Original: Fish Division
cc: Education-Game
Mr. J. Marks 1-20-42
Mr. Funk

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

January 12, 1942

REPORT NO. 727

FISHERIES SURVEY OF CABLE AND HEMLOCK LAKES, CASS COUNTY

by

John Funk

Introduction

Cable Lake (T. 5 S., R. 16 W., Sec. 5) is located in Silver Creek Township, Cass County. Hemlock Lake (T. 5 S., R. 13 W., Sec. 3) is in Marcellus Township, Cass County. Both are landlocked lakes, but the territory in which they are located is in the St. Joseph River drainage. Cable is in the northwestern part of the County about 8 miles from Dowagiac. Crooked, Dewey, and Magician Lakes are near it. Hemlock is in the northeastern part of the County about $2\frac{1}{2}$ miles from Marcellus.

Maps of the lakes showing shoreline, soundings, and bottom types were prepared by an Institute mapping party. Fish collections and a biological inventory were made on each lake by parties from the Institute. The dates of these investigations are as follows:

Lake	Mapped*	Fish survey**	Inventory***
Cable	March 5, 1941	May 30-June 1, 1941	July 9, 1941
Hemlock	March 3-4, 1941	May 29-30, 1941	July 8, 1941

* Personnel of mapping party: Lee Anderson, leader; Richard Wilson, Royal Howe, assistants.

** Personnel of fish party: W. C. Beckman, leader; Lee Anderson, Raymond Buller, Donald Thomas, assistants.

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

No information is available as to possible past industrial use of these lakes. Since they are small and have no outlets, any extensive use seems improbable. Reports as to the early fishing history of the lakes vary. Fishing is said to have gone down in recent years in Cable Lake. Certainly fish are not numerous there, although some fine large bluegills are reported. Perch fishing is said to have formerly been much better than at present in Hemlock. Good catches of bluegills, largemouth bass, crappies, and sunfish are made in this lake at the present time.

There is no resort development on Hemlock Lake, although much suitable land is available. Its adjacent shore is high and it has a clean, sandy shoal. There is a picnic ground and a boat livery, as well as many private boats. There are about 30 cottages on Cable Lake and a public park with a well developed bathing beach. There is a fine, sand beach most of the way around the lake. Much of the land is high, making pleasant cottage sites. In addition, the other lakes in the near vicinity have extensive resort development. Both lakes are easily accessible, Cable by paved highway (M-152), and Hemlock by gravel road from M-119. The lakes are both undoubtedly of considerable potential importance as public fishing waters.

Physical Characteristics

Each lake has a maximum length of about $\frac{1}{2}$ mile and their long axes run a little to the east of north. The basins are both roughly oval in shape but that of Hemlock is more regular. The outline of Cable is broken by a large point, or peninsula, on the northeast shore and a shallow bay on the west margin.

These lakes are undoubtedly of glacial origin. The surrounding country is rather irregular and shows the effect of glaciation. The soil is sandy and seems to be of fair fertility. Neither lake has any inlet stream, the water supply being derived from springs and run-off. The drainage basins are therefore quite small.

Other physical characteristics not mentioned above are given in the following table.

Lake	Area in acres	Maximum depths (feet)	Shore development	Approximate per cent of shoal	Bottom types: Shoal	Bottom types: Depths	Color of water	Secchi disc (feet)
Cable	91.2	41	1.29	20	Sand, fibrous peat, pulpy peat and sand.	Pulpy peat	Clear, colorless	14
Hemlock	63.8	75	1.14	20	Sand, fibrous peat, fibrous peat and sand.	Pulpy peat	Clear, colorless	23

Cable and Hemlock Lakes are quite similar in some of their physical characteristics. Both are small and are protected enough so that there is practically no destructive wind action. Each has a rather low shore development. This factor expresses the relationship between the length of shoreline and the circumference of a circle of the same area as that of the lake. For instance, Cable Lake has a shore development of 1.29. This means that its shoreline is 1.29 times longer than that of a perfectly round lake of the same area. Since the most productive areas of lakes are usually along the shore, a lake with a high shore development is generally more productive.

Both lakes are about 20 per cent shoal. This means that approximately 20 per cent of the area is of a depth suitable for plant growth. Vegetation beds are the most important fish food larders of lakes. Therefore, other things being equal, the more area in a lake potentially capable of growing plants, the more productive it will be. The bottom types for shoal and depths in both lakes are quite similar, and the water is colorless and quite clear.

The lakes differ in depth, Hemlock being almost twice as deep as Cable. Hence, it has a much greater volume of water. The water in Hemlock Lake is the most transparent. This is shown by a Secchi disc reading of 23 feet as compared to 14 feet for Cable Lake. The Secchi disc reading is taken with a black and white plate, lowered below the surface until it disappears. Since plants are dependent upon light penetration, this factor gives us some idea of the depth to which plants will grow. Clear water allows light to penetrate further and plants to grow at greater depths. On the other hand, clearness may indicate a lack of plankton organisms which are important in the food chain of fish.

Temperature and Chemical Characteristics

The following table shows the temperature and chemical characteristics of these lakes at the time of the inventory.

Lake	Station	Location	M. O. Alkalinity range	pH range	Depth Temperature Oxygen	Surface	Thermocline Top	Thermocline Bottom	Bottom
Cable	I	Deepest part of lake	6.0-13.0	5.6-6.8	Depth in ft.	...	17.5	32.5	41
					Temp. in ^{o}F.	76	71	49	48
					O_2 in p.p.m.	8.0	8.2	0.0	0.0
Hemlock	I	Deepest part of lake	48.0-57.0	6.6-8.4	Depth in ft.	...	17.5	30	73
					Temp. in ^{o}F.	76	73	48	41
					O_2 in p.p.m.	8.4	8.6	14.7	0.2

Water temperature has two important effects from a fisheries standpoint. First, certain fish have definite temperature requirements. Trout, for instance, are generally considered to require water which usually remains below 70°F. Bass and bluegills, on the other hand, do best in warmer water. Second, all fish grow best in water which is near the upper limit of their range of temperature toleration. This is because fish, being "cold-blooded" animals are most active and feed most when the water is about as warm as they can stand. The upper water of both lakes gets warm enough to promote good growth in warm water fishes.

Both lakes are stratified, that is the temperature and chemical conditions change in a regular manner from top to bottom. Thermoclines are present in both. The thermocline is a zone of rapid change of temperature ($\frac{1}{2}^{o}$F. or more per foot in depth). This zone is probably present most of the summer and separates the water of the lake into layers. Practically all circulation due to wind action, etc., is confined to the upper layer. The water here is well aerated and follows more or less the temperature of the air. The water below the thermocline is stagnant during the summer and remains comparatively cold. In the lower water the supply of oxygen is often reduced below the requirements for fish. This is presumably used up mostly by the decomposition of organic matter on the bottom. In Cable Lake the oxygen below the thermocline was entirely exhausted so that the lower zone could not be inhabited by fish. In Hemlock, depletion of oxygen had started at the bottom but there was a good supply in the region of the thermocline. Since the water within and just below the thermocline had an ample amount of oxygen and was of suitable temperature, trout should do well in this lake.

Other chemical characteristics tested were pH or the condition of acidity or alkalinity and the amount of dissolved solids or hardness. Dissolved solids are considered to be essential for good growths of aquatic vegetation since plants are known to require minerals for their growth. Extremes of either acidity or alkalinity are limiting to most forms of life. The water of productive lakes is usually moderately hard and slightly alkaline. In Cable Lake the water is very soft (M. O. Alkalinity 6.0-13.0) and definitely acid (pH 5.6-6.8). The water of Hemlock is soft (M. O. Alkalinity 48.0-57.0) and slightly alkaline in the upper strata (pH 6.6-8.4).

The above statements apply to lake productivity in general. The best trout lakes seldom show all the conditions mentioned and frequently trout will thrive in a lake which is apparently almost barren. Good trout lakes have cold, clear water, clean bottom, and may have scanty vegetation. These characteristics are in direct opposition to those which would indicate maximum productivity for warm-water species. Food conditions in such lakes are probably much below the average of our warm-water lakes. If temperature conditions are right, however, trout are able to utilize the available food to much greater advantage than any of the warm-water fishes.

Biological Characteristics

It need hardly be stated that the vegetation in a lake has a definite bearing on the production of fish. The plants furnish shelter for fish of all sizes. They also harbor great numbers of fish food organisms which are readily available. In lakes such as those under consideration, it is probably safe to say the more plants the better.

The following table gives the types and relative abundance of the vegetation in the lakes.

Species*	Relative abundance Cable	Relative abundance Hemlock
Waterweed (*Anacharis canadensis*)	...	Abundant
Swamp loosestrife (*Decodon verticillatus*)	Few	...
Spike rush (*Eleocharis Smallii*)	...	Rare
Horsetail (*Equisetum fluviatile*)	...	Rare
Pipewort (*Eriocaulon septangulare*)	Few	Few
Bushy pondweed (*Najas flexilis*)	...	Common
Yellow water lily (*Nuphar advena*)	Few	Few
White water lily (*Nymphaea odorata*)	Few	Common
Pickerel weed (*Pontederia cordata*)	Rare	Common
Large-leaf pondweed (*Potamogeton amplifolius*)	...	Abundant
Pondweed (*Potamogeton crispus*)	...	Abundant
Robbins' pondweed (*Potamogeton Robbinsii*)	...	Abundant
Pondweed (*Potamogeton angustifolius*)	...	Few
Pondweed (*Potamogeton foliosus*)	...	Few
Pondweed (*Potamogeton pusillus* var. *mucronatus*)	...	Few
Three-square (*Scirpus americanus*)	Rare	...
Big duckweed (*Spirodela polyrhiza*)	...	Rare
Narrow-leaved cattail (*Typha angustifolia*)	Rare	...
Bladderwort (*Utricularia vulgaris* var. *americana*)	Rare	...
Water marigold (*Megalodonta Beckii*)	...	Rare
Musk grass (*Chara* sp.)	...	Few
Water moss (*Drepanocladus* sp.)	Few	...

* Identifications by B. M. Robertson

The difference in number of species and density of the vegetation in the two lakes are noticeable. Much of Cable Lake was almost devoid of plants. The few species found were mostly in the shallow, peaty bay on the west shore. The dominant forms there were swamp loosestrife (Decodon) along the margin and water lilies (Nuphar, Nymphaea) in the shallow water. Pondweed (Potamogetons) were entirely absent. Hemlock had a much greater variety of plants and many of those present were quite abundant. The most extensive beds were at the ends of the lake where the slope was gradual. However, even along the two sides where the drop-off was very steep, there was a dense band of pondweeds. Some characteristic plants were the water moss (Drepanocladus) and pipewort (Eriocaulon), usually found in acid waters, and the pondweed (Potamogeton crispus), considered characteristic of soft water. In summarization, it seems evident that Hemlock has an adequate plant population for a productive lake. Cable Lake, however, certainly has too few plants.

Plankton is made up of the microscopic or nearly microscopic plants and animals which float free in the water. They are utilized as food by all young fish, by larger fish food organisms, and, to some extent, by certain game fish. The amount and kind of plankton organisms vary greatly in the same lake even from week to week so that a single sampling may not be representative. In Cable Lake zooplankton, or animal plankton, was quite abundant (approximately 7 cc. per cubic meter) while in Hemlock Lake the plankton was less abundant (2.3-3.9 cc. per cubic meter). Zooplankton was again predominant.

An attempt was made to measure the relative abundance of the insects and other bottom food organisms in all parts of the lake. Definite areas of the bottom material were taken from deep water, the debris washed out, and the animals counted. The same method was used on the shoals where plants were scarce or lacking. The food organisms from weighed quantities of plants were counted. Plants were so scarce in Cable that only one plant sample was collected for this purpose, however.

The following table gives the relative abundance of the different organisms found in these lakes. The number and size of samples, depth range and bottom types are also given.

Type of sample	Shoal			Depths	
Lake	Cable		Hemlock	Cable	Hemlock
Number of samples	4	1	3	1	3
Average size of sample	½ sq. ft.	4 lb. plants	4 3/4 lb. plants	½ sq. ft.	½ sq. ft.
Depth range	1-10 ft.	1-2 ft.	7-12 ft.	40 ft.	20-73 ft.
Bottom type	Sand, gravel, pulpy peat	Fibrous peat	Fibrous peat, sand	Pulpy peat	Pulpy peat
Organisms					
Planarions (Turbellaria)	...	...	Rare	...	...
Aquatic earthworms (Oligochaeta)	Few	Rare	Few	...	Rare
Leeches (Hirudinea)	Rare	...	Few	...	...
Snails (Gastropoda)	...	...	Few	...	...
Fresh water shrimps (Amphipoda)	...	...	Abundant	...	...
Water mites (Hydracarina)	Rare	Rare	Common	...	...
Mayflies (Ephemeroptera)	Few	Rare	Rare	...	...
Dragonflies (Anisoptera)	Rare	Rare	Few-common	...	...
Damselflies (Zygoptera)	...	...	Rare	...	...
Fish flies (Neuroptera)	...	...	...	...	Rare
Caddisflies (Trichoptera)	Few	...	Few	...	...
Beetles (Coleoptera)	...	...	Few	...	...
Phantom midges (*Corethra*)	...	...	...	Rare	Few
Midges (Chironomidae)	Few-common	Rare	Abundant	Rare	Few-common
Other flies (Diptera)	Rare	...	...	...	...

Bottom food organisms were scarce in all parts of Cable Lake. Even the plant sample, which was expected to be quite productive, produced but a few individuals of only five different kinds. This is probably because five-leaved plants which usually support the most animals are very scarce. Fish food organisms are much more abundant in Hemlock. Fourteen different forms were collected. On the shoals scuds (Amphipoda) and midge larvae (Chironomidae) were abundant. Even the deeper water produced four forms with midge larvae being quite common. In general it would seem that the bottom food in Hemlock is good, but that of Cable is definitely below average.

The kinds of fish taken, their relative abundance, and the number of game fish stocked in 1933-40 are given in the following table.

Species	Cable: Relative abundance	Cable: Stocking 1933-40	Hemlock: Relative abundance	Hemlock: Stocking 1933-40
GAME FISH*				
Mud pickerel (*Esox vermiculatus*)	...	...	Rare	...
Perch (*Perca flavescens*)	Common	22,000	Common	...
Largemouth bass (*Huro salmoides*)	Few	5,700	Abundant	...
Warmouth bass (*Chaenobryttus gulosus*)	...	...	Few-common	...
Bluegill (*Lepomis macrochirus*)	Abundant	146,100	Abundant	80,000
Pumpkinseed (*Lepomis gibbosus*)	...	...	Abundant	...
Black crappie (*Pomoxis nigro-maculatus*)	...	...	Common-abundant	...
COARSE FISH				
Lake chub-sucker (*Erimyzon sucetta*)	...		Few	
Brown bullhead (*Ameiurus nebulosus*)	...		Rare	
Yellow bullhead (*Ameiurus natalis*)	Rare		...	
OBNOXIOUS FISH				
Dogfish (*Amia calva*)	...		Rare	
FORAGE FISH				
Black-chinned shiner (*Notropis heterodon*)	...		Rare	
Lake emerald shiner (*Notropis atherinoides*)	Rare		...	
Spot-finned shiner (*Notropis spilopterus*)	Common		...	
Blunt-nosed minnow (*Hyborhynchus notatus*)	...		Rare	
Star-headed top-minnow (*Fundulus dispar*)	...		Few	
Golden shiner (*Notemigonus crysoleucas*)	...		Few	

* Smallmouth bass are reported for Cable Lake but this may be a case of mistaken identity.

These results throw some interesting light on the past policy of stocking waters. Cable has been heavily stocked, yet has a scanty population of game fish, limited to the three species planted. Hemlock, on the other hand, has received very few hatchery fish, yet supports an abundant and varied population. Other noticeable things are the small numbers of forage fish in each lake and the fact that there is no overlapping of species of forage fish.

Scale samples were taken and growth rate studies made for all the game fish collected. The results of this study are given in the following table. Since the fish were collected early in the season it can be assumed that there has been little growth beyond the last winter mark.

Species	Age* group	Cable: Number of specimens	Cable: Length in inches	Hemlock: Number of specimens	Hemlock: Length in inches
Mud pickerel	I	...	...	1	5.6
	IV	...	...	1	10.8
Yellow perch	II	8	7.4	10	5.1
	III	5	8.8	15	7.6
	IV	1	9.5	3	7.5
	V	6	11.5	2	10.6
	VII	1	12.9	1	13.1
	VIII	2	11.7	...	...
	IX	1	11.6	...	...
	X	4	12.2	...	...
Largemouth bass	I	4	3.0	...	...
	II	1	7.3	25	6.2
	III	6	9.3	8	8.0
	IV	3	11.4	7	9.5
	VI	1	13.4	...	...
Warmouth bass	III	...	...	5	3.9
	IV	...	...	5	4.5
	V	...	...	4	5.2
	VI	...	...	2	5.2
	VII	...	...	4	5.7
Bluegill	I	1	2.3	...	...
	II	26	3.5	8	3.1
	III	4	5.3	47	5.2
	IV	6	7.2	2	6.1
	V	4	8.3	1	6.4
	VI	1	9.9	2	8.9
	VII	...	...	2	9.8
	VIII	1	10.4	2	9.2
	IX	1	10.4	...	...
Pumpkinseed	III	...	...	29	5.2
	IV	...	...	13	6.3
	V	...	...	1	5.8
	VI	...	...	2	6.8
Black crappie	II	...	...	41	6.5
	III	...	...	2	8.8
	IV	...	...	3	10.1

*Age determinations by W. C. Beckman.

All the fish from Cable Lake were doing better than average. Perch at the end of their second year were past legal size, largemouth bass were more than 10 inches long at the end of their fourth season, and bluegills were past legal size at the end of the fourth season. This growth is equal to, or better than, the average for the State.

In Hemlock Lake the growth rate in general was about one year behind that in Cable. In the case of the bluegills, the difference does not seem to be so great. Of the other species found only in Hemlock Lake, the warmouth bass never reaches six inches in length (if the sample studied is representative). The pumpkinseeds become legal in the fifth year, and the crappies in the second. The mud pickerel (not protected by law) seldom grow to 14 inches, which is the legal size for its close relative, the northern pike.

These results seem to contradict the observations made frequently while discussing the physical, chemical, and biological factors, to the effect that Hemlock was much the more productive lake. Any body of water seems to be able to produce only a certain number of pounds of fish. Either there will be many small fish or a few large ones. It may be that Cable Lake has a few fish which are able to grow well in the lake because they are not numerous enough to cause serious competition for food. Hemlock may have so many fish that even its great potential productivity is overtaxed and the keen competition for food slows the growth rate somewhat. A comparison of pounds of fish per acre would probably show a great difference in favor of Hemlock. A like difference would also be expected in the productivity of the two lakes.

Spawning facilities for all species present should be abundant in both lakes. Cable has plenty of solid sand shoal which should be ideal for bluegills and smallmouth bass. Weed areas suitable for perch and largemouth bass are more limited but enough to provide adequate spawning facilities. In Hemlock the bluegills, etc., utilized the sand shoals along the sides of the lake. The weedy areas at each end provide facilities suitable for perch and largemouth bass, while mud pickerel probably utilize the marshy zone along shore. It seems certain that natural propagation would be adequate to maintain the fishing in these lakes against any ordinary pressure.

Management Suggestions

Both lakes are now in the "all other lakes" class and for the present no change is suggested. Should rainbow trout do well in either or both, the lake or lakes should be opened to fall fishing for rainbow.

Since temperature and chemical conditions in Hemlock Lake are suitable for cold-water fish, the following experimental program is proposed. It is suggested that 1,000 adult rainbow trout be planted each year for three years. Plantings should be made late in the fall and the fish should be marked each year by clipping different fins. It is important that the fish planted be of good size (at least 8 inches) in order to prevent overpredation by the species already present. Stocking of all other species should be discontinued. At the end of the three-year period a careful check should be made to determine the extent to which the trout have become established. If reproduction is not taking place, desirable numbers to be stocked to maintain the population should be suggested at that time.

Cable Lake is definitely marginal for trout. There is a possibility that they might be able to survive the critical warm months in the lake. However, before an experimental planting is recommended, it is thought that another check of the temperature and oxygen conditions should be made during the summer of 1942.

If Cable Lake proves to be unsuitable for trout, the present population of game fish seems to be about adequate. Since spawning grounds are abundant, it seems certain that natural propagation will be able to maintain that population. All stocking should, therefore, be stopped.

The fish in these lakes were remarkably free from parasites. Those present were probably causing the fish little inconvenience and were certainly harmless to man. A few predators were observed. They were not numerous enough, however, to warrant any control measures.

Since vegetation is very scarce in Cable Lake, conditions might be improved considerably for fish by the introduction of some shelter devices. Brush shelters of the hollow square or some similar type are suggested, since these are thought to encourage the formation of weed beds. These should be installed along the shore in about 8 - 15 feet of water. Care should be taken to see that the shelters are well scattered and not concentrated in one area, and well submerged below the water surface.

Water level fluctuation seems to be slight on these lakes, but in any case control would be impractical. Spawning facilities seem to be adequate for all species present. No attempts at improvement are suggested.

INSTITUTE FOR FISHERIES RESEARCH

By John Funk

Report approved by: A. S. Hazzard

Report typed by: R. Bauch