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COOPERATING WITH THE
UNIVERSITY OF MICHIGAN

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ANN ARBOR, MICHIGAN

November 18, 1957

Report No. 1531

INVESTIGATIONS ON LAKE CHARLEVOIX, MICHIGAN, BY THE U. S. FISH AND WILDLIFE SERVICE, 1955

By

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While assigned to fishery and limnological studies on Lake Michigan in 1955, the U. S. Fish and Wildlife Service's research vessel Cisco entered Lake Charlevoix, Charlevoix County, five times. During these visits, limnological samples and fish were collected from this coastal inland lake by biologists[1] aboard the Cisco. Results of these investigations are given in this report. Some information on the lake on file at the Institute for Fisheries Research is included.

The area of Lake Charlevoix, as determined from aerial survey photos, is 17,000 acres. The 1929 map of this lake prepared by the U. S. Army Corps of Engineers indicates the maximum depth as 122 feet, but the greatest depth recorded by the fathometer on the Cisco was 107 feet. Former names of the lake were Long and Pine.

Visits of the Cisco to Lake Charlevoix during 1955 were as follows: July 15 and 16, during Cruise VI; September 3, during Cruise VIII; October 15 and 16, during Cruise X. Part of the routine operation of the vessel was the continuous use of a recording sonic fathometer and a thermograph.

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[1] Alfred M. Beeton, LaRue Wells, and Kenneth M. Allen

These data are on file at the Ann Arbor office of the Fish and Wildlife Service. At least one bathythermograph cast was made during each trip.

Hydrographic Station 35 was established on July 15 in the deep water area where the two arms of the lake meet, and was revisited on September 3 and October 15. The original bathythermograph records, as well as photographs of them, are filed at the Ann Arbor office of the Fish and Wildlife Service; prints of the photos are also on file at the Institute for Fisheries Research. Water samples were collected with Nansen bottles; analyses for dissolved oxygen were made aboard ship, and additional water samples were retained in 4-ounce polyethylene bottles for analysis of salt content.

Deep-water and mid-water trawling constituted part of the ship's operations on July 16. Additional data on the fish population were provided by a gill net set from October 15 to 16.

Physical and Chemical Data

On July 15, the thermograph recorded a maximum surface water temperature of 75.2° F. (24.0° C.) in the central part of Lake Charlevoix; the surface water was much cooler (70.2° F.) at the outlet. The epilimnion extended down to a depth of 20 feet. A well defined thermocline occurred between 20 and 30 feet. The temperature dropped from 73.4° to 59.9° F. in this region. The temperature from 30 feet to the bottom (at 99 feet), decreased more gradually, to a low of 46.6° F. (8.1° C.).

At Station 35 on September 3, the maximum surface temperature was 70.3° F. As on July 15, the temperature was lower at the outlet (68.1° F.). The lower limits of the epilimnion were somewhat deeper than on July 15, extending to depths of 25 to 30 feet. Some erosion of the thermocline may have occurred, as it was not so sharply delineated as on July 15. The temperature dropped from 69.8° to 64.4° F. in the 30- to 37-foot level,

with another drop, from 63.5° to 55.4° F., occurring between 45 and 52 feet. The lowest temperature (46.5° F.) was recorded at 96 feet.

By October 15 the lake was undergoing its fall overturn, as indicated by an increase in dissolved oxygen in deep water. On September 3 the oxygen content near bottom was 5.8 p.p.m., whereas on October 15 it was 8.6 p.p.m. The bathythermograph slides for October 15 and 16 show that the lake was almost homothermous, at a temperature of 57.5° F. (14.2° C.), to a depth of 65 feet, with a moderate drop in temperature, to 54.6° F., at 102 feet. The highest surface reading for these dates was 58.2° F. in the eastern end of the lake, near Boyne City. As on previous thermograph records, the surface water at the outlet was somewhat cooler (56.9° F.). This condition suggests that some upwelling may occur in an area at or near the outlet.

Chemical data are recorded in Table 1. An adequate supply of dissolved oxygen was present throughout all depths in summer. The total alkalinity is comparable to that of other lakes in this region. The sodium concentrations (3.2 p.p.m.) are within the limits recorded for Lake Michigan, while the calcium and silica concentrations are somewhat greater (approximately 6 p.p.m. and 2 p.p.m. higher, respectively). Specific conductance of the Lake Charlevoix water is also higher, this being, in part, related to the greater salt content.

Secchi disk readings on July 15, September 3, and October 15 (7, 10, and 18 feet, respectively) showed a progressive increase in transparency from summer into fall.

Plankton and Bottom Organisms

Seven plankton samples were collected at Station 35. Of these, five have been examined and the organisms listed with an indication of their relative abundance (Table 2). The samples are not considered quantitative.

Table 1.--Temperature and chemical data collected in 1955 on Lake Charlevoix at latitude 45° 17' 12", longitude 85° 11' 20"

Depth (feet)	Temperature (°F.)			Dissolved oxygen (p.p.m.)			Total alkalinity (p.p.m.)	pH			Ca (p.p.m.)	Na (p.p.m.)	SiO_2 (p.p.m.)	Specific conductance $K_{18} \times 10^6$
	July 15	Sept. 3	Oct. 15	July 15	Sept. 3	Oct. 15	July 15	July 15	Sept. 3	Oct. 15	July 15	July 15	July 15	July 15
0.0	74.8	70.5	57.6	8.0	7.8	8.8	146	8.2	8.2	8.2	36.00	3.29	4.29	253.8
39.4	55.4	63.3	57.6	8.9	7.8	8.8	133	8.0	8.0	8.2	38.67	3.16	5.15	261.8
75.5	....	....	57.0	...	...	8.6	...	...	...	8.1	.....	....	....	.....
85.3	....	49.3	....	...	5.8	...	...	...	7.5	...	.....	....	....	.....
88.6	47.1	....	....	8.2	...	...	140	7.7	...	...	38.00	3.21	6.80	257.7

Table 2.--Plankton and bottom organisms collected from Lake Charlevoix, 1955

Organism	Relative abundance[1]				
	July 15[2]	Sept. 3[3]	Sept. 3[4]	Sept. 3[5]	Oct. 15[6]
Cladocera					
Daphnia longispina	A	F	F	...	F
Daphnia retrocurva	F	...	...	...	...
Bosmina sp.	R	C	...	...	F
Leptodora Kindti	F	...	F	...	...
Copepoda					
Diaptomus sp.	C	F	...	...	C
Limnocalanus macrurus	C	...	C	...	F
Epischura lacustris	F	...	...	...	...
Copepodid stages	...	C	...	...	...
Ostracoda	...	...	...	F	...
Amphipoda					
Pontoporeia affinis	...	...	...	A	...
Rotatoria	F	...	...	...	...
Annelida	...	...	...	C	...
Insecta					
Tendipedid larvae	...	...	...	A[7]	...
Algae					
Microcystis aeruginosa	...	C	...	...	F
Anabena sp.	...	F	...	...	F
Lyngbya Birgei	C	A	A	F	F
Microcoleous vaginatus	...	...	...	A	...
Oscillatoria limnetica	...	...	...	F	...
Dinobryon sp.	...	C	...	...	...
Melosira sp.	...	...	...	...	F
Asterionella gracillina	...	...	...	...	F
Fragilaria sp.	...	F	...	...	A
Bulbochaete sp.	...	...	...	C	...
Aphanochaete sp.	...	R	...	...	...
Vaucheria sp.	...	...	...	C	...
Ankistrodesmus sp.	F	...	...	...	...
Coleochaete sp.	...	...	...	...	R
Ceratium hirundinella	...	A	...	...	A
Ceratium sp.	F	...	...	...	...

[1] A = abundant, C = common, F = few, R = rare, ... = not collected
[2] Sample collected at 4:00 p.m.; depth 90 feet; 1/2-meter net, 32 XXX grit cloth
[3] Sample collected at 3:15 p.m.; depth 16 feet; Clarke-Bumpus sampler, No. 10 mesh
[4] Sample collected at 3:45 p.m.; depth 96 feet; 1/2-meter net, 32 XXX grit cloth
[5] Sample collected at 4:15 p.m.; depth 78 feet; 1/2-meter net, 32 XXX grit cloth
[6] Sample collected at 10:30 a.m.; depth 16 feet; Clarke-Bumpus sampler, No. 10 mesh
[7] Taken from tubes in bottom material

Clarke-Bumpus samplers with No. 10 mesh nets and a 1/2-meter net, 32 XXX grit cloth, were used for collecting. These nets were towed horizontally.

Samples collected with the 1/2-meter net undoubtedly are not so representative of the entire plankton community as those collected with the Clarke-Bumpus sampler because of the relatively large size of the mesh. However, the data on crustaceans are probably reliable.

Samples collected with the Clarke-Bumpus device indicate that the phytoplankton community of Lake Charlevoix was characterized mainly by Ceratium hirundinella, Lyngbya Birgei, Microcystis aeruginosa, and Anabena sp. The filamentous alga, Lyngbya Birgei, was decidedly the dominant form and probably was the cause of the peculiar green color of the water. This species is indicative of high alkalinity and it is usually associated with Microcystis aeruginosa. Evidently a bloom of Ceratium hirundinella occurred during September and October, since this species was abundant in both collections taken with the Clarke-Bumpus sampler. Few Fragilaria occurred in the September collection, but a fall bloom was indicated by its abundance in the October collection.

The September 3 collection (4:15 P.M.) taken with the 1/2-meter net, gives an idea of the benthic community, since the net touched bottom and was filled with bottom material. This sample consisted almost entirely of masses of matted filamentous algae with various organisms in some marl. Most of the algae had lost their pigment, indicating that those forms had settled out. The occurrence of Pontoporeia affinis is interesting in that Mysis relicta was not found; these two species usually occur in the same habitat.

Marsh (1895) recorded five calanoid and three cyclopoid species of copepods from Lake Charlevoix. Although he recorded most of the species

found during the recent study, he did not list Limnocalanus macrurus. The plants found by an 1894 investigation (Ward, 1895) were almost completely different from those collected in 1955. Lyngbya and Fragilaria were the only forms collected both in 1894 and 1955. A comparable change in the fish fauna has occurred. Evidently there have been some changes of considerable magnitude in the environmental factors during the relatively short period of 61 years.

Fish Collections and Growth Rate

Four tows with an otter trawl were made at various depths on July 16, 1955. The trawl was approximately 35 feet wide and 6 feet high when in operation and had a 1/2-inch-mesh (stretch measure) cod end. Tow No. 1, for 10 minutes at a speed of 3 1/2 m.p.h., on the bottom at depths from 99 to 102 feet, caught 3 smelt, 4 perch, and 1 mottled sculpin (Cottus bairdi). Tow No. 2, for 10 minutes at 5 1/4 m.p.h., made at the 25-foot level over a depth of 102 feet, yielded no fish. Tow No. 3, for 8 minutes at 3 1/2 m.p.h., made on the bottom at depths that ranged from 22 to 42 feet, netted a large quantity of smelt fry, 12 smelt of larger size, 33 perch, 11 Johnny darters, and 3 logperch. Tow No. 4, for 10 minutes at 5 1/4 m.p.h., made on the bottom at depths from 51 to 84 feet, yielded 160 perch.

Data on vertical distribution of fish were obtained by setting a 600-foot, 2-inch-mesh (stretch measure), nylon gill net obliquely from bottom to surface in 72 feet of water. This net was set on October 15 and fished for 22 hours. The distribution of the catch by depth levels is shown in Table 3.

Scales of the fish collected in 1955 have been examined for information on age and growth. Four smelt of age-group I averaged 6.1 inches in length, and 4 age-group-II fish averaged 7.3 inches. The data for the perch are presented in Table 4.

Table 3.--Numbers of fish caught at different depths in an oblique set of a 600-foot, 2-inch mesh nylon gill net in Lake Charlevoix, October 15-16, 1955

Depth level (feet)	Length of net (feet)	Species	Number caught
Surface-20	150	Perch	1
		Smelt	1
20-40	150	Alewife	3
		Perch	2
40-60	150	Alewife	5
		Perch	4
60-72	150	Alewife	1
		Perch	50
		Smelt	6

Table 4.--Average total length (inches) of yellow perch of different ages collected from Lake Charlevoix in 1955, compared with the state average for this species

Source of data	Age group					
	II	III	IV	V	VI	VII
Lake Charlevoix[1]	7.7 (11)	7.3 (74)	6.7 (113)	7.1 (30)	7.9 (10)	8.6 (5)
State average	5.8	6.4	7.5	8.5	9.5	10.4

[1] Number of fish in sample shown in parentheses

An off-hand conclusion that might be drawn from these age and growth data is that growth rates of 2- and 3-year-old perch were above average for inland waters of Michigan, while fish of age classes IV through VII were below average. However, the preponderance of male perch over females in the catch and disproportionate distribution of the sexes within the age classes should be taken into consideration. These factors evidently account for discrepancies in the size averages and probably also make comparison with state averages invalid because male perch grow more slowly than females. Approximately 74 percent of the total catch (180 of 243) consisted of males. There were proportionally far fewer females represented in age-groups IV (100 males to 13 females) and V (27-3) than in age-groups II (5-6) and III (43-31).

The Fishes of Lake Charlevoix

Table 5 lists the kinds of game and pan fishes that have been reported from Lake Charlevoix. The bulk of this information has been obtained from general creel census records, on file at the Institute for Fisheries Research, that date from 1928 through 1956. An attempt has also been made to evaluate the abundance of the various species from these records.

Apparently perch, smallmouth bass, and rock bass are caught in greatest numbers during the open-water fishing seasons. Anglers catch numerous smelt during winter.

The fishery of Lake Charlevoix obviously has changed in several respects within recent years. The lake provided some good fishing for rainbow trout in the 1930's and 1940's, but evidently this species has decreased in abundance considerably since then. Lake trout were caught occasionally in earlier years; it is questionable if any lake trout are present now. Depredations by sea lampreys in Lake Michigan and Lake Charlevoix doubtless have influenced the decrease of both species. The sea lamprey has been re-

Table 5.--Game and pan fishes recorded from Lake Charlevoix

Species	Relative abundance
Brown trout	Few
Rainbow trout	Few
Lake trout	Few
Cisco	Common
Whitefish	Few
Smelt	Abundant
Northern pike	Few
Muskellunge	Few
Yellow perch	Abundant
Smallmouth bass	Common
Largemouth bass	Few
Pumpkinseed	Few
Bluegill	Few
Rock bass	Common
Crappie	Few
Suckers[1]	?
Bullheads	?
Burbot[1]	?

[1] Ward, 1896

ported in Lake Charlevoix (Guard, 1953). The fish collection records of 1955 show that the alewife has also invaded Lake Charlevoix.

Small walleyes were reported caught by ice fishermen on Lake Charlevoix during the winter of 1955-56. One of the fish was between 9 and 10 inches long. These walleyes may have originated from the plantings of 1955, when two introductions of fingerlings were made, one of 22,000 fish (average length, 2.5 inches) on July 15, and one of 12,000 fish (4.1 inches) on September 30. A planting of 25,000 fingerlings (2.5-inch average) was made on July 3, 1957. Although walleye fry (125,000) were stocked here in 1937 and also in the early 1900's, the Institute for Fisheries Research has no other record of capture of walleyes in Lake Charlevoix.

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