REPORT NO. 406

A SURVEY OF THE WATERS IN THE LOST LAKE WOODS CLUB WITH RECOMMENDATIONS FOR THE IMPROVEMENT OF FISHING

by

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INSTITUTE FOR FISHERIES RESEARCH

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Introduction

The Institute for Fisheries Research was requested and authorized to survey the waters in the Lost Lake Woods Club through its secretary, Mr. Roy Brooks. This survey was to be made at a cost for services of not more than $150 which is to be paid by the Club.

Accordingly, a party of fishery biologists consisting of Mr. Lowell A. Woodbury, leader, and Messrs. W. Fenton Carbine and E. L. Cheatum, assistants, was assigned to this investigation. Dr. A. S. Hazzard, Director of the Institute, spent two days with the party in Mr. Woodbury's absence. The investigation required a period of 10 days, from September 18 to 27. Food and lodging were furnished the party at the Club in lieu of subsistence.

Purpose of the Survey. There are four lakes and a portion of trout stream, Sucker Creek, on the property controlled by the Lost Lake Woods Association. To date some plantings of fish have been made in the lakes and some sporadic lake improvement has been attempted. These efforts, although indicating that the technician in charge was aware of modern methods, have been without any definite plan and without the basic knowledge

of conditions existing in the lakes. Each lake should be regarded as an aquatic farm having its own individual problems and requiring systematic management if it is to yield a good crop of fish for the angler. Three steps are necessary in bringing a water under scientific management:

1. A survey of the fundamental physical, chemical and biological conditions for fish in each water.
2. Determination of the factors limiting fish production from study and interpretation of the survey data and preparation of management plans for the correction of these unfavorable factors.
3. Execution of these plans under competent supervision, keeping careful records of the work and the results. Some modification of the original management proposals as given in this report is to be expected as conditions change in the lakes.

It should be emphasized at this point that lake management is a very new science and many procedures have not been thoroughly tested as yet. It is therefore essential that the results of plans suggested be carefully recorded in order that the full benefits may be determined and changes made in the original plans if this proves to be necessary. A lake is similar to a farm in this respect in that constant management is essential to continuous and generous production.

It should likewise be emphasized that results from lake management cannot be secured in a single year. Several seasons under improved conditions are usually required before the fish yield is appreciably affected. A trout stream can be improved and planted with catchable fish in time to make an immediate showing the same season; the problem of improving lake fishing is more complex and difficult. Unless an intelligent plan be followed consistently, the work of one year may cancel that of the next.

In order to know what results are being obtained from a given management plan, it is essential that accurate records of the improvement work,

fish planting and of the fish catch in the lakes be kept. This will be further outlined under General Recommendations as follows:

General Recommendations for Improvement of Fishing: The following procedure should be followed in the management of the waters of the area. Specific management proposals for each lake and for Sucker Creek will be found following the discussion of the waters concerned.

1. A creel census report properly filled out should be made by each member or guest for each day (or part) of fishing on each lake. The Institute will supply the cards for this purpose in convenient books and will analyze the results of the fishing at the end of the year. The cards and this service will be gratis since the information obtained will help us in the management of public waters. In this way the Club will know the trend of fishing in the different lakes over a period of years and the results of the management efforts will be demonstrated.

The following is a sample of the report form which should be used:

CREEL CENSUS—Michigan Department of Conservation

Lake or Stream____ Fisherman's Name____

Township____ City or Town____

County____ Sex?____ Approximate Age?____

SPECIES CAUGHT	LEGAL SIZE		UNDERSIZE	
	Number	Av. Lgth.	Number	Av. Lgth.
Brook Trout				
Rainbow Trout				
Brown Trout				
Large Mouth Bass				
Small Mouth Bass				
Bluegills				
Sunfish				
Yellow Perch				
Pike Perch (Walleyes)				
Northern (Grass) Pike				

(Enter other kinds taken on blank spaces above)

Date____ 193____

Kind of Fishing:

Ice?____ Still Fishing?____

Boat?____ Trolling?____

Shore?____ Casting?____

No. of persons?____ Total No. of lines?____

Bait (Check if only one kind of bait used)

How many fish caught with worms?____

Insects?____ Minnows?____ Spinner?____

Plug?____ Artificial Fly?____

If taken with other bait, or by spear, dipnet or other means, state how____

Weather: Clear?____ Heavy Wind?____ Cold?____

(Check) Cloudy?____ Light Wind?____ Mild?____

Rain?____ Calm?____ Warm?____

TIME FISHED ____ HRS.

A.M. ▼ 12 1 2 3 4 5 6 7 8 9 10 11 12

P.M. ▲ 12 1 2 3 4 5 6 7 8 9 10 11 12

Draw line through hours and quarter hours fished; double line through indicated time when fishing was best. Make out report whether fish are caught or not.

2. A separate record of stocking for each lake should be kept by the Secretary or Manager of the Club. This should show: name of lake, date of planting, species of fish, length when planted, by whom planted and the name and address of the organization from which the fish are secured.

3. Follow the stocking plan for each lake exactly as to species and as nearly as possible as to numbers as outlined under the management proposals for that lake. No change in the plan should be made without competent advice.

4. Keep an accurate record of any improvement work, as installation of shelters, addition of fertilizer, etc. with the dates of work, amount accomplished and location of structures. (An extra outline map of each lake will be provided, if this plan is adopted, for this purpose upon which the improvements can be located as installed.)

5. Secure the unanimous consent of the Club to the management proposals and impress upon them the necessity for cooperating in furnishing accurate records of their catches.

6. The improvements recommended should be constructed and installed under the supervision of a technician experienced in this work. The Institute can furnish the names of several young men who are competent to undertake this task.

7. It is recommended that a re-survey of the area be made at the end of a five year period to determine the effects of the management plan and make any further improvements or changes in plans which are needed. During the first five year period the Institute will be pleased to act as consultant in the execution of the management proposals.

At this point it may be well to mention the fact that in the management of a lake a choice must be made between having a comparatively few large fish in a lake or a large number of smaller sized fish. A large number of large fish cannot live together in a small lake due to a shortage of food and the space factor (the space factor is the amount of space

required by each fish and this amount is larger in proportion for the larger fish than for the smaller ones). The recommendations in this report are designed to promote a good catch of moderate sized fish rather than a poor catch of larger fish.

DISCUSSION OF THE PHYSICAL, CHEMICAL AND BIOLOGICAL CONDITIONS FOR FISH LIFE IN THE LAKES AND IN SUCKER CREEK WITH MANAGEMENT PROPOSALS FOR EACH WATER

Badger Lake

Size and Location. Badger Lake is a moderate sized lake of 83 acres, roughly trapezoidal in shape with the base to the north, it is about 3,300 feet long by about 1,600 feet wide. On the north and northwest it is bounded by a swampy, brushy area; on the east by open rolling country, where the clubhouse, garage, camp grounds and other properties of the Club headquarters are located; on the south by marsh. Trees are common around the lake, especially on the west and southeast shore.

Inlets and Outlets. The inlet consists of a branching stream from Lost Lake which meanders through the swamp between Lost and Badger lakes, entering the latter at two or more places along the northern shore. At the time of examination there was no perceptible current.

The outlet is the head of Sucker Creek and drains eventually into Hubbard Lake. Drainage is then into the Thunder Bay River and Lake Huron. Sucker Creek is shown on the county map as Pettis Creek, but the government charts give the name as Sucker Creek and it is known by this name locally.

Springs occur on the east side, but the lake's main water supply is probably rain and snow and subsurface water.

Water. The lake appears to be free of pollution. This is a private area and the only possible source of pollution is the clubhouse. It was stated that no sewage is disposed of in the lake, so there is little possibility of contamination.

Use of Water. The water is used entirely for recreation. A swimming beach occurs on the southeastern shore; numerous (12-18) boats are on the lake and are used both for boating and fishing. As the headquarters of the Club are on this lake, the lake is more widely used than the other lakes on the property.

Temperature. On September 21 the surface water was moderately cold (air 74.5° F., water 65°F.) and dropped rapidly toward the bottom, the drop being most rapid between 21 and 27 feet, where it changed from 62.2°F. to 52.7°F. The bottom temperature was 47.5°F. A definite thermal stratification existed.

Transparency. The average depth at which a six inch black and white disk disappeared when lowered over the side of the boat was 8.3 feet. This indicates relatively clear water and low plankton content for lakes in this region.

Oxygen. Oxygen was high in the warm upper layer down to 21 feet, but below this depth it disappeared almost entirely, dropping from 5.2 p.p.m. at 21 feet (an amount adequate for fish life) to 0.4 p.p.m. at 24 feet, an amount too low to sustain fish life, to 0.0 p.p.m. at the bottom. This indicates that below 21 feet no fish life can exist more than briefly during this period of oxygen and thermal stratification.

Other Chemical Conditions. The chemical conditions in the two layers of water, the layer containing oxygen and the layer lacking oxygen, are somewhat different. The upper layer has a high degree of alkalinity with a pH of 8.4 and no carbon dioxide, and 10.0 p.p.m. of carbonates (phenolpthalein

alkalinity), while the lower layer is almost neutral and has a high carbon dioxide content (9-16 p.p.m.). This indicates the decay of organic material on the bottom with which oxygen deficiency is usually associated. The water is moderately hard, having an M.O. reading of 143 p.p.m. at the top and 174 at the bottom. This is a favorable condition, however, as hard waters are more productive of fish food than soft if other conditions are suitable.

Depth. (See map). Badger Lake is moderately deep, about half the area being over 20 feet in depth and attaining a maximum depth of 46 feet. The shoal zone is in general quite narrow, varying from 6 to 300 feet, with an average width of about 150-200 feet. A drop-off occurs in the lake; in some places it is quite sudden and in others very gradual. The shoal zone is the only area in this lake in which plants grow; no vegetation was found beyond the 12 foot depth contour. Most of the food of the lake is produced in this area and very little is found elsewhere. In general, shallow lakes are more productive than deep ones, other conditions being equal, and in the case of Badger Lake most of the productive area is above the 12 foot depth contour.

Bottom. (See map). The shoal areas of this lake which have no swamp or marsh along the shore have a fine gravel and sand bottom extending out to about 8 feet in depth; elsewhere the shoal bottom is fibrous peat out to the 15 foot contour except for a few patches of marl along the northwest side. Beyond 15 feet the bottom is entirely pulpy peat. Both of these types of peat are of organic origin. The fibrous peat consists for the most part of small plant fibers, while in the pulpy peat decay is more advanced, so that it has a peculiar gelatinous consistency.

Cover. In the outlet bay and to some extent along the west and north shore, logs and snags are fairly abundant. Thick plant beds in various portions of the lake also furnish some cover. Along the gravel beach where spawning may be expected to occur, the cover is inadequate. For the larger part of the lake, cover is not very satisfactory.

Vegetation. (See map). Vegetation is extremely dense along the north shore and in the outlet and is abundant over most of the lake, except for the gravel beaches, out to the 12 foot contour. It was reported that vegetation was planted along the north end of the lake in about 1933 or 1934, but no records were furnished us as to species and quantity introduced. The more abundant species of plants found in our survey were floating pondweed, coontail, water milfoil, bushy pondweed, chara or muskgrass, yellow waterlilies and white waterlilies. A list of plants collected will be found in Table 3 of the Appendix.

The vegetation of the lake is recorded in greater detail on the green vegetation-analysis chart. The figure in the circle on the map indicates the general location of the plant analysis station and corresponds to the number on the plant card. (The field record cards for this and other lakes of the area are on file at the Institute and are available for inspection.) The symbols on the map represent the various types of plants as follows: ⊤ floating vegetation, ⊥ bottom vegetation, — submergent vegetation and | emergent vegetation. The relative densities of the symbols represent the relative densities of the various types of plants.

Natural Food. The supply of fish food organisms in this lake appears to be relatively scant. Plankton (the small, almost invisible plants and animals that swim or float freely in the water and form an important fish food) at the time of sampling was very poor, an average of only 2.9 c.c. per cubic ~~millimeter~~ meter being present. Bottom food production in the shoal zone was poor, having an average value of 0.24 c.c. per 1/4 square foot of bottom or 91.4 pounds per acre. (This is calculated on the assumption that volume is equivalent to weight. This is only true if the specific gravity is exactly 1. However, the error introduced is very small and in the opinion of the writers may be neglected.) The production of food in the lake bottom beyond the 12 foot contour was almost nothing (too small to measure).

One of the bad features of this lake is the complete absence of minnows. These form a large part of the food of such fish as bass, perch, walleyed pike and northern pike and in the absence of minnows the fish prey upon the young of the game fish, thereby depleting the stock.

Spawning. Spawning conditions are fairly favorable for the large-mouth bass along the gravel beach. For rock bass and small-mouth bass insufficient cover is present near the suitable gravel areas, as these fish seem to prefer to spawn under cover or close to objects, such as large logs or boulders.

Walleye pike apparently prefer to spawn in streams, but reproduction is successfully accomplished in some lakes having inadequate spawning grounds in adjacent streams. Spawning conditions for this species seem to be fair, and it will be interesting to note whether the adult fish planted by the Club this year reproduce. The planting of walleyes in 1929 apparently did not spawn, as no young of this species were found in the lake.

Spawning conditions for perch, which lay their eggs on brush and vegetation, are probably too good for the present food supply. (See under rate of growth of this species.) Northern pike also find favorable spawning places in the adjoining marshes.

Spawning areas for brook trout appear to be lacking in the lake proper, as these trout apparently must deposit their eggs in gravel over seeping springs and no areas of the lake were noticed in which this condition prevailed, though such areas may be present. However, it is doubtful if trout fishing could be maintained in this lake because of competition from pike and perch and because of the unfavorable chemical conditions in the cold bottom water required by this species.

In general spawning conditions are fairly good in this lake except for small-mouth and rock bass.

Predators. No obnoxious species of predatory fish were found. Turtles and water snakes may have been present but were not observed.

Fish eating birds such as Bitterns, Kingfishers and Ospreys were observed but not in large numbers and they would presumably do little damage.

The northern pike is the chief predator in this lake and must consume large numbers of bluegills, bass and perch. Fishing for these latter species would undoubtedly be better if fewer pike were present. If the proposed introduction of golden shiners is successful, these minnows may relieve the pressure of predation on young game fish even though pike remain numerous.

History of Fishing. Few data are available on this very important point, as no records have been kept to show the extent of fishing on the various lakes or the numbers and kinds caught. In any consistent program of lake management, a detailed record of fish caught (as well as of plantings and improvements) is indispenable. This is discussed more fully under general management proposals for the area.

Plantings. 1929, black and green bass, northern pike, walleye pike; 1932, northern pike; 1936, walleye pike. It is hard to say what has been the result of these plantings. The walleye pike do not appear to have taken hold as none were taken in netting or seining operations and of those planted in the fall of 1936 many were found dead in the open water and along the shore of the lake.

Planting records such as were made available to us for the Club waters are not adequate for proper management purposes. In order to determine the effectiveness of the planting program, a card should be kept for each lake on which complete information for each year is recorded. The form recommended is given under general management proposals for the area.

Abundance, Condition and Rate of Growth of the Fish Present. Game Fish. A fairly large variety of game fish are present, but unfortunately not all are abundant enough to afford good fishing.

One brook trout 14.7 inches long and weighing 1 pound, 11 ounces was

taken. This fish was in its fifth year and had a condition of 2.09 compared with an average condition for this species of 1.60. This is an unusually fat fish for a brook trout. It had probably been resident in the lake for some time (although undoubtedly originating from Sucker Creek), as stream brook trout are usually thinner and with a lower condition factor.

Perch are abundant in this lake but are of a small average size. Thirty-four perch were taken in four gill nets. These fish ranged in size from 4.7 to 8.5 inches in length, but had an average size of only 5 1/2 inches. The Club manager and others stated that perch usually ran small in size in Badger Lake, although they could be caught in large numbers.

Examination of the scales[1] of these perch under a microscope reveals slow growth of this species (Table 1). It apparently requires four years for perch to reach legal size (6 inches) in the lake. In other lakes of this general region, yellow perch average 9 inches or more at this time of life.

Badger Lake apparently is overpopulated with perch or is rapidly becoming so. Establishment of small-mouthed bass should help to check their numbers. Installation of brush shelters and spawning beds should increase the number of bluegills, bass and rock bass and will not favor the perch. Increase in fertility by adding phosphate and establishment of minnows will improve the food supply for all piscivorous species including the perch. The end result should be a better growth rate (and larger average size) of perch.

Bluegills do not appear to be very abundant in Badger Lake, probably due to their young being eaten extensively by perch, pike and bass in the absence of a suitable forage fish. Growth of this species is also very poor.

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[1] The method of using the scales of fish for growth determination is described on page a of the Appendix.

As shown by Table 1, bluegills do not reach legal size (6 inches) until their fifth year of life. Increasing the lake's fertility and establishment of brush shelters should result in improved growth.

Rock bass are about as abundant in the lake as bluegills, but reach a larger size. One was taken 10.3 inches in length and weighing 13 ounces. The condition was rather good, having a value of 3.48 as compared with a tentative average of 3.28. Growth is fairly rapid for this species (the six inch legal size is attained in the fifth year), although not as rapid as in more southern waters.

Pumpkinseed sunfish are present and in good condition (3.68) but do not attain a large size, the biggest one taken being 8 inches long, while the average length was 5.3 inches. Three specimens showed extremely slow growth, averaging less than an inch a year (Table 1).

Northern pike are reported as being fairly abundant in this lake, at times reaching a good size. Only one specimen was taken by our party. This had a total length of 41 inches and weighed 16 pounds.

The northern pike, or pickerel as it is sometimes called, is very predacious, its food consisting almost exclusively of other fish. For this reason encouragement of the pike in Badger Lake may be questioned unless it is desired to keep the lake mainly for pike fishing. In the absence of minnows to act as food, the pike is necessarily forced to depend upon game fish. This results in a serious drain upon the game fish population, especially for such fish as bluegills and allied types. If bluegill and bass fishing is desired in preference to pike fishing, an attempt should be made to reduce the numbers of the pike, although such an action is not recommended until the effect of other improvements can be determined. This could be done by installing a trap in the outlet and trapping the pike as they descend the stream to spawn and transferring them elsewhere or by not allowing them to return into the lake after spawning. A competition might be set up with prizes for the largest pike and the largest catch of

this species. Winter fishing and spearing might also be encouraged. Reduction of the pike would relieve the strain on the other game fish to some extent and allow more to develop to maturity.

Walleye pike were not taken in this lake, though they have been planted here in 1929 and in 1936. It does not seem advisable to try to establish walleyed-pike in Badger Lake. The reasons for this may be summarized as follows: The walleye pike is a highly predacious fish and as such would be in direct competition with the northern pike, which would result in a decreased food supply for both and a greater drain on the fish upon which they feed. Another argument which may be adduced is that the walleyes furnish only sporadic fishing, fishing being good for this species only at certain times of the year.

Large-mouth black bass are present in the lake but seem rather rare. Growth of three specimens appears normal. Legal size (10 inches) is probably attained in the fourth year of life. It is suggested that this lake is more suitable for the small-mouth bass. For this reason this species should be encouraged by planting rather than the large-mouth. The small-mouth is the gamier of the two species and is held in high esteem by fishermen in general because of its fighting characteristics and the fact that it furnishes more consistent fishing than most other game fish.

Coarse Fish. The common sucker is present in the lake to some extent but is not especially abundant, probably because of limited spawning grounds and predation by game fish. The young of this species doubtless serve as forage fish, particularly for the pike.

Forage Fish. One of the major faults of Badger Lake is the lack of forage fish. If we exclude the common sucker, no forage fish of any description was found in the lake. It is of primary importance to remedy this condition, as the lack of such food is a serious handicap to such fish as pike, black bass, and perch.

Management Proposals for Badger Lake

1. Predator Control. Predatory birds and mammals are rather scarce and apparently have little effect on the fish population. No efforts as to control are recommended.

2. Improvement of Cover and Spawning Devices to Improve Fishing. Cover is fairly adequate in many portions of the lake, but along the southeast beach where the majority of spawning takes place cover is rather lacking. This is a serious fault, as many species prefer to spawn near cover. This same condition applies to the sand beach on the west shore directly across from the lodge. To remedy this condition the following recommendations are made:

West sand beach: Due to the lack of gravel in this beach, spawning conditions are rather poor. To remedy this condition 6 spawning boxes (lake improvement device no. 17 as illustrated in the attached folder) should be placed in this area in water 3 to 4 feet deep. These boxes should be at least ten feet apart, and about 10 feet from each box in 4 to 5 feet of water should be placed a small circular brush shelter, 6 to 8 feet in diameter (lake improvement device no. 12). The spawning boxes should be filled with washed gravel 1.5 to 3 inches in diameter.

Southeast gravel beach: To remedy the lack of cover on this spawning beach, 20 circular brush shelters, 6 to 8 feet in diameter (lake improvement device no. 12) should be placed along the beach in water of such depth that the top of the shelter is 2 to 3 feet below the surface. These small shelters furnish cover for the young fish after hatching and provide some measure of protection for the spawning fish.

Large brush shelters (lake improvement device no. 4) about 5' x 10' furnish cover for larger fish and are an aid in fishing, as the fish tend to congregate in these areas. Seven of these shelters should be placed

along the east shore of the lake except in the region of the swimming beach, and 3 should be placed on the west sand beach. They should be placed in water of such a depth that the tops of the shelters are about 2 to 3 feet below the surface of the water. It will be desirable to mark the locations of these shelters by buoys as an aid to fishermen and to facilitate future check ups.

3. Increase of Fertility of Lake. In common with many other lakes of this region, Badger Lake is rather infertile, as is evidenced by the low supply of both bottom and planktonic food. This basic infertility is a serious fault in a lake and in order to obtain the maximum growth of fish this must be remedied. Addition of fertilizer to the lake is the answer. Of the various types available, a high phosphate fertilizer is the kind best suited for this job. The fertilizer should be added annually at the rate of 3 tons per year for a five-year period.

The fertilizer may be bought in bulk or in 200 pound sacks (the sacks should be of burlap or other porous material). If bought in bulk, it should be sacked in burlap sacks in 200 pound lots before using. The fertilizer is best added to the lake by placing the sacks of fertilizer on a raft which will support the sack in such a manner that it is partly submerged and so that the waves will wash over it. Six of these rafts should be constructed and securely anchored at intervals around the north half of the lake in water 5 to 6 feet deep. The addition of fertilizer should be started about the first of May and continued throughout the season, replenishing the rafts with new sacks as the contents of the old ones dissolve in the water. The sacks should be wired to the raft.

If desired, some of the sacks of fertilizer may be placed in brush shelters, as this will in time increase the fishing around the shelters. The fertilizer will stimulate plankton growth in that region, the plankton will attract small fish, and the small fish will in turn attract larger fish to that locality.

No other chemical fertilizer is apparently needed in the lake. The lake is alkaline and contains plenty of lime and it is highly probable that sulphates and nitrates are sufficiently abundant.

4. Introduce Forage Fish. Plant at least 10,000 golden shiners (Notemigonus crysoleucas) in 1937 and the same number each succeeding year if possible. These fish can usually be obtained from the U. S. Bureau of Fisheries on application. The Bureau has a hatchery at Northville, Michigan. Applications for fish from the Bureau should be made at once, as the supply is limited and applications are many.

5. Game Fish Plantings. Plant 10,000 small-mouthed bass (Micropterus dolomieu) each year for three years. Three inch fingerlings are recommended if this size is obtainable.

Ten thousand bluegill fingerlings per year for three years should also be made. These may also be obtained from the U. S. Bureau of Fisheries upon application.

Lost Lake

Size and Location. Lost Lake, draining into Badger Lake, is a lake of 17 acres, completely surrounded by bog and thick brush and forest. It is accessible by a short foot trail from the road. Roughly oval in shape, it is about 1200 feet long by 750 feet wide, with a distance of 1090 feet from the dock to the outlet.

Inlets and Outlets. No inlet was found, and it is probable that the water supply is mainly from seepage. The outlet is well defined,but a short distance below the lake it flows through a swamp and apparently breaks up and enters Badger Lake in two or more places. At the time of examination (September, 1936) no perceptible stream was flowing, and it is probable that this is the condition most of the year.

Water. The water is a light brown color due to the dissolved organic matter, but is relatively clear and free from turbidity. Pollution of the water is apparently out of the question as there are no human habitations on or near the lake.

Use of Water. Fishing and to a lesser extent boating are the only uses of this lake. A dock is present on the northwest shore and two or three boats are habitually kept there for fishermen. Fishing is moderate and confined principally to the summer season.

Temperature. The surface temperature of the lake in September was 59°F. with an air temperature of 55°F. While the bottom was 57.7°F., no marked drop occurred between the top and bottom of the lake, and considering the relative shallowness of the lake, this is not surprising.

Oxygen. Oxygen is high in both the top and bottom of the lake. In both places a concentration of 8.0 p.p.m. was found, which is satisfactory for all species of warm water fish.

Other Chemical Conditions. Chemical conditions vary little from top to bottom. The water is moderately hard and is quite alkaline, having an average value of 125 p.p.m. bicarbonates and 4.5 p.p.m. free carbonates. No free carbon dioxide was present.

Depth. (See map). Lost Lake is quite shallow in most places and has a very soft bottom through which a sounding lead sinks from 2 to 4 feet. The depth contours on the lake are interpolated from soundings made with a lead weight and include both the depth of the water and the very soft bottom, so soft that it is hard to say where the water leaves off and the bottom begins. The maximum depth, by sounding line, was about 15 feet. The entire lake can be regarded as shoal.

Bottom. (See map). A narrow band of fibrous peat occurs around the entire lake to a depth of 1 to 3 feet. The rest of the lake bottom is pulpy peat except for a marl patch along the southwest shore and along the east shore.

Cover. Unfortunately the cover is rather poor on the whole. Vegetation is relatively thick in some areas, but is mainly procumbent Chara which affords little cover. Snags and logs along parts of the shore supply fair cover but are not used by fish much because of extremely shallow water.

Two brush shelters are present in the lake near the center but are inadequate and not very effective due to improper anchoring.

Vegetation. Vegetation of one type or another is common all over the lake out to the ten foot contour and an occasional plant is found here and there in the region beyond this depth. Inspection of the map gives the impression that vegetation is abundant in the lake, but closer examination will show that the majority of the symbols indicate bottom vegetation of the Chara type, so that an erroneous impression is given on the first glance. Chara in this lake is a short, stubby bottom form fairly rich in food but affording almost no shelter to fish, and the result is that this lake is rather deficient in plant cover for fish.

Natural Food. As most of the lake bottom is pulpy peat, little bottom food can be expected. A sample from this type of bottom gave a value of 0.3 c.c. per 1/4 square foot of bottom or 1,150 pounds per acre, not all of which is available as fish food. A sample from the peat marl area gave a figure of 0.1 c.c. per 1/4 square foot or 38 pounds per acre--an extremely poor bottom food, and the absence of this rather important food places a limitation not only upon the predacious fish such as bass and pike, but also upon the fry and fingerlings of all the fish in the lake which must perforce serve as food in the absence of minnows.

Plankton was fairly abundant in the lake at the time of sampling. A single vertical haul yielded 16.7 c.c. (by precipitation with formalin) per cubic meter of water strained.

In general it may be said that the fertility of this lake is rather low as refelcted by the available food present, and to obtain better fish production, the basic fertility should be increased as indicated under management proposals.

Spawning. Spawning conditions for perch seem fairly satisfactory, but the conditions for other species such as bass and bluegills are very poor. How these may be improved will be discussed further under management recommendations.

Predators. Various fish eating birds were seen in this area, but it is not believed that the predator problem in these lakes warrants any attempts at control because of the comparatively slight amount of damage done.

Fish Plantings. In 1929, black and green bass, and northern and walleyed pike were planted in this lake. Aside from this, no records are available as to other plantings.

The results of this planting seem to have been somewhat successful in the case of the bass. No bass, either black or green, nor any walleyed pike were taken in a series of netting and seining operations, and only a few northern pike of small size were captured. However, a few legal

bass (1 estimated at 4 pounds) were observed, also a few yearlings and fingerlings.

Species of Fish Present. Game Fish: Northern pike are rare and do not attain a large size; bass (of both species) are rare; yellow perch are common, as are bluegills and pumpkinseed sunfish, while rock bass are occasionally present.

Insufficient numbers of fish were obtained from Lost Lake to determine the growth rate, but judging by those seen, growth here is little if any better than in Badger Lake, probably from the same causes.

The presence of the Great Northern Pike in this lake may be considered a detriment rather than an advantage. Northern pike will seldom attain any great size in a lake of this area, and their depredations may be considered to far outweigh any advantages of their presence. It is recommended that as far as possible these fish be removed by fishing, possibly as outlined under Badger Lake, and that a brush log dam as described under management proposals be placed across the outlet to prevent the entrance of further pike into the lake and to restrict the spawning of those present.

Coarse Fish: Common Sucker Common. The log and brush dam at the outlet will also restrict the entrance and increase of this species which will be desirable as the number of pike becomes less.

Obnoxious Fish: Absent.

Forage Fish: Absent.

Management Proposals For Lost Lake

1. Predator Control. No predator control is necessary aside from that recommended for northern pike.

2. Cover. Inasmuch as cover is rather poor in these lakes, it appears necessary to supplement with brush shelters.

Five rectangular brush shelters (Lake Improvement Device No. 4) about

10' x 5' and 20 circular brush shelters (Lake Improvement Device No. 2) about 4' in diameter should be placed around the lake in from about 8 to 10 feet of water for the larger shelters and in about 6-8 feet of water for the smaller shelters. These should be very securely anchored in place. Two brush shelters are already present in the lake, but these were not well anchored and are now floating, losing a large part of their value. The larger shelters are to be placed especially on the barren bottom on the south side. About three should be placed here, and the other two may be placed in other barren spots in the lake. The smaller shelters should be associated with the spawning boxes as specified for Badger Lake.

3. Spawning Improvement. Spawning conditions are rather poor for all except the yellow perch and northern pike. To remedy this situation, 20 spawning boxes (Lake Improvement Device No. 17) 2 1/2' x 2 1/2' square and containing clean gravel 1 1/2" to 3" in diameter, should be placed at intervals around the lake shore in water from 2 to 3 feet deep. It is advisable to keep a check on these boxes to determine which ones are used.

Because of the extremely soft bottom, the spawning boxes should be set on piles driven into the bottom and firmly nailed to them at the level of or a few inches above the bottom of the lake. About 10 feet from each box and towards the center of the lake should be placed a circular brush shelter (Lake Improvement Device No. 12) 5 to 8 feet in diameter in such a depth that the top of the shelter will be below the ice line (about 3 feet below the surface).

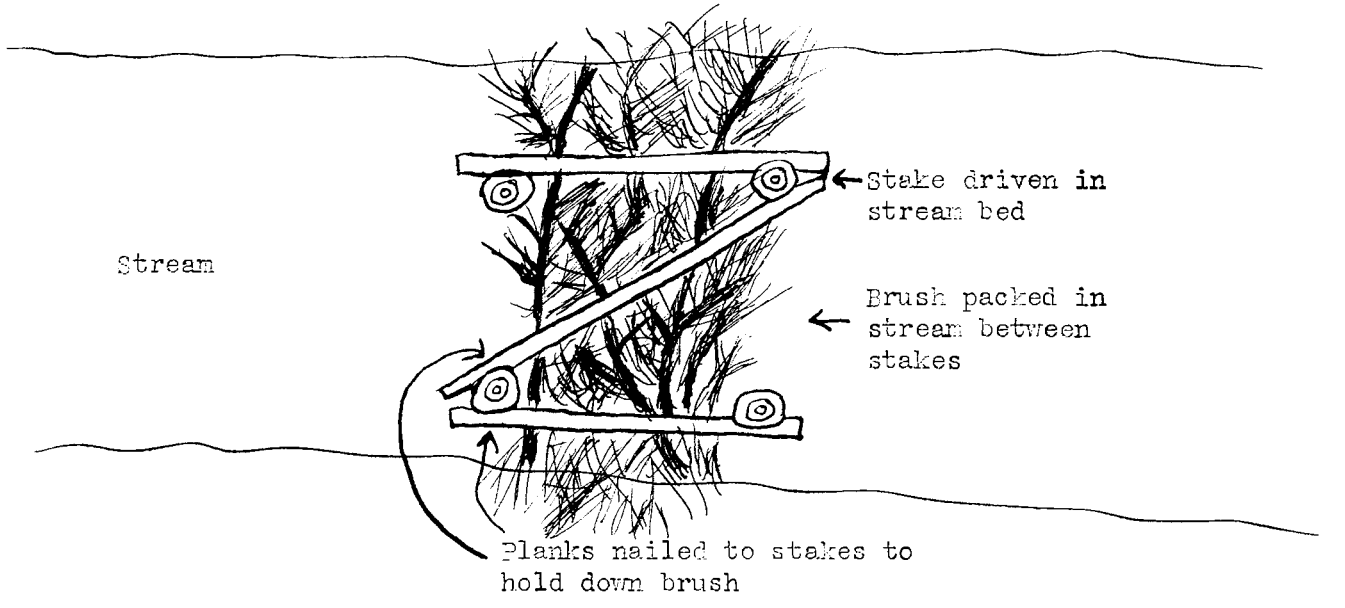
The spawning boxes that were present were incorrectly made and have since fallen apart and washed up on the shore. The gravel used in these contained a great deal of dirt. However, the only bass and bluegill fingerlings from this year's hatch were seen around one box near the outlet which must have been at least partially effective.

Place 15 of the minnow spawning devices (Lake Improvement Device No. 19) in about 1 1/2 feet of water at intervals around the margin of the lake. Unless water-logged slabs can be obtained, these devices will have to be anchored to the bottom.

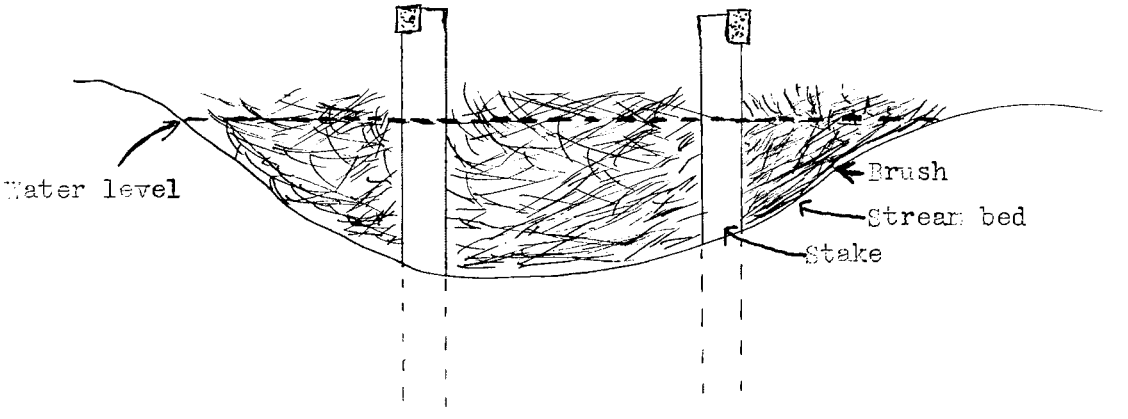
4. Stocking. No stocking of game fish is recommended for this lake, as it is believed that sufficient game fish are present and that the primary problem is the lack of suitable spawning grounds and of forage fish. To this end at least 2,000 minnows whould be transferred to Lost Lake from Bear Lake.

5. Increase Fertility. As was mentioned before, the basic fertility of the lake is rather poor and this condition must be remedied before optimum conditions for fish can be expected. To this end about 1,000 pounds of high phosphate fertilizer should be added to the lake. Each 200 pound sack should be placed in or on a large brush shelter.

6. Control of Pike and Suckers. In order to reduce the number of northern pike and suckers in Lost Lake, a log and brush dam should be placed in the outlet within 100 feet of the point where this stream leaves the lake. The addition of a little brush as required will keep this screen effective. Following is a diagram showing one method of constructing such a dam.



TOP VIEW



CROSS SECTION

Deer Lake

Size and Location. Deer Lake, probably the most beautiful lake in the area, is entirely surrounded by trees, mostly of the coniferous types. Roughly triangular in shape with the long axis of about 2,000 feet lying in a north and south direction and with the vertex of 1,500 feet to the east, it has an area of 51 acres.

Inlets and Outlets. No inlets or outlets were discernible and the water supply is probably mostly from rain and snow and subsurface water. It lies in the Hubbard Lake drainage area, which in turn is part of the Thunder Bay River, Lake Huron system.

Water. The water is clear with no hint of coloring matter and appears to be free of pollution.

Use of Water. The water is used solely for recreation, chiefly fishing. A dock is present on one shore and two or three boats are habitually kept there for use of Club members.

Temperature. The surface temperature was warm for the time of year it was taken (September 23), the air being 82°F. and the surface water 70°F., the bottom water 68.2°F., while the mud at the bottom of the lake was 63.3°F. No thermal stratification was present.

Oxygen. Oxygen was high from the top to the bottom of the lake, having a value of 8.7 p.p.m., a figure entirely adequate for fish life.

Other Chemical Conditions. The water was moderately hard. No carbon dioxide was present in the water, nor was any to be expected, as this is a lake with a bottom mainly of marl which will absorb any free carbon dioxide present. Bicarbonates are only moderately high (119 p.p.m.), while free carbonates are fairly abundant (11.5 p.p.m.). The net result is an alkaline lake (pH 8.5).

Depth. Deer Lake is relatively shallow, having a maximum depth (by sounding weight) of 16 feet. Approximately two-thirds of the lake has a depth of less than 5 feet, while only a very small area (1/10) is 15 feet or over.

Bottom. A narrow zone of fibrous peat extends from the dock around the west shore to slightly more than half the distance around the lake; a bank of sand and occasionally gravel continues from the end of the fibrous peat on around the lake and back to the dock. The bottom from the edge of the peat and sand is marl out to the five foot contour, where it shades off into pulpy peat.

Cover. Cover is very poor in this lake, a number of snags and logs along the west side and a few small pondweed and Chara beds being about all the cover available. This is a serious fault and should be remedied as described under the management proposals.

Vegetation. A bed of dense Chara in the east corner of the lake, a few scattering plants in the southwest corner, a few water lilies along the west shore and a small bed of pondweed on the west side constitute almost the entire vegetation of the lake. A detailed list of the vegetation will be given in the Appendix.

The lake would probably be benefited if more plants were present, and it would be worthwhile to attempt their introduction as described later.

Natural Food. Planktonic food is very abundant in Deer Lake in comparison with the other lakes of this vicinity (a 12 foot vertical haul of the net yielded 60.2 c.c. per cubic meter) and should provide a fair amount of food for the minnows and young game fish present.

Minnows (of 4 different species) and one species of darter are present and supply excellent forage for the game fish.

Bottom food varies from point to point in the lake, depending upon the bottom type. Sand bottom gave a value of 0.3 c.c. per 1/4 square foot or 115 pounds per acre, while pulpy peat and a mixture of sand, marl, and

pulpy peat each gave a value of only 0.1 c.c. or 384 pounds per acre.

Crayfish are common and will provide excellent food for the small-mouthed bass which is to be introduced.

Insect food from the plants is probably negligible due to the comparatively small amount of vegetation present.

Spawning. A good sand and gravel beach is present along the northeast, east and southeast shore, and probably supplies fair spawning grounds for bluegills, while the perch can spawn on the snags and logs along the west shore. Spawning requirements for the minnows present are likewise fairly good, but can be improved as recommended below.

Spawning cover is lacking along the gravel beach mentioned above and should be remedied.

Predators. Predators are not important in the economy of this lake and little consideration need be given them. A few fish eating birds are found in the vicinity, but it is doubtful if they do much damage.

Fish Planted. 1929: black and green bass, northern and walleyed pike. In 1935, 1200 legal sized perch and 200,000 grey-backed minnows were planted in the lake.

Yellow perch and walleyed pike seem to be doing very well, but no trace was found of northern pike, black or green bass, or of the grey-backed minnows (assuming that these were great lake shiners, Notropis atheranoides).

Abundance, Condition and Growth of Fish Present. Game Fish. Walleye pike are fairly common and are of a good size for a landlocked lake; 9 specimens averaged 18.6 inches in total length and weighed an average of 2 pounds, 6 ounces each, with a condition of 1.49. These fish may be the result of the 1929 planting, but if so, have grown very slowly. Scale examination indicated they were all in the fifth year of life, which suggests an unrecorded planting of fry may have been made in the spring of 1932 or that a planting of legal sized fish, all of the same age, may have been

made in some later year.

Yellow perch were common in the lake and had a fair rate of growth, attaining a length of 8.4 inches at the fifth winter of life. Table No. 1 gives the growth history of the perch from this lake and will be found in the Appendix of this report. This is the only growth history obtainable for this lake, as bluegills and sunfish were too rare to obtain a satisfactory series.

Forage Fish (Table 2). The following forage fish are present and were probably native to this lake: fathead minnow, black-nosed shiner, sand shiner, western golden shiner and Iowa darter. While not very abundant, all of these are excellent forage species for the perch, walleyes and for the small-mouthed bass.

Management Proposals for Deer Lake

1. Improvement of Shelter. The lack of vegetation in this lake makes for a condition of unusual sparsity of cover, and this is a serious defect. To remedy this condition, the most obvious and satisfactory method is to add brush shelters. To this end about 10 large (Lake Improvement Device No. 4) brush shelters should be installed in the lake within the 10 foot contour (see map). As shelter for spawning fish, about 20 small brush shelters (Lake Improvement Device No. 12) should be placed near the gravel beds which are to be placed along the east shore in sufficient water to protect them from ice action (about 3' below the surface).

2. Vegetation Planting. An increase in the vegetation of this lake would be highly desirable from a number of standpoints such as increased food supply, cover, etc. Transplantation of plants into a lake of this sort presents difficulties and success may not always follow the attempts. In order to protect transplanted vegetation, two of the hollow type of shelters (Lake Improvement Device No. 9) should be placed in water about

4-5 feet in depth on the north side of the lake, where the bottom is barren of plants. The hollow centers should be filled with a high grade loam to a depth of about 1 1/2 to 2 feet. Into these should be transplanted a selection of the various plants from Badger Lake collected, roots and all, in the early fall when seeds will be present and the plants dormant. The loam will provide a good foothold for the first growth of the plants, while the brush shelters will provide protection from wave action till the plants are established. Tie the plants in bunches, weight them with stone anchors and sink them carefully within the shelters. If these plantings become established they will tend to spread to areas surrounding the brush shelters and eventually create useful shelter.

3. Improvement of Spawning Facilities. Due among other things to the incrustation of marl and to the scantiness of the gravel in the sand along the east shore, spawning facilities would be greatly improved by the addition of about 25 piles of washed gravel not closer than 10 feet apart along the sand beach on the southeast side in at least 2 1/2 to 3 feet of water. The gravel should be about 1 1/2" to 3" in diameter for best results and each pile should contain about 1 bushel.

These piles of gravel should be placed near the small brush shelters mentioned in the previous section, and in some cases water-soaked logs should be placed over the gravel piles.

Because of the fibrous peat bottom along the west shore, no spawning facilities for fish requiring gravel bottom exist. To remedy this situation, fifteen (15) spawning boxes, constructed as described previously, should be placed along the west shore in from 2 to 3 feet of water.

Twenty minnow spawning devices (Lake Improvement Device No. 19) should be anchored along the shores in water about 1 1/2 feet deep in order to encourage the production of minnows as food for perch, bass and walleyes.

4. Increase Fertility. In common with many other lakes, Deer Lake is rather infertile as is evidenced by the scanty food and vegetation. To remedy this condition, it is recommended that 2 tons of a high phosphate fertilizer be added annually. The method of adding this fertilizer is as described under Badger Lake.

5. Stocking. This lake appears to be well suited for small-mouth black bass, and it is recommended that 5,000 3-inch small-mouth black bass be planted annually for 3 years.

If it is desired by the members to maintain the walleye fishing in this lake, it is suggested that 50 to 100 of the smallest walleyes obtainable from commercial fishermen be planted annually. It is our opinion that maintaining this lake for small-mouthed bass, perch and bluegills might be more desirable than attempting to maintain walleyes in addition to these species. Walleyes apparently will not spawn here successfully as evidenced by the fact that no young were obtained and will require a yearly expenditure for adult stock, while small-mouthed bass when once established will reproduce and will be self maintaining. The establishment of bass may be difficult or impossible if walleyes are planted in the future.

Bear Lake

Size and Location. Bear Lake is a small lake lying in the midst of an encroaching sphagnum bog, which is in turn surrounded by forest. It is roughly shield shaped and is approximately 900 feet wide and 1,000 feet long, with an area of 15.7 acres.

Inlets and Outlets. No outlet was observed, and the nearest approach to an inlet was a sort of a ditch leading down through the marsh carrying seepage water. The water supply is mainly from seepage from the surrounding bog and from rain or snow.

Water. The water is light brown in color and is apparently not polluted.

Use of Water. The lake is used only occasionally for bullhead fishing and duck hunting. For these purposes one boat is kept on the lake.

Temperature and Transparency. The surface water on September 25 was 59°F., while the water at the bottom was 57.2°F. No thermal stratification was present. The disk disappeared at 3.5 feet, due to suspended peat particles and plankton.

Oxygen. Oxygen was high both at the surface (9.0 p.p.m.) and at the bottom (8.3 p.p.m.) of the lake and was entirely adequate for fish life.

Other Chemical Conditions. Conditions are quite uniform throughout the lake. The water is moderately hard (M.O. Alk. 107 p.p.m.; Phth. Alk. 9.0 p.p.m.) and quite alkaline in intensity (pH 8.5).

Depth. (See map). The lake for the most part is very shallow, only about a fifth being over 8 feet. The maximum depth is about 9 feet.

Bottom (See map). The lake bottom is covered with pulpy peat ooze under which is a layer of fibrous peat. The layer of ooze is subject to movement by wave action, and at times a portion of the underlying firmer bottom may be exposed. A small area of fibrous peat occurs in the northeast corner.

Shore. The entire shoreline is of the floating bog type and is very unsteady. It is composed of a mat of sphagnum, grass and roots which half floats in the water.

Cover. Cover is almost entirely lacking as snags are buried in the bottom and shelter from vegetation is not abundant.

Vegetation. Plant life is rather scarce, both species and individuals being rare. Chara, bushy pond weed, and a few pondweeds were all that were present in limited numbers.

Natural Food. No food was found in the bottom sample that was taken, and the scanty vegetation gives little prospect of supplying much insect food. Plankton was very abundant (101.6 c.c. per cubic meter) as were minnows.

Spawning. Spawning conditions are very poor for the ordinary game fish, but minnows appear to maintain themselves in large numbers, no doubt partly due to an absence of predatory game fish.

Species of Fish Present. Game Fish. The bullhead seems to be the only game fish present and these are not very abundant. Fishing for these is only sporadic.

Forage Fish (see Table 2). At present Bear Lake is principally a minnow pond. Northern dace, fine scaled dace, northern red-bellied dace, blacknosed shiners, fathead minnows, Iowa darters, western mud minnows and brook sticklebacks are present in goodly numbers. This lake will serve as an excellent source of the smaller minnows for stocking Lost Lake.

Management Proposals for Bear Lake

Bear is an extremely poor lake for game fish production, being shallow, soft bottomed and poor in plants and cover.

The chief value of this lake seems to be for ducks and for minnow production, although it might be very much worth while to try an experimental

planting of 1,000 bluegill 1 1/2" fingerlings. If this plant is made, it should be carefully checked. We are familiar with a number of lakes of much this same type which produce good bluegill fishing.

Sucker Creek (Fish or Pettis Creek)

Time did not permit a complete study of Sucker Creek, but since the Club expressed some interest in having this stream examined, a few observations were made as recorded below.

On September 22 an examination was made of the mouth of this creek at the point where it enters Hubbard Lake. At this point the stream averages 30 feet in width, with an estimated flow of 8 cubic feet per second. The water was light brown in color and slightly turbid, as swamp waters frequently are. The mouth appeared to have been cleaned out to permit boating, entrance of fish, or to improve the drainage of the swamp through which it flows from the new highway to the lake.

At 3 p.m. the air temperature was 78°F.; the water, 60°F. Hubbard Lake surface water 100 yards from the entrance of this stream was 66°F.

A fair supply of crayfish, mayflies, caddisflies and green algae were noted in the stream.

On September 23rd Sucker Creek was examined at the new highway bridge. The flow is slightly more rapid with numerous logs in the stream and fairly dense forest cover along the banks. The bottom is of sand and silt with some weed beds. At 10 a.m. the air was 42°F.; the water 55°F. Dissolved oxygen at the surface tested 6.3 p.p.m.; free carbon dioxide 6.5; the pH was alkaline (7.8) and bicarbonates were present to the value of 193 p.p.m., indicating hard water.

Seining above and below the bridge yielded the following: 65 young common bullhead (Ameiurus nebulosus), 11 young mud minnows (Umbra limi), 4 young rock bass (Ambloplites rupestris), a young common sunfish (Eupomotis gibbosus), 1 black-sided darter (Hydropterus maculatus), and 1 large-mouthed bass (Huro salmoides). This collection indicates warmer water

than above in the meadow section, also that bullheads, bass and rock bass may run up from the lake to spawn. Planting of trout here not recommended. Both subspecies of crayfish found at the end of Sucker Creek Trail are also present here.

On September 22 and 23 examination was made at the end of the Club's Sucker Creek Trail. At this point the stream is of the beautiful meadow type, with fairly rapid current, clear, brown water, with clumps of tag alder, osier and willow overhanging the frequent pools. The stream probably averages 25 feet in this section, with silt and sand bottom in the pools and considerable gravel in the riffles. Recent beaver cutting above this point was evidenced by chips and partly peeled aspen poles floating in the stream. Time did not permit cruising the stream from here to Badger Lake, which should have been done to secure a clear picture of conditions for trout in the stream. At 4:30 p.m., with the air at 78°, the water temperature was 58°, which indicates suitable trout environment. Pools were considered average as to size, type and frequency. A fair food supply was also present (including 2 species of crayfish, C. [faxonius] virilis and C. [faxonius] propingus). No trout were seen, but several rises were noted which I was almost positive were trout. The stream was seined quite intensively in this section and the following species were taken: 1 common shiner (N. cornutus frontalis), 1 black-sided darter (Hadropterus maculatus), 12 muddlers (C. bairdii bairdii). This limited fish fauna, characteristic of cold water, also supports the contention that conditions are suitable for trout existence in this part of the stream. The only requirement lacking for brook trout seemed to be suitable spawning grounds. (Brook trout require spring-fed gravel areas.) There must be some spawning grounds on this stream or in tributuaries of it, since according to report no planting is ever done here and a few good sized trout are caught each year. From reports of the Club that trout are few but of good size and very fat, we judge that suitable spawning areas are few on this stream and that this

together with a lack of stocking accounts for the scarcity of trout in Sucker Creek.

Management Proposals For Sucker Creek

1. Plant about 5,000 fingerling brook trout each year in the meadow section on the Club property. Fish can be trucked to within about 1/2 mile of the stream, from which point the cans would have to be carried to the stream.

It should be possible to secure these fish from the U. S. Bureau of Fisheries station at Northville, either delivered free or for the cost of transportation. Applications should be made early each year to the U. S. Bureau of Fisheries, Washington, D. C.

Since the stream is only partly on Club property (part of Section 31, T. 28 N., R. 8 E.), planting by the state Conservation Department should be possible in that part above the Club holding. The map of Alcona County shows one road which almost reaches the stream near the upper Club boundary and another road which crosses the stream about one mile south of the southern boundary of the Club. It is suggested that the Club make application to Mr. Floyd Potts, District Superintendent of Fisheries, State Conservation Department, Harrisville, Michigan, requesting the state to stock this stream with brook trout in Section 5, T. 27 N., R. 8 E.

Planting by the Club in its section and by the state in the section above (upstream) the Club's holdings should benefit trout fishing in both public and private water.

INSTITUTE FOR FISHERIES RESEARCH

By: A. S. Hazzard,
Lowell A. Woodbury and
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APPENDIX

Rate of Growth in Fishes or Their Growth History. When the length and age of a sample of the fish in a lake are known, a valuable piece of information has been acquired and when one can determine not only the length and age at the time of capture of the fish but also the length at the end of each year of life, the value of the information is greatly enhanced. By means of this knowledge one can to a certain extent evaluate the relative fitness of each fish within the lake for that lake. That is, excluding all other factors, the fastest growing fish is the best suited fish for that lake as far as fishing is concerned. However, other factors, such as density of population and type of available food, enter into and modify the picture; nevertheless, the information is extremely valuable if adequate data is available.

The determination of the so-called "rate of growth" better defined as the "Growth History" is based upon examination of the scales from the fish. The determination of the age from examination of the scales is based on the interpretation of the microscopic features appearing on the surface. An examination ofa scale under a high magnification reveals a series of roughly concentric lines known as "circuli." The distribution of these lines is not perfectly regular but shows breaks at varying intervals. These breaks are the year marks or "annuli" by which age is determined.

At the end of the summer season the growth of the fish slows down and during the winter ceases entirely or nearly so. Since the scale grows along with the fish, scale growth also comes to a standstill. When the body and scale growth are resumed in the spring the first circuli of the new year are laid down without any reference to the position of the last circuli of

the preceding summer. The result is a break in the regularity of the circuli--the year mark or annulus. (Hile, R. 1936, Age determination of fish from scales. Prog. Fish. Cult., U. S. Bureau of Fisheries, Mem. I-131, no. 23.)

Now the fact that makes it possible to determine the length at the end of any growing season is this. The distance from the center (or focus) of the scale to ~~the~~ any annulus may be connected with length at any winter of life by means of a mathematical expression. In some cases this is a simple proportion, in others it is more complex. The relations between the length of the scale and the length of the body have not been determined for all fish, and in the absence of this information, it is necessary to assume that a simple proportion connects the two. This form has been used to calculate the following tables.

Growth of Fish in Badger Lake

The accompanying tables give the calculated total lengths at each winter of life for the various species of game fish in Badger Lake.

Table 1. Growth Rate of Some Fish From Badger and Deer Lakes

BADGER LAKE

Bluegill

Age Group	No. of Fish	Average Total Length mm.*	Calculated Length at End of Each Year mm. I	II	III	IV	V	VI	VII
V	2	183.5	33	73	107	137.5	164		
III	5	137.0	23.2	57.6	97				
Average mm.			26	62	100	138	164		
" Inches			1.0	2.4	3.9	5.4	6.5		

Pumpkinseed

VI	1	145.0	15	43	61	83	105	123	
V	1	180.0	34	70	106	131	162		
III	6	124.8	27.3	64	98.5				
Average mm.			26.6 (8)	62.1 (8)	94.7 (8)	107 (2)	133.5 (2)	123 (1)	
" inches			1.0	2.4	3.7	4.2	5.2	4.8	

Rock Bass

VII	1	262.0	35	76	114	149	179	218	250
V	2	167.0	29.5	57	90	119	146.5		
III	4	136.5	30.5	57.8	89.5				
II	1	100.0	28	55					
Average mm.			30.5 (8)	59.5 (8)	93.1 (7)	129 (3)	157.3 (3)	218 (1)	250 (1)
" inches			1.2	2.3	3.7	5.1	6.2	8.6	9.8

Yellow Perch

IV	4	190.2	57.5	92.0	134.0	167.0			
III	20	141.8	45.4	78.6	111.2				
II	2	136.5	58.5	100.5					
I	10	113.2	67.7						
Average mm.			53.7	82.4	115.0	167.0			
" inches			2.1	3.2	4.5	6.6			

Large-mouth Bass

III	2	286	37.5	141	227				
I	1	170	53.0						
Average mm.			42.6	141	227				
" inches			1.7	5.6	8.9				

Brook Trout

IV	1	372	114	168	270	350			
Length in inches 14.6			4.5	6.6	10.6	13.8			

* To convert mm. (Millimeters) to inches multiply by 0.0394

Table 1 Continued

DEER LAKE

Yellow Perch

Age Group	No. of Fish	Average Total Length mm.*	Calculated Length at End of Each Year mm.						
			I	II	III	IV	V	VI	VII
V	5	230.2	42.2	89.8	125.6	170	214.2		
IV	3	233.7	38.3	88	138	187.7			
III	6	219.3	43.2	99.5	163.7				
II	16	169.2	44.5	93.4					
Average mm.			43.2	93.5	144.6	176.6	214.2		
" inches			1.7	3.7	5.7	7.0	8.4		

* To convert mm. (millimeters) to inches multiply by 0.0394

Table 2. Minnows Collected From Lakes of Lost Lake Woods Club

Lake	Common Name	Scientific Name
Bear Lake	Northern Dace	Margariscus margarita nachtriebi (Cox)
	Fine Scaled Dace	Pfrille neogaea (Cope)
	Northern Red-bellied Dace	Chrosomus eos Cope
Coll. Nos. 180 & 189	Northern Black-Nosed Shiner	Notropis heterolepis heterolepis (Eigenmann & Eigenmann)
	Northern Fat-headed Minnow	Pimephales promelas promelas (Raf.)
	Iowa Darter	Poecilichthys exilis (Girard)
	Western Mud Minnow	Umbra limi (Kirtland)
	Brook Stickleback	Eucalia inconstans (Kirtland)
	Common Bullhead	Ameiurus nebulosus (LeSueur)
Deer Lake	Iowa Darter	Poecilichthys exilis (Girard)
	Northern Fat-headed Minnow	Pimephales p. promelas (Rafin.)
Coll. Nos. 183 & 184	Northern Black-Nosed Shiner	Notropis h. heterolepis (Eigenmann & Eigenmann)
	Northern Sand Shiner	Notropis deliciosus stramineus (Cope)
	Western Golden Shiner*	Notemigonus crysoleucas auratus (Raf.)
Lost Lake	Only young bluegills taken in seine	
Badger Lake	Only young game fish taken in seines	

* Two taken in gill net but were never positively identified because they were badly eaten by crayfish while in nets.

Table 3

LIST OF PLANTS

Badger Lake

Scientific Name	Common Name
Chara sp.	Musk grass, Skunk grass
Potamogeton angustifolius B & G.	Ziz's Pondweed
P. epihydrus Raff.	Nuttal's Pondweed
P. Zosteriformis Fern.	Pondweed
P. natans L.	Floating pondweed
P. heterophyllus Schreb.	Various leaved pondweed
P. pusillus	Fine leaved pondweed
Bidens Beckii Torr	Water marigold
Utricularia vulgaris americanus	Bladderwort
Myriophyllum sp.	Water millfoil
Ceratophyllum demersum	Coontail, Hornwort
Scirpus sp.	Bulrush
Equisetum limosum	Mares tail
Sagittaria-sp.	Arrowhead
Nymphozanthus	Yellow waterlily
Naias flexilis	Bushy pondweed
Typha latifolius	Cattail
Brasenia Schreberi gmel.	Watershield

Lost Lake

Potamogeton epihydrus	Nuttal's Pondweed
P. natans	Floating Pondweed
P. pusillus	Fine leaved pondweed

Lost Lake (Continued)

Utricularia vulgaris americanus	Bladderwort
Iris versicolor	Wild Flag, Iris
Chara sp.	Musk grass
Nymphozanthus sp.	Yellow waterlily

Bear Lake

Potamogeton angustifolius	Ziz's Pondweed
P. Richardsonius (?)	Richardson's pondweed
P. natans	Floating Pondweed
Chara sp.	Muskgrass
Naias flexilis	Bush Pondweed
Nymphozanthus sp.	Yellow waterlily
Typha latifolius	Cattail

Deer Lake

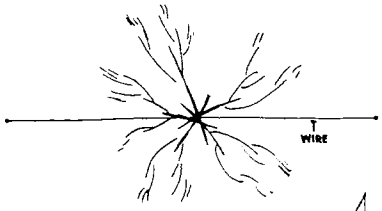
Potamogeton angustifolius	Ziz's pondweed
P. lucens	Pondweed
Chara sp.	Muskgrass
Nymphozanthus sp.	Yellow waterlily
Algae	

List of Commercial Hatcheries Which Handle Bluegills and/or Bass

(From U. S. Bureau of Fisheries
Memorandum I-121b, April 1, 1935)

Locality	Firm or Proprietor	Species Handled
OHIO:		
Beach City	Clifford E. Parrott	Blue Gills
Cleveland	Dr. W. E. Newcomb, 1532 Keith Bldg.	Black Bass
London	George Morcher	Black Bass
Port Clinton	Clinton J. Riley	Black Bass
Seville	D. McDermott	Blue Gills, Bass

INSTITUTE FOR FISHERIES RESEARCH



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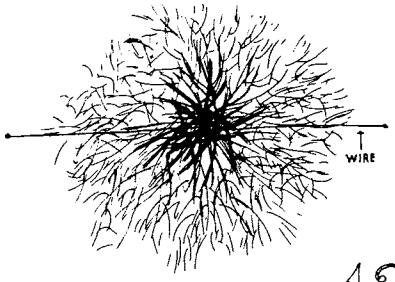

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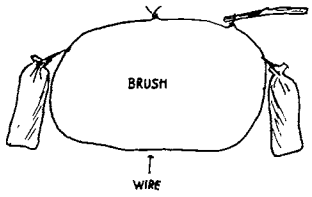

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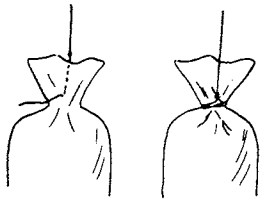

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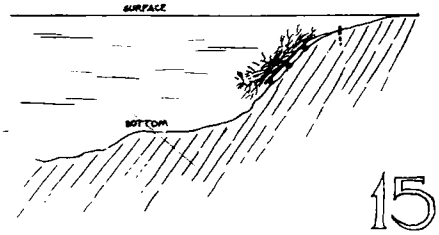

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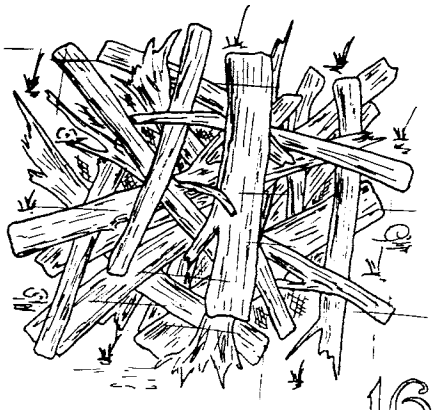

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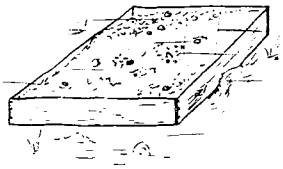

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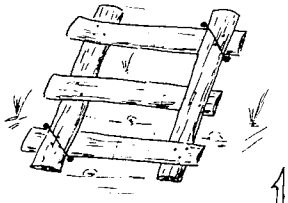

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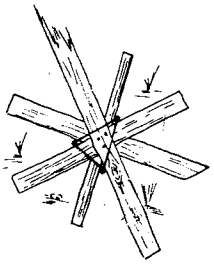

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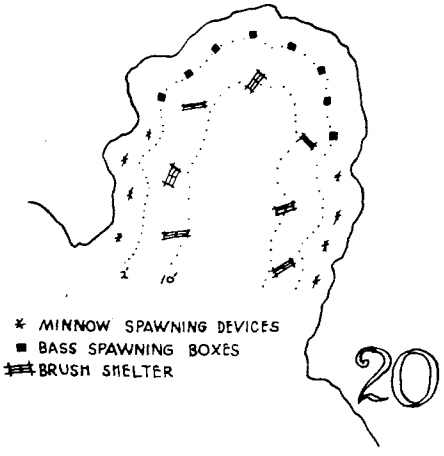

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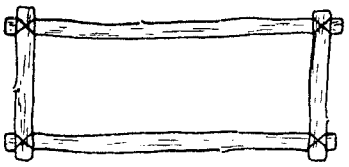
See Other Side

LAKE IMPROVEMENT DEVICES



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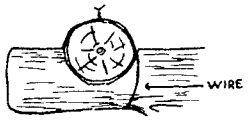

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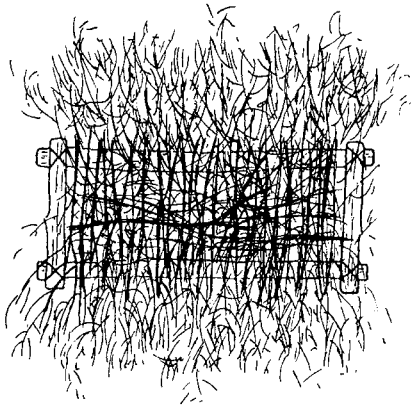

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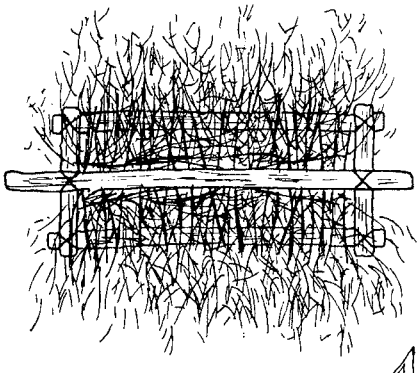

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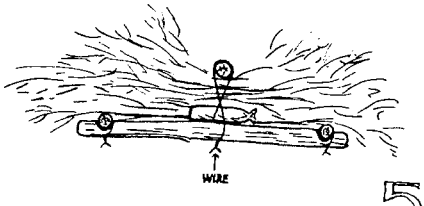

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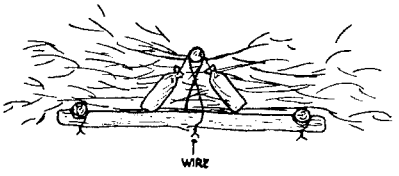

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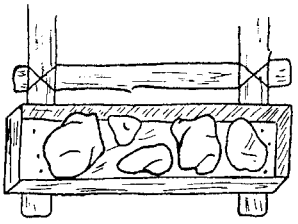

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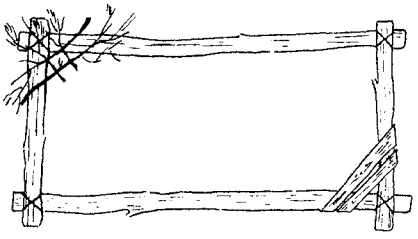

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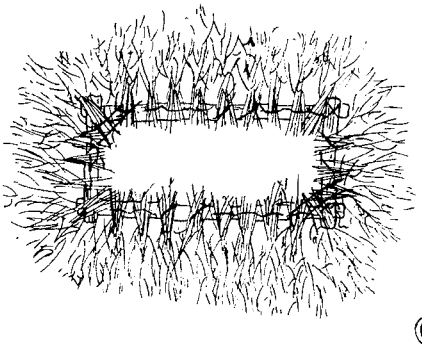

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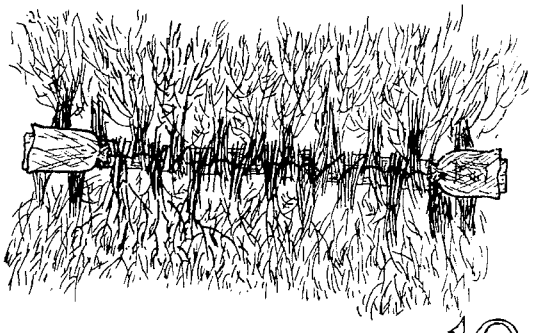

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For Explanation

DIAGRAMS

Fig. 1. Frame for ladder shelter.
A cross-member in the middle is desirable if the frame is over 10 or 12 feet long. Frames can be made any length. A width equal to about one half the average length of the brush is desirable. If built too narrow the shelter is apt to turn over when being submerged.

Fig. 2. A method of fastening the several pieces of the frame.
By notching and wiring as shown, spikes or nails are not needed.

Fig. 3. Shelter practically completed.
Brush is more loosely packed by placing some brush lengthwise to the frame as shown.

Fig. 4. Shelter completed.
The pole is wired to the two cross-members at the ends of the frame and holds the brush in place. Size of shelter depends upon the size of material available and on the particular taste of the individual making them as well as on means of moving the shelter if not built where it is to be submerged. Brush is generally piled to a height of 3 to 5 or 6 feet. The wire holding down the upper timber should be stapled to the timber.

Fig. 5. Method of weighting shelter.
Bag of sand (or rocks) placed in shelter after a supporting layer of brush has been put on the frame. This method serves where shelters are built on rafts or on the ice where they will not submerge prematurely by adding the weight.

Fig. 6. Method of weighting shelter.
This is considered superior to placing the weight on top since the shelter has no tendency to be top-heavy or to turn over while being submerged. One bag at each end may be sufficient, the number depending on the size of the shelter.

Fig. 7. Method of weighting shelter.
Suitable especially where rocks are used. An extension of the two members of the frame at each end of the shelter, covered by a box-like structure as shown, serves the purpose well. Rocks must be placed at both ends simultaneously. This method, by using boards or a layer of brush, also works well where bags of sand are used.

Fig. 8. Frame for square type shelter.
This shows two ways of building up ends to support sandbags or rocks.

DIAGRAMS

Fig. 9. Square type completed.
Ready to be submerged.

Fig. 10. I-type.
Weighted. Ready to be submerged.

Fig. 11. Circular shelter, starting construction.
Wire is temporarily fastened down to prevent its being moved.

Fig. 12. Circular shelter, partially completed.
Showing method of placing brush.

Fig. 13. Circular shelter. Method of wiring, drawing wire tight, and attaching weights.

Fig. 14. Wiring bag.
If wire is placed through bag and then twisted around bag there will be less tendency of the sack slipping out of the wire.

Fig. 15. Method of placing shelter on slope.
If the water is too shallow above the drop-off and if the slope is sharp and extends into deep water, the shelter can be held on the slope by use of a stake and wire as shown. Once it has settled down the shelter will stay on a slope of considerable angle if currents are not strong.

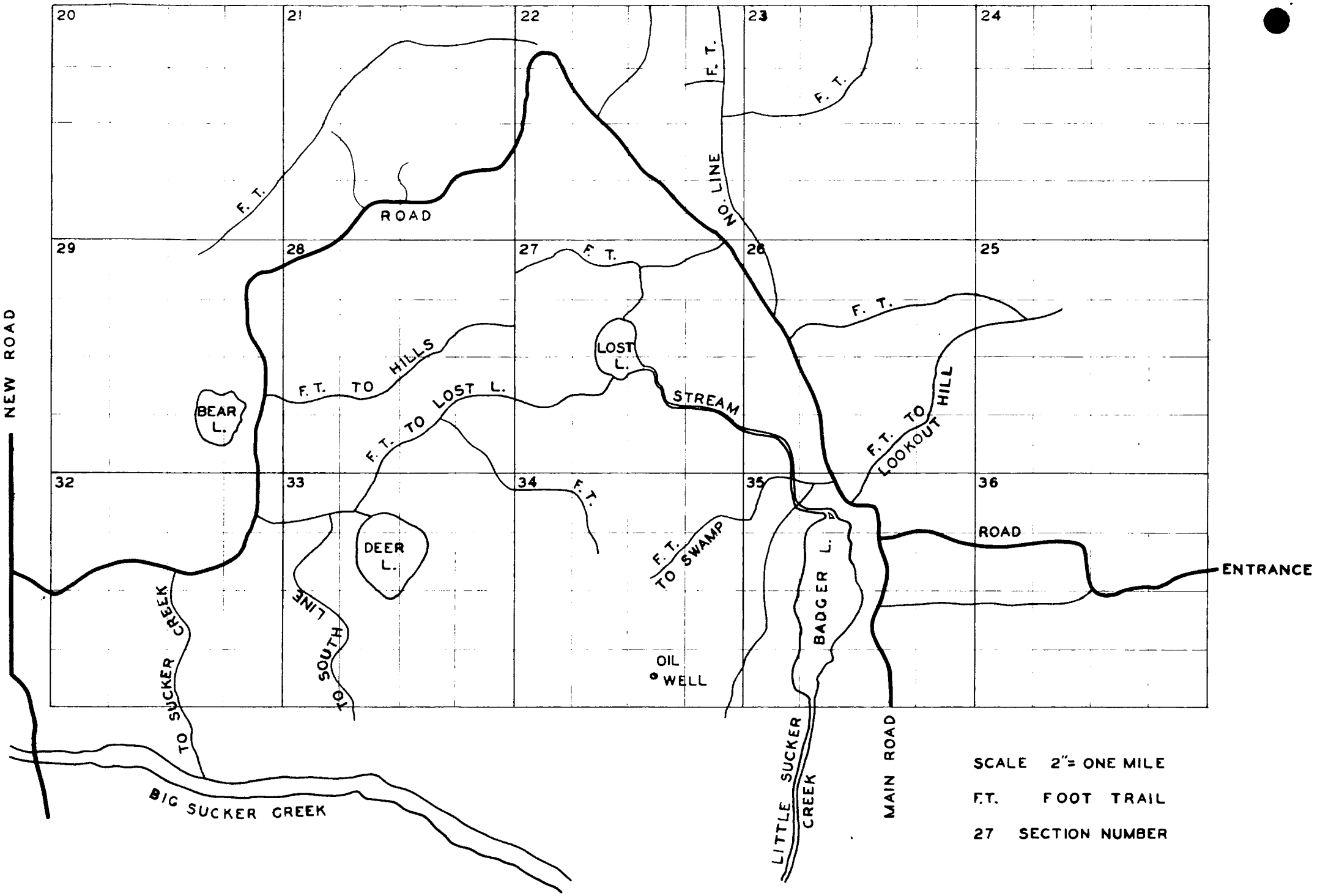
Fig. 16. Water-logged shelter.
Water-logged material placed in heap at proper depth.

Fig. 17. Small-mouth bass spawning box.
Made of boards and filled with gravel and sand.

Fig. 18. Slab device.
Staked to bottom in water $\frac{1}{2}$ to $1\frac{1}{2}$ feet deep. Used by minnows for spawning.

Fig. 19. Board device.
Used in place of slabs.

Fig. 20. One method of arranging improvements.



LOCATION OF LAKES IN

LOST LAKE WOODS CLUB

ALCONA COUNTY, MICHIGAN

1936

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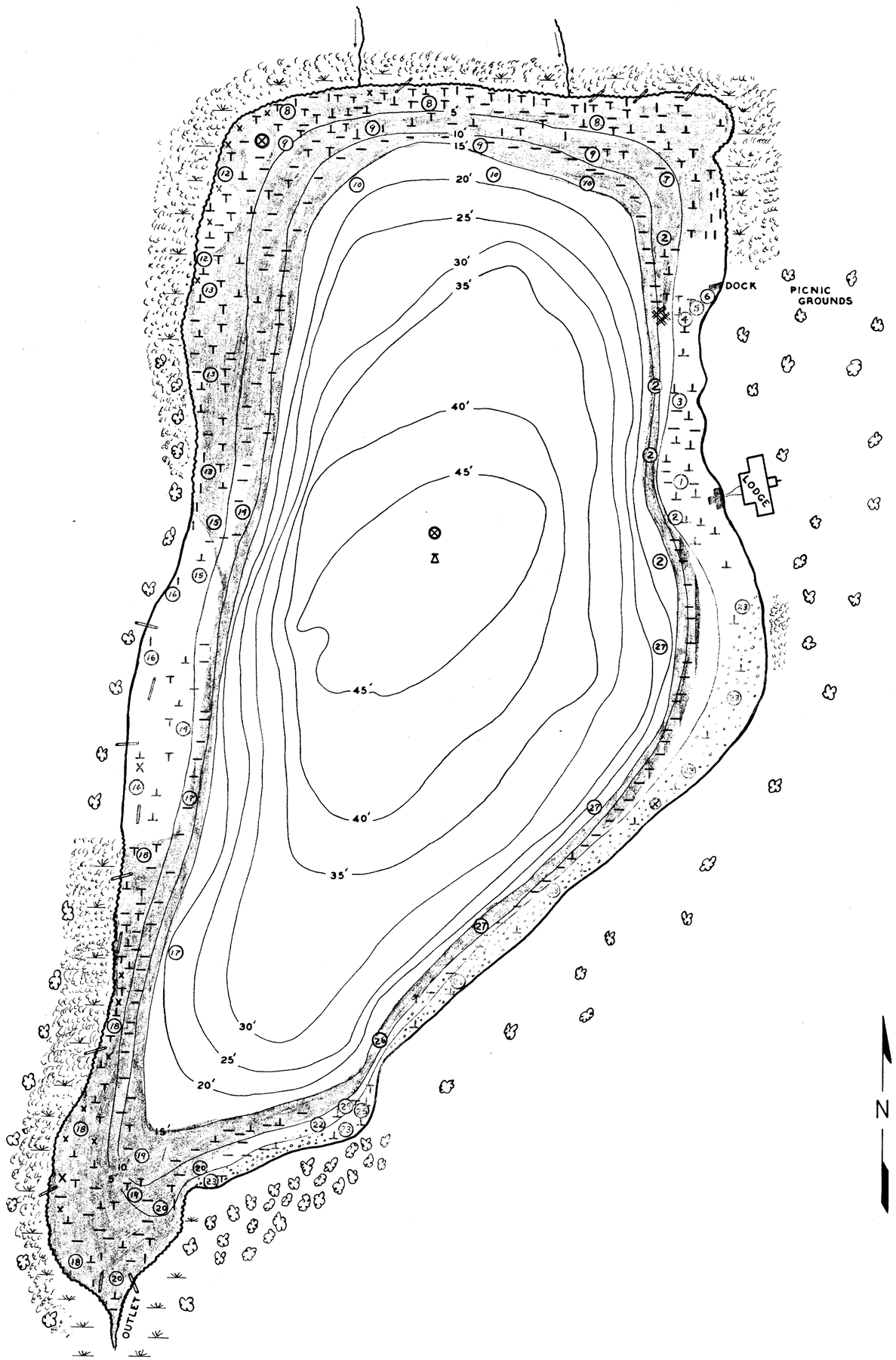
DIVISION OF FISHERIES, MICHIGAN CONSERVATION DEPARTMENT

LAKE INVENTORY MAP

BADGER LAKE

ALCONA COUNTY | AREA 83 ACRES | T.28N. R.8 E.

ALCONA TOWNSHIP | SCALE 1" = 200' | SECTION 35.



MARL

FIBROUS PEAT

PULPY PEAT

SAND

(18) VEGETATION EXAMINATION

I EMERGENT VEGETATION

T FLOATING VEGETATION

– SUBMERGENT VEGETATION

⊥ BOTTOM VEGETATION

CHEM. & PLANK. STATION

BOTTOM FOOD STATION

BRUSH SHELTER

LOGS

BOG

TREES

SHRUBS

X TRASH

GRAVEL

INLET

ENCROACHING SHORE LINE

CONTOUR

CONTOUR INTERVAL 5'

MAPPED BY L.A.W.

1936

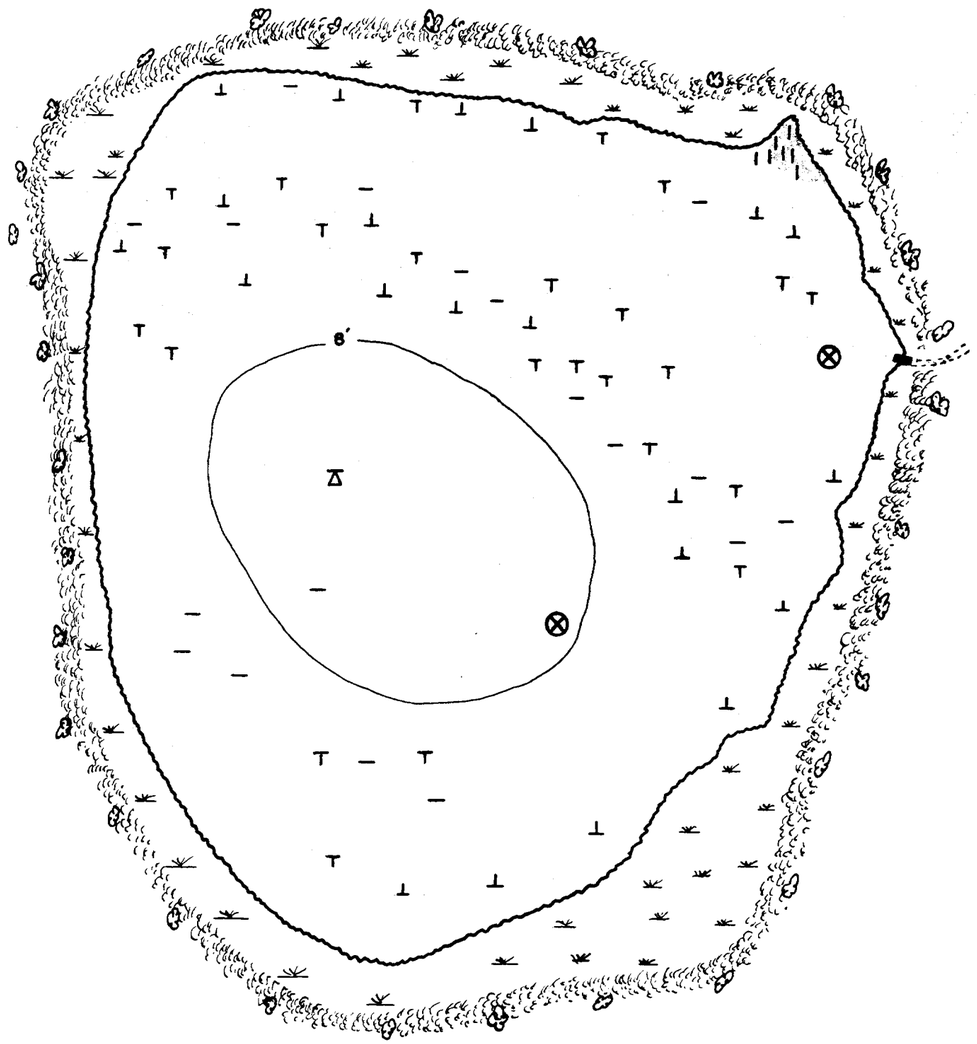
INSTITUTE FOR FISHERIES RESEARCH

DIVISION OF FISHERIES, MICHIGAN CONSERVATION DEPARTMENT

LAKE INVENTORY MAP

BEAR LAKE

ALCONA COUNTY	AREA 15.7 ACRES	T. 28 N. R. 8 E.
ALCONA TOWNSHIP	SCALE 1" = 150'	SECTION 29



PULPY PEAT

FIBROUS PEAT

I EMERGENT VEGETATION

T FLOATING VEGETATION

— SUBMERGENT VEGETATION

⊥ BOTTOM VEGETATION

CHEM. & PLANK. STATION

BOTTOM FOOD STATION

TREES

SHRUBS

CONTOUR

BOG

MAPPED BY L.A.W.

1936

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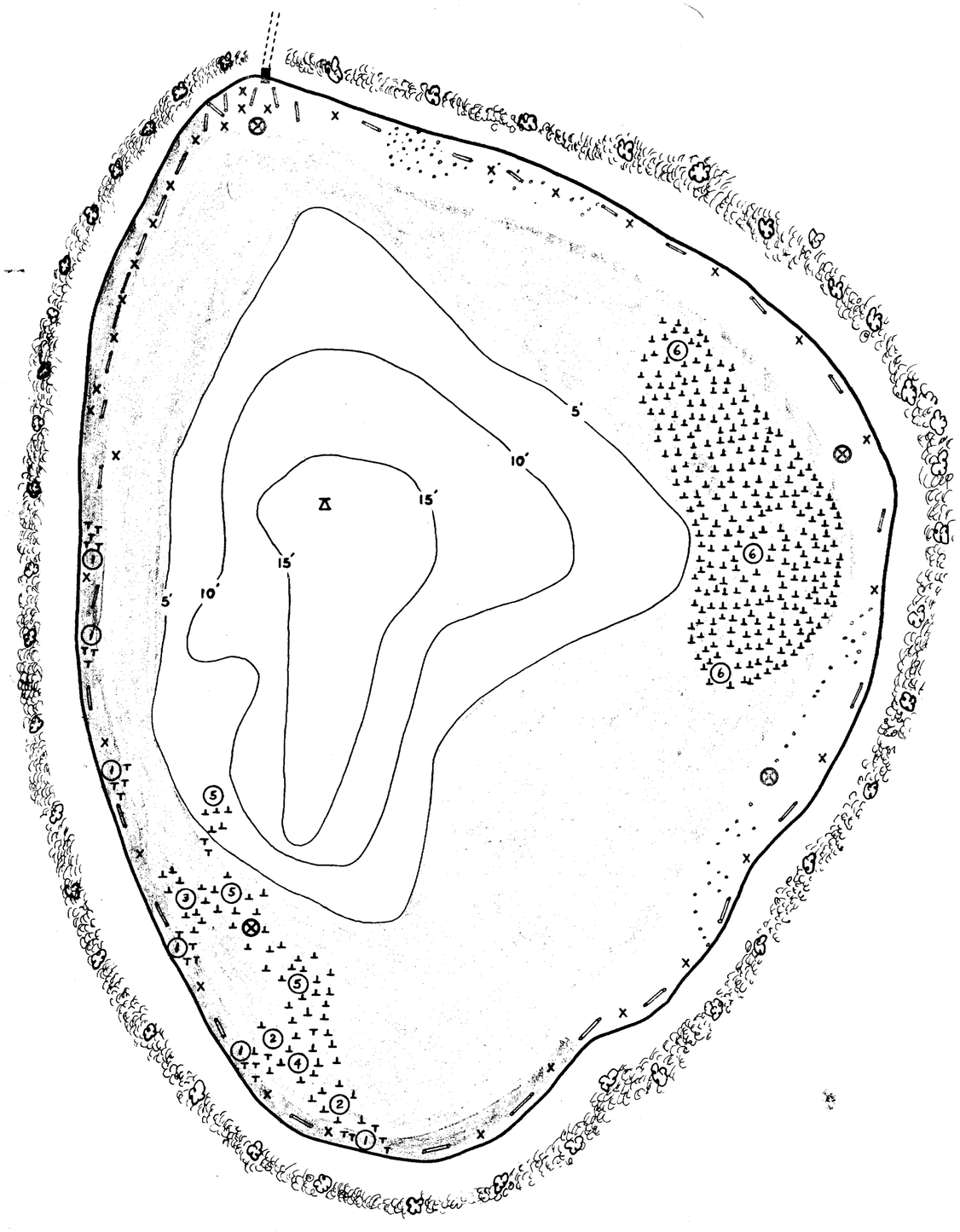
DIVISION OF FISHERIES, MICHIGAN CONSERVATION DEPARTMENT

LAKE INVENTORY MAP

DEER LAKE

ALCONA COUNTY	AREA 51 ACRES	T.28N. R.8 E.
ALCONA TOWNSHIP	SCALE 1" = 200'	SECTION 33



LEGEND

- MARL
- SAND
- FIBROUS PEAT
- PULPY PEAT
- ④ VEGETATION EXAMINATION
- T FLOATING VEGETATION
- ⊥ BOTTOM VEGETATION
- ⊼ CHEM. & PLANK. STATION
- ⊗ BOTTOM FOOD STATION
- SHRUBS AND TREES
- LOGS
- X TRASH
- CONTOUR
- GRAVEL

CONTOUR INTERVAL 5'

MAPPED BY L.A.W.

N

1936

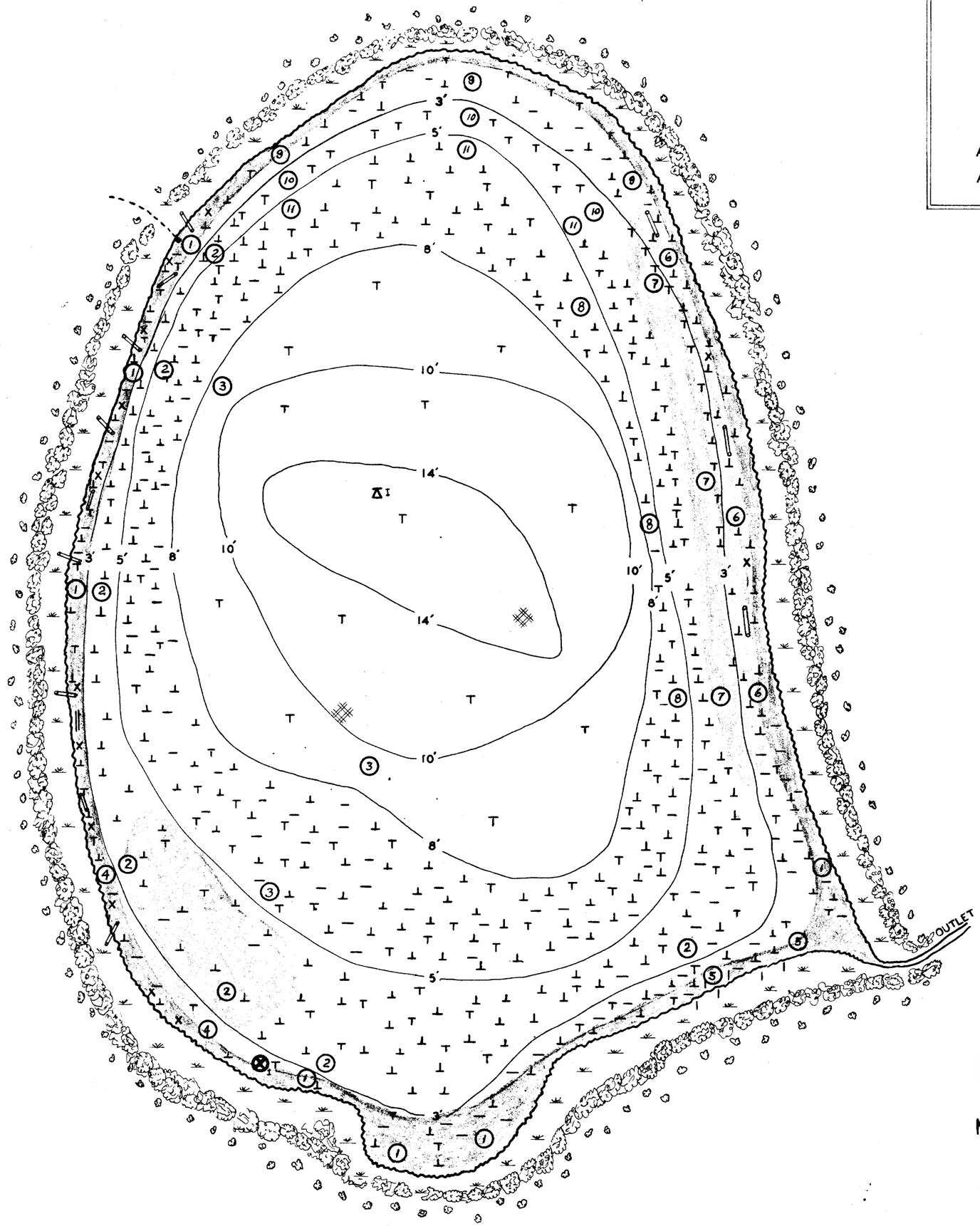
INSTITUTE FOR FISHERIES RESEARCH

DIVISION OF FISHERIES, MICHIGAN CONSERVATION DEPARTMENT

LAKE INVENTORY MAP

LOST LAKE

ALCONA COUNTY	AREA 17 ACRES	T.28N. R.8 E.
ALCONA TOWNSHIP	SCALE 1" = 100'	SECTION 27.



LEGEND

- MARL
- FIBROUS PEAT
- PULPY PEAT
- ⑧ VEGETATION EXAMINATION
- I EMERGENT VEGETATION
- T FLOATING VEGETATION
- — SUBMERGENT VEGETATION
- ⊥ BOTTOM VEGETATION
- ⊗ BOTTOM FOOD STATION
- Δ CHEM. & PLANK STATION
- I STATION NUMBER
- TREES
- SHRUBS AND TREES
- LOGS
- X TRASH
- BRUSH SHELTER
- BOG
- ENCROACHING SHORE LINE
- CONTOUR
- FOOT TRAIL

1936