	1.5	...	...
Caddis flies	4.9	3.5	...	40.5
Moths	...	...	...	30.0
Beetles	1.7	0.5	3.0	...
Midges	46.9	18.5	0.3	3.0
Other flies	0.8	...	0.3	...
Unknown	0.2	...	...	...
Average No.	102.3	70.5	90.7	109.5
Volume in cc.	2.1	1.1	1.9	4.9

Eleven species of game fish were collected or reliably reported for Long Lake during the period of the survey. A list of the species with their numbers and sizes as well as the number planted are given in the following table.

Game Fish Taken During a Survey of Long Lake, Alpena and Presque Isle Counties, June 10-30, 1939

Species	Number	Size Range in inches (Standard Length)	Total Stocking in last 5 years
Yellow perch	many	0.6 - 1.0	267,000
" "	171	2.6 - 5.9	
" "	42	5.1 - 11.8	
Northern pike	5	2.0-- 3.8	
" "	58	7.8 - 40.2	
Pumpkinseed	24	1.2 - 9.5	220
Walleyed pike	10	0.6 - 6.8	1,425,000
" "	11	9.7 - 19.7	
Rock bass	19	1.3 - 6.2	200
Small-mouthed bass	5	5.3 - 18.1	7,931
Whitefish	1	15.9	
Long-eared sunfish	1	2.1	
Bluegills	...	...	119,700
Large-mouthed bass	...	...	9,000
Calico bass	...	...	180
Total	347		

Collections were made by seining and gillnetting and may not represent the exact ratio between the species. However, collections of this kind, if

extensive enough, often give approximate ratios and can be safely used as a rough estimate of relative abundance. Assuming the sample to be adequate, the numerical percentage of the total collection for each species is as follows: perch, 61.5%; Northern pike, 18.2%; pumpkinseeds, 7.0%; walleyed pike, 6.0%; rock bass, 5.5%; small-mouthed bass, 1.4%; whitefish, 0.2%; long-eared sunfish, 0.2%; bluegills, large-mouthed bass, and crappies were entirely absent from collections made. The ratio given between Northern pike and small-mouthed bass is probably incorrect, because pike are more easily taken in gill nets than bass. There is little question however that Northern pike are far more abundant than small-mouthed bass.

The game fish stocked during the past five years are shown in the above table. Several things are apparent from these records. While 120,000 bluegills have been stocked since 1934, the present study shows this species to be either extremely rare or completely absent in the lake. Not a single bluegill was taken by the survey. It only seems logical that this species has not proved its ability to survive and compete with the other fish present. Perhaps the six years of stocking is not sufficient time to establish this species, but it seems more likely that conditions are not favorable for its existence in Long Lake.

Large-mouthed bass have been reported only a few times. The lack of muck bottoms and dense extensive weed beds explains, at least in part, why large-mouthed bass have not thrived. The spawning facilities in Long Lake are not well suited to large-mouthed bass production.

There are no records to show that any of the crappies survived from the small stocking made. This is probably fortunate as the lake is already populated with a large number of predaceous species, e.g., pike, walleye and perch. Experience elsewhere has shown that the establishment of crappies

in northern lakes has been a mistake since this species often crowds out other desirable species and does not furnish satisfactory fishing.

Creel census information shows yellow perch to be the most predominant species taken in nearly every year since 1927. A more extensive census taken in 1936 by the M.E.C.W. shows yellow perch and Northern pike to dominate the catches both in winter and summer. In this census 109 fishermen were reported on during the winter. In a total of 433 hours of fishing, 66 caught no fish, the other 43 caught 186 fish or an average of 0.4 fish per hour. Eighty-six per cent of the total catch were yellow perch, 10% Northern pike, and 4% walleyes. Of course bass were lacking since they are illegal at this season of the year.

During the following summer 618 fishermen were reported on; one half of this number failed to take any fish. In a total of 2,176 hours of fishing, 1,422 legal fish were caught. The catch per hour was 0.65 fish. Of the total fish taken, 69% were perch, 9% Northern pike, 6% rock bass, 5% sunfish, 3% walleyes, 3% small-mouthed bass, 3% bluegills (possibly also sunfish), and 2% large-mouthed bass. (We believe the large-mouthed bass reported were actually small-mouthed bass misidentified.)

A one day census (June 25, 1939) conducted by the survey party, reported 255 fish. Sixty-two per cent of these were Northern pike, 22% yellow perch, 11% walleye pike, 4% small-mouthed bass, and 1% rock bass. Not all fishermen were reported on, but an estimate placed the number of fishermen on this date at 300 and the average catch at 5 legal fish per man.

Forage fish are plentiful in Long Lake both in number of species and individuals. The following species were collected by means of seines. They are given in the order of their relative abundance of the total number taken.

Blunt-nosed minnow

Black-chinned shiner

Straw-colored shiner

Common shiner

Johnny darter

Spot-finned shiner

Iowa darter

Menona killifish

Log perch

Black-nosed shiner

Spot-tailed shiner

Rosy-faced shiner

Red-bellied dace

Lake emerald shiner

Mud minnow

Mimic shiner

The blunt-nosed minnow makes up about 2/3 of the entire minnow population and the black-chinned shiner is second in abundance constituting about 10%.

The only coarse fish taken was the common sucker. Carp have been reported but were not seen during the survey and must be relatively scarce if present at all.

A study has been made of the ages and growth rate of the five most abundant game fish collected during the survey. The following table gives a summary of this information (See p. 14).

The northern pike reached legal length late in their second summer. Five year old fish averaged nearly 5 lbs. in weight and one 7 year old pike

Summary of Growth Rate Data* of the Fish from Long Lake, Alpena and Presque Isle Counties, taken June 10-30, 1939

Species	Age Class	No. of fish	Ave. Standard length in inches	Ave. Total length in inches	Weight in ounces
Northern pike	I	3	11.0	12.8	8.6
" "	II	36	16.7	19.4	24.7
" "	III	7	19.0	22.0	37.5
" "	IV	5	22.4	25.9	62.3
" "	V	3	24.4	28.2	78.0
" "	VII	1	36.0	40.5	256.0
Yellow perch	II	16	4.7	5.6	1.4
" "	III	6	6.6	7.9	3.9
" "	IV	4	7.9	9.6	6.7
" "	V	1	8.5	10.0	7.9
" "	VI	3	9.6	11.4	12.0
" "	VII	2	9.8	11.5	13.6
" "	VIII	4	10.5	12.4	16.8
" "	IX	4	10.8	12.7	17.4
" "	X	3	11.0	12.9	18.6
Walleyed pike	I	2	5.2	6.2	1.2
" "	II	1	9.0	10.6	7.0
" "	III	1	12.3	14.4	15.0
" "	IV	1	14.9	17.6	26.0
" "	V	1	15.6	18.4	30.5
" "	VI	2	15.4	18.1	30.7
" "	VII	5	15.8	18.7	30.8
" "	VIII	7	17.0	20.4	37.3
" "	IX	3	16.6	19.5	34.0
Small-mouthed bass	II	2	5.4	6.5	2.25
" " "	III	3	8.5	10.3	9.0
" " "	IV	1	11.7	14.1	26.0
" " "	V	2	13.0	15.8	39.0
" " "	VI	2	14.0	17.1	50.0
" " "	VII	3	14.1	17.3	47.0
" " "	VIII	1	14.2	17.2	44.0
Rock bass	II	1	2.8	3.5	0.6
" "	III	2	3.6	4.5	1.2
" "	IV	5	4.7	5.8	2.7
" "	VII	1	7.1	8.8	9.7

*Ages determined from scale studies by Mr. W. C. Beckman of the Institute staff.

was 40 inches in total length and weighed 16 lbs. This is good growth being somewhat better than average for the larger lakes studied in the region.

The average yellow perch reached legal length early in its third year of life. Five year old perch were 10 inches in length and averaged $\frac{1}{2}$ lb. in weight. Three 10 year old fish averaged 12.9 inches in length and $1\frac{1}{2}$ lbs. in weight. This is exceptionally fine growth. Perch, here, grew almost twice as fast as those studied from Black Lake.

The walleyed pike studied reached legal length late in their third or early in their fourth year. Five year old fish averaged about 18 inches in length and weighed nearly 2 lbs. Older specimens did not show a great deal of growth after their fifth year. While the growth of these fish was not more than fair as compared with other lakes, it seems to be satisfactory.

Small-mouthed bass reach legal length by the end of their third year or early in their fourth year. Two six year old fish averaged 17 inches in length and 3 1/8 lbs. in weight. An insufficient number of specimens was available for study and no extensive conclusion could be drawn. However their rate of growth is good when compared with the same species from other inland lakes.

Rock bass do not reach legal length in Long Lake until their fourth or fifth years. For some reason this species seems to have rather slow growth in Long Lake.

For the most part the spawning facilities for the game and forage fish in Long Lake seem adequate. Northern pike find good spawning grounds in the grassy shallow water of the northeast end and in the numerous shallow bays. It is entirely possible that they may utilize marshy stretches of the various inlet streams for this purpose although no one has actually observed their doing so.

There are considerable spawning grounds for yellow perch. The rather extensive bulrush beds, although not good food producers, are utilized by

this species. Almost any extending object is suitable as a substratum for perch spawn.

Very little is known about the spawning habits of walleyed pike and we are therefore not certain whether or not this species is able to reproduce successfully in Long Lake. It seems likely that at least some natural propagation exists.

Small-mouthed bass are partial to gravelly shoal as a spawning ground. The extensive gravel and rubble bottom on the shoals of Long Lake suggest an ideal breeding place for this species. Of several larger lakes studied in Michigan, Long Lake seems to offer the best opportunity for natural reproduction of small-mouthed bass. Observations were made during the survey on the nesting of bass and schools of young bass were observed in the very shallow water at night.

Management Suggestions

Designation

Long Lake is at present in the "all other lakes" classification making it eligible for the stocking of bass and pan fish. Past and present records show this lake to be an ideal pike and perch lake. These species have proven their ability to get along by maintaining their predominance in the total fish population. We recommend, therefore, that the designation be changed to the "Pike lake" class. Northern pike, yellow perch, walleyed pike and small-mouthed bass should be encouraged.

Stocking

As has already been pointed out, the facilities for natural propagation are abundant in Long Lake. The northern pike, has proven its ability to maintain an abundant population by natural means since none of this species

has been stocked. Yellow perch are so abundant that further stocking would seem to be wasted effort. The natural population of young perch is tremendous as shown by seining operations. There must be a great mortality to make room for even a small number of the young produced each year.

It may be necessary to make periodical plantings of walleyed pike in order to maintain this species. As has been stated above, the lack of information on the habits of this fish makes us uncertain. It would be desirable to withhold stocking for at least two years so that checks could be made to see if young walleyes appeared. If small fish were present after a year of no stocking, this would help to answer the question of the adequacy of natural reproduction.

If the designation of this lake is changed, as we believe it should be, then further stocking of small-mouthed bass would be impossible under the existing rules of the Conservation Department. We believe that small-mouthed bass have a place in this lake and should be encouraged. It is very probable that this species will maintain itself in limited numbers by natural propagation. It is also very probable that the number maintained by natural means will be near, if not exactly, the number the lake will carry with its present population of pike and perch. If by a change in the designation of this lake, the pike and perch populations are reduced, it is quite safe to assume that the bass will increase. An increase in the pike-perch population will, on the other hand, cause a decrease in the bass. We believe that the present reported decrease in bass is the result of an increase in the pike.

There is little likelihood that small-mouthed bass could ever become the dominant game fish without the complete removal of perch and pike and, while we do not consider pike and bass as incompatible species, they are highly competitive. The conditions in this lake are in favor of the pike or how else would this species maintain itself without stocking.

The greatest problem involved in maintaining both pike and bass fishing is to secure the cooperation of the fishermen who must help to prevent the loss of spawning bass during the early pike fishing. But as has been observed, all the bass in this and other northern lakes do not spawn early. In certain years many of the spawning fish are taken after the opening of the bass season. Just what should be done to protect the spawning fish when their reproductive activities extend over two months time is an open question.

Bluegills, sunfish and crappies should definitely be eliminated from the species to be encouraged. Conditions are not suited to them and future stocking, like those in the past, will probably be ineffective.

Predators

Although some fish predators have been reported from the Long Lake area, we do not believe they are a menace to the fish population and therefore do not recommend any control measures at this time. On the other hand those fish-eating animals present, are probably of great benefit in removing the sick and diseased fish as they appear.

Parasites

Several fish parasites were observed. Some gill lice were found on the different game fish but their presence had no apparent serious effect on the fish. The most serious parasite observed was the bass tapeworm (*Proteocephalus ambloplitis*). The survey records and other subsequent reports show a very high incidence of this parasite in the small-mouthed bass of Long Lake.

The life history of this tapeworm is complete within the fish and fish-food organisms found in the lake and therefore offers a serious problem if control measures are anticipated. A brief description of the life-history

of this worm is given by Hubbs and Eschmeyer in their book, "The Improvement of Lakes for Fishing." It follows:

"(1) The adult tapeworm living in the intestine of the bass breaks up into segments which are discharged into the water.

(2) The mature segments liberate thousands of eggs.

(3) These eggs are eaten by a minute crustacean (Cyclops), which becomes the first intermediate host of the bass tapeworm. The parasite must pass one stage of its life history in each host.

(4) The Cyclops is eaten by some small fish, as a perch, in which the parasite then lives in a different form. This fish is the second intermediate host.

(5) The small-mouthed bass becomes infected by eating a second intermediate host. The tapeworm then matures in the bass, which is known as a definative host. Thus the cycle of the parasite is completed. The parasite could be controlled by eliminating the host of any stage."

The last statement of this quotation while true is not economically possible. The elimination of either crustaceans, small perch or minnows (intermediate stage may also occur in young bass) would not be desirable if economically possible. All are necessary in the biological cycle of a lake—if fish are to be produced. It would probably be more practical to discourage the bass and in doing so interrupt the life cycle of the parasite.

The exact effect of this parasite upon the bass population can be nothing more than conjecture. There is evidence from other studies that heavy infestations of this worm cause stunting and sterility in small-mouthed bass. In certain bass examined from Long Lake the reproductive organs were partially or completely destroyed. This condition may or may not have reached serious proportions in the bass population of the lake.

Future stocking of "clean" bass could do no more than temporarily relieve this condition as they would soon become infected and stocking of parasitized individuals would probably but slightly aggravate it. The sooner indiscriminate distribution of fish from one lake to another is discontinued the sooner it will be possible to work out a program of control. Many of our inland lakes have probably been stocked with bass tapeworm by the transfer of fish from the Great Lakes. This is certainly a questionable practice under any circumstances unless the fish to be transferred have been examined and shown to be free from parasites and disease before, or unless the same parasites are already present in the lake to which they are being taken.

Cover Improvement

Lake improvement structures designed to help increase the vegetation or cover will undoubtedly be of value in making conditions more favorable for increased yields of fish in Long Lake. These needs are limited to the southeast one-half of the lake and the shelters should be dispersed as widely as possible over this portion of the lake as general interests will permit.

Some devices that will act as breakwaters and thus give protection for plants in this region of the lake would certainly be desirable. Plant beds are absent or at least sparse in most of the unprotected area. While it is realized that swimming and boating interests will not be in favor of increased vegetation, we feel that in a lake of this size, an increase would not interfere with these activities, nor is it likely to spread in extent to jeopardize these interests in years to come. Plantings of vegetation in these areas without some protection from the wave action will not be able to survive.

A considerable number of shelter devices distributed in this part of the lake would be particularly valuable in the protection of young bass. Regular brush shelters placed in water 8-20 feet in depth are recommended. These should not be concentrated in any one spot but should be well scattered around the entire southeast half of the lake. Caution should be used to see that they are properly tied and weighted. A poor half floating shelter is an eyesore and menace to all interests.

Regulation of Water Level

The present level of Long Lake, as maintained by the dam in the outlet seems desirable. Any action that tends to decrease severe water fluctuation will increase a lake's productivity. The rise in water level caused by this dam has probably made conditions more suitable for pike by increasing their spawning grounds. It may be that this action is partly responsible for the increase in pike and decrease in small-mouthed bass.

Typed by C. Lloed