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FISHERIES SURVEY OF BIG BEAR LAKE, OTSEGO COUNTY

By

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Big Bear Lake is located in Otsego County (T. 29-30 N., R. 1 W., Sec. 1, 2, 36). It lies approximately on the divide between the Au Sable River drainage, and the Thunder Bay River drainage within a few miles of the headwaters of the North Branch of the Au Sable. Several small ponds are close to it, but the only other lake of any importance which occupies the same general region is Little Bear, separated on the southwest by a hill. There are other lakes in the same general locality, but they have no connection with Big Bear, and consequently need not be mentioned further here. Big Bear Lake lies mid-way between Johannesburg and Lewiston, about eight miles distant from each town. The map of the lake (outline and soundings) was made by the Michigan C.C.C. in the winter of 1938-39. The inventory* of the lake was made during the latter part of the summer of 1940.

*Personnel of survey party -- Walter Crowe and Boyd Walker.

Lumbering carried on in the vicinity of the lake by the Kneeland-Biglow Co. probably ceased about 1900-1910. The logs were hauled to the mill on the shores of East Twin Lake at Lewiston. The old railroad grade is still evident on the hillside east of the lake. The writer was able to learn little of the lake's early fishing history. Fishermen who had fished the lake for a number of years all said that large yellow perch were once abundant. Apparently the lake has always had a reputation as a fair fishing lake, but has never been considered as exceptional. There are 25 cottages on the lake at present and more are being constructed. All the cottages are on the southeast side of the lake. Two boat liveries are present. Much of the lake shore is privately owned, but since the state owns several hundred feet on the northwest shore the public has ready access. Big Bear Lake furnishes considerable recreation to the public: fishing, boating and swimming, in that order.

The shape of the basin is irregular, and approximately triangular. The three sides of the triangle are roughly 6,800 feet in length. The greatest north-south and east-west diameters are about 5,200 feet. The lake is of glacial origin, and was probably formed by a melting block of ice at the edge of a moraine. A glacial map of the region shows the lake to lie at the intersection of a morainic region and the sandy outwash plain. The country immediately surrounding the lake is somewhat hilly; to the south it is flat, jack pine and scrub oak plain. At present the lake is landlocked. It very possibly had a drainage connection with the Au Sable River in earlier times. The water level in the lake has apparently dropped considerably in the past few years. This is evident from the fact that many of the brush shelters which are indicated on the map as being placed beyond the five-foot contour

are now out of water. Some of the shelters, of course, may have been pushed ashore by ice, but others which are firmly anchored are now partially above the surface. Also, various former water levels can be clearly seen around the shore in the form of steps or benches, especially where the shore is composed of gravel and rubble. The sunken island on the south shore is now scarcely five feet below the surface, and on the map it is indicated as being ten feet below the surface, so the water level has probably dropped at least three to four feet in the past two or three years. The drop in level seems to be characteristic of the landlocked lakes in the region and in others it has been even more pronounced than in Big Bear.

The physical characters of a lake may have considerable importance in relation to its fisheries. Plant growth, bottom food production, and spawning activities are all more or less dependent upon bottom types, and the amount of shoal. Many fish find either gravel or plant growth essential to successful spawning. Forage fish and the young of the game fish present are for the most part limited to the shoal areas. Big Bear Lake has sufficient shoal area, especially on the northwest side. Unfortunately, many of the small bays are becoming filled with decaying vegetation, but this filling had no noticeable effect on the main basin of the lake. The water in the small bays is extremely shallow, and few fish were observed in them. Such factors as shore irregularities and water color also have an effect on the fish. Small, protected bays which are not subjected to strong wind and wave action will tend to be more productive than exposed shores, where wave action caused by the wind often causes poor plant growth and little bottom food production.

Barren shores usually result if the winds are generally from one direction, especially if this direction coincides with the long axis of the lake. Since at Big Bear the prevailing winds are from the northwest, the southeast shore is more or less unproductive, at least in plant growth. However, it should be mentioned that such a situation as this is by no means a disadvantage, especially since the northwest shore is quite well protected and plants grow well there. At least partly as a result of the wind action, the southeast shore, where the cottages are located, has a clean sand beach and affords excellent swimming, which must be considered as an important feature of the recreation offered by the lake. Plant growth is also directly dependent on light and consequently better growth is made when light is able to penetrate deep enough to allow plants to grow in those depths where they will have a good chance to withstand wave action. The water in the lake is clear enough to allow light to penetrate to a considerable depth, and plants grow best in water up to 9-10 feet, but they are also found growing up to 13-14 feet, though not as abundantly as in water ten feet or less in depth. The physical characteristics of the lake are presented in the following table (Table I).

Table I

Physical Characteristics of Big Bear Lake, Otsego County, Michigan

Area in acres	362
Maximum depth	30 ft.
% of shoal	20-25
Bottom types	
Shoal	Sand, gravel, fibrous peat
Deep	Pulpy peat, clay
Color of water	Colorless (visual test)
Secchi disk	12' 6"

The chemical conditions in a lake are also extremely important in connection with the general fishing conditions. Temperatures play an important role -- various species having different requirements, and all of them limited within certain ranges. The growth of fish is directly influenced by temperature. Temperature has a direct bearing on the dissolved oxygen retention of the water, and hence on the fish themselves. Other chemical factors, as pH (acidity) and M.O. (hardness), have direct effects on plant growth and consequently affect the production of the fish. Extreme conditions, either chemical or physical, are at once noticeable, but a normal fish population is not found in a lake with such conditions. A tabulation of the temperatures and chemical factors for Big Bear Lake follows (Table II).

Table II

Chemical Characteristics of Big Bear Lake,
Otsego County, Michigan

Date	Depth (ft.)	Temp. (°F.)	Oxygen p.p.m.	CO_2 range	M.O. range	pH range	Pollution
8-23-40	1	68	8.7	0.0	97	8.0	none
	4	68	...	...	..	...	..
	7	68	...	...	..	...	..
	10	68	...	...	..	...	..
	13	68	8.2	0.0	98	8.0	none
	16	68	...	...	...	...	..
	19	68	...	...	...	...	..
	22	68	...	...	...	...	..
	25	68	8.1	0.0	45	8.2	none

It will be noted that at the time of the chemical analysis no thermocline (that layer of water in a lake where the temperature drops one degree Centigrade or more with each meter of depth) was formed. Although this may

not represent the exact conditions every year, it is probably safe to assume that the lake does not stratify (a lake is spoken of as being stratified when a thermocline is present) for any long periods during the summer. This absence of a thermocline is important, for it means that the lake water is of about the same density throughout, enabling the oxygen-laden water from the top to mix constantly with that in the lower levels, thereby assuring an adequate supply of dissolved oxygen all through the lake. In a stratified lake the oxygen in the water below the thermocline may be used up through oxidation of decaying plant and animal material, etc. Since this water is denser than that above the thermocline it is unable to mix, and consequently, the regions below the thermocline are often uninhabitable for fish and certain important types of fish foods. It should be made clear, however, that whether or not the region below a thermocline is habitable depends upon the supply of dissolved oxygen, and not upon the presence or absence of a thermocline. The one chemical analysis made at Big Bear Lake indicates that there is sufficient oxygen from top to bottom for fish. In some instances one chemical analysis at one point in the lake would not be enough, but for Big Bear Lake it probably is enough to show the usual conditions. Most of the lake is exposed to wind action for a part of the time at least, and thus the water has a good chance to become thoroughly mixed. Also, with the temperature about the same throughout there is not much chance that a thermocline would be formed at any place except in the deepest part of the lake. The analysis was made in the deepest water in the lake. The water was found to be alkaline and moderately soft. No free carbon dioxide was present at the time of the analysis.

The aquatic vegetation present in a lake has a considerable effect upon the general productivity of the water. It serves as shelter and as a basic

source of food. It furnishes spawning areas for certain species. Aquatic vegetation, though not abundant in Big Bear Lake, is believed to be adequate for fish life. The 11 species found are listed below in the order of general abundance.

Species	Common name
Potamogeton amplifolius	Large-leaf pondweed
Nymphaea odorata	White water lily
Potamogeton natans	Floating-leaf pondweed
Potamogeton gramineus	Variable pondweed
Potamogeton praelongus	Whitestem pondweed
Potamogeton perfoliatus	Clasping-leaf pondweed
Potamogeton angustifolius	
Najas flexilis	Bushy pondweed
Scirpus acutus	Hardstem bulrush
Chara	
Nuphar variegatum	Yellow water lily

Fish foods may be divided into three classes: plankton (free swimming or free floating microscopic plants and animals, i.e., water bloom, water fleas), bottom or plant inhabiting foods(larval insects, aquatic earthworms, small crustaceans, small clams and snails), and forage fish. No plankton collections were made because it was felt that the data secured from collections of bottom and plant inhabiting foods would be more reliable. The amount of plankton present varies greatly through the season and even from day to day, and for this reason collections would have had to be made throughout the summer, and the earlier part of the summer was spent in making a fish population estimate and getting a creel census on the lake. Turning to the bottom foods, we find that in this respect the lake was not very productive, at least in comparison with similar bottom samples taken from other lakes throughout the state. Sample collections of $\frac{1}{2}$ square foot were taken in different parts of the lake at different depths through the use of an Ekman (clam shell type) dredge. The analyses of these

samples are tabulated below (Table III).

Table III

Summary of the Bottom Samples Taken during the Summer of 1940 at Big Bear Lake, Otsego County, Michigan

Sample no.	I	II	III	IV	V	VI	VII
Date	8-6-40	8-6-40	8-6-40	8-7-40	8-7-40	8-9-40	8-9-40
Depth	19 ft.	3½ ft.	3 ft.	23 ft.	10 ft.	10 ft.	11½ ft.
Bottom	Pulpy peat	Sand and detritus	Fibrous peat	Fibrous and pulpy peat	Sand	Fibrous and pulpy peat	Sand
Volume	Not meas.	.2 cc.	Not meas.	Not meas.	Not meas.	.1 cc.	.1 cc.
Oligochaeta	..	1	..	..	..	..	..
Gastropoda	..	2	..	..	..	4	..
Pelecypoda	..	7	..	1	1	4	..
Amphipoda	..	18	2	2	11	2	8
Hydracarina	..	..	..	..	1	..	..
Ephemeroptera	..	..	1	..	..	..	..
Anisoptera	..	..	..	..	..	..	1
Tricoptera	..	..	..	..	..	3	..
Coleoptera	..	..	..	..	..	1	..
Corethra	2	..	..	9	..	..	..
Chironomidae	4	17	2	4	12	9	3
Other Diptera	..	..	..	..	..	..	..
Totals	6	45	5	16	25	23	12

The following table (Table IV) gives an idea of the fish species present in the lake; they are listed in order of abundance in each of the groups: game, coarse, and forage species. A total of 13 species is present which is about average for lakes in the region. The population estimates given are based on the population study made on the lake. The common sucker is the most abundant fish in the lake, though it is possible that the blunt-nosed minnow surpasses it in numbers. However, the sucker population is far larger than that of any of the game species.

Table IV

Fish Species Present in Big Bear Lake, Otsego County, Michigan

(All species listed in order of abundance in each group)

GAME SPECIES	Stocking 1935-40	Est. pop.**	Range, inches	COARSE SPECIES	Est. pop.**	Range, inches	FORAGE SPECIES
Largemouth	3,500 (3)*	2,254	6.8-17.1	Sucker	7,295	10.4-19.0	Blunt-nosed minnow
Bluegill	53,750(3,4,5)	1,940	4.8-9.6	Brown bullhead Yellow bullhead	19	8.7-11.8	Menona killifish Muddler (bairdii)
Smallmouth	477(adult) 3,400(4)	1,333	5.5-15.4				
Pumpkinseed	....	1,325	4.2-8.4				
Rock bass	....	1,307	4.9-7.6				
Perch	5,000(6)	...	...				
Black crappie	....	...	...				

*Numbers in parentheses denote age in months.

**Estimated population from marking and netting operations conducted during the summer of 1940.

A fairly adequate series of scale samples was obtained. Growth studies have been made for the various game species in the lake. The results obtained from an examination of these scales are tabulated below (Table V).

Table V

Growth of Game Species in Big Bear Lake, Otsego County, Michigan

Species	Age group	No. specimens	Av. total length (inches)
Largemouth bass	0	1	3.0
	II	28	8.7
	III	3	11.9
	IV	3	13.2
	V	3	13.5
	VI	1	16.7
	VII	1	17.3
Smallmouth bass	I	2	6.5
	II	27	9.6
	III	2	12.0
Pumpkinseed	I	2	2.6
	II	4	5.3
	III	19	6.3
	IV	4	7.2
	V	1	8.4
Bluegill	II	15	6.0
	IV	3	8.7
Rock bass	II	5	5.5
	III	7	6.0
	IV	3	7.5
Perch	II	4	5.2
	III	3	7.0

The game species in the lake grow rather well, as compared with the growth of the same species over the entire state. They would be expected to grow faster than fish in the Upper Peninsula, but their growth is as good as, or perhaps a little better than, the same species from the more southern waters of the state. The largemouth bass reach legal size early in their fourth summer of life. Unfortunately, few scale samples were obtained from largemouth

bass in their fourth summer, but since a very few (4 per cent) reach legal size in their third summer, it is almost certain that most of them reach ten inches early in their fourth summer. Thirty per cent of the smallmouth bass from which scale samples were taken had reached legal size in their third summer, and two were over 12 inches, indicating that all of them probably reach ten inches early in their fourth summer. As can be seen (Table V) the average smallmouth lacked only one-half inch of being legal size in its third summer. Most of the scale samples were taken in early August, and, consequently, growth was not yet complete for the season, so that actually probably more than 30 per cent of the smallmouth reach legal size in the third growing season. Virtually all the pumpkinseeds had reached legal size during their fourth growing season. Better than 50 per cent of the bluegills had reached legal size towards the end of their third growing season. Rock bass reached legal size during their fourth growing season. Perch probably reach 6 inches early in their fourth summer of life, for those taken in August were well over legal size.

The species in the lake all spawn successfully, and natural propagation probably is adequate to maintain their numbers. Spawning areas for all the centrarchid species present are available, with good gravel shoals and a good deal of debris in the form of small sticks and deadheads. All species except the bluegill were actually observed on the beds, and fry (young of the year) were observed for all species. There is ample vegetation present for the perch. The only game species whose position in the lake is doubtful is the black crappie, but since only two were taken during the whole summer's netting, it is not likely that they are present in any numbers.

Management Suggestions

Population estimates (Table IV) indicate that from 50 to 60 per cent of the adult fish population (non-forage species) is composed of suckers and this number may possibly be reduced with benefit to the game fish crop. For the present the problem requires further investigation, and removal is not to be undertaken until a further understanding of the sucker's position in the lake is acquired. At present the lake is in the "All other lakes" class and should remain there. One million walleye fry were introduced into the lake in three different plantings in 1934, 1935 and 1936, and there have been no results. Either the water is not suited to this species, or else a nearly complete mortality occurred with each planting. If any of the walleyes had survived it seems likely that they would have appeared in the fishermen's "take" by this time or would have been taken in the extensive netting operations, but none was caught either by fishermen or nets during the summer of 1940. For this reason and because we do not think it advisable to introduce other predatory species besides the perch, largemouth bass, smallmouth bass and rock bass into the lake, we advise that further attempts to establish walleyes in this body of water be discontinued for the time being, at least. Until further investigation can be made during the summer of 1941, we recommend that stocking be limited to largemouth bass and bluegills, if it is necessary to plant the lake because of public demand. In order to further test the actual results from the transfer of adult bass from the Great Lakes, it is recommended that during the summer of 1941, 250 to 300 adult smallmouth bass be transferred from Lake Huron. They will be tagged, so that the results of planting may be carefully followed.

Concerning the predators on the lake, it does not seem advisable to try

to introduce an extremely predatory species such as the walleye. Perch, largemouth, smallmouth and rock bass undoubtedly devour large numbers of young fish and minnows. Some check on any population is always necessary to maintain the balance, and to prevent overcrowding resulting in poor growth. Besides the fish species already mentioned, the lake supports two pairs of herons, two pairs of ospreys, one pair of eagles, several kingfishers, a few gulls, turtles (at least one large snapper) and a few water snakes. The good growth made by all species (with the possible exception of the rock bass), and the fairly heavy population, at least compared with that of East Twin Lake in the same region, is in itself good evidence that the predators, either fish or birds, should not be destroyed.

In this body of water, parasitism is not important and very few parasitized fish were observed.

Cover is adequate in the form of vegetation, deadheads, and about ninety artificial brush shelters installed by the C.C.C. on the north, southwest and south shores of the lake. Vegetation has grown up through some of the shelters, and spawning beds were observed close in under several of them. Whether or not they increase the productivity of the lake, they do serve as cover, and do concentrate the fish for fishermen which in itself makes them an aid to the fishermen, though the value might be short-lived if by concentration of fish the removal was too great. In Big Bear Lake the shelters are numerous and the concentration of fish at any one shelter is not very great. The lake's drop in water level is probably correlated with a drop in the water table in the surrounding country and little can be done. The investigation of the lake will be continued during the summer of 1941.

INSTITUTE FOR FISHERIES RESEARCH

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