Original: Fish Division
cc: Education - Game
Institute for Fisheries Research
J. T. Wilkinson
H. L. Thompson
I. A. Rodeheffer

INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
UNIVERSITY OF MICHIGAN

ALBERT S. HAZZARD, PH.D.
DIRECTOR

ADDRESS
UNIVERSITY MUSEUMS ANNEX
ANN ARBOR, MICHIGAN

April 21, 1950

Report No. 1251

A FISHERIES SURVEY REPORT OF GLEN LAKE, LEELANAU COUNTY, MICHIGAN

By I. A. Rodeheffer and Jason Day

Abstract

Glen Lake, one of Michigan's larger inland waters, has been acclaimed one of the most beautiful lakes in the world. It has two distinct basins, the smaller west basin (Little Glen Lake) being suited for warm-water fishes while the east basin (Big Glen Lake) is adapted for cold-water species as well as warm-water forms. The fishing is good, especially for perch, but since the lake is somewhat removed from the beaten vacation roads, angling intensity on the whole is not as great here as on a number of other lakes of the State.

A fisheries survey was made of Glen Lake during August, 1949. Chemistry tests revealed the water of both basins to be hard, a favorable condition from the fisheries viewpoint. Big Glen is suited for trout since an adequate supply of dissolved oxygen occurs in the depths even during the critical mid-summer period; Little Glen is not adapted for trout because it is too shallow.

Aquatic vegetation was found to be sharply limited in occurrence in Big Glen Lake, but was rather common in Little Glen. Fish food appeared plentiful in both basins, and forage fish (minnows) especially were abundant.

Principal game fish are perch, smallmouth and largemouth bass, rock bass, with some northern pike also present; in addition, there are lake trout and ciscoes in Big Glen Lake. Natural reproduction among all established species, with the possible exception of lake trout, was found adequate. Examination of scales showed that the fish were experiencing good growth.

Management proposals include installation of brush shelters in Big Glen Lake, stocking with rainbow trout, and continuation of the lake trout stocking program. Potential invasion of the sea lamprey is discussed and control measures are considered.

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A FISHERIES SURVEY REPORT OF GLEN LAKE, LEELANAU COUNTY, MICHIGAN

By I. A. Rodeheffer and Jason Day[*]

Introduction

Location and Drainage

Glen Lake lies in Glen Arbor and Empire townships, (T. 28, 29 N., R. 13, 14 W., Secs. 1-3, 6, 10-12, 25-27, 31, 34-36, 4, 5, 29, 31-33), Leelanau County. The lake consists of a west basin (Little Glen Lake) and a larger, much deeper east basin.

At the nearest point, the east basin is about 3/4 mile from the town of Glen Arbor and about a mile from Sleeping Bear Bay of Lake Michigan. The village of Burdickville is on the southeast shore of the east basin. Glen Haven is situated approximately a mile south of the west basin. The village of Empire lies about 3 miles southwest of Glen Lake.

Intimately associated with Glen Lake are Big and Little Fisher lakes, which are located in Sections 24 and 25 of Glen Arbor Township and north of the east basin. Tucker Lake, in Section 24, drains into Little Fisher Lake. Another small body of water, known as Day's Pond (or Day Mill Pond) lies off the northwest corner of the west basin in Section 29 of the same township. Entering the east basin by way of the east shore and in Section 31

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[*] With some additions and revisions by C. M. Taube

is the small outlet stream from Brooks Lake, a pot-hole of about 10 acres.

Drainage of Glen Lake is by way of Big and Little Fisher lakes and Crystal River. This stream originates in Little Fisher Lake. The river meanders in a northwesterly direction, and after a distance of about 1 1/2 miles, as the crow flies, enters Sleeping Bear Bay.

The east and west basins of Glen Lake will for the most part be considered separately in this report and will be referred to as Big Glen and Little Glen respectively. However, it should be understood that local people think and speak of these two bodies of water as one, and they also are so indicated on county and state maps.

Acknowledgments

Glen Lake was mapped during the winter of 1949 by a party [1] from the Institute for Fisheries Research. Mapping was followed by a biological survey during August, 1949 by Institute personnel. [2] The survey party was aided in its work by many local residents among whom, to mention a few, were Messrs. W. W. Charters, C. A. Cheney, [3] Lud Garthe, and Carl Olsen.

Past and Present Use

From the earliest days the Glen lakes have occupied an outstanding place in the economy of the region. They were important when lumbering was the leading industry. When cordwood was used for fuel by the lake steamers, much of the hard wood in the area about the lakes was removed for this purpose, being transported by tramway from the lakes to Glen Arbor and Glen Haven piers and loaded aboard the ships. Fruits were also transported across the Glen lakes to follow the route to Chicago markets. Evidence of the use

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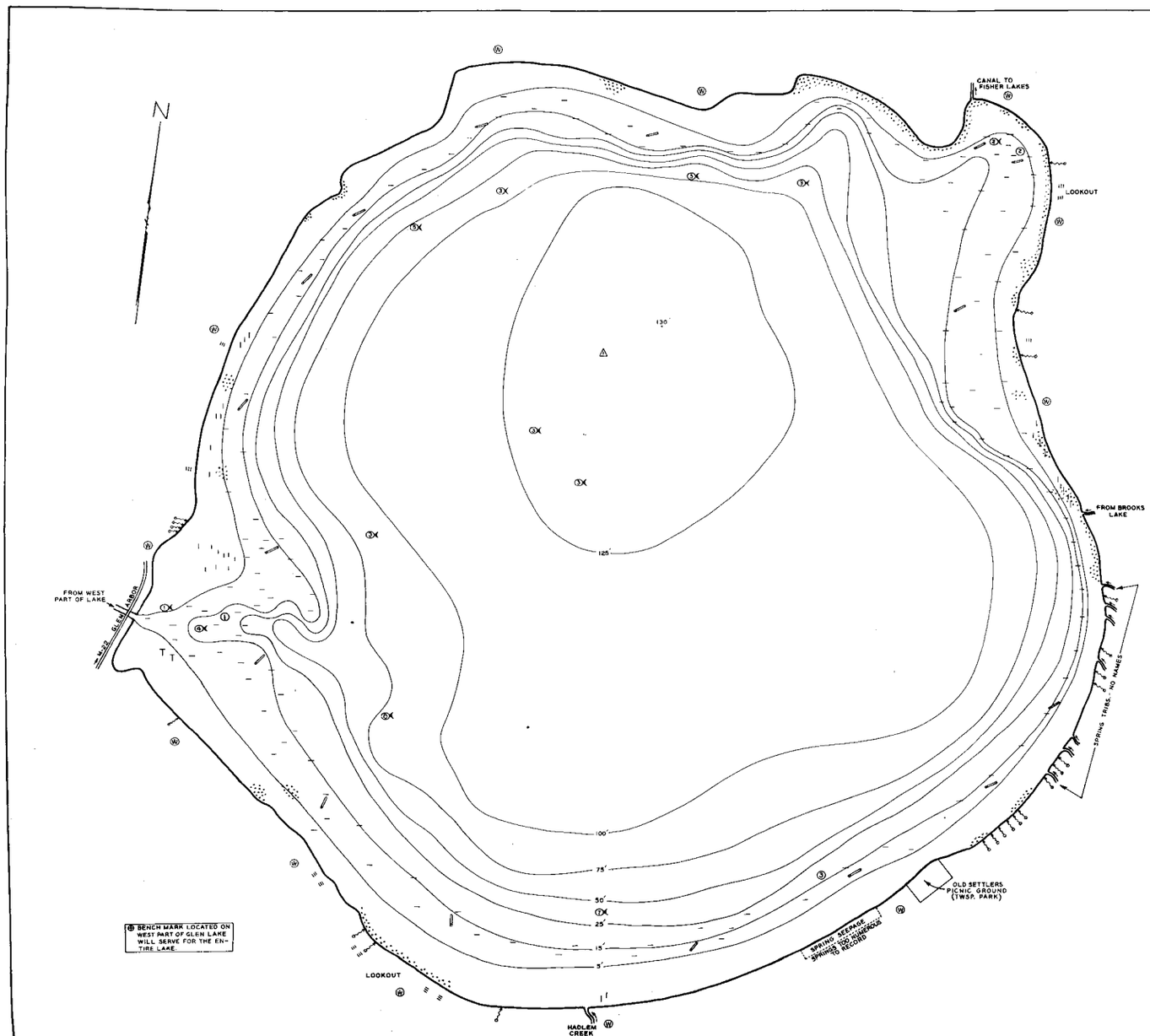
[1] O. M. Corbett, leader; Harold Wilson and George Allard, assistants.

[2] I. A. Rodeheffer, leader; Jason Day, assistant.

[3] Mr. Cheney kindly allowed the survey group use of his property for camping.



INSTITUTE FOR FISHERIES RESEARCH

DIVISION OF FISHERIES — MICHIGAN CONSERVATION DEPT.

LAKE INVENTORY MAP

GLEN LAKE

(EAST PART)

AREA 4865 ACRES

MARGINAL SURVEY AND SOUNDINGS 2/25-28 & 3/1-15/49
INVENTORY 8/49

LEELANAU CO. T.28-29 N., R.13-14 W., SEC'S 1,2,3,6,10,11,12,25,26,27,31,34,35,36

LEGEND

BOTTOM
- Sand
- Marl
- Gravel
- Deadheads

OUTLINE & CONTOURS
- Shoreline
- Contours

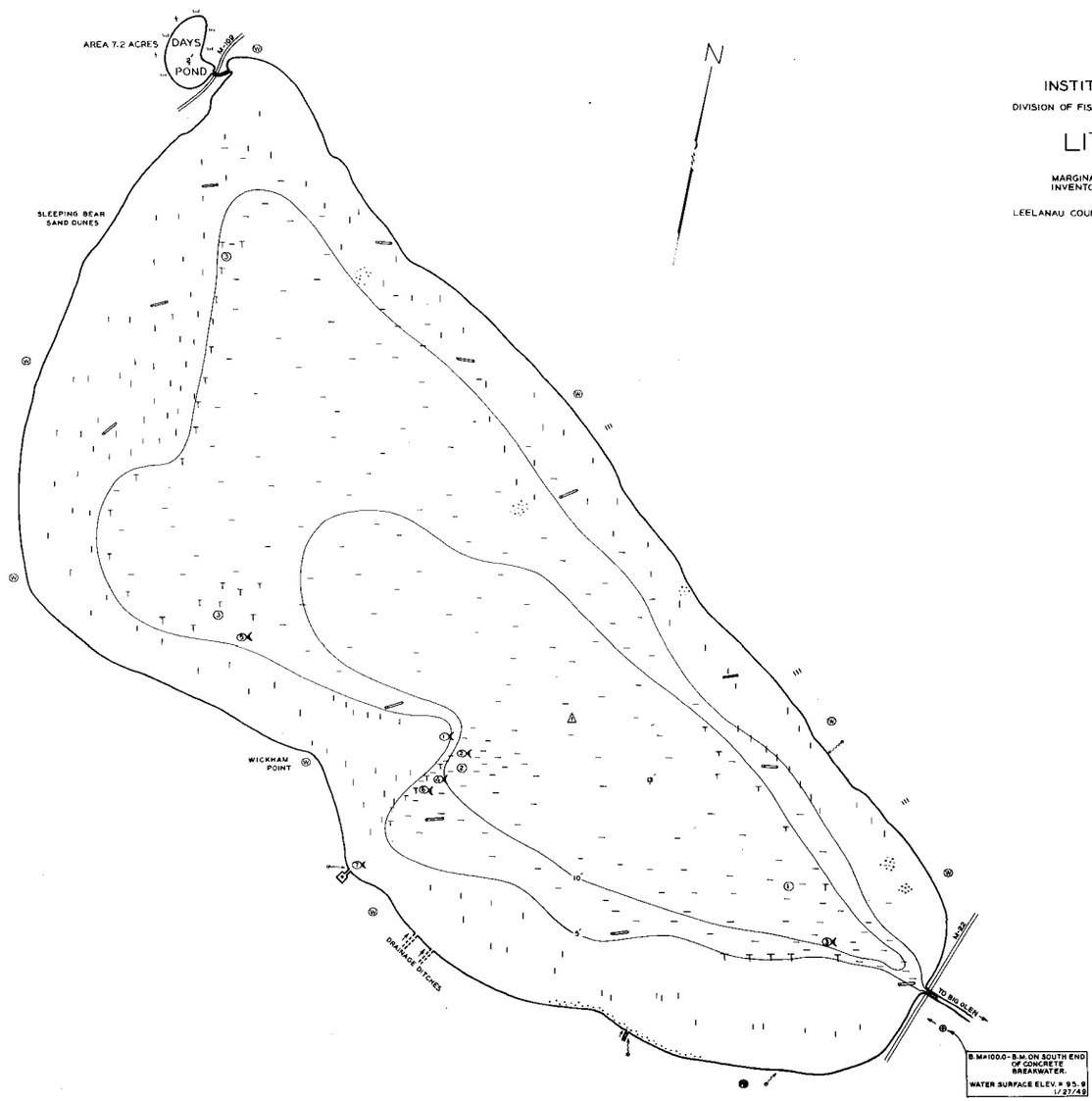
SHORE FEATURES
- Road
- Slope
- Spring
- Wooded
- Inlet
- Outlet

VEGETATION
- T Floating
- I Emergent
- – Submergent

STATIONS
- ① Vegetation
- △ Temp., chem., analysis
- ⑦X Fish sample

0 600' 1800' 2400' 3200'
SCALE

GLEN LAKE (EAST PART) Leelanau County T.28-29 N., R.13-14W. Sec's. 1,2,3,6,10,11,12,25,26,27,31,34,35,36



INSTITUTE FOR FISHERIES RESEARCH

DIVISION OF FISHERIES — MICHIGAN CONSERVATION DEPT.

LAKE INVENTORY MAP

LITTLE GLEN LAKE

AREA 1400 ACRES

MARGINAL SURVEY AND SOUNDINGS 1/18-21 & 24-27/48
INVENTORY 8/49

LEELANAU COUNTY — T.28-29 N., R.14 W., SEC'S. 3,4,5,29,31,32,33

LEGEND

BOTTOM
- Sand
- Marl
- Fibrous peat
- Gravel
- Deadheads

OUTLINE & CONTOURS
- Shoreline
- 5 Contours

SHORE FEATURES
- Road
- Spring
- Marsh
- Brush
- Wooded
- Partly wooded
- Boathouse
- Outlet
- Inlet
- Slope

VEGETATION
- T Floating
- ! Emergent
- – Submergent

STATIONS
- ① Vegetation
- △ Temp, chem, analysis
- ⊗ Fish sample

0 600' 1200' 1800' 2400'
SCALE

W.C.

LITTLE GLEN LAKE Leelanau County T. 28-29 N., R. 14 W., Sec's. 3,4,5,29,31,32,33

of these lakes for water power exists today in the form of a mill on the Crystal River, just north of Glen Arbor.

Residents often speak of the excellence of fishing in the lakes for perch and lake trout. Winter fishing is reported as very good. There are about 300 cottages on the lakes, many of which are substantial summer homes. Several resorts and hotels cater to the summer vacationist, and liveries supply motors and boats. A large number of the residents and visitors also engage in water sports other than fishing. These lakes are not so heavily fished as many other lakes in the northern vacation land of Michigan.

Possibly more resorts will open, resulting in an increase of fishing pressure, but the high price of land about the lakes is an inhibiting factor. Public access is available by way of the resorts and boat liveries and the state highway bridge which crosses the narrows between the two lakes. A road running southeast of Glen Arbor ends at Big Glen Lake and apparently is used by fishermen in launching their boats. This road-end is immediately south of Krull's boat livery. Another road-end, on the south shore of the lake, lies about 3/4 mile west of the bridge between the two lakes, and this also seems to be used by the public for launching boats and swimming.

A township park known as Old Settlers Picnic Grounds is located on the southeast shore about a mile north of Burdickville. This is used as a public access point.

Physical Characteristics

General Description

These are considered to be among the most beautiful lakes in the world. The water takes on an aqua hue and the shallows give various tints and shades of this hue. The most striking physiographic feature associated with the lakes is the Sleeping Bear sand dunes which lie off the west end of Little Glen Lake.

In outline the lakes take the shape of a short-handled hatchet with a triangular blade extending northeastward, the handle being the waters of Little Glen while the head forms Big Glen. A trip up the handle to a point of the blade would traverse a distance of approximately 6 miles. At the westernmost end of the handle are the sand dunes, and along the north shore of it a high range of forested hills extends eastward to the head, or Big Glen Lake. On the south shore of the handle a plain extends back an average distance of about 1/8 mile over much of its length. To the south beyond this plain another high range of forested hills runs the entire length of the handle and joins the bare sand dunes to the west.

Big Glen Lake is completely surrounded by high forested hills except for the level plain of the Crystal River valley extending to Lake Michigan. This valley is heavily forested. A narrow shelf, which was probably the shoal area of an ancient lake, surrounds much of the shoreline of Big Glen. It is upon this shelf that we find resorts, roads, and cottages.

Writing of the geological origin of the Glen lakes, I. D. Scott[4] says: "The depression was very probably in existence previous to the final invasion by the glacier which slightly overran the depression and persisted in its position. During this time earthy material was constantly being brought forward and dropped as the ice melted. This material was piled higher and higher in huge hummocks so that when the ice finally disappeared a high moraine or wall was left, which constitutes the south and east limits of the basin. But this explanation does not account for the high land (island) in the central part of the basin and, therefore, is qualified. This high land was once certainly an island for the waters of Lake Algonquin entered the basin through channels on the north and on the west sides isolating it. For a time the waves

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[4] Scott, I. D. Inland Lakes of Michigan, Wynkoop Hallenbeck Crawford Co., Lansing, 1921. pp. 360-361.

and currents of Algonquin coursed the track but eventually the western entrance was closed by a sand bar. Then followed a subsidence of the lake to the level called Nipissing and the west stand (the Sleeping Bear Point) was erected, the material being the sand of the bar and the builder the wind. The great Sleeping Bear is now a blow out, or better, a moving dune."

Drainage

Glen Lake drains the area within the basin of the hills about it and the tributary lakes, ponds, and streams, an area of about 25 square miles. No inlets of great importance exist. In Section 31 of Cleveland Township is Brooks Lake, a pot-hole of about 10 acres and 30 feet deep. This lake drains into Big Glen Lake through a stream which was about 5 feet wide and only inches deep at the time of the survey. Its length is about a quarter mile, the downstream end having a gravel bottom for about 200 feet up from the mouth while the rest of it up to Brooks Lake has a mucky bottom.

West of the village of Burdickville, in Section 11 of Empire Township, another stream enters Big Glen Lake. It is about a mile long, averages 6 feet wide and about 8 inches deep. A dam, about a half mile upstream from the lake, makes a private trout pond which is considered good fishing. The pond is not open to the public except by permission of the owner, Mr. John Hatlem. The dam is concrete and withholds a head of about 10 feet of water. A sluiceway deposits water from the pool about 15 feet from the foot of the dam. Fish could go up the sluiceway and undoubtedly the sea lamprey, if present, could also ascend its slope of about 45°. That part of the stream below the dam has a sandy bottom.

Large numbers of springs on the shores give their waters to the lake and it is thought that springs also replenish the lake from the bottom.

Day's Pond drains through a 36-inch corrugated metal pipe which crosses under highway M-109 and enters Little Glen Lake at the west end. At the time

of the survey in August, 1949, no water was flowing through this culvert. The pond encompasses an area of about 7 acres and has a maximum depth of only 2 feet. During the period of the survey it was mostly overgrown with vegetation. The pond was the scene of great lumbering activity years ago and much debris from that industry is still evident along the shoreline and in the water. The pond is reported to be used by fish, especially northern pike, as a spawning area. Many of these fish and their young may be trapped yearly by the seasonal falling of the water level, and winterkill possibly may result in the shallow water.

Water Fluctuation

The flow of water out of Glen Lake is controlled by a privately owned dam in the Crystal River in Section 23 of Glen Arbor Township. The dam is about 20 feet wide and in August, 1949, 5 inches of water was flowing over its retaining boards, which are about 15 feet long.

No inlets other than seeping springs, the stream from Brooks Lake, and Hatlem Creek were found, although in the spring time water is reported to enter the lake from Day's Pond.

Morphometry

Table 1

Physical data for Big Glen Lake and Little Glen Lake

	Big Glen Lake	Little Glen Lake
Area in acres	4865	1400
Area of shoal (to 15') acres	940	1400
Percent shoal	18	100
Type of bottom Shoal	Marl, sand, gravel	Marl, sand, gravel
Depths	Marl	Marl
Color and extent of transparency, feet	White to 20	White to 11
Maximum depth, feet	130	13

As shown in Table 1, Big Glen Lake has an area of 4865 acres of which only 18% or about 940 acres is 15 feet or less deep. Water of this depth is commonly considered shoal area. The lake has a maximum depth of 130 feet. The bottom is sand, gravel, and marl on the shoal and marl in deeper places. The water was colorless and the Secchi disk (a black and white circular metal plate 8 inches in diameter used to test water transparency) could be seen to a depth of 20 feet.

Little Glen Lake has an area of 1400 acres, all of which is considered shoal inasmuch as it is less than 15 feet in depth. The maximum depth is only 13 feet. The bottom consists of sand and some gravel along the shoreline while marl occurs in depths of over 5 feet. The water is colorless and the Secchi disk could be seen to 11 feet.

Discussion of Physical Features in Relation to Fisheries

In Big Glen Lake the relatively small amount of shoal area limits plant life. Furthermore, much of this water is 5 feet or less in depth, thus exposing the bottom to wave and ice action so that plants find it almost impossible to grow there. Aquatic plants harbor insects and other invertebrates upon which fish feed, and are considered desirable for good production of warm-water species of fish. Plants are found in this lake in depths down to 45 feet, although obviously most of them occur in depths of 5 to 15 feet. It is over this belt of vegetation where much of the fishing is done.

Approximately one-half of the bottom area lies at depths of 75 to 100 feet. Such great depths do not favor warm-water fishes such as largemouth and smallmouth bass, perch, and northern pike. If sufficient oxygen is found in these depths, however, trout and ciscoes may thrive.

As opposed to the great area of low productive water in Big Glen Lake, Little Glen Lake is admirably adapted to the production of warm-water fishes. Vegetation grows in all depths here except the extreme shallows. In all places

tested, beginning at about 4 feet, the bottom was covered with plant life. This thick carpet of plants provides protection for young fish as well as food for young and adults in the form of invertebrate animal life.

An adequate number of suitable spawning sites are available to most of the fish species inhabiting the Glen lakes. The smallmouth bass, if possible, chooses gravel for spawning purposes. Upon the sandy shoals where pieces of bark and similar debris collects, the largemouth bass may spawn, as well as in the rushes if wave action is not excessive. On the underside of fixed logs and boards along the shoreline in shallow water the bluntnose minnow deposits its eggs, and the large numbers of this forage fish in the Glen lakes is evidence of a satisfactory number of such reproductive areas. The perch deposits its eggs on vegetation.

The clearness of the water in the two lakes favors plant life, since light is necessary for its growth. Plants release oxygen into the water, about 4 parts per million of this gas dissolved in water usually being considered requisite for fish. Other sources of oxygen are wave and current action which mix it from the atmosphere.

Significance of Temperature and Chemical Data

Water temperatures are important in fisheries investigations. Each species has a definite range of temperature toleration as well as a more restricted range of temperature in which it grows best.

The chemical characteristics of water that are of particular interest in fisheries investigations are the amount of dissolved oxygen, the amount of dissolved minerals (hardness), and the acidity and alkalinity. Dissolved oxygen is necessary to fish and most other forms of aquatic life. A good supply of dissolved minerals is essential for maximum production of aquatic plants and animals, moderately hard waters generally being more productive than soft waters.

Temperature and Chemical Characteristics of Big Glen Lake.

In Big Glen Lake the upper 40 feet of water is warm (over 70° F.) in August. This upper warm water is affected by wave action and circulates during the summer. In the layer at 40 to 45 feet the temperature was found to drop from 73° to 55.7° F. This zone of rapidly dropping temperatures is called the thermocline. The thermocline separates the warm upper circulating layer (epilimnion) from the colder, deeper water of more uniform temperature (hypolimnion). Warm-water species of fish live in the upper layer of water. The colder layers are suitable for trout provided a satisfactory supply of oxygen is available. In this lake these comprise a large volume of water, more than 70 feet in depth.

In Big Glen Lake there is an abundance of dissolved oxygen. The amount varies from 7.6 parts per million at the surface to 11 parts per million at 60 feet to 2.6 parts per million at the bottom (128 feet). Only the few lower feet of the depths will not support fish life in August.

There is no free carbon dioxide at the surface and less than one part per million near the bottom.

The water is hard, a methyl orange test showing 135 to 155 parts per million of calcium carbonates.

The lake is for the most part moderately alkaline. A pH test gave readings ranging from 7 (neutral) to 8.1 (alkaline).

As far as could be determined there is no pollution in Big Glen Lake. Local sportsmen are pollution-conscious and have been instrumental in having a county regulation passed prohibiting pollution.

Table 2

Temperature and chemical characteristics of Big Glen Lake, August, 1949

(Oxygen, Methyl Orange Alkalinity, Phenolphthalein Alkalinity, and Carbon Dioxide in parts per million; potential hydrogen (pH))

Depth, feet	Temperature (° F)	O_2 ppm	M.O. ppm	Ph-th ppm	CO_2 ppm	pH
Surface	76	7.6	135	9.0	...	8.1
20	73.7	7.6	...	...	...	7.0
40	73.0	8.0	...	...	...	7.0
45	55.7	...	...	...	...	...
60	50.7	11.3	...	...	...	7.2
80	47.8	9.5	...	...	...	7.8
100	46.0	8.0	...	...	...	...
115	44.3	5.7	...	...	...	...
128	43.1	2.6	155	0.0	0.6	7.4

Temperature and Chemical Characteristics of Little Glen Lake

In Little Glen Lake the water temperature on August 16, 1949 was 76° F. at the surface and at a depth of 12 feet the temperature was about the same. In this lake during summer months we can expect to find only those fish which tolerate warm water. Among these are the largemouth and smallmouth bass, perch, rock bass, and northern pike, as well as many species of minnows.

At the surface the analysis showed 7.3 parts of oxygen to a million parts of water while at the bottom the oxygen present was 8.3 ppm. These two tests indicate that there is plenty of oxygen here to support fish life even during August when the dissolved oxygen content in deeper water of some lakes is very low.

The phenolphthalein (ph-th) test showed 10 parts per million of carbonates and bicarbonates. Methyl orange (M.O.) alkalinity tests showed the water to be hard, with 109 parts per million of calcium carbonate.

No free carbon dioxide was found in Little Glen Lake. Plants use carbon dioxide in minute quantities to manufacture starch with the aid of light. When this chemical is not present some plants will use the so-called "half-bound" carbon dioxide present in bicarbonates.

The pH readings were 8.2; pH tests the acidity and alkalinity of a lake.

No evidence of pollution was found in Little Glen Lake.

Table 3

Temperature and chemical characteristics of Little Glen Lake, August, 1949

Depth, feet	Temperature (° F.)	O_2 ppm	M.O. ppm	Ph-th ppm	CO_2 ppm	pH
Surface	76	7.3	109	10	0.0	8.2
12	76.4	8.3	109	10	0.0	8.2

Temperature and Chemical Factors in Relation to Fisheries

In regard to summer temperatures, the upper 40 feet of water in Big Glen Lake are suitable for warm-water fishes such as bass and pan fish, and in addition the lake has a considerable volume of cold water suited for trout. The whole of Little Glen Lake is adapted to warm-water species only. Because of the shallowness of the latter lake, it can be expected to warm up considerably with the advance of summer. Any fish requiring cold water will not as a rule be found here.

Free carbon dioxide was found to be virtually of no importance in either body of water. When the chemical analyses were run very little of this gas was found in Big Glen Lake and none at all in Little Glen. Carbon dioxide does not by itself kill fish until it reaches very high concentrations.

Positive phenolphthalein alkalinity readings were obtained on both lakes. From the fisheries standpoint it has considerably less significance than the methyl orange alkalinity test.

The water of Big Glen Lake is somewhat harder than that of Little Glen Lake as shown by the methyl orange readings of 135 to 155 parts per million of hardness for the former and 109 ppm for the latter. This test mainly indicates calcium carbonate (lime) in solution. Lakes giving values of 50 ppm or over are considered hard-water lakes. Hard or moderately hard water tends to favor good fish production.

The pH (potential hydrogen) test evaluates acidity and alkalinity. A reading of 7 is regarded as neutral. Readings over 7 indicate an alkaline condition and readings under 7 an acid condition. The water of Big Glen Lake ranges from neutral to moderately alkaline and that of Little Glen Lake is moderately alkaline. Fish tolerate waters showing a wide range in pH values.

Biological Characteristics

The biological characteristics of a lake of interest from a fisheries standpoint are the kinds and abundance of aquatic vegetation, fish-food organisms, and fishes. Plant life is of importance in furnishing shelter, particularly for very young fish. Plants use inorganic material in the manufacture of food and through them this material becomes available in digestible form for animals. The larger plants harbor insects and snails. They are also used for spawning by such species as perch and pike. The photosynthetic activity of plants adds oxygen to the water.

Fish foods include microscopic or near-microscopic plant and animal life known as plankton, insects and other invertebrates, and small fishes. Plankton is free-floating or free-swimming and furnishes food for very young fish and the larger fish-food organisms.

A study of the kinds and abundance of fish present is obviously important. Also of importance is a large collection of scale samples from the game fish for establishing an index of their growth and success.

Vegetation of Big Glen Lake

The vegetation zone in Big Glen Lake is mostly restricted to the drop-off. Just east of the M-22 highway bridge lies one of the denser beds of aquatic vegetation. Here the comparatively shallow bottom,as well as the drop-off, is covered with plants. The most abundant species is waterweed which forms a dense mat on much of the drop-off as well as on some of the shoal. Here also various pondweeds are found. And in the deeper water Chara and bushy pondweed extend out into the lake.

Progressing northward along the west shore from the bridge, one finds bulrushes on the sand shoal. In the deeper water on the gradual drop-off short-stemmed pondweed and Chara are sparsely scattered. Water-logged timbers

lying on the bottom are usually surrounded by a dense growth of waterweed. Chara, varying in sparsity, is found along most of the west shore particularly at the 10- to 12-foot depths and occasionally in places much deeper. Along the north shore all vegetation is very sparse. Here there is not even much Chara.

In the bay where the outlet enters Fisher Lake there is another area of dense vegetation. Chara and various pondweeds are prevalent. Along the east shore south of the outlet much of the bottom is stony and there is little vegetation. Farther south near where the outlet from Brooks Lake enters Big Glen Lake there are dense areas of rushes near the shore. In this area Chara extends down to a depth of 45 feet. On the steep drop-off there is a narrow belt of water milfoil, wild celery and pondweeds. Along the southeast and south shores a narrow belt of bladderwort, water milfoil, and some pondweeds occurs at about the 15-foot depth. Around water-logged timber lying on the bottom in 10 to 15 feet of water there are dense growths of waterweed.

In summary, approximately 400 acres of the bottom of Glen Lake supports aquatic vegetation. Most of this is found in the 10- to 20-foot depths but vegetation does extend from 1 to 45 feet.

The aquatic plants found in Big Glen Lake are listed in Table 4.

Vegetation of Little Glen Lake

About 20% of Little Glen Lake's 1400 acres is over 10 feet deep. An estimated 30% is from 5 to 10 feet deep and approximately 50% is from 1 to 5 feet in depth. Practically the entire bottom 5 feet and over in depth is covered with submergent vegetation but in the shallows there are large barren areas. In some places there are sparsely scattered emergent and subemergent plants. Approximately 75% of the bottom is covered with vegetation, varying in abundance from sparse in the shallows to dense in the deeper water.

Table 4

List of aquatic plants in Big Glen Lake and their relative abundance

Common name	Scientific name	Relative abundance
Waterweed	*Anacharis canadensis*	Abundant
Muskgrass	*Chara sp.*	Sparse to abundant
Water milfoil	*Myriophyllum sp.*	Common to abundant
Bushy pondweed	*Najas flexilis*	Sparse to common
Large-leaf pondweed	*Potamogeton amplifolius*	Sparse
Pondweed	*Potamogeton angustifolius*	Sparse to common
Pondweed	*Potamogeton filiformis*	Sparse
Pondweed	*Potamogeton Friesii*	Sparse
Floating-leaf pondweed	*Potamogeton natans*	Sparse
Sago pondweed	*Potamogeton pectinatus*	Sparse
White-stem pondweed	*Potamogeton praelongus*	Sparse to common
Clasping-leaf pondweed	*Potamogeton Richardsonii*	Sparse to common
Flat-stem pondweed	*Potamogeton zosteriformis*	Sparse to common
Three-square bulrush	*Scirpus americanus*	Sparse to abundant
Softstem bulrush	*Scirpus validus*	Sparse to common
Bladderwort	*Utricularia sp.*	Sparse to common
Wild celery	*Vallisneria spiralis*	Sparse to common

In the shallows, bulrushes are scattered along the north, west, and southwest shores, being thickest in the upper (west) end of the lake. Among the rushes, as well as on other areas of the shallow bottom, there are patches of muskgrass. In water 5 to 10 feet deep are found some barren areas in which there are only patches of pondweed. One such area exists about 1/4 mile northwest of the bridge between the two lakes.

The most abundant plants in the 5- to 10-foot belt are bushy pondweed and muskgrass. Along the drop-offs, and also frequently next to the bulrushes and in scattered areas where there is no perceptible drop-off, the floating-leaf pondweed flourishes. Large-leaf, short-stem, blunt-leaf, Sago, clasping-leaf and Robbin's pondweeds are also found. In water 10 feet or more in depth, the densest areas of pondweeds and other submergent plants are found near the bridge and northeast of the large sand bar that extends almost a third of the way across the lake from the south shore. Here waterweed is dense, and coontail, water milfoil, bladderwort, as well as various pondweeds occur. Bushy pondweed is abundant over most of the bottom 10 feet or more in depth. Wild celery and Chara are also found here.

A list of the aquatic plants and their relative abundance is given in Table 5.

Fish Foods of Big Glen Lake.

No tests were made for plankton. These important fish foods vary in abundance from season to season and from time to time within a season so that a few samplings, such as would be possible during a survey, do not give a true picture of plankton production in a lake.

Stomach examinations of fish revealed that perch, bass and rock bass were feeding almost entirely on crayfish, minnows, and young perch.

Bluntnose minnows are the most abundant forage fish in the shallower water. Here also are found the common spottail and sand shiners. These minnows

Table 5

List of aquatic plants in Little Glen Lake and their relative abundance

Common name	Scientific name	Relative abundance
Waterweed	Anacharis canadensis	Common to abundant
Coontail	Ceratophyllum demersum	Sparse
Muskgrass	Chara sp.	Sparse to dense
Water milfoil	Myriophyllum sp.	Sparse to common
Bushy pondweed	Najas flexilis	Common to dense
Large-leaf pondweed	Potamogeton amplifolius	Sparse
Pondweed	Potamogeton angustifolius	Sparse
Pondweed	Potamogeton Friesii	Sparse
Floating-leaf pondweed	Potamogeton natans	Common
Sago pondweed	Potamogeton pectinatus	Common
White-stem pondweed	Potamogeton praelongus	Sparse
Clasping-leaf pondweed	Potamogeton Richardsonii	Sparse to common
Robbin's pondweed	Potamogeton Robbinsii	Sparse
Flat-stem pondweed	Potamogeton zosteriformis	Common
Softstem bulrush	Scirpus validus	Sparse to common
Bladderwort	Utricularia sp.	Sparse
Wild celery	Vallisneria spiralis	Sparse

may be seen in greatest numbers in the vegetation along the drop-off. Young suckers are present in considerable numbers. Logperch and Johnny darters are found on the sand shoals.

Fish Foods of Little Glen Lake

As in Big Glen Lake, no plankton samples were collected here. Stomach examinations revealed that game fish were feeding primarily on minnows and crayfish. Minnows are abundant in Little Glen Lake. The bluntnose minnow is particularly abundant. Hauls with a 125-foot bag seine frequently captured 1 to 2 gallons of this species in one haul. Water-soaked timbers are scattered in the shallows and they offer excellent spawning places for these minnows. Sand shiners and spottail shiners are present in the vegetation along the drop-off. Sand shiners are common on the sandy shoals.

Crayfish are very abundant. They are common food organisms in the stomachs of perch, rock bass and black bass in August. Fishermen collect them on the shoals to use for bait, from under water-soaked wood scattered over the bottom. The abundance of aquatic vegetation over much of the bottom furnishes good harbor for many forms of invertebrates used by fish for food.

All observations and checks indicate that there is an abundance of fish food in Little Glen Lake.

Fish Present in Big Glen Lake

The kinds of fish found in Big Glen Lake, their relative abundance, size range, and the number stocked from hatcheries during recent years, are given in Table 6.

Perch are the most abundant species in the lake, many limit catches of these being made by fishermen during the time of the survey. Perch from 4 to 11 inches in length are abundant. They were caught in gill nets in water varying from 10 to 60 feet. Young perch are particularly abundant. In one of the better hauls with a 125-foot seine 4,531 perch were taken. All but 17 of these

were young-of-the-year, judging from their sizes. The lake has a reputation of being outstanding for year-round perch fishing. Mayfly nymphs, minnows, and crayfish are favorite baits.

Rock bass are second in abundance. Four- to 6-inch fish represented the dominant size group in our collections. Many young rock bass were netted in seining operations. Large rock bass, 10 to 11 inches in length, are present but there is little fishing for them.

Smallmouth bass are third in abundance. Big Glen Lake is a good smallmouth lake. An average haul with a 125-foot bag seine took 12 to 15 of these fish 2 to 4 inches long.

The young of largemouth bass are common, particularly amid the aquatic vegetation.

Thirteen northern pike were netted in Big Glen Lake. These were all caught in the vicinity of the bridge on highway M-22, and ranged from 22 to 33 inches in length. No smaller ones were taken or seen. Northern pike are not abundant in Big Glen Lake and an inspection of sizes netted causes one to question if the pike spawn successfully every year.

Big Glen is a good lake for lake trout. It is said that lake trout were always present here. General creel census records show that this species was taken previous to the first Department of Conservation planting (in 1933). Some stocking had been done as early as the late 1800's. In more recent times there have been almost yearly plantings of this fish.

Gill-netting for lake trout was not successful, only one trout being netted. Six other trout that were caught on hook and line by the survey party and fishermen were inspected. Three of the 7 specimens had the dorsal fin clipped, indicating that these definitely were planted fish. The other 4 specimens also could have been planted, since prior to 1947 a considerable number of

unmarked lake trout were stocked in Glen Lake. However, it is possible that natural reproduction of this species is occurring here. All trout were in excellent condition, one of them weighing 10 1/2 pounds and carrying 8,250 eggs.

Fishing for lake trout is not heavy during the summer, but when weather permits, two or three boats may be seen trolling for these fish. It is reported that this continues into the fall and that fishing through the ice in the winter is heavier than summer fishing.

In summer, trout are sought by trolling with a lure attached to from 300 to 500 feet of wire line. In winter trout are taken by fishing with a herring for bait. The method has been described as follows: The bait is lowered through a hole in the ice and permitted to rest on the bottom. The area is then "chummed" by dropping minnows weighted with nails to make them sink. Fishermen usually use a nail of about 8-penny size, shoving it into the minnow. Trout are sometimes caught with a number of nails in their stomachs.

White suckers are common. Young were taken by seine and adults were taken in both deep and shallow water with gill nets.

One burbot was captured in deep water. Gars and bowfins (dogfish) are reported present in the lake. However, none were taken in extensive netting operations.

Of the forage fishes, the bluntnose minnow is the most abundant. This probably is in part due to the excellent spawning conditions available for this species. The large amount of water-soaked driftwood along the shores provides ideal spawning places. Sand shiners, common shiners, and spottail shiners are also common in the lake. The mimic shiner is represented, and one hornyhead chub was collected. The Johnny darter and log perch occur on the sandy shoals.

Table 6

List of fish, taken or reported, their relative abundance, and stocking in Big Glen Lake

Common name	Scientific name	Relative abundance	Stocking record,[3] 1933 - 1948
Game fish:			
Northern pike	Esox lucius	Few	...
Perch	Perca flavescens	Abundant	10,000
Smallmouth bass	Micropterus dolomieu	Common	20,518
Largemouth bass	Micropterus salmoides	Common	11,000
Rock bass	Ambloplites rupestris	Abundant	...
Bluegill	Lepomis macrochirus	Few	168,200
Walleye[1]	Stizostedion vitreum		2,020,000
Lake trout	Cristivomer namaycush	Common	135,850
Cisco	Leucichthys artedi[2]	Common	...
Coarse fish:			
White sucker	Catostomus commersonnii	Common	...
Burbot	Lota lota maculosa	Few	...
Obnoxious fish:			
Bowfin[1]	Amia calva		...
Gar[1]	Lepisosteus sp.		...
Forage fish:[2]			
Mimic shiner	Notropis volucellus	Few	...
Sand shiner	Notropis deliciosus	Common	...
Spottail shiner	Notropis hudsonius	Common	...
Bluntnose minnow	Hyborhynchus notatus	Abundant	...
Logperch	Percina caprodes	Common	...
Johnny darter	Boleosoma nigrum	Common	...
Hornyhead chub	Nocomis biguttatus	Few	...

[1] Reported only.

[2] Identifications verified by Dr. R. M. Bailey, Curator of Fishes, University of Michigan Museum of Zoology.

[3] Stocking records are for both Glen lakes. No warm-water species stocked since 1944.

The fish in Big Glen Lake are mostly free of common parasites. Table 7 gives the number of fish of each species checked for parasites and the number infested. The fish were checked for yellow grub (Clinostonum marginatum), white spot (Neascus vanclevei), black spot (Neascus ambloplites), tapeworm (Proteocephalus, and allied forms), and copepods.

No severe infestations were found. Of the perch checked, from 3 to 10 black spots were counted on affected specimens, and 23 was the greatest number seen on any one perch.

Table 7

Number of Big Glen Lake game fish, by species, checked for parasites and the number found infested

Species of fish	Number checked	Number infested with: Black spot	White spot	Yellow grub	Tapeworm	Copepods
Perch	151	44	0	3	0	0
Northern pike	11	1	0	0	0	0
Rock bass	19	0	6	0	0	0
Smallmouth bass	3	2	0	0	0	0
Lake trout ✻	7	0	0	0	0	0

✻ Two of the seven lake trout checked had small white worms about 1/2 inch long (similar in appearance to flatworms) attached to the walls of the intestine near the rectum.

Fish Present in Little Glen Lake

Table 8 lists the fish and the general abundance of each species in Little Glen Lake. Stocking data from 1933 to 1944 are combined with those for Big Glen Lake.

Perch are the most common species in Little Glen Lake, the lake being known throughout the country for its good perch fishing. Large perch, 9 to 12 inches in length, are common, and many of these are caught. An average haul

with a 125-foot bag seine took 400 to 500 perch of which 15 to 20 were 6 to 11 inches long, the others apparently being young-of-the-year fish. Some seining produced over 2,000 perch per haul.

Smallmouth bass rank second in abundance. An average haul with the 125-foot bag seine would capture 15 to 20 of these fish, usually, from 3 to 5 inches in length. In one haul 5 smallmouths 8 to 12 inches long were netted. Another haul took 97 young smallmouth bass 3 to 5 inches long.

The largemouth bass also is an important species in Little Glen Lake. Each haul with the 125-foot bag seine produced 10 young largemouth bass on the average, 2 to 4 inches long, and as high as 20 were taken in a single haul.

There is little fishing for bass on the lake. Only occasionally does one see a fisherman casting for them. Bass are frequently caught, usually under limit sizes, by perch fishermen.

Rock bass are also found in Little Glen Lake. An average haul with the 125-foot seine usually captured 5 or 6 of this species, 5 inches or less in length. Gill nets caught a few larger ones. The dominant size class of rock bass caught was that of 5 inches.

Northern pike are not abundant. Most of the pike taken were caught in gill nets at one location--- near the large sand bar that extends into the lake from the south shore. They ranged in size from 17 to 28 inches.

The young of white suckers were taken in seines. About 10 adult suckers, either dead or dying, were found along the shore in August. These fish were extremely emaciated and apparently blind. Yellow and black bullheads were taken in a boat canal south of Wickham Point with a common sense seine.

Of the obnoxious fishes, gars and bowfins (dogfish) are reported as present in the lake. Neither of these species was caught or seen by the survey party.

The bluntnose minnow is the dominant forage species in Little Glen Lake. Water-soaked debris on the shoals offers many spawning places for this fish, and

the abundant vegetation provides ideal habitat.

Johnny darters are abundant and Iowa darters are fairly common on the extensive sand shoals of Little Glen Lake. Sand shiners, spottail shiners, blacknose shiners, and common shiners are also present.

Table 8

List of fish, taken or reported, their relative abundance and stocking in Little Glen Lake

Common name	Scientific name	Relative abundance	Stocking record,[3] 1933-1944
Game fish:			
Northern pike	Esox lucius	Few	...
Perch	Perca flavescens	Abundant	10,000
Smallmouth bass	Micropterus dolomieu	Common	20,518
Largemouth bass	Micropterus salmoides	Common	11,000
Rock bass	Ambloplites rupestris	Common	...
Bluegill	Lepomis machrochirus	Few	168,200
Walleye[1]	Stizostedion vitreum		2,020,000
Coarse fish:			
White sucker	Castostomus commersonnii	Common	...
Black bullhead	Amieurus melas	Few	...
Yellow bullhead	Amieurus natalis	Few	...
Obnoxious fish:			
Bowfin[1]	Amia calva		...
Gar[1]	Lepisosteus sp.		...
Forage fish:[2]			
Blacknose shiner	Notropis heterolepis	Common	...
Sand shiner	Notropis deliciosus	Common	...
Spottail shiner	Notropis hudsonius	Common	...
Common shiner	Notropis cornutus	Few	...
Bluntnose minnow	Hyborhynchus notatus	Abundant	...
Mudminnow	Umbra limi	Common	...
Johnny darter	Boleosoma nigrum	Abundant	...
Iowa darter	Poecilichthys exilis	Common	...

[1] Reported only.

[2] Identifications verified by Dr. R. M. Bailey, Curator of Fishes, University of Michigan Museum of Zoology.

[3] Stocking records are for both Glen lakes. No warm-water species stocked since 1944.

Little Glen Lake is one of the cleanest lakes from the standpoint of parasite infestations that the survey party members have seen in numerous summers of survey work. Table 9 gives the number of fish by species checked for parasites and the number infested.

Table 9

Number of Little Glen Lake game fishes, by species, checked for parasites and the number found infested

Species of fish	Number checked	Number infested with: Black spot	White spot	Yellow grub	Tape-worm	Copepods
Perch	116	15	0	3	0	0
Northern pike	9	3	0	0	0	0
Rock bass	31	4	0	0	0	0
Smallmouth bass	17	0	0	0	0	0
Largemouth bass	7	0	0	0	0	0

No severe infestations were found. In general, from 3 to 7 black spots were observed. The greatest number counted on any one perch was 17 black spots. Control of parasites is not considered necessary.

Stocking in Big and Little Glen Lakes

An extensive program of stocking warm-water species of fish was carried on in Big and Little Glen lakes in earlier years. The numbers stocked in both lakes during the period of 1933-1944 are listed in Tables 6 and 8. While planting of lake trout in Big Glen Lake has been continued, no warm-water fish have been planted in either Big or Little Glen since 1944. This is in line with the statewide policy begun in 1946 of sharply curtailing the stocking of warm-water fish after it was found that natural reproduction can provide an adequate stock of those warm-water species which are suited to a given body of water.

It is of significance to note that, whereas a considerable number of bluegills (168,200) were planted in these lakes within the period of 1933-1944 and that an immense number of walleye fry (2,020,000) were stocked during the same period, the survey party collected no samples of either species, and reported catches have been extremely rare.

Natural Propagation in Big and Little Glen Lakes.

Obviously good production of perch occurs in the Glen lakes. Likely some of the spawning facilities for perch are provided by vegetation.

Fisher and Brooks lakes appear to offer the most likely spawning areas for northern pike. The marshy sections of these waters are typical pike spawning grounds.

Smallmouth bass require gravel bottom for most successful reproduction; largemouth bass are less restricted in their spawning site requirements, utilizing various types of bottom soil. Big Glen Lake has considerable gravel on the shoals, and netting results indicate that smallmouth bass predominate over largemouth bass there. The bottom soil of Little Glen Lake in the shallows is mostly sand, and here largemouths apparently outnumber smallmouths, although the latter are also well represented. Every indication is that natural production is adequate for maintaining the bass stock in these lakes.

Rock bass show preference for areas near sunken logs or rocks as spawning sites. Water-soaked logs occur in both lakes and rock bass are quite plentiful.

Little is known concerning the natural reproduction of lake trout in Big Glen Lake, because so few lake trout were collected by the field party and all of those which were collected could have been from hatchery plantings.

Growth Rate of Game Species

Scale samples were collected from game fish, and microscopic examination of these resulted in the determination of ages and growth rates. Compared with

other lakes of the State, the growth rates of the fish of Glen Lake were found to be from average to slightly above average. This fact indicates that a good balance exists between the fish population and the food supply, which is a fortunate circumstance. Fishes from Little Glen Lake generally showed somewhat better growth than those from Big Glen Lake, which suggests that the former has a richer food supply. Such condition could be expected to occur since shoals are more conducive to food production than are depths, and Little Glen Lake has proportionately more shoal area than Big Glen Lake.

Detailed growth data are given in Table 10.

Management Proposals for Big Glen Lake

Regulations.

Big Glen Lake has been open to year-round fishing for such species as the law allows since January 1, 1946. It is said that in the spring there frequently are 60 to 70 boats in the vicinity of the bridge and that limit catches of large perch are so common that many of the residents are afraid the lake will be depleted of perch. However, present indications are that there is no danger of depletion, but rather that fishermen are only harvesting part of the available perch crop.

Stocking.

The stocking of warm-water species of fish is not recommended. Judging by the number of young smallmouth and largemouth bass, rock bass and perch present, stocking of these species is not necessary.

It is recommended that the stocking of lake trout be continued. Of the 7 lake trout checked by the survey party 3 had the dorsal fin clipped. It is said that Big Glen Lake always had lake trout. A stony area along the northeast shore may provide a spawning ground for lake trout, but information gathered from trout fishermen and observation show that planted lake trout are consistently taken.

Table 10

Growth rates of the fishes*

Species	Age group**	Big Glen Lake: Number of specimens	Big Glen Lake: Average total length, inches	Little Glen Lake: Number of specimens	Little Glen Lake: Average total length, inches	State average total length, inches
Perch	I	32	4.4	22	4.5	4.1
	II	30	5.9	24	6.2	5.8
	III	20	7.0	25	7.9	6.4
	IV	15	8.2	15	8.7	7.5
	V	22	8.9	9	10.3	8.5
	VI	15	10.2	3	10.7	9.5
	VII	19	10.6	1	11.7	10.4
	VIII	4	11.2	...	...	10.8
Largemouth bass	I	3	8.8	3	8.3	6.1
	II	...	...	2	8.1	8.7
Smallmouth bass	I	...	...	13	7.7	5.9
	II	...	...	4	10.6	9.0
	III	...	...	1	12.1	11.2
	IV	...	...	1	14.3	13.3
	V	1	16.3	...	...	15.0
	VI	1	15.8	...	...	15.3
	VII	1	18.3	...	...	16.4
Rock bass	I	...	...	4	3.5	3.2
	II	15	4.8	11	5.2	4.3
	III	30	5.6	14	6.4	5.2
	IV	2	7.2	1	7.6	6.2
	V	4	9.1	...	...	7.3
	VI	2	10.1	...	...	7.9
	VIII	2	11.3	1	10.8	9.0

* Age determinations by J. E. Williams.

** Number of annuli or completed growing seasons.

It is also recommended that rainbow trout be planted in Big Glen Lake. The water should be kept at the level set by court action so as to keep northern pike under control. Raising of the water level would make the channels from Day's pond and Tucker Lake passable to fish and possibly would also flood areas like the one at the west end of Little Glen Lake. These would then become pike spawning areas. Large pike populations are believed to be detrimental to trout.

Predators and Parasites

Few predators were observed in Big Glen Lake. Those seen were 2 blue herons, a flock of about 20 merganser ducks, and a few turtles. Longnose gars and bowfins are reported present.

Control measures for the above-named predators are not considered necessary.

A special section about the sea lamprey as related to Glen Lake is included in this report. No signs of sea lamprey were found, but the potential entry of this parasite into the lake deserves consideration.

Measures to control common fish parasites in Big Glen Lake are not considered necessary.

Cover.

Aquatic vegetation in Big Glen Lake is mostly confined to a rather narrow belt near the drop-off, varying in width from 5 to 40 feet. There also are some submerged timbers which provide cover for fish, but the addition of cover in the form of brush shelters may be desirable and their installation is recommended.

Regulation of Water Level.

The water level of Little and Big Glen lakes is regulated by a dam in the Crystal River, the outlet of Big Glen Lake. Court action has established an official water level of 596.75 feet above sea level. There are several groups

around Glen Lake interested in level control. People of one group favor a high water level so they can more easily float their boats through the canal between Glen and Fisher lakes; members of the other group favor a low level because they claim high water washes sand from the shoreline into the lake. Complete details of this are given in a report prepared by H. G. Hanes, hydraulic engineer, in which he presents the findings of a preliminary investigation made in the spring of 1949 by the Department of Conservation's Engineering and Architecture Section of the General Operations Division. This report presents evidence that high water causes bank erosion and creates shallow beaches and bars in the lake.

From a fisheries viewpoint, these shallow bars of shifting sand are unproductive. Shifting sand does not permit vegetation to grow, few fish-food organisms live on it, and it is not usable for spawning grounds. To improve the productivity of such areas, insurance should be provided against further sharp fluctuations of the water level.

Management Proposals for Little Glen Lake

Little Glen Lake has also been open to year-round fishing for such species as the law allows since January 1, 1946. Here, too, large numbers of perch are caught in the spring, illustrating one of the several justifications for permitting a liberalized season for some species when this does not endanger the welfare of other resident species of fish. Despite the large catch of perch, all evidence produced by the survey indicates this is not depleting the supply.

Stocking.

No stocking of warm-water fish is recommended. There are great numbers of young perch and largemouth and smallmouth bass present in the lake. The young of rock bass also are plentiful. Stocking of any of these species is not necessary.

Predators and Parasites.

A few turtles, several blue herons, and a flock of merganser ducks were the only predators observed on Little Glen Lake. Control measures for predators or parasites are not considered necessary.

Cover.

There is an abundance of vegetation in Little Glen Lake. Large amounts of water-soaked driftwood and timbers are scattered over the bottom on the shoals. This offers protection to young fish and provides spawning places for bluntnose minnows and rock bass. No provision of structures to furnish additional cover for fish is recommended at this time.

Regulation of Water Level.

The comments for Big Glen Lake under this heading also apply to Little Glen Lake.

Improvement of Spawning Facilities.

The aquatic vegetation in Little Glen Lake furnishes adequate spawning facilities for perch. Judging by the number of young smallmouth and largemouth bass in the lake, spawning areas for these species are adequate. There are 5 definite gravel areas along the north shore and another along the south shore that make good bass spawning grounds.

Northern pike production could be improved by deepening the channel and lowering the culvert under highway M-109 which connects Day's Pond and Little Glen Lake. This 7-acre pond averages about 2 feet deep and offers ideal conditions for pike spawning. However, since Little Glen Lake is directly connected with Big Glen Lake, it is the opinion of the survey group that northern pike should not be encouraged as they might interfere with the trout population of the latter.

Consideration of the Sea Lamprey in the Survey of Glen Lake

A major consideration in the survey of Glen Lake was the possibility of the presence of the sea lamprey, inasmuch as fish, and especially lake trout, have from time to time been caught which showed markings similar to those made by this parasitic fish.

In the spring of 1949 a lamprey was seen below the dam near Seeburg's boat landing by Leon Cluff, Leelanau County Conservation Officer, and also by sportsmen.

A trout was caught by Harvey Wells of Manistee, Michigan on March 12, 1949 and reported to the Institute for Fisheries Research as being scarred with marks similar to those made by lampreys.

In its investigation the survey party inquired of many sportsmen to determine if any of them had seen lamprey-marked fish. All reported that no marks which they had seen could positively be identified as caused by the sea lamprey. Some spoke of scars on fish but the description of them did not tally with those made by this lamprey. Possibly these marks were caused by one of the relatively unimportant native lampreys or by some accidental injury.

As a further check on the lamprey report, the survey party placed gill nets in Glen Lake to capture lake trout for inspection. While only one trout was taken by this method, 6 others caught with hook and line were checked and none of these 7 fish showed any signs of lamprey attacks. All of them were in excellent condition except for intestinal worms.

The investigators checked the two small streams entering Big Glen Lake in search for areas suitable for sea lamprey spawning. One of these streams, Hatlem's Creek, has a dam in it which has created a trout pond about 1/2 mile from the mouth. Below the dam the stream is about 5 feet wide, approximately 6 inches in average depth and the bottom is sand. Since the sea lamprey requires

some gravel for successful spawning, this part of the stream is not suited for lamprey reproduction. Above the pond the stream has some gravel bottom where lamprey spawning could take place. However, if the lamprey is spawning above the dam, its presence has not been observed, nor are the captive trout in the pond subject to lamprey attacks, according to reports.

The other stream examined enters Big Glen Lake on the east shore, north of Dunn's farm. The stream is about 1/4 mile long and averages about 5 feet wide and is approximately 6 inches deep. It drains from Brooks Lake. The lower half of this stream has a clean gravel bottom, while the upper half is mucky. The survey party checked both these types of bottom but could find no lamprey larvae.

Below a dam at Seeburg's Landing the Crystal River meanders a distance of approximately 6 miles to enter Lake Michigan. At no place inspected was gravel found in any quantity in this stream. The party checked its sandy bed and areas of muck along shore for lamprey larvae but could find none.

As a result of these observations it was concluded that the sea lamprey probably is not now present in Glen Lake. Although the possibility that lampreys could enter sometime in the future under present conditions cannot be ruled out altogether, their apparent absence at this time suggests that they either do not ascend the Crystal River or else cannot negotiate the dam below the lake. However, sea lampreys have been known to cross dams of some types.

Sportsmen of the Glen Arbor area constructed a screen barrier at the outlet culverts during the spring of 1949 but no one took the responsibility of keeping it clean and it became cluttered with debris. Screens for lamprey control do not appear practicable here. The dam in the outlet should be examined more thoroughly to determine its effectiveness in blocking possible lamprey migrations and, if found inadequate, modifications perhaps can be provided to make it effective.

This matter will be referred to V. C. Applegate, in charge of sea lamprey investigations in the Great Lakes for the U. S. Fish and Wildlife Service, and he may make a survey of the situation and offer suggestions.

INSTITUTE FOR FISHERIES RESEARCH

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