Original: Fish Division
cc: Education-Game
Mr. Fortney 6-5-42
H. H. Wallace 10-29-42

INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
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UNIVERSITY OF MICHIGAN

ALBERT S. HAZZARD, PH.D.
DIRECTOR

ADDRESS
UNIVERSITY MUSEUMS ANNEX
ANN ARBOR, MICHIGAN

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FISHERIES SURVEY OF CROOKED LAKE, CLARE COUNTY

by

John Funk

Introduction

Location and Drainages

Crooked Lake (T. 17 N., R. 6 W., Secs. 21, 22, 23, 27) is located in Garfield Township, Clare County. It is in the drainage of the Tittabawassee River, a branch of the Saginaw River. Eight Point Lake and Big Cranberry Lake are other important waters in the vicinity. The lake is about 12 miles west of Clare. The Village of Lake Station is on the northeast shore. US-10 goes through Lake Station.

Acknowledgements

A map of the lake showing shoreline and bottom contours was prepared by the M.E.C.W. during the winter of 1936-37. This map was used in charting vegetation beds and in locating sampling stations in the biological inventory. Fish collections were made July 2-4, 1941.* The biological inventory was conducted August 4-6, 1941.**

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*Personnel of fish party: W. C. Beckman, leader; Lee Anderson, Pat Galvin, Michael Pawlick, assistants.

**Personnel of inventory party: John Funk, leader; Eugene Roelofs, Stanley Lievense, assistants.

Past and Present Use

Crooked Lake is reported to have been used extensively for transporting logs when lumbering was the chief industry in the vicinity. Lake Station was then an important lumbering town.

The lake is one of the most beautiful in this part of the state. The high wooded shores provide pleasant cottage sites. There are about 100 well kept cottages, most of which seem to be occupied by the owners during the summer season.

A municipal park in which camping is permitted is located near the east shore but the park has no actual frontage on the lake. Boats may be put in at the terminus of a street in Lake Station.

Fishing, as usual, is reported to have been much better in the past than at present. In recent years there have been numerous complaints concerning the small size of the bluegills and other fish caught. Flagrant disregard of the legal size limit has been reported. On the other hand, some fishermen say they are catching larger fish than they formerly did. Spearing for pike through the ice is reported to be fair.

Easy accessibility and its popularity as a resort make this lake highly important as a public fishing water.

Physical Characteristics

Geological Origin

Although definite information is not available, the basin of Crooked Lake is undoubtedly of glacial origin.

Shape of Basin and Extent of Drainage

Crooked Lake consists of three oblong depressions which lie more or less parallel; their long axes extend approximately in a northwest-southeast direction. The southeast ends of the easternmost and central

depression are joined as are the northwest ends of the central and westernmost. Thus the entire basin is shaped somewhat like a letter S written backwards. The derivation of the name is obvious.

The drainage basin of the lake is of very limited extent, being not more than 4 or 5 square miles in area. The immediate shores are high, with sandy soil, and are covered with a rather thick growth of aspen and birch. The surrounding country is rolling with rather poor sandy soil. Farming does not seem to be very profitable. Part of the land is wooded.

Water Fluctuations

Fluctuations of water level are reported to be rather slight.

The inlet is 8-10 feet wide, a few inches deep, with no perceptible current at the time of the survey. It rises in Gray Lake about 1/2 mile south of the south end of Crooked Lake.

The outlet is so marshy that definite dimensions were difficult to determine. The main channel was apparently 20-50 feet wide, and 2-6 feet deep. There was little or no current. This stream flows through Mystic Lake into Big Cranberry Lake. The outlet of Big Cranberry is Chippewa Creek which follows a circuitous course through Clare, Osceola, Mecosta and Isabella Counties and finally becomes the Chippewa River. The Chippewa enters the Tittabawassee at Midland and the Tittabawassee joins the Saginaw near Saginaw. The Saginaw empties into Saginaw Bay.

Table I

Physical Data

Area in acres	Maximum depth	Shore development	Bottom types		Color of water	Secchi disc in feet
			Shallows	Depths		
264	73	1.92	Sand, marl, pulpy peat.	Pulpy peat, muck.	Brown, clear	9-12

Crooked Lake is moderately large and rather deep for inland lakes of the Southern Peninsula. The shoreline development of 1.92 means that the shoreline is almost twice as long as that of a perfectly round lake of equal area. A high shore development suggests a greater productivity since it usually indicates the presence of numerous protected bays and coves which are generally quite productive. The bottom materials are of types which frequently support luxuriant growths of vegetation. The brown color of the water is to be expected from the large amounts of organic matter in the lake. The Secchi disc is a black and white disc 8 inches in diameter which, when lowered into the water until it disappears, gives a rough measure of the transparency. A range of 9-12 feet is about average for lakes in this part of the state.

Physical Factors in Relation to Fisheries

The combination of physical factors possessed by Crooked Lake is in general near average for productive lakes in the vicinity. Although the lake is fairly large, the irregular shape and high, wooded shores combine to keep destructive wave action at a minimum. The fertile bottom types, moderately deep light penetration, and large amount of shallow water (45 per cent less than 15 feet in depth) are all favorable to the growth of aquatic plants. Although the small drainage area and poor soil limits the amount of fertilizing material washed into the lake, this may be somewhat compensated for by the relatively stable water level.

Temperature and Chemical Characteristics

Temperature

All fish have a definite range of temperature within which they can survive. Thus trout, etc., cannot survive for long periods in water which is warmer than 75°F. Bluegills, bass, etc., on the other hand, can stand much warmer temperatures. Within these ranges of toleration are optimum temperatures at which fish grow best. Since fish are "cold-blooded" and feed most actively when relatively warm, their optimum temperature is usually near the upper limit of toleration. Trout grow best in water near 70°F. but this is too cold to permit best growth of bluegills, bass, etc.

Another temperature phenomenon which affects fisheries is the formation of thermoclines in many Michigan lakes each summer. The thermocline is a zone of rapid change of temperature ($\frac{1}{2}$°F. or more per foot). This thermocline zone divides a lake into two horizontal layers, (1) An upper warm water layer where there is regular circulation and thus plenty of oxygen, and (2) A lower layer where the water is cold and often lacks adequate oxygen. Chemical changes which take place in this lower, stagnant layer will be discussed below.

Chemical Conditions

The amount of dissolved oxygen, the amount of dissolved minerals (hardness) and the acidity or alkalinity of the water are the chemical characteristics of most interest to a fisheries biologist.

Oxygen

Dissolved oxygen is necessary for fish and most other forms of aquatic life. A lake receives most of its oxygen supply by absorption from the air. Therefore when the water is in contact with the air and is mixed by circulation, dissolved oxygen is usually abundant. Ice in

the winter or the presence of a thermocline in the summer may remove all or part of the water from contact with the air and prevent mixing. When this occurs, respiration of organisms and decomposition of organic matter may use up part or all of the dissolved oxygen present. If the supply is reduced below 3 or 4 parts per million in certain parts of a lake, then fish cannot live there.

Alkalinity and pH

Dissolved minerals in the water are necessary for the growth of aquatic plants. The water of productive lakes is usually moderately hard, that is, contains sufficient amounts of dissolved minerals. Extremes of either acidity or alkalinity may have a limiting effect upon the organisms in a lake. Most productive lakes are slightly alkaline.

Pollution

Pollution is not a serious problem on Crooked Lake since that present is limited to domestic sewage from the cottages along the shore and the amount is not sufficient to cause any harmful effects.

Table II

Temperature and Chemical Data

Station	Location	M.O. Alkalinity range	pH range		Surface	Thermocline Top	Thermocline Bottom	Bottom
1	Deepest part of south depression	105-126	6.8-8.7	Depth in ft.	...	15	32	44
				Temp. in °F.	77	68	48	47
				O_2 in p.p.m.	7.6	7.7	0.0	0.0
2	Deepest part of lake	104-144	...	Depth in ft.	...	15	35	70
				Temp. in °F.	79	67	47	41
				O_2 in p.p.m.	7.6	7.1	1.1	0.0
3	Deepest part of north depression	85-133	...	Depth in ft.	...	...	...	25
				Temp. in °F.	79	...	...	52
				O_2 in p.p.m.	8.3	...	...	0.8
4	Inlet	189	7.4	Temp. in °F.	71	...	...	...
				O_2 in p.p.m.	4.5	...	...	...
5	Outlet	134	8.5	Temp. in °F.	81	...	...	...
				O_2 in p.p.m.	13.5	...	...	...

Temperature and Chemical Factors in Relation to Fisheries

The surface water of the lake had an abundance of oxygen and was warm enough to promote good growth of warm-water fish. Thermoclines were present in both of the deeper depressions. The water at the bottom of the thermocline and below contained little or no oxygen and so could not be inhabited by fish. The shallow depression at the northeast end of the lake was not stratified but the oxygen supply was greatly reduced in the deeper water.

The water of the lake was moderately hard (M. O. Alkalinity 85-189). This is about average for productive lakes. pH (acidity or alkalinity) ranged from slightly acid (6.8) to strongly alkaline (8.7). This upper limit, while not impossible, is unusually high. The data on pH may be faulty and should be checked at the first opportunity.

Biological Characteristics

Vegetation

Table III

Species and Relative Abundance of Plants

Species*	Relative abundance
Waterweed (Anacharis canadensis)	Rare
Water shield (Brasenia Schreberi)	Few
Coontail (Ceratophyllum demersum)	Abundant
Swamp loosestrife (Decodon verticillatus)	Few
Spike rush (Eleocharis Smallii)	Rare
Mud plantain (Heteranthera dubia)	Few
Water marigold (Megalodonta Beckii)	Rare
Water milfoil (Myriophyllum exalbescens)	Common
Bushy pondweed (Najas flexilis)	Common
Yellow water lily (Nuphar variegatum)	Few
White water lily (Nymphaea odorata)	Few
Pickerel weed (Pontederia cordata)	Common
Large-leaf pondweed (Potamogeton amplifolius)	Few
Pondweed (Potamogeton angustifolius)	Few
Pondweed (Potamogeton Friesii)	Few
Pondweed (Potamogeton gramineus var. graminifolius f. myriophyllus)	Few
Sago pondweed (Potamogeton pectinatus)	Few
Whitestem pondweed (Potamogeton praelongus)	Few
Flat-stemmed pondweed (Potamogeton zosteriformis)	Few
Arrowhead (Sagittaria latifolia)	Rare
Big bulrush (Scirpus acutus)	Few
Three-square bulrush (Scirpus americanus)	Rare
Common cattail (Typha latifolia)	Few
Wild celery (Vallisneria americana)	Few
Musk grass (Chara sp.)	Common

* Determinations by B. M. Robertson, Botany Department, University of Michigan.

Crooked Lake contained 25 species of plants at the time of the survey and 5 species were common or abundant. This plant population is somewhat larger than average for lakes in the vicinity. Aquatic plants benefit fisheries in a number of ways. They support large numbers of fish food organisms, most of which should be readily available to the fish. Their photosynthetic activity adds to supply of dissolved oxygen in the water. They are one of the most commonly available forms of shelter for fish and they may serve as spawning grounds. In lakes with limited amounts of shallow water, it would be almost impossible to have too many plants. However, in large expanses of shallow water,

weeds may become a nuisance. It is possible that they may become so thick as to restrict fish movements and prevent normal reduction of the number of small fish by predation.

Fish Foods

Plankton is composed of microscopic or nearly microscopic plants and animals which float free in the water. It is the chief food of all very young fish, most larger fish food organisms, and forage fish, and is utilized at times by some game fish. At the time of the survey plankton was moderately abundant in Crooked Lake. Animal organisms predominated. Since plankton populations are known to vary greatly from time to time and from place to place in a lake, a few samples taken at one time are only of general significance.

Invertebrate food organisms were abundant on the vegetation. Scuds (Amphipoda) predominated in the samples and midge largae (Chironomidae) and snails (Gastropoda) were common. Twelve or thirteen other kinds of organisms were present in smaller numbers. The bottom material from the deeper water contained only a few midge larvae and phantom midge larvae (Corethra). This is not of much significance, however, since the fish could not inhabit the area.

Four species of forage fish were collected (Table IV) of which three were considered common or abundant.

Fish Present

Table IV

Species and Relative Abundance of Fish

Species	Relative abundance	Stocking 1933-40
GAME FISH		
Northern pike (Esox lucius)	Rare	...
Perch (Perca flavescens)	Common	5,000
Walleye (Stizostedion vitreum)	...	80,000
Smallmouth bass (Micropterus dolomieu)	Rare	625
Largemouth bass (Huro salmoides)	Few	2,400
Green sunfish (Lepomis cyanellus)	Rare	...
Bluegill (Lepomis macrochirus)	Very abundant	9,500
Long-eared sunfish (Lepomis megalotis)	Rare	...
Pumpkinseed (Lepomis gibbosus)	Abundant	...
Rock bass (Ambloplites rupestris)	Few	...
Black crappie (Pomoxis nigro-maculatus)	Few	...
COARSE FISH		
Mud pickerel (Esox vermiculatus)	Rare	...
Yellow bullhead (Ameiurus natalis)	Rare	...
OBNOXIOUS FISH		
Dogfish (Amia calva)	Reported	...
FORAGE FISH		
Black-chinned shiner (Notropis heterodon)	Common	...
Common shiner (Notropis cornutus)	Rare	...
Golden shiner (Notemigonus crysoleucas)	Common	...
Blunt-nosed minnow (Hyborhynchus notatus)	Abundant	...

Eleven species of game fish were collected in the lake. The bluegill seems to be, by far, the most abundant, followed in order by the pumpkinseed and perch. Coarse and obnoxious fish are apparently relatively rare.

Creel Census

The few records for the lake from the general creel census seem to indicate that the species of fish mentioned above are the ones which are the most frequently caught.

Growth Rate

Table V

Growth Rate of Game Fish

Species	Age* group	Summer of life	Number of specimens	Average total length in inches	Tentative** state average total length in inches
Northern pike	I	2	1	12.7	...
	II	3	2	18.7	...
	III	4	1	26.2	...
Perch	II	3	5	4.4	6.2
	III	4	13	5.8	7.1
	IV	5	8	6.3	7.8
	V	6	2	8.5	9.4
Smallmouth bass	I	2	1	5.6	6.0
Largemouth bass	II	3	2	6.0	8.4
	III	4	6	7.5	10.8
	IV	5	1	7.6	12.1
	V	6	1	11.2	13.3
Green sunfish	II	3	1	2.6	...
	III	4	4	3.7	...
	IV	5	1	4.5	...
	V	6	1	5.6	...
Bluegill	II	3	2	2.6	4.3
	III	4	19	3.7	5.6
	IV	5	11	4.8	6.7
	V	6	22	6.0	7.4
	VI	7	4	6.2	7.8
	VII	8	4	6.8	7.9
	VIII	9	1	7.5	8.3
Long-eared sunfish	III	4	6	3.3	...
Pumpkinseed	III	4	8	3.6	5.8
	IV	5	11	4.7	6.4
	V	6	7	5.5	6.8
	VI	7	1	5.6	7.1
	VII	8	1	6.3	7.8
	VIII	9	1	6.9	...
Rock bass	III	4	1	5.4	4.9
	IV	5	9	6.0	5.6
	V	6	2	7.1	6.6
	VI	7	1	7.9	8.3
Black crappie	III	4	8	6.0	8.7
	IV	5	...	...	9.2
	V	6	1	8.2	9.7

*Age determinations by W. C. Beckman.

**Institute Report No. 741, Growth rate of some Michigan game fishes.

The ages of the game fish were determined by the scale method. Although the collections of some species are not large, it is thought that in general the results represent the general conditions in the lake. A comparison of the average total lengths of the fish from Crooked Lake with the tentative state average total lengths shows that in almost every case the Crocked Lake fish are growing more slowly, even though the physical and chemical characteristics indicate the lake to be average or better in its potential productivity.

Although our knowledge of the growth rate of northern pike is limited, it seems probable that the few specimens from Crooked Lake were making about average growth. The perch were definitely stunted, being a year and one half to two years behind the average for the state. Largemouth bass, bluegills, and pumpkinseeds were all growing quite slowly. It is hard to explain why largemouth bass should be below average in their growth when there is so much available forage in the form of small perch and bluegills.

Of the remaining species, the rock bass were growing considerably better than average although other species with similar habits were stunted. Black crappies were growing slowly, as were the green and the long-eared sunfishes. These latter, however, are generally slow growers all over the state and seldom reach legal size in Michigan waters. The one smallmouth bass taken was smaller than it should have been for its age.

Natural Propagation

All of the fish in the lake are, without doubt, reproducing successfully, if not too successfully. Numerous young of the game species were taken in seining operations.

Spawning facilities for all species present are abundant. Most of the shoreline is bordered with sand which should be ideal for bluegills and other Centrarchids. Gravel, which is required for smallmouth bass, is present in a few places. Perch and largemouth bass, which utilize weed beds, have abundant facilities. Pike, no doubt, spawn in the marshy region in the vicinity of the inlet and outlet. It seems probable that the slow growth of the fish in the lake may be due to unusually successful natural propagation, causing the lake to become overpopulated.

Management Proposals

Designation of Lake

At present Crocked Lake is in the "all other lakes" classification which the survey results indicate to be the proper designation. Since it seems desirable to encourage the more predacious species of game fish, such as pike, in order to reduce the numbers of the stunted perch and bluegills, it is recommended that the lake be closed by Commission order to the taking of northern pike by any method at any time of year for a period of 5 years.

Stocking

Since natural propagation of panfish seems to have been all too successful in the past, it is suggested that all stocking of bluegills, perch, etc., be discontinued, and that, as an experiment, heavy plantings of largemouth bass yearlings and walleyed pike yearlings be made for the next three years. If successful, this, together with the protection of northern pike, should result in an increase in the number of large fish-eating species and a reduction in the panfish. Better growth of bluegills, perch, etc., should follow. Results of this experimental program should be closely followed by the Institute.

Predators and Parasites

The only predators observed were a few herons, kingfishers, loons, and turtles. Dogfish were reported to be present. The amount of harm these animals do to fish populations is not definitely known. However, in the present case, the effect would probably be beneficial if they helped to reduce the number of small fish. In any case, control would not be advisable. Most of the game fish were parasitized (bass contained tapeworm) to some extent. Few of the grubs present cause the fish any great inconvenience, except the bass tapeworm. None of them are harmful to man. At any rate, no control measures are practical.

Shelter

The dense beds of vegetation in the shallower water all around the lake and especially in the northeast arm provides a great abundance of shelter. Some brush shelters have been installed in the lake. This is certainly wasted effort in a lake where natural protection is so abundant.

Regulation of Water Level

Since the water level is reported to be quite stable, regulation should not be necessary.

Spawning Facilities

Spawning facilities have apparently been so satisfactory and reproduction of panfish so successful in the past that more fish have been produced than the lake can support. Competition for food or living space has become so keen that none get enough and poor growth is the result. A lake, like a corn field, can produce only in accordance with its basic fertility. It can produce many small fish or a smaller number of larger fish. In either case, the number of pounds of fish per acre would probably be about the same.

On the assumption that there are too many game fish in Crooked Lake, either of two management procedures can be practiced. One, attempt to reduce the numbers of panfish by encouraging predacious species, as suggested above. Two, attempt to reduce the success of natural propagation. Methods for this latter type of management have not yet been perfected. Until further experiments can be carried out in this field of research, no recommendation for the artificial control of excess young fish can be made.

Other Suggestion

If the above program is carried out, a careful check by the Institute should be made each year for the next 5 years to determine the effect on the growth rate of the fish.

INSTITUTE FOR FISHERIES RESEARCH

By John Funk
Junior Aquatic Biologist

Report approved by: A. S. Hazzard

Report typed by: R. Bauch